THE MINERAL SPRINGS OF JAPAN

R. ISHIZU

$17.50

JAPAN

ERRATA.

Pt. II, pp. 1–55, Electric conductivity, for $\chi_{18} \times 10^{-4}$, read $\chi_{18} \times 10^{4}$.
„ p. 18, Table 16, No. 2, Classification, for sulphur, read acid vitriol.
„ „ „ No. 3, Temp. of spring in C., for 100,0°, read 103,0°.
„ p. 29, Table 27, Emanation per litre of water in 10^{-10} curies, for 21,05, read 12,05.
„ p. 49, The hot spring "Goza-no-yu," Temperature, for 53,9° C., read 63,9° C.
„ p. 61, The cold spring "Anamori-Kōsen," Calcium ion, for 0,7183 grm., read 0,1873 grm.
Pt. III, p. 9, line 6 from top, for 1,135, read 4,135.
„ p. 30, line 9 from top, for 6,500, read 65,000.

THE MINERAL SPRINGS OF JAPAN

with

Tables of Analyses, Radio-activity,
Notes on Prominent Spas and List of Seaside Resorts
and Summer Retreats

specially edited

for

THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

By

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TOKYO IMPERIAL HYGIENIC LABORATORY

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PREFACE

The scenic beauty of Japan is known abroad only by sacred Mt. Fuji, the grand Nikkō temples, beautiful Hakone, and other such world-famous sights. These renowned beauty spots are truly typical of the characteristic charms of the Empire and it is little wonder foreign tourists never fail to visit any of these spots, but the fact that these places are so widely known is mostly due to their easy means of access and the better accommodation procurable. If you are willing to leave the beaten track and are ready for out-of-the-ordinary tours, you will find not a few fair sights and scenes, some even excelling the aforesaid places in their charms and beauty. This is especially the case with the simple rustic settings and surroundings of mineral springs. We find in remote districts not easy of access and out of reach of the bustle and noise of city life, by far the most excellent hot springs for therapeutic purposes, both on account of their good quality and healthy geographical situation. We cannot say that the medicinal value of mineral springs is in proportion to their popular fame, for in many instances the reverse seems to hold good. Accordingly it is not too much to claim, that almost all really efficacious mineral springs are hidden in distant places and unknown to ordinary tourists. But if physicians at large kept abreast of the progress of physical therapy and made full use of mineral springs with a thorough knowledge of their individual merits, so that they might be able to point to particularly suitable ones and induce patients and health-seekers to try them, the springs hitherto neglected would certainly be improved and provided with adequate facility of approach, accommodation, etc., and we believe the time will soon arrive for winning fame for Japan as an ideal health resort.

Japan is among the few countries endowed with an abundance of mineral springs, and no statistics are available to show exactly the total number of them now in existence. The investigation of Japanese mineral springs was made for the first time by the Government and reported in the International Exposition held in Frankfort, Germany, in 1881, some diagrams based on the data collected from the prefectural governments being exhibited. These materials were compiled in book form and published in Japanese under the title "The Mineral Springs of Japan." Since then our Imperial Hygienic Laboratory has continued, at the request of the prefectural authorities or private individuals, to experiment on the origins of springs or analyze sample mineral waters submitted to their investigation. The mineral springs, thus experimented upon, number more than one thousand. With the recent introduction of radio-therapy, public attention has been gradually drawn to the radio-activity of mineral springs, and since 1913 the Imperial Hygienic Laboratories, both of Tokyo and Osaka, have been making researches about the radio-activity of famous mineral springs, which number up to now more than one hundred and fifty, with more than one thousand origins of springs.

The present volume was compiled as an exhibit in the Panama-Pacific International Exposition in 1915, in order to make known to the world the general conditions of Japanese mineral springs, and consists chiefly of the analyses of famous mineral springs in Japan and reports of experiments on their radio-activity, both based on the materials above referred to, and some other items, with an appendix of descriptions of principal hot spring resorts, their locations, communications, geography, places of interest in the neighbourhood, and some adjacent sea bathing and climatic health resorts. This book, therefore, may lay claim to be the most authentic and up to date on the subject as yet attempted or compiled in English. But there are so many mineral springs in Japan that we cannot investigate all, some have been experimented upon imperfectly and others left out altogether. Under such circumstances the scope of the present work, it is needless to add, still leaves much to be desired.

The analyses shown in this volume were mostly made by our Imperial Hygienic Laboratory, and some by the prefectural hygienic laboratories, military garrison hospitals, etc., the names of assayers and dates of experiments being shown for each in the latter case.

For the articles on "the Scenery of Japan" and "Volcanoes and Mineral Springs in Japan," in the "Introductory Remarks," I am indebted to Dr. N. Yamazaki, Professor of the Tokyo Imperial University, and T. Katō, Professor of the Tokyo Higher Normal School; that on "Geology" were based on the publications of the Imperial Geological Survey of the Department of Agriculture and Commerce.

The article on "the Climate of Japan" was specially compiled by the Central Meteorological Observatory of Japan, and that on "the Radio-active Minerals in Japan," by Prof., K. Jimbō of the Tokyo Imperial University, from whom I have had most kind and valuable help also in dealing with subjects bearing on mineralogy and geology.

Not a few medical references I owe to R. Fortescue Fox's "Medical Hydrology," Dawson Turner's "Radium, its Physics and Therapeutics" (2nd edition), and "Deutches Bäderbuch." The article on "the Geyser in Atami" in Chapter XII was taken from the Physical Review, Vol. XXII., No. 5, 1906, with consent of the authors. For the information on "the Geyser in Onikōbe" given in the Appendix, I am indebted to Prof. K. Honda, who has supplied me with suggestions and data on the subject.

For the descriptions of hot spring resorts at the end of this work, and the "Map of Imperial Government Railways" inserted herein, I am indebted to "An Official Guide to Eastern Asia," published by the Imperial Government Railways of Japan in 1914.

The compiler has pleasure in expressing his thanks to the above-named Government Institutions and individuals for their valuable help and assistance. I wish also to acknowledge my indebtness to the reports of Mr. D. Ishitani, Professor of Physics in the Imperial Peers' College, who started the investigation of the radio-activity of mineral springs in Japan for the first time. In particular, I desire to express my sincere thanks to my assistants, Mr. Y. Kinugasa and Mr. T. Saitō, for the great care and trouble they have taken in the correction of proof sheets, and for undertaking the laborious task of checking a number of quotations from various authorities which are included in the volume.

Compiled by order of N. Nakagawa, the Director of the Sanitary Bureau, the Department of Home Affairs, to constitute part of the exhibits of the Imperial Hygienic Laboratory at the Panama Exposition.

RISAKU ISHIZU.

TOKYO IMPERIAL HYGIENIC LABORATORY,
April, 1915.

EXPLANATORY REMARKS.

1. The locations of mineral springs are here grouped by the prefectures and arranged in geographical order from the north-east to the south-west, thus beginning with Hokkaido and running through to Kagoshima, after which come those of Taiwan (Formosa) and ending with Chōsen (Korea). As no data are available for Karafuto (Saghalien), no mention is made of it.

2. It is not always easy to exactly determine the geological structure of the spot where a spring gushes out; we mentioned only the general geological feature in most cases.

3. As it is sometimes very difficult owing to the conditions of spring origins to measure exactly the quantities of their flow of water, such figures herein shown had better to be considered as rough estimates. Nevertheless, we have done our best to point out possible faults in these rough figures, on account of their importance from a hygienic estimation.

4. The composition of each mineral spring is shown herein, according to the results of analyses made by our Imperial Hygienic Laboratory or prefectural governments concerned. The temperatures of original springs are of the latest date available.

5. The classification of mineral springs is generally made according to their chemical composition, based on the ion table. They are divided roughly into six groups, *i.e.*, simple, thermal, acid, carbonated, salt, sulphur, and iron springs. Their minor sub-divitions are shown in the methods of classification of mineral springs at the commencement of this volume, to which the reader is referred. Temperatures, as a rule, are Centigrade, but Fahrenheit is also used to indicate atmospheric temperatures in the appendix at the end of this volume. The distinction between cold and hot springs is drawn at the average bodily temperature 37° C.; those above 37° C. at their origin being classed into hot springs and those below into cold springs. Those springs of some definite radium emanation content are considered mineral springs, even if containing less than one gramme of solid constituents to the kilogramme of water.

6. As analyses are generally made with mineral waters taken from original springs and sent to the laboratory, such ingredients as carbon dioxide, hydrogen sulphide, ferrous salts, bicarbonates, etc., are found of less quantity than in the actual springs, while in some cases no trace even is left of these. Accordingly we cannot presume the classification of mineral springs treated under such analytic conditions to be absolutely or scientifically accurate.

7. "Total residue" given in the tables of analyses denotes the quantity of solid ingredients in one kilogramme of water, which was determined by evaporating to dryness in a weighed platinum dish, first over a lamp, then on the water-bath and finally exposing the residue, in the air-bath, to a temperature of about 180°, until no further diminution of weight took place.

8. The radio-activity of mineral waters is shown herein according to the results recently obtained by chemists of our laboratory, and mostly taken on the actual spot. Samples of water to be examined for radio-activity were taken, not from bath-tubs, but at the source of springs. In some instances specially mentioned, experiments were made, at the request of outsiders, on samples of mineral water sent up to our laboratory. As for the methods adopted, we rely on the accuracy of the experiments in which the Schmidt's electrometer was used; but only nominal value is expected for the results of simpler experiments made by the fontactoscope as used in order to save time by assayers who were despatched to the springs. In these instances comparatively big experimental errors are inevitable; and the reader is requested to grant due allowance for the above fact when comparing one experiment with another. As for the figures quoted, those in the Mache's unit are calculated down to two places of decimals but the second figures after the decimal point are not reliable.

9. The measurement of electric conductivity was made invariably on the spot at the original springs.

10. In the descriptions of hot spring resorts, the numbers of visitors in the year 1909 imply people who stopped overnight, excluding passing visitors. The populations and numbers of houses quoted are also for the same year.

11. Although every effort was made to investigate and point out the traditions regarding the medicinal powers of the mineral springs, no mention is made of any which are said to be simply

efficacious for all diseases and not specially adapted for any particular ailment. The dates of discovery, though often doubtful, are quoted as traditional.

12. Not a few springs are known by more than one name, but to avoid confusion the names most popular or generally understood are adopted.

13. The following abbreviations are used in the present volume to indicate the results of experiments on radio-activity :—

Schmidt's electrom. Schm.	Schmidt's electrometer
Kohl.-Löw. fontact. K. & L.	Kohlraush-Löwenthal's fontactoscope
Eng.-Siev. fontact. E. & S.	Engler-Sieveking's fontactoscope

14. In this work, all Japanese names are translated according to the rules made by the Society for Romanizing the writing of Japanese. Thus, all vowels are pronounced as in Italien, and all consonants as in usual English spelling. Special care must be taken to distinguish long vowels marked with —, as in Mr. Ōta and Mr. Ota, which are two entirely different family names.

15. Japanese words often appearing in geographical and other denominations as prefixes and suffixes, might be mentioned and found of assistance to the reader :—

-ken	Prefecture
-gun	Prefectural district
-machi *-chō*	town
-mura	village or hamlet
-yama *-san* *-zan* *-take* *-dake*	mountain or hill
-oka	low hill
-kawa *-gawa*	river or stream
-tani *-dani*	valley or gorge
-taki *-daki*	waterfall or cascade
-onsen *-yu* *-sen*	hot spring
-no-yu	hot spring of...
-jinsha *-jinja* *-miya*	Shintō shrine
-tera *-dera* *-ji*	Buddhist temple
-dō	small temple
-hara *-bara*	plain or prairie
-iwa	rock
-ishi	stone
-mine	peak
-tōge	mountain pass
-michi	road or path
-kaidō	highway
-saka *-zaka*	ascent or slope
-umi *-nada*	sea
-wan	bay
-fuchi	pool ; deep pool
-shima *-jima*	islet or island
-ko	lake
-gata	lagoon
-ike	pond or small lake
-numa	marshy pond
-sawa *-zawa*	swamp or marsh
Ō-	large or larger
Ko-	small or smaller
Moto-	original or former
Furu-	old
Shin-	new
Kami-	upper
Naka-	middle
Shimo-	lower
Mae-	front
Kōen	park
-ya *-kwan* *-ryokwan* *-ken* *-en*	common suffixes to names of hotels, inns, etc.

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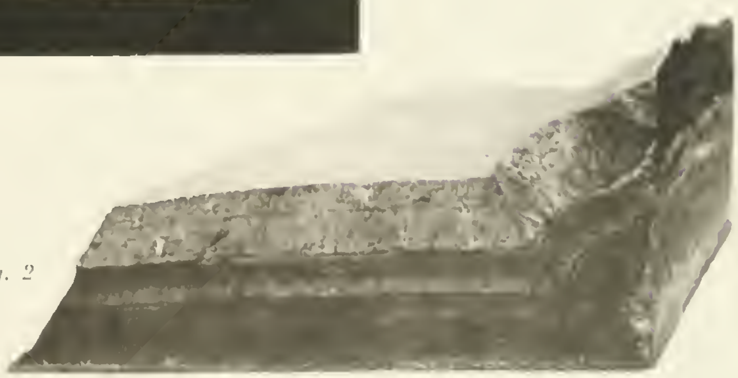

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Fig. 1

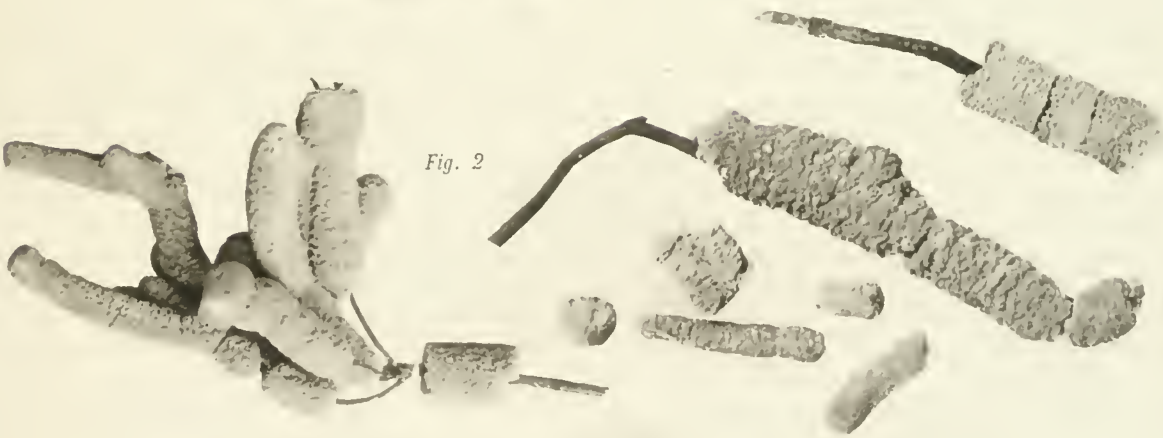

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Fig. 1

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PART I

Introductory Remarks.

INTRODUCTION.

The Empire of Japan is situated at the eastern extremity of Asia and consists of a group of islands, known as the Japanese archipelago, which stretch in a long curve in the north-western corner of the Pacific Ocean, and the Korean Peninsula (now called Chōsen) projecting from the Asiatic Continent. The said group of islands and the continent are separated by such marginal seas as the Sea of Okhotsk, Sea of Japan, and East China Sea. The islands themselves are again divided into the following smaller groups;—the Chishima (Kuriles), Japan Proper, Ryūkyū (Loochoo), etc, each forming a crescent-shaped curve, and thus present, as it were, the appearance of festoons suspended along the eastern shores of the Asiatic Continent. The largest of these islands is the Main Island (Honshū) located about in the middle, which is adjoined by the islands of Shikoku and Kyūshū in the south and the main island of Hokkai-dō in the north. Farther north than Hokkai-dō, there is Karafuto (Saghalien), of which the northern half is Russian territory. Down in the south, the island of Taiwan (Formosa) faces across the Bashee Channel the Phillippines belonging to the United States of America.

Generally speaking, all these islands are mountainous and carry two prominent mountain systems, meeting each other in the central part of the Main Island. In addition, there runs across these systems some volcanic chains, such as the Chishima-Zone, the Kirishima-Zone, and the Fuji-Zone; the last one intersects the middle portion of Honshū. Such being the case, the central part of Honshū is not only its broadest part but also the most complex and variegated in geographical conditions; and here are by far the highest and steepest mountains of the Empire.

As might be expected owing to the topographical nature of the country and the prevalence of volcanoes, mineral springs gush out all over Japan and number more than one thousand. Most of these hot springs are located amid beautiful scenery and the temperature and air leaves little to be desired, so that, combining climatic and therapeutic advantages, nature has adapted them to form ideal health resorts.

In observing the geographical features of Japan carefully, the following conditions may be noticed:—

(1) The abundance of water; every valley among the mountains has a stream of clear and lucid water, constantly flowing and never dried up.

(2) The diversity and density of vegetation; especially needle-leaved and foliage trees thrive everywhere and sometimes form very thick forests, thus contributing greatly to harmonize atmospheric humidity and adjust the flow of water in rivers.

(3) The variety of geographical structures and consequently of sceneries.

These three elements as a national asset do much to enhance the distinctive charms peculiar to Japan. To cite some examples of special merit and admiration we might mention as typical the beach of Suma and Maiko (both in the neighbourhood of Kobe) with its beautiful white sand dotted with green pines of quaint picturesque shapes of various age and size; the shady Mt. Arashi-yama in the suburbs of Kyōto with a rippling stream at its foot; the famous hot spring resorts, e. g., Hakone, Atami, Shuzenji, Ikao, Kusatsu, Arima, Beppu, etc.;—all these charming spots may be counted among the choicest of Japanese pleasure resorts. The land is fertile in cultivation and rich in a continual seasonable supply of domestic fresh vegetables, and moreover the country being seagirt, many kinds of fish are obtainable everywhere. This wealth of vegetables and fish forms a light diet every visitor finds satisfying and reasonably cheap. Furthermore the mild climate and fine weather generally prevailing make Japanese visits always enjoyable. The last, but not the least, significant among objects of interest, are the historic remains and monuments scattered all over the country, whereby visitors with an inclination for antique study may find ample interest in tracing Japanese history. Indeed the combination of healthy climate, historic interest, and scenic beauty is nowhere so well-blended and complete as here in Japan. Thus each year brings more tourists to these shores and it goes without saying that this great increase in the number of the visitors is due to the inducements offered by the natural attractions of this country. Some tourists of international experience speak comparatively very highly of Japan and go so far as to remark that although Switzerland and Italy may well be proud of the majesty and grandeur of their scenery, neither country can excel Japan in the subtly soothing display of nature, its lichen and moss clothed rocks, its incomparable blossom, its terraced fields and pastures, its musical streams diapasoned with rumbling water-wheels, its thatched homesteads and peaceful landscapes characterized by a delicate gentle picturesqueness. Such a statement cannot be considered simply as a compliment, for indeed Japan in justice deserves the name of the Park of the World. From a climatic point of view, the whole of Japan is a great health resort. The only drawback is that our hot springs, as well as our mountain and seaside resorts leave much to be desired in point of various equipments either for enjoyment or accommodation, and owing to a past seclusive reserve their natural excellence and attractive merits have not been turned to the best advantage nor their rich resources fully utilized. But the Government Authorities are considering the organization of a society for the investigation of Japanese health resorts, in order to carry out their study in a scientific manner, will further provide some of those promising places with adequate arrangements and perfect their efficiency for medical purposes. Therefore it is confidently anticipated that all our hot spring, mountain, and seaside health resorts will in the near future be so developed in all that pertains to creature comfort and enjoyment, and creation of a greater health, and that there will be sufficient commodious hotels and hydros suitably equipped on modern lines to accommodate any demands the foreign visitor may make.

ENT RAILWAYS

LIST OF IMPERIAL GOVERNMENT RAILWAY LINES

1. Tōkaidō Lines
   - **Tokaido Main Line** (Tōkyō—Kōbe, Kanagawa—Yokohama—Hodogaya & freight side lines)
   - **Yokohama Line** (Higashi Kanagawa—Hachiōji & freight side line, leased lines)
   - **Yokosuka Line** (Ōfuna—Yokosuka)
   - **Taketoyo Line** (Ōbu—Taketoyo)
   - **Nishinari Line** (Ōsaka—Sakurajima)
   - **Fukuchiyama Line** (Kanzaki—Fukuchiyama & Tsukaguchi—Amagasaki)
2. Hokuroku Lines
   - **Hokuroku Main Line** (Maibara—Naoetsu & freight side line)
   - **Mikuni Line** (Kanatsu—Mikuni)
   - **Nanao Line** (Tsubata—Yatashin)
3. Central Lines
   - **Central Main Line** (Manseibashi—Nagoya)
   - **Shinonoi Line** (Shiojiri—Shinonoi)
4. San-yō Lines
   - **San-yō Main Line** (Kōbe—Shimonoseki, Hyōgo—Wada-no-misaki & freight side line)
   - **Bantan Line** (Shikama—Wadayama)
   - **Uno Line** (Okayama—Uno)
   - **Kure Line** (Kaitaichi—Kure)
   - **Ujina Line** (Hiroshima—Ujina)
   - **Yamaguchi Line** (Ogōri—Yamaguchi)
   - **Ōmine Line** (Asa—Ōmine)
5. San-in Lines
   - **San-in Main Line** (Kyōto—Ōda)
   - **Maizuru Line** (Ayabe—Shin-maizuru & Maizuru—Umi-maizuru)
   - **Kurayoshi Light Railway Line** (Agei—Kurayoshi)
   - **Sakai Line** (Yonago—Sakai)
   - **Taisha Line** (Izumo-imaichi—Taisha)
6. Kwansai Lines
   - **Kwansai Main Line** (Nagoya—Kizu, Nara—Minato-machi)
   - **Sangū Line** (Kameyama—Toba)
   - **Kusatsu Line** (Tsuge—Kusatsu)
   - **Nara Line** (Kizu—Kyōto)
   - **Sakurai Line** (Nara—Takada)
   - **Katamachi Line** (Kizu—Katamachi)
   - **Wakayama Line** (Ōji—Wakayama-shi & freight side line)
   - **Joto Line** (Tennōji—Ōsaka)
7. Sanuki Line
   - **Sanuki Line** (Takamatsu—Kwannon-ji, Tadotsu—Kotohira, & freight side line)
8. Tokushima Lines
   - **Tokushima Main Line** (Tokushima—Awa-ikeda)
   - **Komatsushima Light Railway Line** (Tokushima—Komatsushima, leased line)
9. Shin-etsu Lines
   - **Shin-etsu Main Line** (Takasaki—Niigata)
   - **Murakami Line** (Niitsu—Murakami)
10. Sōbu Lines
    - **Sobu Main Line** (Ryogokubashi—Chōshi & freight side line)
    - **Bosō Line** (Chiba—Katsuura)
    - **Kisarazu Line** (Soga—Kisarazu)
    - **Togane Line** (Ōami—Naruto)
11. Ō-u Lines
    - **Ō-u Main Line** (Fukushima—Aomori & freight side line)
    - **Nagai Light Railway Line** (Akayu—Kigo)
    - **Sakata Line** (Shinjō—Sakata)
    - **Funakawa Light Railway Line** (Oiwake—Futada)
    - **Noshiro Line** (Higashi-Noshiro—Noshiro)
    - **Kuroishi Light Railway Line** (Kawabe—Kuroishi)
12. Rikuu Line
    - **Riku-u Line** (Kogota—Kawatabi)
13. North-Eastern Lines
    - **North-Eastern Main Line** (Ueno—Aomori & freight side line)
    - **Yamate Line** (Akabane—Shinagawa, Ikebukuro—Tabata, Ōsaki—Ōi)
    - **Joban Line** (Nippori—Iwanuma, Tabata—Mikawajima & freight side line)
    - **Takasaki Line** (Ōmiya—Takasaki)
    - **Ryomō Line** (Oyama—Takasaki)
    - **Ashio Line** (Kiryu—Ashio & freight side line, leased lines)
    - **Mito Line** (Oyama—Tomobe)
    - **Moka Light Railway Line** (Shimodate—Nanai)
    - **Nikkō Line** (Utsunomiya—Nikkō)
    - **Heigun Western Line** (Kōriyama—Mibaru)
    - **Shiogama Line** (Iwakiri—Shiogama)
    - **Hachinobe Line** (Shiriuchi—Minato)
14. Gan-etsu Line
    - **Gan-etsu Line** (Kōriyama—Niitsu)
15. Kagoshima Lines
    - **Kagoshima Main Line** (Moji—Kagoshima & freight side line)
    - **Muroki Line** (Ongagawa—Muroki)
    - **Sasaguri Line** (Yoshizuka—Sasaguri)
    - **Miyaji Light Railway Line** (Kumamoto—Higo-ōtsu)
    - **Misumi Line** (Uto—Misumi)
16. Miyazaki Line
    - **Miyazaki Line** (Yoshimatsu—Yama-no-kuchi)
17. Sendai Line
    - **Sendai Line** (Kagoshima—Sendai-machi)
18. Nagasaki Lines
    - **Nagasaki Main Line** (Tosu—Nagasaki)
    - **Karatsu Line** (Kubota—Nishi-karatsu, Yamamoto—Kishitake, & freight side line)
    - **Imari Line** (Arita—Imari)
    - **Sasebo Line** (Haiki—Sasebo)
19. Hōshū Lines
    - **Hōshū Main Line** (Kokura—Kōzaki)
    - **Tagawa Line** (Yukuhashi—Soeda & freight side lines)
    - **Miyatoko Line** (Gotoji—Miyatoko & freight side lines)
    - **Inugai Light Railway Line** (Oita—Nakahanda)
20. Chikuhō Lines
    - **Chikuhō Main Line** (Wakamatsu—Kamiyamada & freight side lines)
    - **Kazuki Line** (Nakama—Kazuki)
    - **Ita Line** (Nōgata—Ita & freight side lines)
    - **Kirino Line** (Katsuno—Kirino & freight side line)
    - **Kōbukuro Line** (Kotake—Futase & freight side lines)
    - **Nagao Line** (Iizuka—Nagao & freight side lines)
21. Hakodate Lines
    - **Hakodate Main Line** (Hakodate—Asahigawa)
    - **Kamiiso Light Railway Line** (Goryōkaku—Kamiiso)
    - **Iwanai Light Railway Line** (Kozawa—Iwanai)
    - **Horonai Line** (Iwamizawa—Horonai & Horonaibuto—Ikushunbetsu)
    - **Utashinai Line** (Sunagawa—Utashinai)
    - **Temiya Line** (Otaru—Temiya)
22. Muroran Lines
    - **Muroran Main Line** (Iwamizawa—Muroran)
    - **Yūbari Line** (Oiwake—Yubari & Momijiyama—Kaede)
23. Rumoi Line
    - **Rumoi Line** (Fukagawa—Rumoi)
24. Kushiro Lines
    - **Kushiro Main Line** (Takigawa—Kushiro)
    - **Furano Line** (Shimo-furano—Asahigawa)
25. Sōya Line
    - **Soya Line** (Asahigawa—Otoineppu)
26. Abashiri Lines
    - **Abashiri Main Line** (Ikeda—Abashiri)
    - **Rubeshibe Light Railway Line** (Nokkeushi—Rubeshibe)
    - **Yūbetsu Light Railway Line** (Rubeshibe—Shimoikutahara)

MAP OF IMPERIAL GOVERNMENT RAILWAYS

Chapter I

SCENERY OF JAPAN.

A cursory glance at any map of the Northern Pacific shows us a long chain of islands hanging like a jewelled festoon on the aqueous frontage of the Asiatic continent and extending like guardian sentinels, the enormous length of about 2,500 miles from tropical seas to the subarctic waters. Adding to these the projection of the large peninsula of Chōsen (Korea) from the continent, these form our Japanese Empire.

The drift of a warm equatorial current washes the east coast, acting similarly as the Gulf Stream of the Atlantic, and summer and winter monsoons bring with them a plentiful precipitation of rain and snow throughout the year. When the traveller becomes tired of the monotonous fortnights' voyage across the Pacific Ocean or the tedious travel through the sameness of Siberian plains and sombre forests he will hail with a sense of relief, the first glance of the contrasting leaves of the book of nature, the picturesque Japan, its isles and islets and mountains covered by beautiful leafy forests. As one's steamer nears the coast one sees white silvery shining sandy beaches lined with beautiful pine-trees and dotted with fishermens huts and seaside villas, while in summer these beaches resound with the joy and laughter of the thousands who come to breathe the fresh exhilerating air and to swim in the warm genial rolling surfs. When one steps farther inland one will find everywhere clear and lucid hot springs and neatly equipped bathing houses, and that all these seas, mountains, and forests, play an important rôle in the beautiful scenery of Japan and form that base for the undieing native love of the homeland the visitor at once can understand and feel in sympathy with.

Situated on the oceanic border of the Asiatic Continent, the Japanese Islands and Korean Peninsula have been influenced enormously by several geological agencies. The present features of these lands are the results of the repeated modifications and transformations from the remotest archæan era to the recent. Especially during the palæozoic and tertiary age were these changes exceedingly violent, though the general outlines of the islands were constructed mainly during the tertiary period. The archæan gneiss and granite in Japan which lie under the paleozoic rocks are the prolongation of that system found in Central China, particularly do we find these well developed in the Korean Peninsula with its smooth downs and gentle escarpments. The deeply engrained valleys of crystalline schists, slate and sandstone of palæozoic formation in Kyūshū and Shikoku, and the rounded hills of granite in Chūgoku along the Inland Sea, form a distinct scenery characteristic of Southern Japan. In Northern Japan these palæozoic mountains have been cut into several blocks, which were afterwards surrounded by the tertiary sea. Its tufaceous deposits then were elevated and form at present extensive subdued mountains and hills, which are a characteristic of that district. There are small patches of the mesozoic deposits, but they have not any topographic peculiarities. During the post-tertiary age violent eruptions of volcanoes took place, these modifying strongly the configurations of land features throughout the country, especially in Kyūshū and Northern Japan. Numerous volcanoes were formed in several trails along the long axis of islands. Besides these trails there is another large one known as the Fuji-Zone across the Main Island, Honshū. On the northern boundary of Korea, there is an extensive area of lava plateau, extending further into Kirin Province in Manchuria. Though it has not come into popular notority, the scenery of this plateau land is found to be of an excellent type. The terraced deposits of the old quaternary epoch are developed very well in Northern Japan where volcanic activity has been powerful. Both these terraces and younger fluviatile flats afford scope for the development of agriculture and industry, and attract a prosperous inhabitation.

Now let us briefly describe our land, namely the characteristics of its mountain ranges, volcanic cones, valleys, lakes and seas. The lofty and wide extending elevation of the principal mountain chains are naturally caused by the orogenetic actions, while their rugged peaks, gentle hills, deep gorges and wide valleys, all such features are detailed by the erosion, which is especially effective in such a country as Japan on account of much rainfall. Tectonically our islands consist of two arcs of mountain systems: the northern system extends from the Island of Saghalien southwards, while the other stretches itself from China north-eastwards. They run along the northern and southern halves of the islands, and meet together in the central part of the main island of Honshū, where the most mountainous and high tracts are formed. Hida and Akaishi mountains so called the "*Japanese Alps*," which are now popular among our mountaineers, are the most eminent ridges in this district. Only one day's tour from Tōkyō by the Central Railway is required to find ourselves at the foot of the snow-clad peaks or in the alpine forests of these lofty mountains. Within their lonely valleys are some rural and simple bathing places, such as *Shirahone*, *Kamikōchi*, *Nakabusa*, etc. Not only by the mountaineers but by the people of the neighbouring provinces, these places are celebrated as summer resorts. The eminent needle of the Japanese Matterhorn, *Yari-ga-take*, and the rugged peak of our Jungfrau, *Hotaka-yama* with their perpetual snow fields, tranquil pools, or roaring torrents in their foregrounds, never fail to make impressions on the memory and Kodak films of the nature-loving tourist.

The numerous volcanoes we may divide into two types with regard to their forms,—one being represented by the simple cone of *Mt. Fuji*, and the other by the truncated cones with large caldera and central cones similar to Mt. Hakone. Without exaggeration the lofty cone of Mt. Fuji is, "*Mons excellsus et singularis*" rising in majestic grandeur 12,467 ft. above the sea-level, on the picturesque Bay of Suruga. Its perfect and splendid conical peak is clothed in snow nearly all the year round, snow remaining for a few weeks in summer only in shady nooks, hollows and crevices, and during that season the mountain is visited by multitudes of pilgrims climbing its sacred slopes as well as the feat-loving sportsman and worshippers of the sublime in nature. Not only to see the blush of sunrise illuminate the noble brow of this our "National Mountain," to the student and savant she is well known as offering many scientific attractions. On her sweeping skirts extend the pleats and ruffles of many lava flows, decorated further in folds and hollows with the translucent liquid sparkling gems of several silvery lakes. One of these lava streams forced its way down about fifteen miles along the valley of Katsura-gawa, until it stopped at the canyon of *Enkyō*, which is here spanned by the well-known bridge of the same name. Many parasitic cones, lava tunnels, and especially a great explosion crater on the southern flank, offer geological problems and studies much valued by the erudite scholar, whilst it is also very interesting not only for the botanical specialist but for all classes of mountain climbers to observe in one day's tour the varied flora changes found at different altitudes. The thicker forests and denser undergrowth of shrub and bush of the temperate zone found at the foot of the mountain change into conifer woods as we ascend a few thousand feet, and arriving half-way up the mountain we meet only such grasses as are usual in far northern districts, and even these soon disappear, and on the bleaker heights we see only naked blocks or lava, sparsely specked with some rarer varieties of lichen. A mountain observatory found on the summit is easily recognized by the indications of a vane and anemometer, restlessly turning on the top of a rocky cliff of the crater wall. Other mountains such as "*Kaimon*" in Kyūshū, "*Nantai-san*" (Nikkō), "*Iwaki-san*" and "*Ganju-san*" in Honshū, "*Makkarinupri*" or the so-called Yezo-Fuji answer much to the Mt. Fuji example, and we find these are also frequented by many people during the summer period when routes are open and climbing practicable.

In contrast to the lofty peak of the Fuji type comes a second attraction with its mighty somma (old crater) a yawning subsidence of mammoth proportions and another kind of world wonder. A vast caldera or amphitheatre where nature's forces have fought and wrestled in the lists of time is now peacefully turned into fine meadows, brooks and lakes, and forms a natural park, and moreover here are often found charming and comfortable bathing places. Of such, a typical example is *Mt. Hakone*, to reach which is only a three hours' journey in train and tram-car from Tōkyō. Here the beautiful *Lake Ashi* reflecting on its placid surface the inverted image of Fuji seen in the background, and the grand panorama of the mountains and seas as viewed from any point on the somma are splendid and beyond the power of human pen or word to describe. Many beautiful places, well known from mediæval times by the name of "Seven Hot Springs" are found excellent ones in this district, and now boast and justly so the best equipped foreign and native hotels. The grandeur of the caldera of *Mt. Aso* in Kyūshū is far more remarkable, its diameters are ten miles N.-S. and fifteen miles E.-W., its walls around stand at least 3,000 ft. high and the highest peak "Saka-dake" reaching to a height of 5,310 ft. Twenty thousand people living in about eighty villages are here sheltered and sustained in the lap of mother earth, a basin that is computed by scientists to undoubtedly be the largest crater ever found or known to man on earth. This elaborated example and incredible display of immensity of volcanic action still retains a smoldering life, and of the five central cones, one is still found active while a number of hot springs are scattered at their feet. Among the many other volcanoes, especially noteworthy are "*Asama*" with its ascending column of smoke, "*Bandai-san*" with its tremendous explosion crater, "*Nikkō*" with its magnificient water-falls and lakes, "*Kirishima*" with some dozen craters and hot springs, and "*Unzen*" also with many springs and charming coast scenery, "*Sakura-jima*" in the Bay of Kagoshima came also recently to be well known by its sensational great eruption in January, 1914.

Some extinct volcanoes have suffered through the ages such powerful or strange erosion from weather action that they present peculiar mountain formation. In the vicinity of Karuizawa, the famous summer resort, there is a volcanic region, which is so much dissected, that even geologically it is very difficult to trace its original structure. *Mt. Myōgi* in this region is a most remarkable relic of volcanic grotesqueness, its natural arch, rock spines, pinnacles, numerous freak structures, and other wonderful views characterize this type of volcano, another example of which is to be seen in "*Yabakei*," Kyūshū. In the region of the above mentioned volcanic areas we find many hot springs being utilized by the people for bathing and other useful purposes and on which we shall devote a few lines in the next chapter.

As stated previously the current of the mountain streams are often very rapid, and to punt down such torrents over churning rapids and through rocky channels and narrow defiles affords a thrill of adventure and gives a very interesting enterprise and enjoyment to mountain tours. Usually the water which is accumulated in some intermontane basin at a high altitude, flows down to the piedmont flat making deep gorges on the border of upland. The well-known rapid, *Hozu*, near the old capital of Kyōto, is a deep cutting on the western fault-scap of the Tamba Plateau. The *River Tenryū*, *Fuji*, and *Kiso*, in Central Honshū, and the *River Kuma* in Kyūshū are also examples of the same kind but of larger and grander proportions. These rapids are commonly so swift that even the skilled crew often come dangerously near having their boats dashed against the rocks on either side or swamping them in the water. Reverting to the valcanic region, we can always find wonderfull water-falls as "*Kegon*" in Nikkō with its rainbow hued mists, *Chinda-no-taki* on Mt. Aso, etc. The majority of well-known water-falls in Japan are nothing but the water leaping over the edge of some lava flow, but the setting and pictorial mounting of each is an undoubted call on one's highest admiration.

Of course in such mountainous islands as Japan, no one can expect to see the development of large plains, most of our plains are the deltas in the mouths of large rivers or if otherwise they are but narrow flat lands extending some miles along the river. At the foot of volcanoes there usually extend grassy plains with gentle slope, and when these are situated in higher districts, they command a view over a wide stretch of country and on account of the fine bracing air they attract many people in summer for invigorating recuperation such places as "*Karuizawa*," "*Gotemba*," or "*Fujimi*," being resorts of this class, popular, and worthy of mention.

Lake sceneries are not by any means rare in this country, and on volcanoes we find often their old craters filled with snowy water forming lucid emerald lakes. *Lake Ashi* in Hakone, already referred to, or *Lake Haruna* on the volcano of the same name, are the typical examples of these. But after all, *Lake Biwa* is the most popular and well known for its scenic beauty, being also the biggest depression lake in this country. Situated only a few miles from the old metropolis, Miyako, or Kyōto, and the main highway and railroad passing along its shore, it has been since long ages past a favourite resort theme, subject and inspiration for poets and artists. The eight choice views of this pear-shaped sheet of water have become interwoven into soul of the nation through their praises becoming familiarized in song, verse, and illustration.

Along the coast of the sea there are many lagoons embraced by the sand-dunes and sand-spits. *Hachirō-gata* in northern Honshū and the twin lakes of *Shinji-ko* and *Naka-no-umi* in Chūgoku belong to this type. The latter is often called the "*Lac Leman of Japan*" and the finely situated town of *Matsue* is compared to Geneva for its pretty view. We must not neglect to mention these sand-spits as being important elements composing the scenic beauty of the coast, often covered with pine groves, some of those sand-spits stretch long arms for miles into the sea and make such typical beauty spots as *Ama-no-Hashidate* or "Heavenly Bridge," seen in the lovely Bay of Miyazu on the coast of the Sea of Japan, as also *Miho-no-Matsubara* or the "Pine Groves of Miho" which adorn the beach of the charming Bay of Suruga at the foot of Mt. Fuji. Along these sandy stretches are found many summer resorts and that never failing enjoyment of swimming in the surfs gently rolling in from the ocean. Along the shore of the Sagami Bay near Tōkyō there are many such places, among them "*Kamakura*," "*Zushi*," "*Ōiso*," etc., are very famous, while "*Suma*" and "*Akashi*" near Kōbe are also well known.

Besides these flat sandy coasts, another type of the shore seen all over Japan, especially in Kyūshū and Shikoku, is the rocky coast with many indentations, accompanied by numerous islands and rocks, giving diversified beauty. But after all the scenic beauty of the sea may be said to culminate in the world-wide known *Seto-uchi* or the Inland Sea. Enclosed from the tempestuous influence of the ocean, the spirit of peace seems to waft her angelic wand over the calm smooth glassy surface, which seldom shows a ripple, and mirrors the quaint forms of sailing craft, the green pine crested sunlit rocks and islands, and azure cloud flecked dome above in such vivid truthfulness, while the temple-strewn headlands and straw-thatched fishing hamlets nestling in nooks give the deck-bound passenger an ever changing panoramic feast, no wonder the impression given is indeliable, the revel in colour seemingly a dream and the traveller who comes to the Far East and misses taking in this lovely passage certainly is robbed of an inestimable pleasure. The world tourist wearies of the rounds of abbeys and cathedrals, and becomes nauseated with the medley of museums and art-galleries, but the harmony of the Inland Sea hums on the finest silken heart strings and once seen vibrates on the mental vision to eternity in colours that shame earthly pigments. Did you see the Inland Sea? is the one question asked. Don't forget to see the Inland Sea is the advice given.

Chapter II

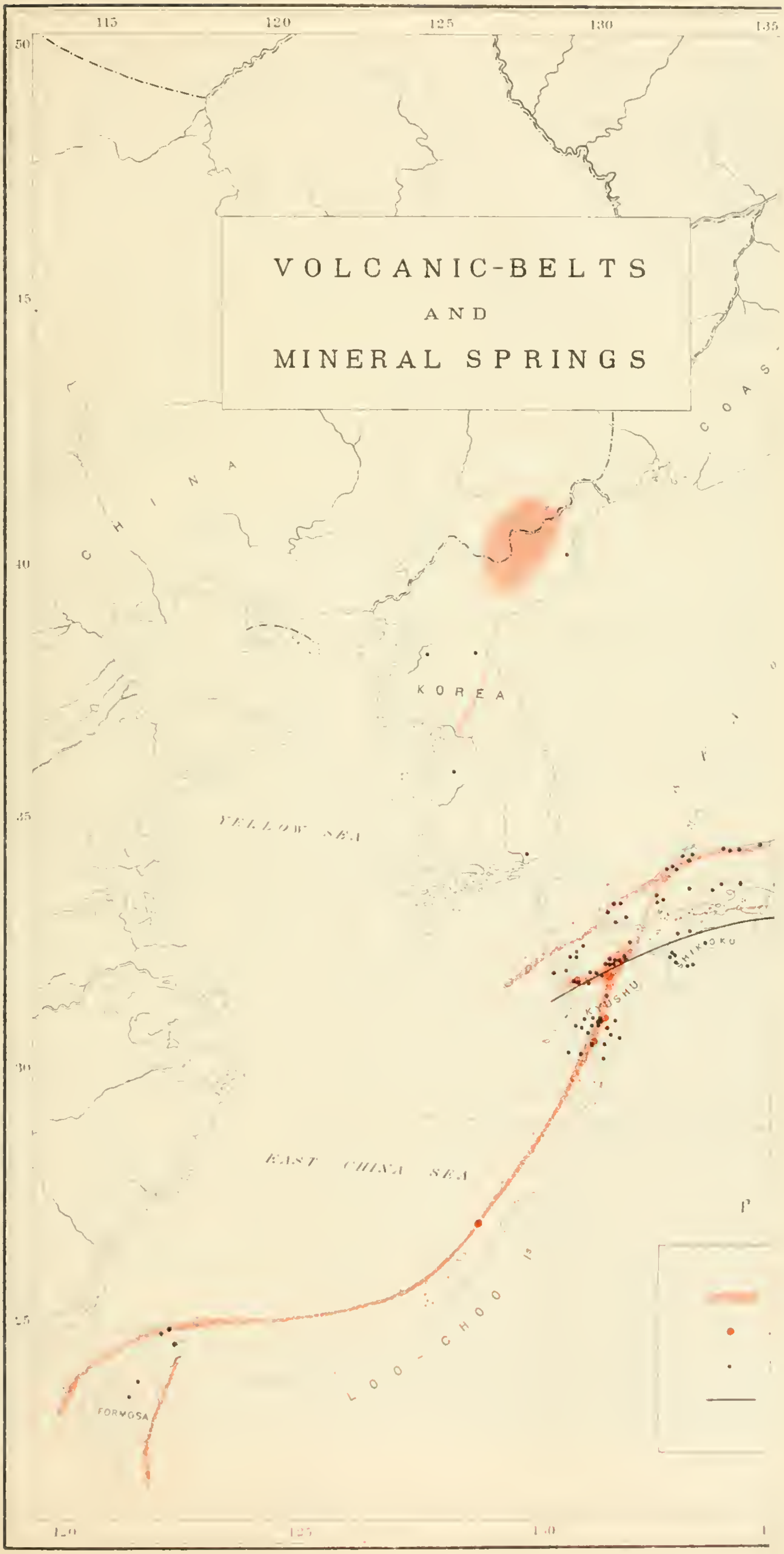
VOLCANOES AND MINERAL SPRINGS IN JAPAN.

From information to hand we have already been able to state that there are in Japan more than one thousand and five hundred mineral springs, already chemically analyzed. Of course there are many practically unknown, or at least not yet described, and valuable ones, especially in the lonely mountain region of Korea and volcanic districts of Hokkaidō are still to be reported on. It is most noticeable that the volcanoes and mineral springs have a consanguineous relationship here as everywhere else, and that their distributions are very intimately associated also here in Japan.

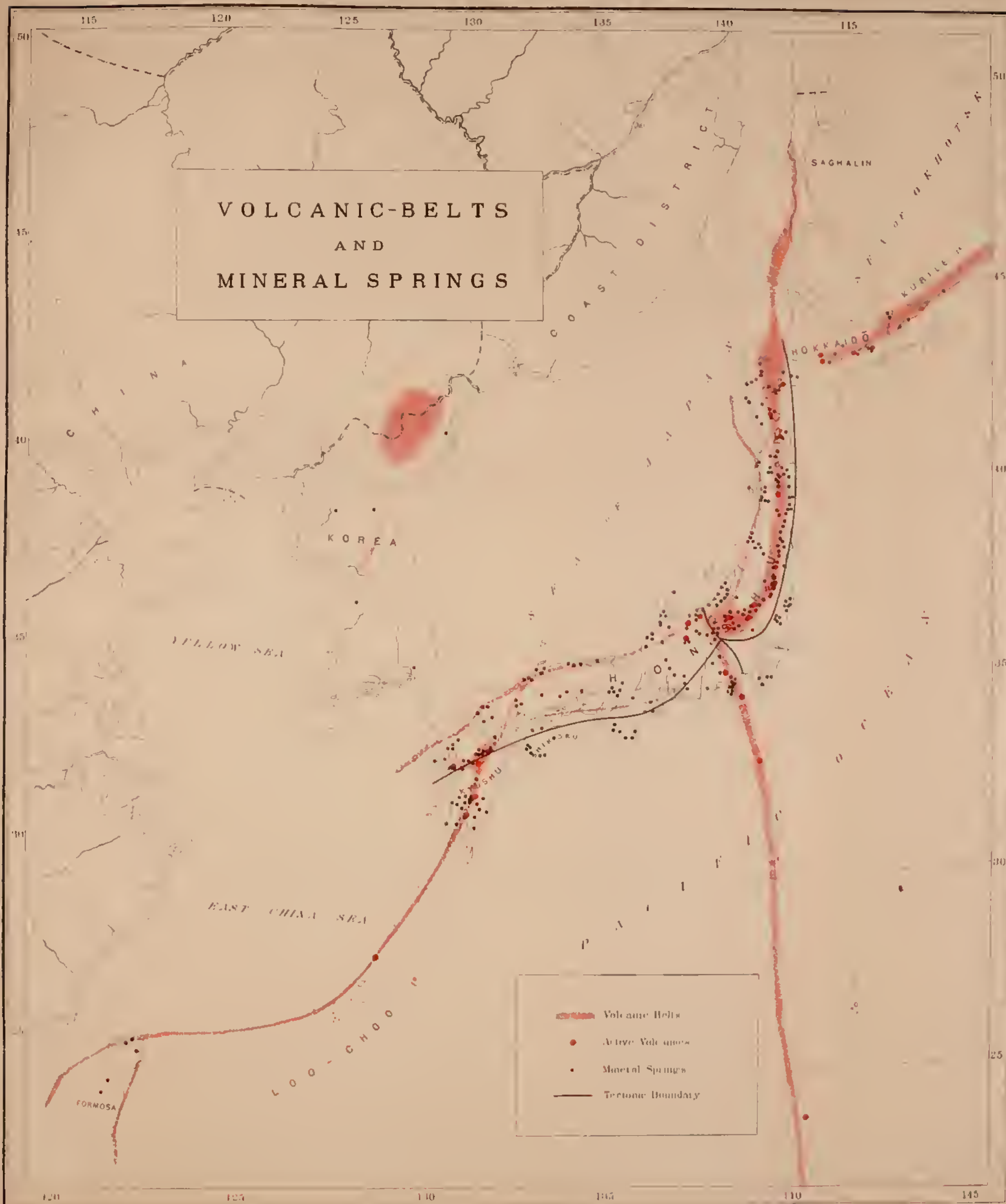
As the accompanying map shows, we find two main volcanic belts in Hokkai-dō which are the prolongations of the volcanic chains of the Kurile and Honshū ones. Accompanying the numerous active volcanoes "*Koma-ga-take*," "*Usu*," "*Tarumae*," "*Tokachi*," "*Meakan*," etc., there are also many springs, but on account of the inconvenience of communication, only some of them are known at present, as those springs of Noboribetsu and Jōzankei. *Noboribetsu*, not far from the harbour of Muroran on the southern coast, is famous for its solfatara in full activity with numerous jets and formerly with a geyser. *Jōzankei* in a beautiful valley near the city of Sapporo is a spring well frequented.

In northern Honshū there are two main volcanic belts running along the long axis of the islands, one of these, the *Nasu-Zone* named after the famous active volcano, forms the backbone of the island of northern Honshū, and is characterized by its compact arrangement of volcanic cones accompanied by innumerable hot springs. The other belt lies on the coast of the Sea of Japan and similarly has well-developed conical mountains, a representative being *Mt. Chōkai*. Among the many hot springs in the northern end of Honshū, *Asamushi* with its railway communications and superior coast scenic attraction is a spring highly popular and widely known, while further inland we can find not only many valuable medicinal springs, but the famous geyser of *Fuki-age* situated in this district; but these latter springs being rather out of the way or a half-day's journey from the nearest railway station, visitors show a preference for the more conveniently connected springs as at Asamushi. Isolated springs only await the recognition of their merits but referring to the question of convenient situation in the vicinity of large cities and towns, there are many celebrated bathing places, e. g., "*Aone*" near Sendai, "*Kaminoyama*" near Yamagata, "*Iizaka*" near Fukushima, "*Higashiyama*" near Wakamatsu, etc., and further southwards more well-known places as "*Nasu*," "*Shiobara*," "*Nikkō*," and "*Ikao*." Nasu is popularly known by the tradition named Sesshō-seki or "Death

Distribution of Mineral Springs and V



Distribution of Mineral Springs and Volcanoes in Japan.



Stone," a feature connected with its solfatara. Shiobara has a series of springs and is most celebrated for its remarkable autumnal foliage, the brilliant maples, etc., seen in its glens and mountain ravines. No one can fail to notice the Imperial villa on the banks of the blue gorge, fringed as it is in prominent relief by dark forests. Nikkō known world-wide for its splendid mausolean temples and scenery, has its bathing place, "*Yumoto*," situated some few miles higher in the mountains and during the summer we find it well frequented. Ikao on the eastern flank of the beautiful volcano Haruna is another famous summer resort. These four springs may be reached from Tokyo after a few hours' run by trains, tram-cars and *jinrikisha*. The above mentioned volcanic zones of northern Honshū meet with the Fuji-Zone in the central part of Honshū, forming there a congested volcanic district having many cones. Passengers on the Central and Shin-etsu Railway Lines succesively, find a courteous and welcome treatment and every help by officials in reaching any desired point. The active volcanoes "*Asama*" and "*Shirane*," and the gigantic cone of "*Myōkō*" and "*Yatsu-ga-take*" are most famous, while we further note other lofty volcanoes like "*On-take*" and "*Norikura*" on the ridge of the Japanese Alps. Accompanying these enumerated volcanoes there are found springs of various kinds, of which such well-known ones as "*Isobe*" near Mt. Myōgi, the most famous sulphur springs of "*Kusatsu*" at the foot of the Mt. Shirane, "*Shibu*," "*Bessho*," "*Asama*" (not associated with the volcano of the same name), and "*Suwa*" may be called to your notice. The latter one is on the shore of the beautiful *Lake Suwa*, which affords the best skating area for contests and sports during the winter. Strange to say Fuji has no share of hot springs, but in Hakone and some dissected volcanoes in the peninsula of Izu, in her zone, meet with numerous bathing places. The so-called "Seven Hot Springs" previously spoken of are found on the banks of the river Haya-kawa, which flows from the crater lake "Ashi" deeply cutting its way through the ring of mountains. "*Yumoto*" and "*Tōnosawa*" along the lower valley are simple thermal springs, while "*Ashi-no-yu*" and "*Ōwakidani*" on the higher reaches are remarkably strong in sulphur. "*Miyanoshita*" with its social life is the bathing place especially popular all the year round with foreigners, and "*Sokokura*" also a bathing resort being situated near, both these springs being of intermediate chemical nature. Near Hakone, on the eastern coast of Izu Peninsula, there is the celebrated geyser of "*Atami*." During the last few years, on account of the careless boring of wells in the vicinity of the geyser, the periodical discharge of hot water has become more or less irregular. Within a day's trip from Atami we can find numerous well-visited bathing places, as "*Izusan*," "*Yugawara*," "*Itō*" and "*Shuzenji*."

Turning to the western half of Honshū we have various hot springs, though they are less in number than in the Central and Northern Japan. Along the coast of the Sea of Japan there is one volcanic belt with the volcanoes "*Hakusan*," "*Daisen*," "*Sambe*," etc., which passes over to the island of Kyūshū. Another belt is found on the Inland Sea, or "Seto-uchi," but its volcanic life is almost extinct. The coast of the Sea of Japan is also not without its hot springs, of which the most noted are "*Wakura*" in Noto Peninsula, "*Yamanaka*" and "*Yamashiro*" in Kaga, and "*Kinosaki*" in Tajima, this latter with a most famous basalt cave "*Gembu-dō*" in its environs.

In the island of Shikoku, where we have no historic record of volcanic eruptions, there are but a few bathing places worthy of note apart from the celebrated "*Dōgo*," whereas the neighbouring great island of Kyūshū, is very richly besprinkled with volcanoes and hot springs, the distribution of these being on the two main zones of "*Aso*" and "*Kirishima*." The former connects the famous volcanoes "*Aso*," "*Unzen*," etc., while the other stretches southwards from the enormous volcano of "Kirishima" passing through "*Sakurajima*," the terrible monster in the Bay of Kagoshima, to the Kawabe islands and Formosa. There are many active volcanoes in both zones, and connected with which we have a terrible history of catastrophes.

Among the numerous bathing places in Kyūshū, "*Beppu*" and "*Unzen*" stand most prominent. The former lies at the foot of the volcanic group of "*Yufu*" on the shore of the picturesque Bay of Beppu, an indentation of the charming Inland Sea. Many springs come out in a novel and strange manner, some of them make ponds of boiling water, while the others dissipate themselves into the sand of the coast, and here the sand-bath taken on the roomy and clear beach is the most interesting and unique one of its kind found in this country. The volcano "Unzen" is a beautiful mountain on the peninsula of Shimabara and commands a fine panorama of land and sea. Its great eruption in 1792 still forms a theme of awe and topic of a conversation among the countrymen. Many thermal springs, especially "*Obama*" are well known for the bathing, and form excellent summer resorts for natives as well as foreigners, and being situated only a few hours' steaming distance from Nagasaki, they are visited every summer both by the local foreign community and the numbers of Europeans and Americans living in China who seek for shelter and change from the summer heat and debiliating influences of that climate. The volcanoes "Aso" and "Kirishima," some of their peaks yet active, have also many bathing places. At the southern end of the Satsuma Peninsula there is the perfect cone of "*Kaimon*" and the crater harbour of "*Yamakawa*," and many springs are found in their vicinities, though the bathing houses are mostly a very simple and unassuming type.

As to hot springs in Formosa we cannot neglect to refer one to the famous one of "*Hokutō*," near Taihoku, the capital of the island. An abundant quantity of hot water is constantly flowing through a valley at the foot of the volcano "*Daiton*," and the deposit of the radio-active mineral "*Hokutōlite*" in that spring has recently attracted keen attention in the scientific world. The governing authorities undertook to plan a park and a splendid and magnificent public bath has been built which has no rival throughout the whole Empire of Japan. Other springs have been also discovered in the deep valleys of the central mountain chain, where the aborigins had previously built primitive bathing places by excavating the natural rock, further details of these being lacking we but record the fact.

Likewise of Korea we have not material enough yet to hand to describe any springs though there are many localities already known, and among which the much frequented bathing places of the following might be mentioned:—"*Tōrai* (Tong-nai) near the harbour of Fuzan and accessible by train, "*On-yō*" (On-yang) in Central Korea and not far from the railway station of Ten-an, and lastly "*Shu-otsu*" (Chyu-eur) in Northern Korea, this lying to the west of Ranan and Kyojō, where a sanatorium for the army is established.

Turning to the relationship between the mineral springs and volcanoes in Japan, it is of course obvious that the volcanic belts are usually accompanied by mineral springs, but we do not venture to assert that mineral springs are necessarily apart of or only confined to those districts. Some of them we find along the dislocation lines quite independent of volcanic zones, while others are noticed in the regions of old plutonic rocks. Where the volcanic regions is traversed by dislocation lines it is of course most favourable for the springs to find their way, as seen in the case of Shinano Highlands, Izu Peninsula, and the middle part of Kyūshū. From the accompanying map we note there are two sets of principal tectonic lines—longitudinal and transversal—which separate our islands into four quadrants. The above mentioned four regions are traversed by these tectonic lines as well as volcanic belts. Of the innumerable mineral springs in Northen Japan we find they are mostly limited to the north-western quadrant, while in the north-eastern quadrant there are only a few springs. The former is not only rich in volcanoes, but its younger beds have been influenced by local disturbances, and even at present are frequented by local earthquakes, while on the contrary the latter area has remained as plateau lands of older formation since remote geological ages without showing any peculiar disturbances but those due to denudation and erosion. Besides the hot springs, carbonated cold springs are found in the vicinity of Ōsaka, and the bottled liquids are in an ever increasing popular demand in the Far East as a table water under the names of "*Tansan*," and "*Hirano Water*." These springs are found along the line of dislocation on the border of the Tamba Plateau.

It is remarkable that the radio-active springs, which are highly esteemed for medical purposes, are mainly formed in the north-western quadrant, where the geology is represented by granite. The cold springs of *Masutomi* in the Province of Kai, and the *Misasa* hot springs in the Chūgoku district, are typical illustrations of this geologic feature.

Regarding the utilization of the products of mineral springs we have only a few things to say. Various kinds of sinters under the name of *Yu-no-hana* or "Flower of Spring" are sold in several bathing places for use in private or household baths. In Beppu, alum is prepared by the action of sulphureous steam upon alum-earth and in Kusatsu the incrustation of sulphur is collected. White clay, which is a bleaching product of volcanic rock, etc., produced by solfataric action at Beppu is used in the manufacture of paper. There are also calcareous and sulphur deposits of ancient hot springs, the former is found in the Prefecture of Akita in northern Honshū and is utilized as a flux in the smelting furnace, and the latter, which gives us the range and forms of marketable products of sulphur, is worked from many volcanoes and exported to various parts of the globe.

Chapter III

GEOLOGY OF THE JAPANESE EMPIRE.

The lowest statified rocks composing the Japanese Empire are the Gneiss and Crystalline Schist Systems of the Archaean Group. Then follows Palæozoic formation, in which the earliest fossiliferous rocks in the empire are found. The Mesozoic formations were next deposited. During the sedimentation of the Palæozoic and the Mesozoic rocks, intrusions of granite, diorite, porphyry, gabbro, porphyrite, and diabase occured. In the Cainozoic era, especially in the Tertiary age, volcanic rocks were erupted in different places and the sediments of volcanic ejectamenta formed the various kinds of tuffs.

ARCHAEAN GROUP.

1. *Gneiss System*:—The Gneiss System consists of biotite-gneiss, granite-gneiss, mica-schist, and amphibolite; and is frequently intercalated with saccharoidal limestone and granulite. Besides, two-mica-gneiss and pyroxene-gneiss are known in Korea, and in southern Manchuria. Various kinds of gneiss show in several cases the characters of the ortho-gneisses, while the mica-schist and limestone seem to be the para-gneisses metamorphosed by the contact action of eruptive rocks. Granites frequently intrude them in a confused manner, and these granites as well as the others which metamorphosed the Palæozoic rocks into gneisses and schists, are often treated together with the sedimentaries.

2. *Crystalline Schist System*:—The Crystalline Schist System consists of various schists of a phyllitic aspect with the characteristic components—sericite, epidote, and calcite. They are graphite-gneiss, epidote-gneiss, sericite-gneiss, graphite-schist, chlorite-schist, sericite-schist, piedmontite-schist, quartz-schist, and chlorite-amphibolite, often accompanied with eruptives, such as serpentine and gabbro, but not with granitic eruptives. Glaucophane-schist is known only in Shikoku and Kyūshū, and in the province of Kii. Crystalline schists are clearly distinguished from the rocks of the Gneiss System, except the amphibolites; but the distinction between them and the lowest series of the Palæozoic, consisting of amphibolites, pyroxenites, and phyllites, cannot always be clearly made.

PALAEOZOIC GROUP.

The Palæozoic of Japan consists of a series of formations of an enormous thickness, which may, in the order of superposition and lithological character, be divided into the Lower, Middle, and Upper Formations. The Upper Carboniferous or Permo-carboniferous fauna of stratigraphical importance is found only in narrow zones in the Middle and Upper Formations. The Lower Palæozoic is composed mainly of metamorphic volcanics or pyroclastic rocks, *i. e.*, pyroxenites and amphibolites, with subordinate layers of phyllites, crystalline limestone, and quartzite; and is often accompanied with serpentine and gabbro. The Middle and Upper Palæozoic consist of schalstein, sandstone, clayslate, quartzite, hornstone, radiolarian slate, adinole slate, limestone, and commonly rest conformably on the Lower Palæozoic. Among these rocks, crumpled quartzite and hornstone of various colours, adinole slate, schalstein with limestone, radiolarian slate, and *Fusulina* and crinoidal limestones, are easily recognizable and are indeed the marks of the correlation. Among the fossils, *Fusulina* and *Schwagerina* are most common. In Rikuzen there occurs a fossiliferous clayslate, containing a trilobite, brachiopods and bryozoans, and occupying an upper horizon.

In Korea, the lower series of the Palæozoic consists of metamorphic rocks, mainly of mica-schist, hornblende-schist, quartz-schist, and phyllite, a part of which seems to represent a certain horizon of v. Richthofen's Ta-ku-shan Series. It is found in scattered patches in North Ham-gyŏng-dō, Kyŏng-geui-dō, and Chōl-la-dō. The Upper or Korean Formation consists mainly of quartzite, clayslate, and sandstone in the lower part, and of limestone and marl in the upper, and seems to represent v. Richthofen's Sinian Formation. The low *Karst*-like plateau in south Phyŏng-an-do and Hoang-hai-dō consists of a thick complex of Carboniferous limestone, containing *Fusulina* and other foraminifera.

In the Liao-tung peninsula, the Palæozoic is divisible into the Cambro-silurian and the Carboniferous Systems. The lower series of the Cambro-silurian, *i. e.*, the Ta-ku-shan Series, consists mainly of quartzite with subordinate layers of quartzose sandstone and clayslate, sometimes conglomerate and limestone. The upper formation, *i. e.*, the Sinian, consists mainly of an alternation of sandstone and clayslate with subordinate layers of quartzite, conglomerate, and limestone in the lower part, and of limestone and marl with sandstone, clayslate and quartzite in the upper. The limestone of the various horizons contains brachiopods, pteropods, cephalopods and trilobites. The Carboniferous is found only in small patches, as in the vicinities of Fu-chou and Chin-chou. The lower formation of the Carboniferous consists of an alternation of limestone and marl. The upper formation or Coal Measure consists mainly of sandstone and clayslate with coal-seams. The clayslate contains abundant plant-remains.

MESOZOIC GROUP.

1. *Triassic System* :—The Triassic System occupies small areas, and consists mainly of sandstone and clayslate or shale, sometimes intercalating tuff, limestone, and also anthracite. The Triassic in Rikuchū, Tosa, and Higo, yields marine fauna, such as *Ceratites* and *Pseudomonotis*, which are considered to be closely allied to those of the Californian Trias. The Trias of Nagato yields Rhætic, flora ; in Bitchū the *Pseudomonotis* bed underlies a plant bed, which seems to be comparable to the Rhætic of Nagato.

2. *Jurassic System* :—The Jurassic of Japan is in small detached areas, consisting of clayslate or shale, sandstone, and conglomerate ; schalstein, crystalline limestone and also anthracite are found in the Jurassic of Nagato. The schalstein, which is widely distributed in Chūgoku and northern Kyūshū and mapped as the Mesozoic of an unknown epoch, resembles the Liassic schalstein of Nagato. The Jurassic in Rikuzen, Echizen, and Nagato contains marine fauna ; that in Echizen, Etchū, Echigo, Kaga, Mino, and Hida consists of brackish-water deposits with plant fossils. Its lower horizon often contains fresh-water shells.

In Korea, the Jurassic develops widely in the south-east, and consists of sandstone, conglomerate, clayslate, and schalstein, intruded by dykes and sheets of porphyry and porphyrite. Plant fossils are imbedded in it. Other small patches of the Jurassic consist mainly of sandstone, conglomerate, and clayslate or shale ; and in some places schalstein and limestone occur.

3. *Cretaceous System* :—The Cretaceous System has the widest distribution of all the Mesozoic, and is rich in fauna and flora. The lower Cretaceous on the Pacific side of Honshū and Shikoku consists of series of shale and sandstone with the so-called Torinosu limestone. The limestone contains abundant fauna, consisting of foraminifera, corals, bryozoans, echinoids, bivalves and gasteropods. The lower Cretaceous in the provinces of Rikuzen, Iwaki, Kōtsuke, Kii, Awa, and Tosa consists of conglomerate, sandstone and shale. Generally, a *Cyrena* bed occurs in the lower horizon, a plant bed a little higher, and a *Trigonia* sandstone in the uppermost. The upper Cretaceous, forming a long chain from the boundary between the provinces of Izumi and Kii, to Amakusa through the provinces of Awaji, Sanuki, Iyo, and Bungo, with strips in Kōtsuke and Shinano, consists chiefly of sandstone and shale with conglomerate, and contains marine fauna, and some flora. On Amakusa Island, several seams of anthracitic coal are found in the series. In southern Shikoku it consists of sandstone and shale with conglomerate and limestone. In Rikuzen the upper Cretaceous consists of sandstone and shale with limestone, quartzite and tuff. The Cretaceous of Hokkaidō, consisting of shale, sandstone, and conglomerate, yields abundant forms of ammonites, besides, shells and other forms. The Cretaceous of Karafuto consists of shale, sandstone, conglomerate, and marl, abundant fauna being imbedded in the strata.

4. *Doubtful Mesozoic* :—The Mesozoic consists mainly of shale and sandstone, sometimes with impure limestone. The Mesozoic of Taiwan consists mainly of clayslate with sandstone.

CAINOZOIC GROUP.

1. *Tertiary System* :—The Tertiary consists of sand, gravel, clay, tuff, sandstone, conglomerate, and shale, with intervening layers of limestone, marl, coal-seams, and diatom-earth. As a result of volcanic activity tuffs are very widely prevalent, sandstone and shale showing very frequently a tufaceous character. The Eocene is known in Ogasawara-jima (the Bonin group) where the series yields the genus *Nummulites*, which has been also discovered in Okinawa Island, and the limestone of Nakaosaka in Kotsuke contains *Orbitoides*. It is highly probable that there exists a horizon which represents a Miocene-Eocene Series. Whether the Miike coal field in Chikugo, where *Aturia ziczac* has been discovered, belongs to the Eocene or not, is now under discussion. Pliocene and

Miocene beds have been recognized, the former being indicated chiefly by shell remains and the latter by plants and a few foraminifera, though the definite boundary between them has not yet been traced except in a few cases. The various kinds of gasteropods, solenochonchæ, conchifera, brachiopods, echinoids, asteroids, foraminifera, etc., are abundantly found in the Tertiary, and those found in the Pliocene belong mostly to species now living in the Japanese and Chinese seas, only a few being extinct in the neighbouring waters. Sometimes the bones and teeth of mammals and rarely the remains of insects are found in the post-Miocene; shark's teeth specified as *Carcharodon megalodon* are found in several parts of Japan. The fossil flora is found most frequently in the pre-Pliocene or Miocene strata, and very often in the Pliocene. In the pre-Pliocene or Miocene flora, both European and Arctic elements are found; while most of the Pliocene flora is very intimately related to species now living especially in the mountain regions of Japan, and some to those now met with in other parts of the world. From these facts together with the evidence of fossil fauna it is supposed that the Pliocene period had a colder climate than that now prevailing in those regions.

In Korea the Tertiary consists of shale, sandstone, conglomerate and tuff, with coal, and is found in a few small scattered areas. In North Kyŏng-syang-dō the shale and tuff of the series contain some fossil floras.

2. *Quaternary System*:—(*a*) *Diluvium*: The Diluvium consists of sand, gravel, clay, and pumice, often covered with a fine deposit of a volcanic nature, and forms low undulatory plateaus or elevated platforms as well as terraces. The Diluvial platform near the western coast of Taiwan is covered with laterite. (b) *Alluvium System*: The Alluvium consists of fluviatile deposits of sand, gravel, and clay, as well as the sands of beaches and dunes.

3. *Raised Coral Reefs*:—Raised coral reefs are only found in Taiwan and Ryūkyū along the beach, or inland, where they form the low plateau.

IGNEOUS ROCKS.

Granite:—The granites consist of hornblende-granite, granitite, and hornblende-granitite with muscovite-granite and are the most widely extended of all the plutonic rocks. Contact phenomena of granite on the Palæozoic and Mesozoic sedimentaries have been observed in several places.

Porphyry:—The porphyries occur forming large masses in the inner zone, especially of South Japan, but mostly as small dykes throughout the mountains. The rocks belong chiefly to quartz-porphyry and often on one side approach granite, known as granite-porphyry, and on the other, liparite.

Diorite:—The diorite is generally quartz-diorite. The age of eruption is often uncertain. Structurally it is considered to be one of the older eruptives, but one mass in Sagami intrudes the Tertiary. Gabbro-diorite occurs in small areas, often accompanied by gabbro.

Gabbro, Peridotite, Serpentine, etc.:—The gabbro, peridotite, serpentine, etc., often occur together. The gabbro and serpentine are found mainly in the Crystalline Schist and the Palæozoic, but those in Chūgoku seem to belong to a later issue.

Diabase:—The diabase is found intercalated in the Palæozoic and the Mesozoic, and is accompanied with schalstein, showing a mighty eruption of it in the Palæozoic and the Mesozoic eras.

Porphyrite:—The porphyrite occurs in tolerably large areas in several places; but generally, it is found as dykes or sheets in the Palæozoic and the Mesozoic. In Chyŏl-la-dō and Kyŏng-syang-dō in Korea it occupies somewhat extensive mountain districts.

Liparite:—The liparite is of various kinds, and its tuffs resulting from the eruptions probably since the beginning of the Tertiary period, develop extensively with thick sediments especially in North Japan. Besides, the liparite occurs as dykes in several places, intruding the Tertiary as well as the older formations.

Andesite:—The andesites, including dacite, mica-hornblende-andesite, pyroxene-andesite, and olivine-pyroxene-andesite, have the widest distribution of all the igneous rocks. Among them, pyroxene-andesite and olivine-pyroxene-andesite are the most widely distributed and form huge volcanoes, especially those of North Japan, such as Fuji, Asama, Nasu, Zaō, Chokai, Iwate, Iwaki, etc. Mica-hornblende-andesite builds the main volcanoes in South Japan, especially those along the coast of the Sea of Japan, such as Norikura, Hakusan, Daisen, Sambe, Kuju, Unzen, etc. The dacite is limited in distribution, being found especially in the northern part of Honshū. Rhombic-pyroxene-andesite forms along the Inland Sea a volcanic series of small simple cones, such as Kabuto-yama in Settsu, Iino-yama in Sanuki, Kofuji in Iyo, etc. The andesite has been erupted extensively since the Tertiary period, being in most cases accompanied with tuff, agglomerate-tuff, lava-breccia, etc. Some andesites are also frequently found as sheets and dykes. The volcanoes of Japan are mostly composed of andesite, and are 165 in number, among which 63 active ones are enumerated. They are simple-coned, such as Fuji, Kaimon, etc.; double-coned as Asama, Sambe, etc.; or more complex, as Aso, Hakone, etc.

Basalt:—The basalt outcrops in rather small areas in Chūgoku, northern Kyūshū, and in northern Korea, forming plateaus and sometimes simple domes or cones, such as Kasa-yama in Nagato, Kannabe-yama in Harima, etc. Also it often occurs as intrusive sheets and dykes in these regions.

Volcanic Ash and Mud Lava:—Volcanic ash is widely distributed especially along the slopes of volcanoes, covering the mud lava, or sometime alternating with it. Mud lava always forms plateaus and the slopes of volcanoes. It occupies wide areas in Kyūshū, where it is considered to have been erupted from the volcanoes of Aso and Kirishima.

Chapter IV

CLIMATE OF JAPAN WITH SPECIAL REFERENCE TO HEALTH RESORTS IN JAPAN.

If there was no intense heat in August in Japan, who could be charmed by the autumnal glory of the coloured foliage in November? If there were no bitter winter monsoons from Siberia, who could expect the magnificent display of cherry blossoms all at once in April? We cannot incessantly endure a succesion of good and fine days, so that Nature gives us summer to purify our blood by perspiring, and winter to brace our shattered nerves by its cold. The climate of Japan is moderate with two severe extremities both in time and in space.

Preceding the autumnal equinox, when the sun becomes somewhat lower in our middle north latitude, the high atmospheric pressure covering the North Pacific Ocean begins to send its force to the west, and the typhoons successively visiting Japan perform the great work of removing the action center of the atmosphere. The south-easterly monsoon gradually loses its intensity only to be replaced by the north-westerly monsoon, which threatens the inhabitants of the Far East. In Central Japan on some clear morning late in the October frost is seen whitening the stones and grasses even tinging the leaves. The mountain slopes are first seen variegated. After a few days the foliage in the valleys turn red or yellow and thence for about a month mountain slopes, hills, lakesides and wherever deciduous trees stand, present the autumnal glory of red and gold. No show window of a draper or mercer could ever be brighter and richer in colour than this. Some trees are as brilliant and as red as fire; others are of the colour of peach; some are as yellow as deep gamboge and still others are purple or white. Pine-trees are always mixed with these gaudily coloured trees and the deep blue of the sky over them gives a very pleasent contrast. Moreover we can see majestic mountain ranges whose shoulders are of ultramarine, but whose heads are as white as a sugar loaf. If we suppose a lake with clear water extending as a gigantic mirror between red and gold foliage; if we suppose a cascade hanging from the edge of white granite rocks, half-covered by coloured leaves and dark green pines, we have a fair picture of an autumnal day in Japan. Autumn scenes are very much appreciated in Japan, and Japanese sightseers never fail to visit some such places as *Arashiyama*, *Nikkō*, *Myōgi*, or *Mitake* during this season, to enjoy the autumnal tranquility amidst the sunny display of coloured nature. Such a pleasent season is but a prognostic of the coming penetrating winter.

From the middle of March there is a rapid change of climate in Japan. The high atmospheric pressure in Siberia begins to move to the Pacific Ocean and, in consequence, the severe, cold north-westerly monsoon gradually subsides and in its place the gentle beams of the spring sun warm the soil from which ice and snow have disappeared. We find that all moats, rivelets, ponds and marshes have become swollen with the water of spring, and the eggs of frogs are seen abundantly in them. Plum trees in blossom from the previous month gradually give their places to soft green sprouts. At the end of March peach trees are in blossom and tadpoles are swimming about in the ponds. On the first or second week of April, cherry blossoms begin to open and are in their full glory all of a sudden. In this season nearly all the people in the great cities of Japan such as Tōkyō, and Kyōto, go out in full dress to play and dance under the blossoms. The weather is warm; swallows and butterflies are sometimes seen flying through the blossoms. Falling petals wafted on the breezes falls like snow flakes on the head and *kimono* (clothes) of the dancers. "*Which is the more beautiful, blossoms or girls?*" is repeated every year by sightseers. Such merry display of cherry blossoms and human flowers is but the reactional outburst against the solitary confinement of winter cold.

One of the most powerful factors in the variation of the climate in Japan is the **Monsoon.** Temperature, humidity, and other elements change very faithfully with it. The monsoon comes in winter from Siberia, and in summer from the Pacific Ocean. The empire of Japan extends from *Taiwan* (Formosa), whose southern half is in the tropics, to *Karafuto* (Saghalien) and *Chishima* (Kuriles) whose most northerly point is in Latitude N 52°. Hence the climate of Japan by no means uniform as already pointed out by many authorities, but it is certain that nearly all districts in Japan undergo the influence of the monsoons and hence the annual variation of the climate is very regularly repeated, and as far as any one of such districts as *Kyushu*, *Naikai* (Inland Sea District) or *O-u* (north-eastern part of the Main Island) is concerned, the climate is uniform in the particular district. We can, thus, estimate the climate of a special place, if the general climate of the district in which the place is situated, is known, together with the orographical features of the place. This is illustrated by the following example. The temperature of *Hakone* must be lower than that of *Yokohama* by about 4,5° C, because Hakone is about 720 metres high above sea-level,—the average vertical gradient of the air temperature in mountainous districts in Japan is 0,6° C per 100 metres —while the temperature of *Miyanoshita* must be about 2° C higher than that of Hakone, because its height is about 420 metres. The observed mean temperatures at Hakone and Yokohama (from the report of Yokohama Met. Station) are shown in the following table, which proves the correctness of the above view.

Table I.

Average Temperature at Hakone and Yokohama. (° C).

Name of Place	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Yokohama	4.4	4,7	7,6	13.0	17,2	20,8	24,2	25,9	22,2	16,7	11,3	6,6	14,6
Hakone	0,0	0,6	3,5	8,2	12,3	16,9	20,1	21,1	17,6	12,3	6,4	1,7	10,0
Diff.	4.4	4,1	4,1	4,8	4,9	3,9	4.1	4,8	4,6	4,3	4,9	4,9	4,6

Thus Hakone and Miyanoshita must be cool in summer, but too cold in winter. *Odawara*, which is situated at the foot of *Hakone-yama* (Mt. Hakone) must be warmer than Yokohama in winter, because the west and the north side of this place are protected by mountain ranges which divert the raw cold of the north-westerly winter monsoons. The observed temperature of January is 9,8° C at Odawara and 8,5° C at Yokohama, the difference is 1,3° C; while that of August is 29,6° C at Odawara and 29,2° C at Yokohama; the difference is only 0,4° C. This fact coincides with the theory. In 1911, it was proposed to make climatological observations at mineral bath localities and health resorts. But there were many obstacles in the way, and since then data have been obtained only at about forty places. Some of these results are given in Table II, but the period over which observations extend is too short to discuss the climate of these places. Fortunately, however, meteorological stations of first and second order are so numerous and so closely situated in this country that for many bath localities and health resorts we can find some meteorological station standing in the close proximity to them, where the meteorological elements have been observed for many years. For example, we have Aomori Meteorological Station near *Asamushi* mineral bath resort (10 miles apart and both on the sea-shore), Utsunomiya Met. St. near *Nikkō*, Maebashi Met. St. near *Ikao*, Ōsaka Met. St. near *Hamadera*, Kobe Met. St. near *Arima*, *Suma*, *Maiko* and *Akashi*, Matsuyama Met. St. near *Dōgo*, Ōita Met. St. near *Beppu*, etc. The complete meteorological observations taken at all meteorological stations are given in the monthly and annual reports of the Central Meteorological Observatory of Japan, and an extract is given in the Japanese Almanac called '*reki.*' We cannot here enter into minute descriptions of the climate observed at each of the meteorological stations. For our present purpose, Tables III—VI are prepared, in which the mean and the absolute extremes of air temperature, the mean and the absolute minimum humidity, the mean and the absolute maximum precipitation, with the number of rainy days and the number of the clear and fair days are given.

Table II.

Climatological Observations at some Health Resorts.

	January	February	March	April	May	June	July	August	September	October	November	December	Year
Unzen in Nagasaki Prefecture; Observation, 1909–1912.													
Mean Temperature °C	1,7	1,7	5,2	9,6	13,6	17,3	21,1	21,9	19,7	13,2	7,8	2,6	11,3
Absolute Max. Temp. °C													29.8
Absolute Min. Temp. °C													−12,2
Humidity %	76	81	81	79	80	89	90	87	88	78	81	80	83
Absolute Min. Humidity %													27
Takeo in Saga Prefecture; Observation, 20 years.													
Mean Temperature °C	5,3	4,7	7,9	13,0	17,3	20,5	24,8	27,1	23,0	16,9	11,9	7,3	15,0
Suma in Hyōgo Prefecture; Observation, 1898–1912.													
Mean Air Temperature °C	6,8	7,1	8,5	13,2	17,3	21,2	24,7	27,5	22,0	16,4	10,7	7,3	15,0
Mean of Daily Max. Temp. °C	8,1	10,9	12,6	17,9	22,2	25,8	28,1	31,8	25,8	21,1	14,6	9,3	19,0
Mean of Daily Min. Temp. °C	0,5	3,4	4,4	8,5	12,5	16,6	21,3	23,3	18,3	11,8	6,8	5,3	11,1
Arima in Hyōgo Prefecture; Observation, 1898–1912.													
Mean Air Temperature °C	2,5	2,0	5,1	11,1	15,6	19,6	23,2	24,3	20,8	14,7	8,8	4,2	12,7
Mean of Daily Max. Temp. °C	5,8	5,5	9,1	15,4	20,4	23,4	26,3	27,7	23,6	17,7	11,9	7,1	16,2
Mean of Daily Min. Temp. °C	−0,7	−1,4	1,2	6,9	10,9	15,9	20,1	20,9	18,1	11,8	5,9	1,4	9,2
Yumoto in Kanagawa Prefecture; Observation, 1902–1913.													
Mean Temperature °C	5,3	5,3	8,3	13,2	16,7	20,2	23,5	24,7	21,6	16,5	11,6	7,4	14,5
Absolute Max. Temp. °C													34,3
Absolute Min. Temp. °C													−7,0
Hakone in Kanagawa Prefecture; Observation, 1911–1913.													
Mean Temperature °C	0,0	0,6	3,5	8,2	12,3	16,9	20.1	21,1	17,6	12,3	6,4	1,7	10,0
Absolute Max. Temp. °C													31,2
Absolute Min. Temp. °C													−13,5
Kami-Suwa in Nagano Prefecture; Observation, 1911–1912.													
Mean Temperature °C	−2,5	1,5	4,3	11,0	15,5	19,2	23,0	24,2	19,6	13,1	7,5	1,0	11,4
Mean Humidity %	77	63	66	57	57	66	69	68	73	70	69	72	67

	January	February	March	April	May	June	July	August	September	October	November	December	Year
Asama **(near Matsumoto) in Nagano Prefecture; Observation, 1911–1912.**													
Mean Air Temperature °C	−1,0	2,5	6,0	12,2	17,2	20,6	24,7	25,5	21,7	14,1	8,3	2,5	12,9
Mean Humidity %	30	71	64	59	60	73	69	75	74	72	69	72	69
Bessho **in Nagano Prefecture; Observation, 1911–1912.**													
Mean Temperature °C	−0,2	2,8	6,0	12,8	17,2	20,6	25,3	26,4	21,1	15,1	9,1	2,3	13,2
Mean Humidity %	37	69	66	58	59	74	79	70	83	66	69	72	70
Karuizawa **in Nagano Prefecture; Observation, 1911.**													
Mean Temperature °C	−1,8	2,1	5,0	—	—	17,3	18,8	21,9	19,9	11,5	10,1	−0,4	—
Mean Humidity %	65	59	61	—	—	73	83	82	72	75	66	61	—
Nikkō **in Tochigi Prefecture; Observation, 1908.**													
Mean Air Temperature °C	0,5	−0,5	3,6	9,0	13,3	17,7	18,6	22,1	15,8	12,1	5,6	1,6	9,9
Mean Daily Range of Temp. °C	13,4	14,3	12,5	14,5	6,8	13,2	10,2	11,8	10,8	13,2	14,5	12,0	12,3
Absolute Max. Temp. °C													35,5
Absolute Min. Temp. °C													−9,5
Humidity %	75	75	74	79	76	83	91	84	91	81	68	64	78
Absolute Min. Humidity %													2 ?
Kaminoyama **in Yamagata Prefecture; Observation, 22 years.**													
Mean Air Temperature °C	0,7	1,5	4,8	12,3	17,7	21,5	24,8	26,5	21,6	15,2	9,0	2,9	13,2
Takayu **in Yamagata Prefecture; Observation, 9 years.**													
Mean Temperature °C	−2,8	−3,2	0,5	7,6	12,0	16,3	20,1	21,5	17,0	11,5	4,7	−1,2	8,7

Table III.

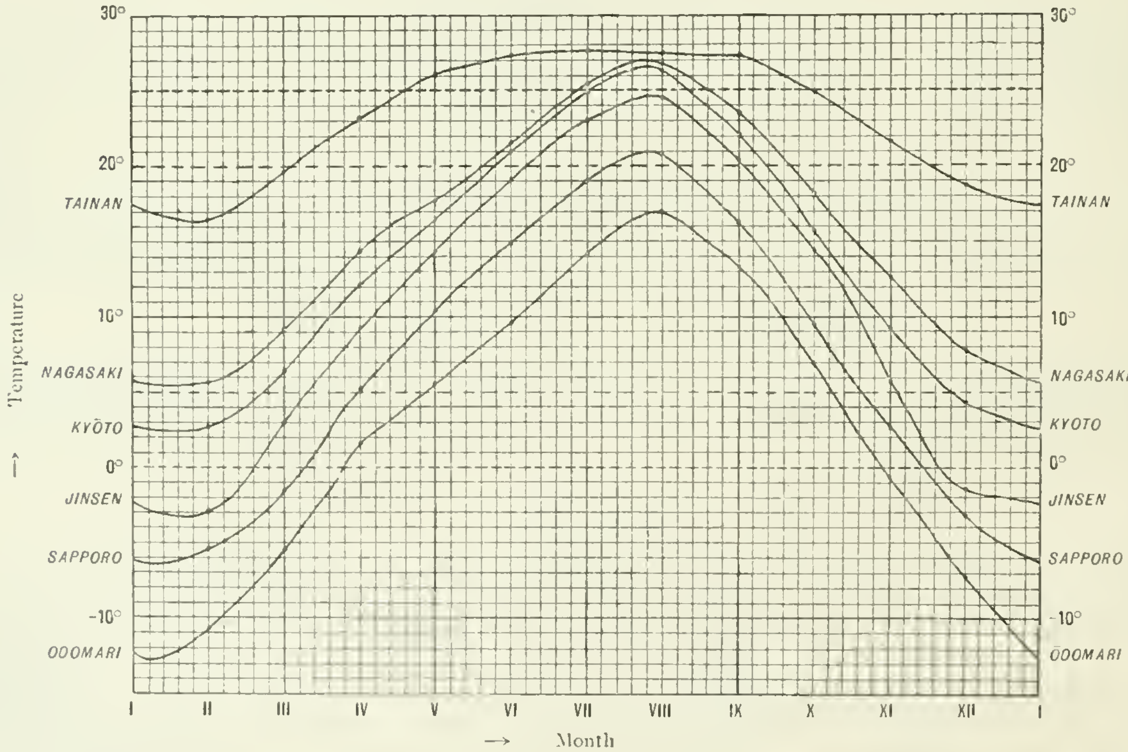
Mean, Absolute Maximum and Absolute Minimum Temperature.

Locality	Name of Place	Height above sea	Latitude N	Longitude E	Number of years of observation	Mean Temperatures													Highest Temperature	Lowest Temperature
						January	February	March	April	May	June	July	August	September	October	November	December	Year		
Taiwan (Formosa)	Tainan	m. 14,3	22°59′	120°12′	15	17,3	16,4	19.7	23,3	26,0	27,2	27,7	27,4	27,1	24.9	21,4	18,4	23,1	36,9	3,0
	Taihoku	9,3	25° 2′	121°31′	15	15,6	14,3	17,0	20,5	23,9	26,6	27,9	27,7	26,2	23,1	19,6	16,8	21.6	37,0	−0,2
Kyūshu	Kagoshima	119,7	31°35′	130°33′	29	7,4	7,2	10,9	15,7	18,7	22,2	25,8	26,6	24,2	19,1	13,8	8,9	16,7	36,2	6,1
	Nagasaki	133,0	32°41′	129°52′	33	5,8	5,8	9,1	14,3	17,9	21,6	25,5	20,7	23,5	18,0	12,6	7,6	15,7	36,7	5,2
	Oita	5,9	33°14′	131°36′	25	5,8	5,4	8,3	13,2	17,0	21,1	24,9	26,0	22,7	17,3	12,3	7,7	15,1	30,0	−7,5
Shikoku	Matsuyama	32,4	33°50′	132°45′	22	4,9	4,6	7,8	12,9	16 8	21,3	25,2	26,1	22,7	16,5	11,5	6,9	14,8	36,0	7,0

Locality	Name of Place	Height above sea	Latitude N	Longitude E	Number of years of observation	Mean Temperatures													Highest Temperature	Lowest Temperature
						January	February	March	April	May	June	July	August	September	October	November	December	Year		
Japan Proper, Main Island	Sakai	2,9	35°33′	133°14′	29	4,1	3,6	6,9	11,9	16,1	20,5	24.5	26,0	22,1	16,3	11,1	6,4	14,1	37,8	-9,7
	Kōbe	58,3	34°41′	135°11′	15	4,9	4.4	7.6	13,2	17,5	21,3	25,0	26,6	23,0	17,2	11,9	6,9	15.0	36,5	-5.5
	Kyōto	49,4	35° 1′	135°46′	31	2,6	2,7	6,1	12,2	16,4	21,0	25.0	26,1	22,2	15,5	9.4	4,3	13,6	37,2	-11,9
	Nagoya	15.2	35°10′	136°55′	21	3.5	3.6	7,3	13,2	17,4	21,5	25.5	26.5	22,9	16,4	10.6	5.3	14,5	36,8	-9,5
	Tōkyō	21,3	35°41′	139°45′	36	2,9	3,5	6,8	12,4	16.5	20,4	24,0	25,4	21,8	15,8	10.1	5.2	13,7	36,6	-9,2
	Niigata	25,6	37°55′	139° 3′	30	1,4	1,2	4.4	10.3	14,8	19,2	23.5	25,4	21,4	15.2	9,4	4.0	12,5	39,1	-9,7
	Matsumoto	582,1	36°14′	137°59′	14	-2,0	-1,7	2.4	9,0	13.7	18,4	21.9	22,5	18,2	11,6	6,0	0,9	10,1	35.2	-24,8
	Utsunomiya	125,0	36°34′	139°53′	21	0,9	1.5	4 9	11,1	15,4	19,6	22,9	24,2	20,6	14,4	8,1	2,7	12,2	35.7	-14,8
	Maebashi	112,9	36°24′	139° 4′	15	2,5	2,5	5.8	11,5	15,8	19,8	23.2	24,4	20,5	14.6	9,3	4.5	12,9	35.8	-9,1
	Aomori	4,3	40°51′	140°45′	30	-2,8	2,5	0,5	6,9	11.7	16,1	20,4	22.6	18,3	11,8	5,6	-0,1	9,0	35,6	-19,0
Hokkaidō	Sapporo	16,9	43° 4′	141°21′	35	-6,2	-5,3	-1,6	5,1	10,4	14,8	19.0	20,8	16,1	9.3	2,7	-3,3	6.8	34.1	-25,6
	Nemuro	26,7	43°20′	145°35′	32	-5,0	-5.5	-2,5	2,9	6,5	9,9	14,2	17,4	15,2	10,5	4,3	-1,4	5.5	31,9	22,7
Karafuto	Ōdomari	37.3	46°39′	142°46′	6	-12,5	-10,8	-5,7	1,5	5.6	9.7	14,2	16,8	13.2	6,9	-0,8	-7,3	2,6	27 9	-32,7
Chōsen	Jinsen	67,6	37°29′	126°32′	8	-2,3	-3,0	2,6	9,2	14.3	19,1	23.0	24.3	20.2	14.3	5,8	-1,6	10,5	34 6	-18,7

Fig. 1.

Temperature.



The air temperature in Japan, except Taiwan (Formosa), belongs to the *temperate-zone type*. Nearly all temperature curves for places in Japan Proper lie between the curves for Nagasaki and Sapporo. If we exclude those for Ō-u and Hokkaidō, then the curves coalesce at the curve for Kyōto. The Tokyō curve nearly coincides with that of Kyōto, which actually does in the warmer period. In these regions—from Kyūshū to Kwantō and Hokuroku excluding the high land in Central Japan—the mean monthly temperature does not fall below 0° C. In Japan Proper it lies between 5° C and 20° C for about 6 months of the year, excepting Kyūshū where for about 7 or 8 months.

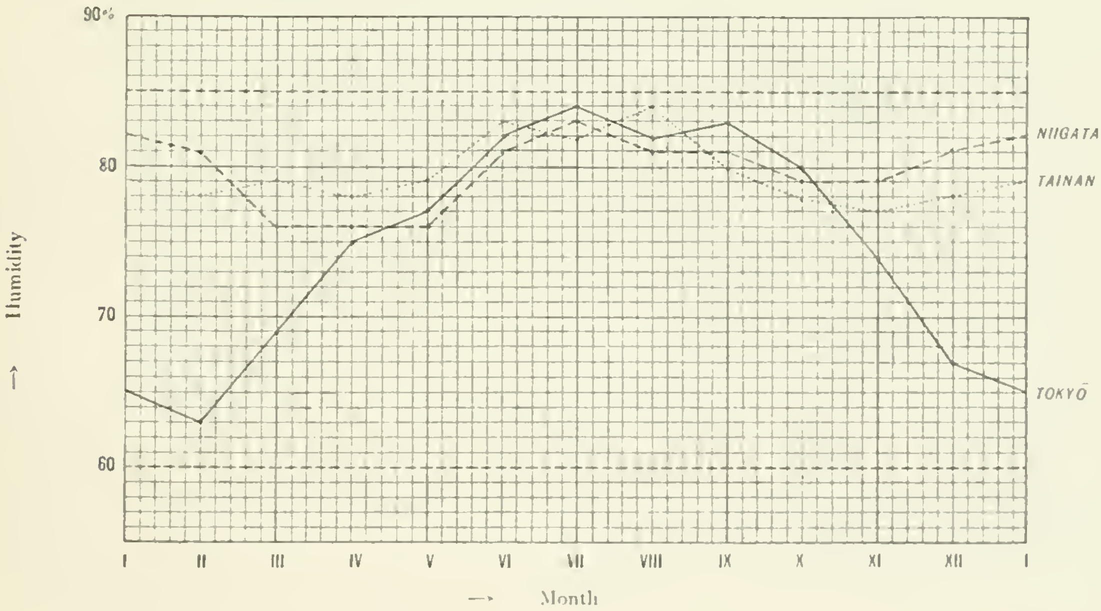
Table IV.

Humidity.

Name of Place	January	February	March	April	May	June	July	August	September	October	November	December	Year	Absolute Min.
Tainan	79	78	79	78	79	83	82	84	80	78	77	78	80	26
Taihoku	84	84	85	83	81	80	77	78	79	81	81	83	81	31
Kagoshima	71	70	72	75	77	83	82	80	78	73	72	72	75	14
Nagasaki	72	70	71	75	76	83	82	78	76	71	72	72	75	17
Ōita	75	73	77	80	81	85	86	85	86	80	77	73	80	22
Matsuyama	73	71	74	77	78	80	80	81	83	80	76	72	77	15
Sakai	79	77	75	77	77	81	83	82	82	79	78	78	79	18
Kōbe	69	65	68	69	70	77	79	75	75	72	70	67	71	17
Kyōto	79	76	74	74	73	77	78	77	80	80	81	79	77	10
Nagoya	75	70	69	73	73	77	79	79	81	77	76	75	75	21
Tōkyō	65	63	69	75	77	82	84	82	83	80	74	67	75	8
Niigata	82	81	76	76	76	81	83	81	81	79	79	81	80	21
Matsumoto	82	77	74	71	71	76	80	82	83	83	78	79	78	17
Utsunomiya	72	68	70	73	76	80	84	84	84	80	77	72	77	7
Maebashi	63	59	62	68	73	79	84	84	84	78	69	63	72	15
Aomori	81	79	75	72	73	79	82	81	79	76	70	79	78	18
Sapporo	79	79	77	73	74	81	84	83	83	81	78	79	79	8
Nemuro	72	75	78	81	83	90	91	91	86	78	72	70	80	13
Ōdomari	85	83	81	82	83	86	88	88	84	79	75	81	83	28
Jinsen	69	62	62	69	74	80	84	81	73	69	66	63	71	17

Fig. 2.

Humidity.



On the Pacific coast the relative humidity varies yearly as does the air temperature on the same coast, but on the Japan Sea coast it changes like the rainy days. In summer there is no striking difference between these two districts. In winter the coast of Japan Sea is wet, the mean monthly humidity exceeding 80 per cent. But the Pacific and Inland regions are dry, the mean monthly humidity sinking below 65 per cent. In summer, it often exceeds 90 per cent on mountain slopes and on some capes and islands in Japan Proper, but this is not the case in ordinary residential localities. The dullest and the wettest period in Japan Proper is experienced in the *bai-u* season when, for about two weeks—from the end of June to the beginning of July—the weather is cloudy, warm and damp indoors. In Karafuto (Sagalien) and in the eastern part of Hokkaidō 90 per cent is surpassed in winter, but Chōsen (Korea) is very dry in winter.

Table V.

Amount of Precipitation. (mm)

Name of Place	January	February	March	April	May	June	July	August	September	October	November	December	Year	Absolute Max. in 24 hrs.
Tainan	29	35	39	56	146	358	353	457	138	38	21	8	1677	385
Taihoku	95	132	164	137	206	248	196	328	262	103	80	80	2030	287
Kagoshima	91	87	153	230	240	372	294	186	228	128	94	81	2184	207
Nagasaki	82	82	133	198	200	326	239	191	220	111	84	82	1947	345
Ōita	50	58	123	135	170	232	224	161	231	152	76	49	1662	444
Matsuyama	55	50	92	121	143	199	169	99	181	112	66	58	1343	157
Sakai	199	141	144	136	109	173	171	130	223	157	159	191	1934	290
Kōbe	59	39	98	136	113	217	174	117	199	116	58	39	1364	199
Kyōto	63	61	113	167	144	237	209	146	206	132	77	50	1604	161
Nagoya	61	56	133	172	162	235	212	187	262	147	83	51	1762	240
Tōkyō	59	69	113	128	150	170	144	140	213	183	100	53	1520	172
Niigata	189	123	107	109	90	133	157	133	187	151	191	231	1799	135
Matsumoto	54	38	80	102	101	168	149	131	174	100	45	44	1187	160
Utsunomiya	41	47	95	130	151	198	247	230	238	119	69	40	1605	153
Maebashi	34	28	59	89	108	157	195	219	228	105	40	29	1290	164
Aomori	127	106	79	65	74	80	135	113	139	111	136	161	1326	108
Sapporo	68	56	59	52	61	63	84	95	136	106	96	93	968	124
Nemuro	30	21	46	70	95	88	86	98	134	93	81	60	901	122
Ōdomari	23	14	36	56	90	66	96	78	83	84	56	48	728	51
Jinsen	15	9	22	56	84	86	193	179	139	39	41	22	884	153

The amount of precipitation is moderate in Japan. The yearly amount is 1520 mm at Tōkyō, 1799 mm at Niigata, 1949 mm at Nagasaki, 2030 mm at Taihoku, 1326 mm at Aomori and 963 mm at Sapporo. The general tendency is that it diminishes towards the north. The heaviest rain ever experienced at Tōkyō was 172 mm in 24 hours, while 444 mm occurred at Ōita. The rainfall is intense on slopes facing monsoons. Hence the Japan Sea coast is rich in rain in winter, and the Pacific coast in summer.

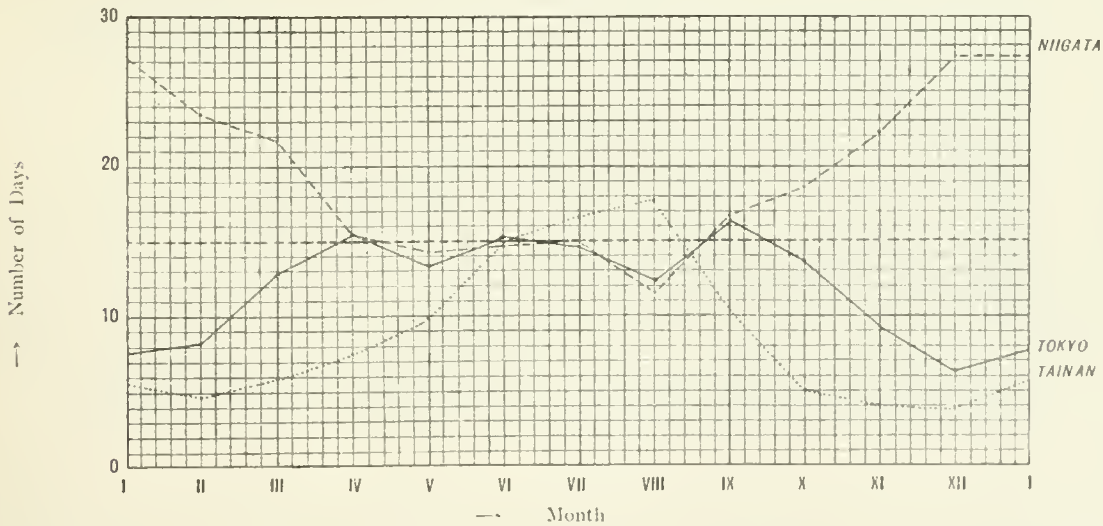
Table VI.

Number of Rainy Days.

Name of Place	January	February	March	April	May	June	July	August	September	October	November	December	Year
Tainan	6	5	6	7	10	15	17	19	10	5	4	4	107
Taihoku	17	17	18	15	15	14	13	16	13	14	15	16	184
Kagoshima	13	12	16	15	15	18	16	14	14	11	10	12	168
Nagasaki	16	13	15	14	13	17	14	13	13	10	11	15	166
Oita	9	8	14	13	13	14	14	12	15	10	8	7	137
Matsuyama	12	10	15	13	13	14	13	10	14	10	10	11	146
Sakai	26	21	19	14	12	13	14	11	16	15	26	25	207
Kobe	11	9	15	13	12	14	13	11	15	10	9	9	140
Kyōto	13	12	15	14	14	15	15	12	15	11	11	12	162
Nagoya	9	8	13	13	12	15	15	12	16	11	10	9	144
Tōkyo	8	8	13	14	13	15	15	12	16	14	9	6	145
Niigata	27	23	22	15	14	15	15	12	17	19	22	27	228
Matsumoto	12	8	13	12	12	15	17	13	15	12	9	9	147
Utsunomiya	7	7	13	14	15	17	21	18	17	13	9	5	156
Maebashi	8	5	11	13	14	18	20	18	18	12	7	5	148
Aomori	26	22	21	13	13	13	14	12	16	17	22	27	216
Sapporo	19	17	17	12	13	13	12	13	16	17	19	20	189
Nemuro	11	10	12	12	13	15	15	14	15	13	13	12	155
Ōdomari	12	12	15	12	13	12	14	14	15	15	17	16	167
Jinsen	8	5	5	7	8	10	14	12	9	7	8	9	103

Fig. 3.

Number of Rainy Days.



By a rainy day is meant a day on which not less than 0,1 mm of any form of precipitation is measured. This amount really is too small to be regarded as a day of rain; hence the number of rainy days thus defined is 10 to 20 per cent greater than that which we understand a rainy day to be in ordinary conversation. The average number of rainy days is 145 in Tokyo and 228 in Niigata. In Taiwan and in Chōsen it is comparatively less.

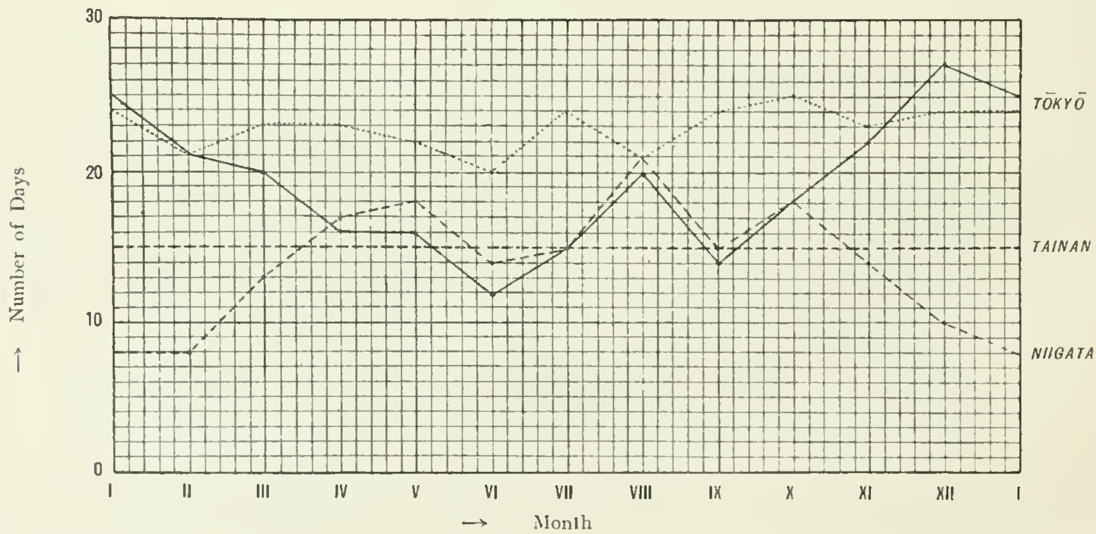
Table VII.

Number of Clear and Fair Days.

Name of Place	January	February	March	April	May	June	July	August	September	October	November	December	Year
Tainan	24	21	23	23	22	20	24	21	24	25	23	24	272
Taihoku	12	8	11	12	15	16	23	22	22	17	12	12	182
Kagoshima	21	18	18	16	16	10	18	24	19	21	23	25	229
Nagasaki	19	17	19	17	17	12	18	23	19	22	23	20	224
Ōita	24	21	20	18	19	14	18	24	17	21	24	26	245
Sakai	8	8	14	17	18	13	16	22	15	19	17	12	179
Kōbe	24	22	20	18	17	12	15	20	16	20	24	26	235
Kyōto	21	18	18	16	17	12	15	20	15	20	22	24	218
Nagoya	26	24	22	18	18	12	16	21	16	20	24	27	243
Tōkyō	25	21	20	16	16	12	15	20	14	18	22	27	226
Niigata	8	8	13	17	18	14	15	21	15	18	14	10	196
Matsumoto	21	21	19	17	17	12	12	17	13	18	23	24	212
Utsunomiya	26	24	21	18	18	12	12	17	14	19	24	28	234
Maebashi	26	24	21	17	16	10	10	14	11	19	24	28	219
Aomori	11	11	16	20	21	17	16	21	20	22	15	10	200
Sapporo	18	16	18	19	18	16	15	19	19	22	17	17	213
Nemuro	23	20	22	17	17	11	11	12	16	22	21	25	217
Ōdomari	24	21	21	17	12	13	12	14	20	22	19	19	213
Jinsen	24	24	22	21	21	18	14	20	22	26	25	27	262

Fig. 4.

Number of Clear and Fair Days.



The weather is fine for about two thirds of a year in Japan, excepting the Japan Sea coast, where about half a year is cloudy. The number of clear and fair days is 226 in Tōkyō, and 196 in Niigata. In Taiwan it is 272 and in Jinsen 262.

The climate of each district is as follows:—

Taiwan (Formosa). The southern half of Taiwan is in the tropics, hence the climate is tropical. The mean annual temperature at Tainan and at Taihoku are respectively 23,1° C and 21,6° C and the absolute maximum temperatures are 36,9° C and 37,0° C; thus mean humidity is 80 and 81 per cent. Rain falls abundantly near Kiirun (Keelung); the yearly amount exceeding 5000 mm; but in Taihoku it is 2030 mm. The rainy season of Taiwan is June, July and August, during which thunder showers are a daily phenomenon. There is no snow in Taiwan, nor frost in the southern half of it; in the other half frost happens sometimes but very rarely. Rice crops are raised three times a year. The sugar-cane and the camphor-tree are two useful plants in Taiwan. Typhoons attack the island very frequently during the summer months. Sometimes it destroys all the sugar crops. The maximum wind velocity reached 56,8 m/s at Koshun in Taiwan during the passage of an intense typhoon.

Kyūshū. Kyūshū is rather warm; the mean annual temperature at *Kagoshima* and at *Nagasaki* is respectively 16,7° C and 15,7° C. Snow and frost occur very seldom. In other climatological respects there is no conspicuous difference between Kyūshū and the Main Island.

Naikai (Inland Sea District). The characteristics of the climate of this region are dryness and a comparatively small amount of rainfall. The latter is 1343 mm and 1115 mm respectively at Matsuyama and Okayama. The number of fine days in this district is greater than that of the surrounding districts, because it is guarded by mountain ranges on all sides and the air currents come across these in a comparatively dry and warm state. The manufacture of common salt on the sea beach is advantageously carried out in this district.

San-in and ***Nankai.*** San-in is situated to the north of Naikai, and Nankai to the south of this, both separated from Naikai by mountain ranges. San-in has abundance of rain in winter, and Nankai in summer; the excessive rain in these districts corresponds to the deficiency of it in Naikai district. The annual amount of rainfall at *Sakai* in San-in is 1934 mm; at *Okayama* 1115 mm; and at *Kōchi* in Nankai 2727 mm. The number of rainy days in January is 26 in Sakai; 8 in Okayama and Kōchi.

Hokuroku. This district lies on the Japan Sea coast of the central part of the Main Island. The summer climate of this district is nearly the same as that of Kwantō, but the winter climate is too wet being under the influence of the north-westerly monsoon. The depth of snow at some places exceeds two metres. The temperature is not low comparatively speaking, because a warm sea current washes the coast. The mean temperature in January at *Kanazawa* in this district is 2,5° C, while at *Mito* on the Pacific coast and at a little low latitude it is 2,2° C.

Kinai and ***Kwansai.*** The climate of these districts approaches the average of Shikoku—Chūgoku (Nankai + Naikai + San-in) and Kwantō. The phenological season in this district is a little earlier than that in Kwantō.

Tōkaidō and ***Kwantō.*** The climate of this region is considered to be the representative of that of Japan, and shall be described later under the heading of "The yearly variation of the climate of Japan."

Central Japan. A little cooler than Kwantō, but with less rainfall.

Ō-u (North-eastern part of the Main Island). This region is much colder than Kwanto in winter, but not appreciably cooler in summer.

Hokkaidō. Though this district is very cold in winter—the January mean temperature at *Sapporo* being −6,2° C and at *Nemuro* −5,0° C—, it becomes warm very rapidly so that the summer air temperature reaches 20° C. The rice plant is cultivated in the western half of this island. The amount of rainfall is less; in Sapporo the annual amount is 968 mm. Hokkaido is a pleasant place to live in summer, but somewhat uncomfortable place in winter.

Karafuto (Sagalien). This island is very cold and humid. Thunder occurs once or twice a year.

Chōsen (Korea). The temperature is very low in the northern part, but moderate in general. The winter climate is dry and fine. In some years there is no snow nor rain in January or December at all. The eastern coast is always warmer than the western coast.

Yearly Variation of Climate in Japan. As formerly mentioned the empire of Japan stretches from Latitude N 22° to N 52°, and hence the climate of the southern and northern extremities is quite different. In the southern half of Taiwan (Formosa) people never experience frost in the plains, and rice can be raised three times a year, while in Karafuto (Saghalien) and in Chishima (Kuriles) the ground is covered with ice and snow during more than half a year; and even in the maximum of their summer heat, we find braiziers or hearths in every house.

As the Japan Islands form the boundary between the Asiatic Continent and the Pacific Ocean, the influence of monsoons and oceanic currents upon the climate is very remarkable. During the winter, the north-westerly monsoon brings moisture from Siberia and Japan Sea, and on reaching Japan, drops it abundantly on the districts bordering on the coast of Japan Sea, which, as a whole, is called the *Ura-Nippon* (Back Japan), hence the winter of this district is very gloomy and humid as formerly stated. The average number of rainy days at Niigata in January amounts to 27 *i.e.* 90 per cent of a month. The monsoon deposits its moisture on the north-westerly side of the central mountain range of Japan, and crosses the system in dry state. Hence on the Pacific coast the weather is very fine during the cold winter months, the number of clear and fair days in Tōkyō in December being 27 *i. e.* 90 per cent. Moreover the warm current called *kuro-shio* (Black Stream) washes the southern coast of Japan as far as *Chōshi*—coasts of Nankai, Tōkaidō and Kwantō—being very warm in winter. For example, the air temperature in Januaay is 5,7° C at *Kōchi* in Nankai, 5,0° C at *Hamamatsu*, and 5,3° C at *Numazu* both in Tōkaidō. In these regions the camellia bears flowers throughout the winter; plum blossoms open in December; the palm flourishes in the open air and the ever green orange-tree is laden with golden fruit in winter. In the central high lands, the weather is very clear in winter, but the air temperature descends conspicuously. It is −2,0° C on the average of January at *Matsumoto*. *Lake Suwa* in this district is covered with thick ice, affording a reliable skating-ground. We can see silver thaw and diamond dust *i. e.* ice-crystals floating in the air, every cold morning at the lakeside.

The weather changes very regularly in the cold months in Japan. This depends on the periodic oscillation of the Siberian high atmospheric pressure. In Korea there is a proverb "*San-kan Shi-on*" that is to say, "three days cold, four days warm." In Japan Proper they say "Wind on every five days and rain on every ten days." The actual periods of this variation is not quite fixed, but fluctuates on an average every six or seven days. In the spring as the air temperature rises, the number of rainy days increases on the Pacific coast but decreases on the Japan Sea coast, which means the change in the monsoons. Rain during this season is known by the special name of "*haru-same*," whose characteristic is that it comes down very calmly and gently as if this silky threads fell soundless from the sky. Thus it scarcely harms the soft young buds but rather nourishes them. It becomes warm by stages with each rainfall. At the beginning of April a weather feature called "*hana-gumori*" (flower cloudy) prevails in the middle part of Japan, under which it is mild, cloudy and rather warm; and *cherry blossoms* begin to display their myriad magnificence. After the cherry we have *peonies*, *wistarias*, *azaleas* and other flowers successively until the end of May. Swallows come back from the south, and begin to build their nests in the interiors or entrances of dwelling-houses. April and May are most enjoyable months in Japan. Fields and woods are bright with fresh verdure and birds such as the nightingale, cuckoo, lark, bunting etc. sing their loveliest songs. In this season farmers prepare their rice-marsh. We see all the gray, withered field of March change into a sort of a lake in May in which thousands of frogs croak. At the beginning or middle of June farmers plant the young shoots of the rice-plant in these shallow marshes. This task is called "*ta-ue*." The wives and daughters of farmers tidily dressed are also in the water planting rice seedlings and singing "*ta-ue-uta*" (Rice planting songs).

The *bai-u* or plum rain begins at the end of June, and it continues about two weeks. In this season the sky is overcast and rain falls continuously. In Fig. 4. we see clearly the diminution of the number of clear and fair days in Tōkyō and Niigata in June. The *bai-u* does not occur in Hokkaidō. It cools June and July temperatures, and consequently the yearly maximum of temperature appears in August. From the middle of July the real Japanese summer begins. The air temperature exceeds 30° C on some days at almost all places in Japan Proper, except in the north-eastern part. During this season the city life is somewhat trying, but in the country it is not so, because since Japan is an island and a mountainous country, the sea, on the one hand, affords gentle breezes (land and sea breezes) and the hills and valleys, on the other, supplies the inhabitants with pleasant winds (mountain and valley winds). *Hakone*, *Nikkō*, *Karuizawa*, *Unzen* etc. are good summer resorts. During this season thunder of thermic origin occurs very frequently. Sometimes it is intense, but in general very refreshingly and clearing. The short night of summer is not sufficient to cool the heated earth and air in the day time. The burning sun projects its beams fiercely increasing from its rise. At about noon, we see many great towers of *cumulo-nimbus* above the mountains. They increase their heights; their heads attain the cirrus height, flattened at the top; they begin to move from their original positions, and soon we hear the distant peals of thunder. After one hour or so, the sky is overcast, the thunder becomes louder and louder and at last the shower begins preceded by cool squally winds. This rain disposes of the heat and clears the dust away. All creatures are refreshed. It passes away after 20 or 30 minutes and the deep blue sky reappears. Thus thunder in Japan in summer is accompanied rather rarely by storm but most frequently by showers. From the end of August until the beginning of September there are frequent visits of Typhoons to Japan. September is the period of transition of the summer and winter monsoons. From the middle of September cool winds begin to blow. People gradually forget to use the fan. The number of rainy days increases a little during this month. October is another pleasant month in the Japan Proper. Fine weather continues till November on the Pacific coast but it begins to rain and snow on the Japan Sea coast. From the end of October until November farmers harvest their rice. The autumn tints in forest are beautiful. In villages we see red *kaki*-fruits still on the branches. *Chrysanthemums* are also in full bloom. We now feel the approach of winter by the cackles of emigrating wild-geese which come from the northern countries flying over the sea. Thus the yearly variation of the climate of Japan is about to repeated.

Chapter V

THE ORIGIN OF CLIMATE THERAPEUTICS IN JAPAN.

The origin of climate therapeutics in Japan is unknown and naturally is not recorded in history. But according to one story, Kōbō-Daishi, a famous and much revered Buddhist priest, opened for worship the eighty-eight temples in the island of Shikoku and the thirty-three temples in the western provinces, and appealing to the religious sentiments of the people, he advocated a circular pilgrimage to these temples in spring and early summer. This is now supposed to be a prominent example of combining climate therapeutics with religious propaganda. We cannot but esteem very highly the originality and far-sightedness of this sage priest, who is generally believed to have possessed a profound medical knowledge. The genuineness of this statement seems fully justified by the fact that these temples founded by him are not located on level land, too easy of access, but in mountainous districts where the air is pure and free from corruption.

Principal Forest Health Resorts. The best forest health resorts in Japan are in the Shinano *see Plate 37*
Province, the Nasu Mountains, the Kiso Valley, and some parts of Hokkaidō. If some suitable grounds be chosen and properly taken care of, all of these places will doubtless present us with ideal *see Plate 25, 38 and 12–14*
climatic sanatoria.

THE ORIGIN OF BALNEO-THERAPY IN JAPAN.

In looking through Japanese history we find in the record of the Age of the Gods, that people bathed in hot springs to recuperate. Following this history later tells us that the two Emperors, Kimmei and Kōtoku, resorted to hot spring baths for medical purposes. The *kojiki* ("Records of Ancient Events") gives evidence that the former Emperor proceeded to *Arima* Hot Spring in Settsu *see Plate 58*
Province, and *Dōgo* Hot Spring in Iyo, to recuperate there. Gotō Konzan, a physician, is said to *see Plates 63 and 64*
have utilized hot springs for medical treatment. Yamamura Tsūan, another physician, walked the round of various hot springs scattered in distant provinces, in order to test their composition and medical efficacy, and published the fact that *Kinosaki* in Tajima Province, and *Kusatsu* in Kozuke, *see Plates 50 and 9*
etc., were of the formost importance from a medical point of view.

THE ORIGIN OF SEA BATHING IN JAPAN.

Tracing back this subject we come across the frequent mention of "*shio-tōji*" (cure in the brine) in old books. The custom of sea bathing, as well as bathing in hot springs, is thus traceable back to the Age of the Gods. These two methods of bathing may be said to be equally of extremely ancient origin, but in mediæval ages hot spring baths alone were popular, while sea bathing dwindled into insignificance. Although of course no definite data are obtainable as regards the vicissitudes of this form of ablution, it is not difficult to infer from the seagirt position of this country that the custom undoubtedly continued to be practised in different places.

Ancient Evidence of Method of Basking in the Sun. In the "*Owari Meisho-zue*" (Pictorial Records of Interesting Places in Owari Province) there is a picture showing sea bathing at Ōno, some five miles from Atsuta (near Nagoya). From this origin we gather sea bathing there dates back to some 700 years ago, or to be more accurate, 765 years ago people used to dip themselves in sea water until they felt cold, and then lie down on sun-burnt stones for warmth. This is nothing but a curious, ancient record of basking in the sun.

New Departure in Sea Bathing since the Restoration. In 1881 the then Governor Rempei Kunisada happened to visit this place during his prefectural tour. On learning the history of sea bathing there, he conferred with Mr. Shimpei Gotō, then the Chief of the Aichi Hospital, who was emphatically teaching the medical value of sea bathing, and had made a certain Shōzō Nijō set up a rest hut for changing the clothes. This erection of a bathing hut marked a new departure in the methods of sea bathing after the Meiji Restoration and gradually led to its present popularity.

It is not rare to find old instances of bathing in waterfalls as an invigorating tonic during the *see Plate 41* heat of summer. In some such waterfalls as in Mt. Takao, Musashi Province, Mt. Ō-iwa, Etchū Province, etc., popularly believed to be efficacious for curing mental derangement, there were constant bathers not only in summer but also in the colder seasons.

The Opening of Sea Bathing at Ōiso. As stated above, though evidence of sea and cool water bathing dates back to mythical ages, but it is only within the past thirty years and long after the introduction of this medical science in the west that the people here have realized or have been awakened to the therapeutic advantages of sea bathing, etc. In 1886 Dr. Jun Matsumoto for the *see Plate 33* first time drew the public attention to Ōiso as an excellent sea bathing place and thus brought about the local popularlity of this method of therapeutics. Since then there have been established seaside sanatoria at Kamakura and Shichiri-ga-hama in Sagami Province, Suma in Harima, etc.

Sea Water Bath-Houses. Sea water bath-houses are still very rare in Japan and the Chū-eikwan outside the port of Yokohama in Kanagawa Prefecture is probably the only one of this kind now in existence.

Natural Sea Bathing Place. On the other hand, there is an endless number of seaside places naturally fit for bathing, the most important of which are dotted along the Pacific coasts of Tōkaidō, Nankaidō, and San-yōdō districts and also the islands of Shikoku and Kyūshū. Most of these places are easily accessible, endowed with a mild climate, and form excellent health resorts. The geographical nature of our islands makes the Pacific side extremely rich in suitable watering places, but no few are found also on the Japan Sea side.

Sand Baths. Sand baths have been and still are very popular on the sandy beaches in the *see Plate 09* neighbourhood of Beppu and Hamawaki Hot Springs, both of these places are naturally suitable for the purpose and are said to cure hæmorrhoids.

Hot Sand Baths. Hot sand baths have been practiced among the people for a considerable period. One such bath is located on the beach of Sōyu-no-hama, Ibusuki-gōri, Satsuma Province. Shōshi Tamiya, a physician, speaks of this place, as follows :—

> "All patients lie down, naked or thinly clad, on the hot sand and the by-standers assist in covering the bathers bodies with the sand leaving only their faces exposed and using for the purpose large wooden spades. Within a short period the bodies are heated by degrees, the perspiration oozes out from every pore of the skin carrying away ill humours and impurities, thus lightening, toning-up, and invigorating the body. During the operation the patients feel as if they were in paradise, and various forms of illness are at once thrown off. Sand baths, as compared with ordinary hot spring baths, inspire a feeling in patients of mild comfort that is often preferable."

Vapour Baths. Vapour baths have existed in Japan for some centuries and were known as *see Plate 37* "*Yumushi-no-hō*" (the method of steaming). An old stone bath in Miyajima Island in Aki Province, was used as a kind of vapour bath and at one time patronized and held in high favour.

Sea Weed Baths. There is in the city of Takamatsu in Sanuki Province a bath known "*mushiburo*" (steam bath), which has existed for a considerable number of years. This is an instance of a weed bath, the sea weeds were collected and warmed, and people bathed in them to heal their illness, especially nephritis being claimed to be curable by perspiration in this heated substance. This peculiar method may also be classed as a variety or type of vapour bath.

Mineral Mud Baths. The practice of mineral mud baths is not yet generally known in Japan. In 1909 when Dr. Ishizu, an expert of the Tōkyō Hygienic Laboratory, visited the Beppu and Kamegawa Hot Springs to test their radio-activity, he had a bath prepared with sinter collected from "*Chino-ike Jigoku*" (Hell of Blood Pond). This name is given owing to the local red colour produced by a large proportion of ferric oxide. This was the first experiment with a sinter bath in Japan, but it has been followed by the inhabitants there in recognizing its benefits and since then has become quite popular.

Chapter VI

GENERAL REMARKS ABOUT HOT SPRINGS IN JAPAN.

The Situation of Hot Springs. Although Japan has numerous volcanoes, hot springs are mostly but not always located in volcanic districts. Hot springs gush out almost everywhere in this country: on the side of high mountains, on plains, in valleys and ravines, in rivers and lakes, and also on the sea shore and from the sea bottom. The character of the surroundings has, on one hand, much to do with their scenery and climate, but, on the other, with the difficulty or ease of access, supplies of variety of food and other daily necessaries, at the resorts, water, drainage, purity of atmosphere, etc., on all of which their hygienic conditions greatly depend. The diversity of geographical features makes the range of choice for visitors very wide, and enables each to select for patronage any place they fancy most suitable for their individual requirements. Thus the division of Japanese hot springs, according to their geographical and scenic characteristics, is not only of special instructive interest to intending visitors but at the same time by pointing out the local hygienic conditions, it facilitates the simplicity and ease of forming a personal decision that is of mutual benefit or satisfaction.

1. Hot springs located in high mountains, and characterized by the so-called upland climate:—*Renge*, *Bandai*, *Tateyama*, etc.
2. Hot springs located on the sides of mountains and commanding a wide view:—*Ikao*, *Akakura*, *Nasu*, etc. see Plates 6 and 25
3. Hot springs located in thick forests, valleys, ravines, etc.:—*Shiobara* and other places. see Plate 11 a
4. Hot springs located on sea shores and combining the advantages of seaside therapeutics:— *Obama*, *Sedo-no-Kanayama*, *Atami*, etc. see Plates 11a, 15 and 34
5. Hot springs close to the sea and thus combining facilities both forms of bathing:— *Beppu*, *Sedo-no-Kanayama*, *Ibusuki* Beach, etc. see Plates 30 and 48
6. Hot springs located near lakes and having picturesque scenery:—*Yumoto* near Nikkō, see Plate 20 *Ashi-no-yu*, *Suwa*, etc.

If we classify hot springs according to their altitude, the highest are the *Shibu* Hot Springs near Lake Suwa (6,950 ft. above sea-level), *Nakabusa* of Japan Alps (5,300 ft.), *Manza* (5,180 ft.), see Plate 37 *Yumoto* near Nikkō (5,088 ft.), *Sandogoya* in Nasu (5,000 ft.), *Kamikōchi* (4,720 ft.), *Kusatsu* (4,500 ft.), *Goshiki* (3,000 ft.), etc. All these hot spring resorts have vigorous upland climate. see Plate 20

The Geology of the Spots where Hot Springs gush out. Most of the hot springs issue from andesite, and next in abundance are those from Tertiary deposits, but not a few springs issue from granite.

The Quantity of Flow. The flow of hot spring waters is various in character and quantity. The most active of springs throw up their jets to a height of from 60 to 100 ft. The "*O-yu*" of Atami see Plate 34 is a famous intermittent spring and once sent up its perpendicular jets with energetic power, so much so that stone walls were built to break its force in order and cultail to avoid possible danger and it is thus deprived of the former grand appearance its unfettered play once inspired. Its activity when in full play is amazing still, and a never failing source of attraction. Another famous intermittent spring is that of *Onikōbe* in Rikuzen Province, which reaches a height of 20 ft. One of the hot springs in *Obama*, called "*Funtō-yu*," is also of intermittent nature. At *Senami* in Echigo see Plate 11 a Province boiling-hot water is being thrown up more than 90 ft. high, which may be said to form a see Plate 21 wonderful sight. Some springs discharge less sensationally, abundant in their quantity, they simply form streams of hot water in the end, as is the case at *Noboribetsu*, *Beppu*, *Kamegawa*, *Onikōbe*, *Kirishima*, etc. At some places such streams make waterfalls which are used to turn mills, e. g., *Shigaku* Hot Springs in Iwami Province. They often accumulate in forming ponds of warm water see Plate 6, fig 1

see Plates 68 and 14 as at *Beppu* and *Noboribetsu*. As regards the origins of hot springs, they are again of diverse kinds. *see Plate 40 and Plate 5, fig. 4* Some gush out of caves (*Ogawa* and *Futami* Hot Springs in Etchū Province, *Shigaku* Hot Springs, *Shin-Goshiki* Hot Springs in Uzen Province, "*Hashiri-yu*" Spring of Izusan, near Atami), in the *see Plate 5, fig. 2* middle of a river bed ("*Dokko-no-yu*" Spring of Shuzenji), from the bottom of a lake (*Tōgō* Hot Springs in Hōki Province), etc. Such extraordinary circumstances as the above examples are not rare. We may point out *Beppu* and *Itō* as the most prominent examples of these places where hot spring veins are numerous and abundant and their sources may easily be found by boring almost at any spot. The baths of the former hot springs number more than one thousand and those of the latter more than three hundred.

The Temperature of Hot Springs. The temperature of hot springs in Japan ranges very widely *see Plate 21* and numerous springs (*Naruko, Ō-yu in Atami, Senami*, etc.,) are above one hundred degrees *see Plate 5, fig. 4* Centigrade, while such hot springs as *Noboribetsu, Nakabusa, Yumura, Ōwakidani in Hakone, Obama, Beppu, Kamegawa*, etc., show above ninety degrees Centigrade. Other hot springs of below eighty degrees are too numerous to be referred to in this brief work.

The Composition of Hot Springs. The composition of hot springs is of a complete variety, and it is no exaggeration to state that Japanese hot springs comprise all possible kinds of hot springs known to the world. As might be expected simple and salt springs are the most numerous, but apart from these, the greatest bulk of the remainder are sulphur springs, these being followed in number by the alkaline carbondioxated springs. Most springs of peculiar properties are those containing *see Plates 9 and 25* free mineral acids (*Kusatsu, Nasu, Noboribetsu, Kirishima*, etc.,) and a large quantity of alumina and iron (*Kusatsu, Kannawa*, etc.,), while not a few springs contain a small proportion of boric acid, iodine, bromine, lithium, manganese, etc.

The mineral springs of Japan, either hot or cold, may be chemically classified, as follows :—

Table VIII.

Classification of Mineral Springs in Japan.

Classification †	Central Japan*	Eastern Japan*	Western Japan*	Northern Japan*	Hokkaidō	Kyūshū	Taiwan	Chōsen	Total
Simple cold springs	64	50	10	10	1	20	0	6	161
Simple thermals	41	60	22	28	3	70	2	10	237
Simple carbondioxated springs . .	4	7	5	1	1	3	2	0	23
Earthy carbondioxated springs . .	1	5	0	6	1	3	2	0	18
Alkaline carbondioxated springs .	39	38	8	9	20	35	4	0	153
Common salt springs.	55	60	9	31	5	19	3	5	187
Bitter springs	6	27	4	21	4	16	1	0	79
Iron springs	12	14	0	3	1	2	1	3	36
Sulphur springs	23	26	10	36	14	18	6	9	142
Acid hydrogen sulphide springs .	0	6	0	4	0	1	0	0	11
Acid vitriol springs	2	3	0	0	1	0	1	0	7
Alum vitriol springs	2	5	0	0	0	1	3	0	11
Not yet examined	19	42	7	14	0	17	2	35	136
Total	268	244	75	163	51	205	27	68	1201

Bathing Equipments. Japan has the largest number of hot springs but they leave still much to be desired as regards bathing equipments. Only very few of them are decently equipped with private baths, so that foreign visitors may take baths at ease. This lack of privacy is due to the custom of common bathing to which Japanese have been accustomed for many centuries, distinctions being made only for both sexes but not for individuals. Also many of the most efficacious hot springs are found in remote districts and are chiefly patronized by the neighbouring inhabitants. At present in Japan, such poorer classes as farmers living among isolated mountain districts take

* See Map of Imperial Government Railways.

† See Chapter XIII.

advantage of the medical treatment with their local hot springs, more often than the better classes from towns and cities. As it is difficult for such poor people to find good doctoring, they economically patronize the natural methods of therapeutics so conveniently at hand. Successive generations of these people have been taught that hot springs are good for almost all diseases, and without any consideration of individual cases or ailments, in simple faith, they invariably go for prolonged stays to hot springs in the neighbourhood as the sole means for recuperation. The people of the better classes consider hot springs simple holiday resorts, and, to our great regret, do not often realize their importance for medical purposes. In recent years physical therapy has been more seriously considered among well-informed circles, some of whom now are trying to experiment on the therapeutic efficacy of such natural treatments as balneo-therapy, sun basking, air baths, etc. Under such transitional circumstances, we have to be contented to await development with the present lack of proper hygienic equipments at most hot spring resorts.

Baths. For bathing accommodation houses are built near the source of springs and water is conducted to baths therein by bamboo, wooden or iron conduit-pipes, etc., the water being thus kept always fresh. At some places baths are made directly over the source. The most comfortable are natural baths hollowed out of the rock formation with hot water flowing in from the rock crevices. *see Plates 6 and 42* The housing accommodation is frequently very simple, but from the modern scientific view-point of the emanation therapy, it should be found to be ideal. Ordinary baths are in most cases made of wood but also not seldom of marble and other natural rocks. Generally clear and pure water is *see Plate 7* conducted from hot springs and offered for drinking.

The Use of Mineral Springs. Besides the ordinary use of mineral springs for bathing the body, there are some places with combined vapour baths as well, these being prepared with the natural steam from hot springs (*Beppu*, *Shima*, *Nakabusa*, *Naruko*, etc.). A method of bathing peculiar *see Plate 37* to Japan is that of utilizing hot waterfalls, artificially made where the flow of hot spring water is abundant. These waterfalls are used for the so-called hot spring massage, bathers standing under them so that the falling water may strike their head, shoulder, etc. In the hot springs of *Noboribetsu*, *Kirishima*, *Beppu*, *Shiobara*, *Kusatsu*, *Takeo*, *Nakabusa*, *Shima*, *Naruko*, etc., there are these water- *see Plates 7 and 67* falls of different forms, breadths, quantities, heights, temperatures, etc., to suit the individual requirements of bathers. Indeed this method is delightful beyond description and may well be said to be an ideal massage method. It is a custom of ancient origin in this country to drink mineral spring waters, so that long experience has taught the people the characteristic efficacy of various springs. At many hot spring resorts, the sediments deposited in reservoirs, conduit-pipes and other parts, are collected and sold as "*yu-no-hana*" (flower of spring), which are again used for preparing household baths. Large quantities of these sediments are produced at some places, e. g., *Kusatsu*, *Ikao*, *Beppu*, *see Plate 8, fig. 1* *Hakone*, *Shiobara*, *Arima*, etc. These substances contain very often sulphur, iron oxide and alumina. Concentrated common salt springs are evaporated and their residue is sold being similar and replacing the salt produced at *Karlsbad* (*Isobe* mineral spring salt). Iron springs are utilized for dyeing at *Arima*, *Ikao*, *Beppu*, etc., and textiles thus dyed are bought by visitors as mementoes. At various places small quantities of mineral water are used in the making of wafers, but the only kind, more or less effective, are those of *Isobe*, while others are in value simply nominal or of minor consequence.

At *Beppu* and *Kannawa* we observe that vegetables, cereals, and other daily food-stuffs, are cooked with the heat of steam rising from the ground. There are ovens at the road side in front of every house, on which pans and kettles are placed when necessary, the cooking being done within a few minutes. This is certainly a case of fully utilizing natures resources and a curious sight. At *see Plate 8, fig. 2 and 3* *Yumura* in Tajima Province, the source of the hot springs forms a small pond, in which villagers dip and boil rice, wheat, beans, fresh vegetables, eggs, bean curds, etc. In that village only very few houses are provided with charcoal heated ovens. There is also a laundry at a spot on the river, a little below its junction with the hot water. The practice of cooking half-boiled eggs is witnessed *see Plate 8, fig. 4* at different hot springs, and the temperature of the springs at Yamanaka and Yamashiro in Kaga Province quite answers this purpose. When eggs are dipped in these springs for six or seven minutes, the yolk congeals and the white is boiled to a palatable nicety. At some places hot-houses are set up over hot springs (*Owani* Hot Springs), and at others the heat of springs is utilized to evaporate sea water (*Asamushi* Hot Springs). In the districts with subterranean hot spring water circulation we find the cultivation of vegetables is much quickened. (*Misasa* Hot Springs in Hōki Province). *see Plate 60*

Although mineral spring waters are drunk at many places, comparatively few are bottled for sale or export to foreign countries. The principal ones exploited are the carbonated springs of *Arima*, *Takarazuka*, *Nunobiki*, *Kasagi*, *Isobe*, *Iizaka*, *Misumi*, etc. As Japan has mineral springs of all known kinds of chemical composion, it is not difficult to find good mineral waters that are equal, or sometimes superior, to the world-famous *Apollinaris*, *Vichy*, *Ems*, *Fachingen*, *Selters*, *Karlsbad*, etc. We greatly regret that the complete analyses of Japanese mineral springs have not yet been made known to the world and no enterprisers have undertaken their bottling on a large scale.

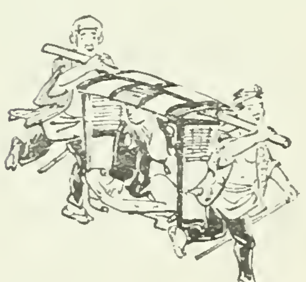
see Plates 52-58

Public and Private Baths. There are two kinds of baths, viz., public and private. At the hot spring resorts where the gush is not abundant, it is not easy for every inn to have its own baths supplied from the spring. This difficulty is experienced particularly at those places that are much below the level of the origin of hot springs. The hot water may be conducted to make public baths but may not be of such a strong flow as to supply private baths of each inn. Seeing the better class people prefer only hot spring resorts having private baths available, naturally such resorts alone prosper. No charge is generally made for common baths which are mostly open at all hours to the public. The cure tax or the like as in Europe and America is not collected at Japanese hot springs.

As Japaneses enjoy and make a habit of frequent bathing, not only health seekers and holiday makers but also ordinary travellers avoid towns for staying overnight, if hot spring places are at all conveniently near and such bathing to be had. This is well exemplified by the case of Beppu Hot Springs and the Town of Ōita.

As a rule, hot spring resorts have ample water supply in the neighbourhood and there is no necessity of water-works. Though no special arrangements may be made for drainage, it is generally satisfactory. Such being the case, it is very rare indeed any epidemic touches hot spring resorts, in spite of the absence of these artificial arrangements. Some hot spring resorts are provided with small parks or gardens for short walks and also with amusement halls. Generally there are such historic monuments and remains as temples, shrines, old castles, etc., which are numerous all over this country, and these add greatly to the interest of walks in the neighbourhood and visitors are easily beguiled of any tedium of long stays.

The Means of Access. As hot springs are generally situated far away from large cities, the means of access leave still much to be desired. But the more famous ones have now the facility of light railways, and electric and horse tramways, and at others omunibuses and *jinrikisha* are available. Across steep passes, where it is difficult to walk over, people can travel by "*kago*" (a kind of sedan chair) or on horse-back. Even if all these means fail, one generally finds full compensation in any personal effort walking through beautiful scenery on the way to the desired destination.



kago

jinrikisha

As for provisions, one may find some difficulty at most hot springs in securing luxurious food the daily fare being usually of a simple kind. When there are railway communications, daily one can get fresh fish from the sea, while again often this is replaced by fish caught in rivers and lakes in the neighbourhood. Trout abounds in mountain lakes and constitute chief dishes at hot springs resorts in their vicinity. Fresh vegetables, chickens, and eggs are obtainable everywhere, but milk is rare except in the environs of cities and towns.

Inns. Hot spring inns are generally built on a thoughtfully selected site commanding a beautiful view, this at the same time being in close proximity to the origin of the springs, though sometimes there are separate well fit up buildings providing private baths for guests' use. We can count but a limited number of hotels, at hot spring resorts that accommodate foreigners adequately, but these are all highly recommendable and well managed, homely and comfortable in their appointments, giving a good table and attendance at a most reasonable rate. But foreign tourists with some little knowledge of Japanese manners and customs will find genuine native inns rather interesting, and if ready to put up with slight incidental inconveniences, this personal adaption affords the visitor such a wider latitude not alone in the cloice of route but in a closer and more intimate enjoyment of the best the country has to offer.

The Methods of Bathing. As previously stated, the majority of Japanese hot springs are chiefly patronized by farmers and their families from the adjacent districts. They come either to recuperate (known as "*tōji*" or hot spring cure) or for a change and rest to be simply free from the cares and drudgery of daily tasks during the spring, when at short periods there is not much work on their farms. They take baths quite frequently and for great lengths of time, so much so that it is not seldom to find them bathing more than ten times a day and passing the whole night in baths, even in sleep. They sometimes bathe in rather hot water for one or two hours. Of course the length of time for bathing depends much upon the temperature of the spring. This long bathing is due to the possibly erroneous belief that the longer they bathe, the more effective it should be. But curious to say, this method, generally considered unhealthy, is not hurtful to them, probably on account of its being a habit. Even ignorant farmers strictly observe the rules for bathing set down for every spring and do not fail in propriety and inborn sense of politeness and good manners.

The Therapeutic Efficacy of Hot Springs. These farmers know from experience the therapeutic efficacy of hot springs and make full use of their knowledge. They have an implicit confidential faith in the tradition of each hot spring and choose the particular spring adapted, to their needs, with the result they are invariably successful in healing their weaknesses. If the desired cure is not entirely complete with one years baths they know a stubborn case needs patience and thus they make a practice of coming for a certain period every year. The largest percentage of these patients are sufferers from wounds, burns, rheumatism, affections of stomach, skin diseases, syphilis, disorders of brain, uterus diseases, neuralgia, etc. There is a curious superstition quite popular among the lower class people that one can be exempted from diseases during that year, if one take spring baths on a certain day in the middle of June. On that particular day all hot springs are crowded with people of both sexes and all ages, coming from far and near. All bath-tubs are filled with bathers from the early dawn and the confusion defies description but possibly can be left to the readers imagination.

The most curious of all methods of bathing is the so-called "time-bath" at *Kusatsu*, which is *see Plate* worth while describing in some details. Four baths daily at stated definite hours are the rule. Before entering the water, at the word of command of the bath-master all bathers take deal boards and stir up the water in the tub with a concerted rhythm of motion to cool it. This cooling operation is an amusingly novel sight to visitors. Then bathers kneel in rows along bath beams and each one pours one or two hundred dippers full of the hot water over their heads to prevent vertigo on entering the water, and it is said to clear the head and freshen the brain. Now by the direction of the bath-master they gradually enter the water. The time of a bath is not allowed to exceed three minutes, the temperature being about 52° C. The second row of bathers stand along the side of the tub waiting for the first bathers to leave the water. There are often a third, fourth, or even fifth row of bathers, and the more the number the later they enter the water, the last batch getting a less heat. The bath-master gives the following signals one after another: "two minutes remain"; "only one minute"; "put up with it a little longer"; "perseverance is necessary"; and "now then, get out." At the final order, who would remain behind! instantly all bathers jump out of the water. Bathers must submit to a sort of semi-military discipline and be obedient to the orders of the bath-master. This is certainly a curiosity of bathing procedure. Another oddity resembling this "time-bath" is the "numbering bath" of *Nasu* Hot Springs. Bathers count one thousand on their fingers, remaining motionless in the water during that time. On finishing one thousand they leave the water with a gasp. These methods are practiced to compel people to bathe for a certain length of time in water of a most uncomfortably high temperature. At *Yunogō* Hot Springs in Mimasaka Province, the temperature of the springs is equal to that of the human body and bathers are accustomed to bathings for great lengths of time. Even short baths are for two or three hours, during which time bathers remain in the water. Gradually they prolong the length of time and not a few bathe overnight. They say it is most pleasant in the winter to sleep in warm water. After all, the various seemingly strange practices and queer methods of bathing at remote hot springs have but been taught by the experience of many years, and it is little wonder that these are sometimes found to be quite in conformity with the scientific theories of the latest balneo-therapy.

The Chance Causes of Spring Discovery. The discovery of Japanese hot springs is very often traceable back to the mythological Age of the Gods, especially is this so with famous ones.

According to history and traditions, the instances of accidental discovery are numerous; some springs were found on seeing animals, especially deer, herons, etc., drink or heal at them; others were accidently discovered by huntsmen, wood-cutters, itinerant priests, etc., when they were climbing mountains, etc. Hence we have such names as "spring of deer," "spring of herons," etc., which are very frequently met with. The locations of some hot springs are said to have been communicated to the discoverers in dreams. Several hot springs have been not seldom discovered on account of snow thawing too early or grasses growing too fast in the early spring on the grounds over them.

Chapter VII

JAPANESE MINERAL SPRINGS AND THEIR THERAPEUTICAL FACTORS.

Since the recent discovery of radium, the scientific and medical investigations as regards radio-activity have revealed the fact, that the radio-activity of mineral springs is one of the most effective therapeutic factors. Thus the hygienic authorities and hot spring managers began to pay serious attention to the matter. Last year the Department for Home Affairs ordered the Hygienic Laboratories to investigate the radio-activity of the principal mineral springs in Japan. This investigation is entirely in the charge of Dr. R. Ishizu, expert of the Tōkyō Hygienic Laboratory, and Mr. Y. Kinugasa and Mr. H. Kibezaki, both being assistant experts of the Hygienic Laboratory. Up to the date of writing more than 150 mineral springs of more than 1,000 origins have been experimented upon. The above do not cover the whole number of mineral springs now known in existence in the empire and even some famous hot springs are owing to the brief notice given left unrecorded. But the results of these experiments are sufficient to show the general nature and value of the radio-activity of Japanese mineral springs. This chapter, therefore, is devoted to the report thereof; and together with the table of analyses, we trust, will prove of some service for balneologists, physicians, patients, etc. in general.

According to the experiments so far made, the quantity of radium emanation in any mineral spring is closely connected with the geology, rather than altitude of the place, chemical composition and temperature of the water, etc.

The bulk of Japanese hot springs are located among volcanic rocks and these have very small quantities of radium emanation, e. g., *Noboribetsu*, *Nasu*, *Bandai*, *Kusatsu*, *Hakone*, *Beppu*, *Aso*, *Kirishima*, *Sakurajima*, etc.; all these are sulphur springs. Mineral springs with large quantities of radium emanation gush out only from granite formations, just as radio-active rocks are found exclusively in granite regions. *Masutomi* in Kai Province, *Naegi* and environs in Mino Province, *Misasa* in Hōki Province, *Murasugi* and *Tochiomata* in Echigo Province, etc., are prominent examples. Masutomi and Takayama, are cold mineral springs. The former is at the foot of Mt. Kimbu-zan to the north-west of Mitake; and there are found in the neighbourhood, scheelite, apatite, tourmaline, sulphide ores, etc. The latter named place is a granite region along the River Kiso, and affords tin sand, together with wolframite and fergusonite, besides monazite and naëgite which both contain thorium. All hot springs of strong radio-activity are located in granite regions, but we cannot say that hot springs gushing out of granite formations are usually strong in radio-activity.

see Plates 35, 38 and 39

see Plates 11, 00, 22 and 23

If we compare these mineral springs with those of the strongest radio-activity in Europe, **Masutomi** is inferior only to *Joachimsthal* and *Brambach* (both in Austria), but superior to *Gastein*, *Landeck*, *Baden-Baden*, etc., holding undoubtedly the third position in the world. **Misasa** is only next to *Ischia* (Italy) and almost equal to the most radio-active hot spring in *Gastein*, being superior to all other hot springs of the world in radio-activity.

As stated above, not only may Japan well be proud of the fact that it holds a prominent position in the world as regards the radio-activity of mineral springs, but also it holds a great healing blessing to our countrymen. These mineral springs cannot be said to lie in remote places, but their real value has not yet been fully realized by the general public. As yet opportunity is not still ripe for paving the way to a fuller access, protecting the origins of the springs, and equipping them properly so as to be used for therapeutic ends. Nothing is more regretable than that we have to leave their management, in spite of their rich qualities, to the small means and limited exploitation of local enterprisers.

ENVIRONS OF ENA MINERAL SPRINGS (strong radio-active) AND NAEGI

MASUTOMI MINERAL SPRINGS (of the strongest radio-activity in Japan) AND ITS ENVIRONS

EASTERN PART OF SAN-IN DISTRICT with most radio-active hot springs of Japan

From Left to Right:

Hot spring	Geology	Radio-activity
Sekigane	Granite	33,47 M. u.
Misasa	„	142,14 „
Asōzu	Andesite	4,33 „
Matsuzaki	Andesite	5,87 M. u.
Kachimi and Hamamura	Granite	8,57 „
Yoshioka	Tertiary	4,36 „
Yoshikata	Alluvium	5,83 „
Yudani (cold sp.)	Tertiary	4,24 M. u.
Iwai	Older Tertiary	4,17 „
Yumura	Granite	1,76 „
Kinosaki	Tertiary	8,41 „

Fig. 1

Hot springs, issuing from the bottom of a stream at **Tamatsukuri,** near *Matsue*.
Gas is collected in bottles, partly from the river bed, partly from a pool near by.
(Pt. I, p. 26; *Pt. III, p. 57*)

Fig. 2

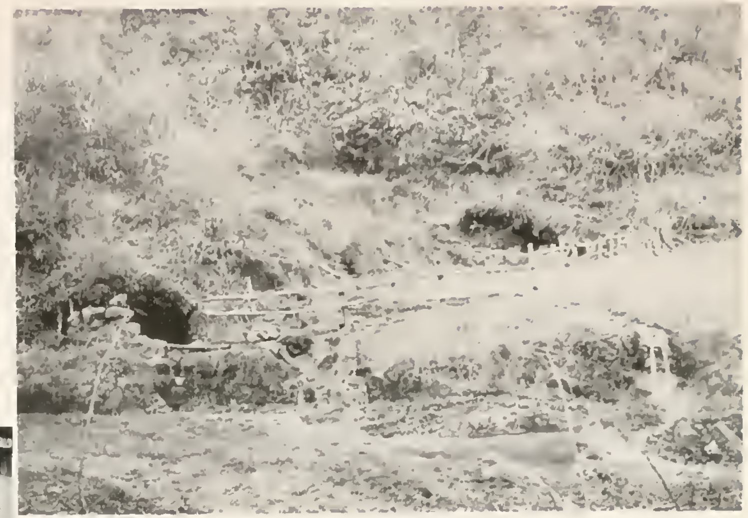
Tōgō Hot Springs,
issuing from the bottom of Lake *Tōgo-ike*, Hoki Province.
(Pt. I, p. 26; *Pt. III, p. 56*)

Fig. 3

Jizō-no-yu or "Hot Spring of Jizo" (the patron of travellers, children, and women in delicate condition) at **Kusatsu Spa,** issuing from fissures in volcanic detritus on a mountain slope.

Jizō-do standing in the background is a small temple dedicated to the divinity. (Pt. I, p. 26; *Pt. III, p. 21*)

Fig. 4



Shigaku Hot Springs,
gushing out of caves, the outflow forming cascades and streams of hot water.
(Pt. I, p. 26; *Pt. III, p. 59*)

Fig. 5

Boiling hot springs at **Yumura,** Tajima Province, gushing out of a bank of a stream
(Pt. I, p. 26; *Pt. III, p. 55*)

Fig. 1

A mill worked by the outflow of **Shigaku Hot Springs,** Iwami Province. (Pt. I, p. 25; *Pt. III, p. 59*)

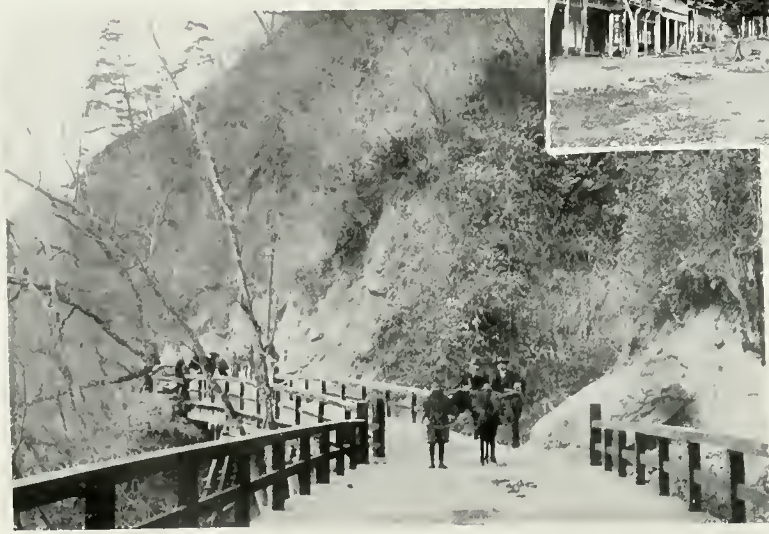
Fig. 4

Yumura Hot Springs, Izumo province. Here a small primitive bath is built direct upon the source of springs, water issuing from crevices in rocks. (Pt. I, p. 27; *Pt. III, p. 58*)

Fig. 3

Akakura Mountain Spa, 2,500 ft. above sea-level, situated on the middle slope of Mt. Myōkō. It is a pleasant summer resort with an extensive view. (Pt. I, p. 25; *Pt. III, p. 14*)

Fig. 2



Dr. Ishizu and his assistant journeying on horse-back to **Kusatsu Spa.** (Pt. I, p. 28; *Pt. III, p. 20*)

Fig. 5

Dr. Ishizu trying an open-air bath at the source of **Tsubame Hot Springs,** near Akakura. This bath is believed to be more efficacious than ordinary baths; water is conducted into it by bamboo pipes over a distance of about 1/3 m. (Pt. I, p. 27; *Pt. III, p. 14*)

Fig. 1

Fig. 3

Fig. 2

Fig. 4

Hot Waterfalls for Massage. (Pt. I, p. 27)

1 "*Taki-no-yu*" at **Noboribetsu Spa,** provided with a row of hot waterfalls, the temperature ranging from 43° to 46° C. (*Pt. III, p. 1*)

2 Hot Water Douche in a bath at **Futami Hot Springs,** Etchu Province. (*Pt. III, p. 17*)

3 Hot Water Douche in a bath (Inn, *Kincho-kwan*) at **Yunokawa Spa,** Hokkai-do. (*Pt. III, p. 5*)

4 Women bathing in "*Taki-no-yu*" at **Noboribetsu Spa.** (*Pt. III, p. 1*)

Fig. 1

Yubatake Hot Spring or "Hot Water Field" at **Kusatsu**.
Boiling water is conducted into wide, long, and shallow reservoirs from which sulphur deposits are collected.
(Pt. I, p. 27; *Pt. III, p. 21*)

Fig. 2

Villagers boiling rice and vegetables in a hot water pool at **Yumura Spa,** Tajima Province.
(Pt. I, p. 27; *Pt. III, p. 55*)

Fig. 3

Cooking food in **Kannawa Spa,** near *Beppu*
Several houses along narrow, stony streets are provided with cement furnaces outdoors, steam rushing out through holes in the ground.

A kettle for boiling rice is placed on one furnace, while vegetables are cooked on another covered with straw mats. (Pt. I, p. 27; *Pt. III, p. 63*)

Fig. 4

Yumura Hot Springs, Tajima Province.
Villagers washing in the stream, into which boiling hot water flows.
(Pt. I, p. 27; *Pt. III, p. 55*)

Fig. 5

Carbonic acid gas produced from **Isobe Spring** is collected and conveyed to a factory for preparing carbonate of lime for tooth-powder.
(Pt. I, p. 27; *Pt. III, p. 22*)

Fig. 1

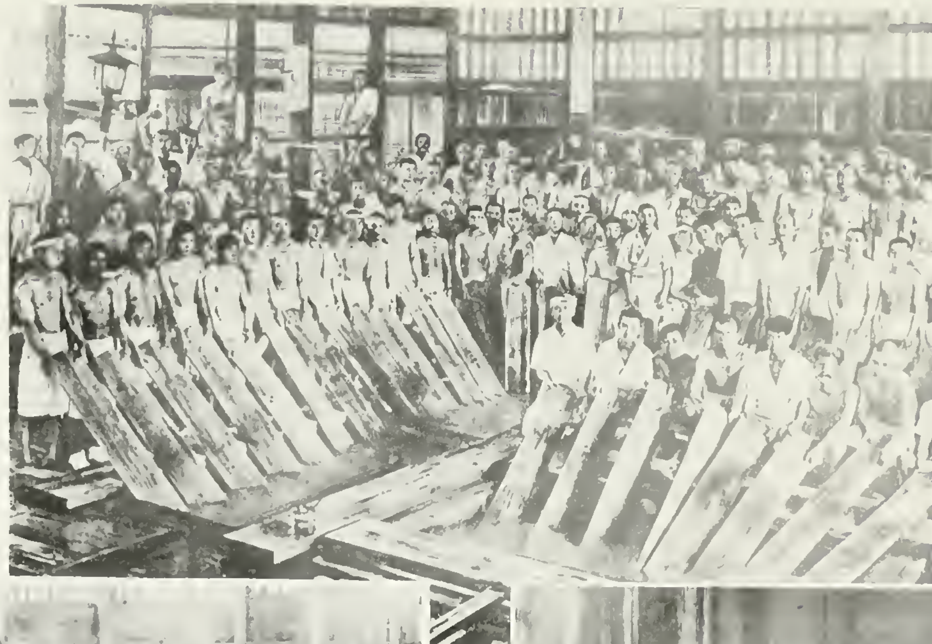


Fig. 3

Fig. 2

Jikan-yu or **"Time-Bath"** at **Kusatsu.**

The usual Kusatsu course includes 120 baths, spread over four or five weeks. Four baths daily at the definite hours are a rule and bathers must submit to a sort of semi-military discipline and be obedient to the orders of the bath-masters. (Pt. I, p. 29; *Pt. III, p. 20*

1. Before entering the water, at the word of command of the bath master all bathers take deal boards and stir up the water in the tub with a concerted rhythm of motion and a vocal chart to cool it—bringing the temperature down from about 135° to 125° F.
2. Then bathers kneel in rows along bath-beams and pour each one or two hundred dippers full of the hot water over their heads to prevent vertigo on entering the water.
3. Now by the direction of the bath master they gradually enter the water. The time of a bath cannot exceed three minutes. The second row of bathers stand along the side of the tub waiting for the first bathers to leave the water. The bath master gives the signals one after another: "*two minutes remain*"; "*only one minute*", *put up with it a little longer*"; "*perseverance is necessary*" and "*now then, get out*". At the final order, who should remain behind! All at once bathers jump out of the water.

Fig. 1

Kohlrausch-Löwenthal's Fontactoscope placed in an old *Yakushi-dō* (a small temple dedicated to the God of Medicine) at the source of Ogawa Hot Springs, Etchū Province. (Pt. I, p. 37; *Pt. III, p. 47*)

Fig. 2

Measuring the flow of water at the source of Nibuzawa Cold Spring in **Masutomi,** Kai Province. (Pt. I, p. 37; *Pt. III, p. 34*)

Fig. 3

Collecting gas rising from *Chi-no-ike-Jigoku* or "Blood Lake Hell," a boiling pool with ochreous mineral-stained border, near *Beppu.* (Pt. I, p. 37; *Pt. III, p. 63*)

Fig. 4

Schmidt's Electrometer.
The picture shows the apparatus set for practical test at **Masutomi,** Kai Province. (Pt. I, p. 37; *Pt. III, p. 34*)

Fig. 5

Dr. R. Ishizu and his assistant taking water to be examined for radioactivity, at the source of Akakura Hot Springs on *Mt. Myōkō*, about 3.7 m. up the spa more than 4,000 ft. above the sea). (Pt. I, p. 37; *Pt. III, p. 14*)

Fig. 1

The left bank of the Misasa gawa, from which hot springs gush out.

Fig. 2

A distant view of Yamada Hot Springs from Misasa Spa.

Fig. 3

Nage-ire do or "Thrown-in Shrine" of Mitokusan Temple meaning that the shrine was first constructed outside and inserted as a whole in a huge cave. The architecture, more than 1,200 years old, is now under the special protection of the government.

Fig. 4

Kompira-yama, a rocky hill wooded with pine-trees, is one of the attractions of Misasa.

Fig. 5

A view of the upper course of the Misasa gawa from the end of the spa.

Misasa Hot Spring Spa, about 30 m. W. from Tottori. *(Pt. III, p. 56)*

This most radio active hot spring of Japan holds the second position in radio activity among all thermals in the world. (Pt. I, p. 30)

Fig. 1

Lake Shōji, a favourite summer retreat, at the N. W. foot of Mt. Fuji. (Pt. II, p. 202)

Fig. 2

Mihashi (Sacred Bridge) in **Nikkō.** (*Pt. III, p. 18*)

Fig. 3

Haku-un-dō or "White Cloud Grotto" in **Shiobara Hot Springs.** (*Pt. III, p. 16*)

Fig. 4

Unzen Resort with hot springs. (*Pt. III, p. 66*)

Fig. 5

Miyanoshita Spa, Hakone. (*Pt. III, p. 27*)

Some well-informed men have of late realized their importance and are undertaking to improve their present conditions. If necessary arrangements be made and it become possible that their therapeutic efficacy is fully utilized for the benefit of patients in general, we believe this must be a great boon to the public at large. Especially considering this country is endowed with a mild climate and the natural beauties of scenery left undamaged by abuse of modern culture; and, moreover the prices of daily necessaries being cheap, these place Japan in a position to ultimately become a health resort, unrivalled all the world over.

We find many hot springs of excellent composition, but there are very few where proper care is taken to protect the source of springs, conduct the water, build baths, and encourage bathing, so as to suit the theory of emanation therapy. In spite of the existence of gases with strong radio-activity at many places, no inhalatorium has yet been established to turn them to account. This deplorable state of affairs is ascribable to the fact, that emanation therapy has only been very recently introduced to Japan and very few hot spring managers have a thorough knowledge or idea of its theoretical and practical importance. But as the hygienic authorities have the matter under attention and are enforcing improvements, undoubtedly all the Japanese hot springs will be greatly improved in the not very distant future.

We are going to point out a few facts witnessed at various hot spring resorts in Japan that go to prove that radium emanation constitutes an important therapeutic factor of mineral springs.

1. Original springs are generally believed to be more efficacious, than the baths into which the water is conducted.

2. The baths prepared with cold mineral water, artificially heated, are generally inferior to natural hot springs in their therapeutic efficacy.

3. Baths are built as close as possible to the source of springs.

4. The efficacy of hot springs is fully experienced, when a bath is taken in the early morning before other bathers.

5. People bathe in those hot springs of which the temperature is somewhat equal to that of the human body, without heightening their heat artificially.

6. To wash the body with fresh water after bathing is generally believed to lessen the therapeutic efficacy of the springs.

7. People try, while taking baths, to be as near as possible to the source of springs, and apply the water fresh from the source to particular diseased parts.

8. There is a popular belief that it is best to drink at the source of springs.

Although of course there may be found more facts, by more attentive observation, the above are the most generally known and entirely conform with the theories of the modern emanation therapy.

Chapter VIII

SHORT REMARKS ABOUT EMANATION THERAPY.

The radio-activity of mineral waters has attracted much attention during the last decade, and it is now widely believed that the therapeutic value of many waters is largely due to their content of radio-active substances. Tests have shown that many of the slightly mineralized waters, which have proved to be efficacious for certain diseases, have various degrees of radio-activity, and consequently, as radium compounds have been found to cause marked physiologic reactions, the improvement in health following sojourn at springs has very naturally attributed to the radio-active properties of the waters. There are yet too few experimental data to settle this point definitely.

The emanation has been used therapeutically in various ways; it has been inhaled, injected, taken in draughts, and administered by means of baths. Some natural waters are radio-active, and their efficacy may in part be due to this. It is well known that a bottled mineral water drunk at home does not produce the same active benefit that it does when drunk fresh and nascent at the spring, and this may be due to the decay of its radio-activity. This will also explain the impossibility of successfully imitating a natural mineral water; it must be made radio-active as well as of the same chemical composition.

In the case of injection or other introduction directly into contact with the tissue the emanation tends to diffuse itself throughout the tissues; it has a predilection for the glands which form an internal secretion, and especially for the suprarenal capsules. It is eliminated by the lungs and the skin, and to a small extent by the kindneys. Injections of water or of vaseline impregnated with the emanation have been made by Radcliffe Crocker, Wickham and Degrais, in lupus, mycosis fungoides, and cancers, with benefit, and baths and drinks containing the emanation have been administered successfully by Strasser in cases of chronic articular rheumatism, sciatica, and neuritis. Gout is also favourably influenced by this treatment.

Löwenthal states that the emanation is chiefly absorbed by the respiratory passages, that it is of value in the treatment of chronic inflammatory processes and residues of the same, and that in therapeutic doses it is quite harmless. In order to subject the body to the permanent action of the emanation, it is necessary to apply the source of emanation several times a day, since the body gets rid of all traces through the urine and expired air within three or four hours. It is necessary in the case of baths so to construct the baths that the nose lies within the space of the bath itself, so that as much emanation may be absorbed as possible. He has found that the emanation is capable of activizing body ferments; this action would mean that the absorbing power of the body would be increased, and in this way the beneficial action on inflammatory processes would be explained. Löwenthal comes to the conclusion that specific urate-dissolving powers are to be found in mineral waters; there may be an action whereby ferments which form and destroy uric acid may be activized by radium. It can be shown that by drinking the radium-containing waters of Baden-Baden the excretion of urea is increased by 34 per cent., while that of urates increased by 14 per cent., as compared to the excretion when the person is drinking the same quantity of ordinary water warmed to the same temperature.

Recently some valuable experiments to test the bactericidal action of radium rays have been carried out by Dr. Helen Chambers and S. Russ, and communicated by them to the Royal Society of Medicine. Their paper concludes as follows:

"1. The emanation in concentration of less than a millicurie per cubic centimeter has a marked bactericidal action.

2. Agglutination of bacteria in distilled water is an early sequel to their erradiation.

3. Bacteria are more quickly destroyed by the emanation than are opsonine and leucocytes."

Dr. Saubermann and Prof. Paul Lazarus have recently conducted a valuable research into the action and use of the emanation. The following remarks are taken from papers contributed by them to the meeting of the Röntgen Society on April 1st, 1913:

"Radium emanation can enter the organism in several ways, but in accordance with the character of an inert gas it totally and rapidly leaves the body. The main portion leaves through the lungs, a large part through the intestines, and some through the skin and kidneys. The mode of entry decides the degree and speed of the passage of the emanation through the organism. It lasts *seconds* by inhaling, *minutes* with an injection, *hours* when taken by the mouth and stomach or *per rectum*. Consequently we distinguish five ways of absorbing emanation:

1. Through the lungs.
2. Through the digestive organs.
3. Through the skin.
4. Through the medium of different forms of injections.
5. Through the employment of local external applications—on wounds, for instance.

Prof. Lazarus went on to speak of emanation administered by the mouth through the drinking of emanation water. This entered the organism in three ways: the first, by direct penetration of the stomach and intestines; the second, by diffusion into the capillaries of the lymph and portal vein systems, the emanation circulating through the liver; the third, a method which he termed 'retrospiration,' for his tests left no doubt that a very large portion of the imbibed emanation reached the arterial blood. By inhalation the emanation reached primarily the lungs, and secondly the intestines; but the opposite took place in the drink cure. The difference between the two resided principally in the speed of the passage of the emanation through the body. Though the emanation was absorbed more rapidly in the case of primary inhalation, it would be retained scarcely as long as it was being breathed; but in the case of the drink cure the emanation was gradually introduced into the circulation, and it left the system also relatively slowly. The important feature in emanation treatment was the constant saturation of the body, which was best achieved by giving the patient a dose to drink every 20 minutes for a period of 3 hours. By administering 10 or more doses or sips from a bottle containing the total quantity, a constant saturation of the body was maintained in a manner that would have been impossible had the total quantity been administered at once. He called this form of application the 'sipping cure'."

In a concluding passage, after dealing with the established fact of the absorption of emanation through the intact skin, Prof. Lazarus was thus quoted by his colleague:

"Emanation injections, whether intravenous, subcutaneous, or intramuscular, must prove useless, because the emanation will escape per pulmones in a very short time. Effects can only be obtained if solutions of radium salts are employed, as though establishing a kind of radium depot within the body, which can produce emanation for some time. I have practiced such injections for the past six years in exsudations, in joints, or in serous cavities, but always locally, and I have never been able to record a damaging effect by permanently depositing emanation within the organism."

General Physiological Results obtained by the Use of the Radium Emanation.

"1. It promotes the growth of healthy cells while inimical to morbid cells.

2. It produces diuresis.

3. It stimulates the activity of the digestive tract, and also promotes digestion and relieves constipation.

4. It increases the excretion of uric acid.

5. It lowers the blood-pressure by dilating the capillaries and diminishing the viscosity of the blood.

6. It increases the sexual activity and power of generation. Some spas—e. g. Gastein and Baden-Baden—now known to be markedly radio-active have for a long time enjoyed a reputation as *rejuvenating* waters. Engelmann refers to Von Noorden's observations, and to the results of O. Hertwig's experiments, who ascertained a specific effect of radium rays on the nuclear substances of the two sexual cells, and to the observations of Halben, who succeeded in enhancing the secondary symptoms of sexual passion in water newts by radium emanation. Affections of the kindneys, tendency to breeding, and tendency to miscarriage, are regarded at present as contra-indications.

7. It modifies the constitution of the blood by diminishing the number of white corpuscles, and by increasing the number of red." (Saubermann, Archives of the Röntgen Ray, August, 1913).

Diseases for which Emanation Treatment is Suitable.

Gout, chronic articular rheumatism, gonorrhœal rheumatism, rheumatoid arthritis, neuralgias of all kinds, certain diseases of women, high blood-pressure, premature old age.

There is a general consensus of medical opinion as to the efficacy of radium emanation treatment in gout (Engelmann, Von Noorden, Löwenthal, etc.). Treatment may combine drinking, inhalation, baths, compresses, but the most important is the *sipping cure*. The patient should every half hour sip a dose of water containing the emanation; the total daily dose should not exceed 1,000 Mache's units to begin with, but this may be gradually increased to as much as 10,000. The body will thus be kept constantly saturated with the emanation. After a few days a gouty reaction, accompanied by pains in the joints, sets in, to be followed by a slow but general improvement. Engelmann recommends a six weeks' course of treatment, which should be repeated once or twice yearly. The same general plan of treatment can be followed for the other diseases enumerated above. Engelmann, in recommending radium emanation treatment for neuritis and neuralgia, states that he has seen two extremely obstinate cases of herpes zoster in persons advanced in years, which had defied every other kind of treatment, quite surprisingly bettered. Even the lancinating pains of tabes are relieved. The author has successfully treated an obstinate case of post-herpetic neuralgia by the radiation of solid radium. Engelmann further recommends the emanation in bronchial asthma, arterio-sclerosis, and diseases of women, especially in cases in which it is important to assist the absorption of chronic exsudates and swellings; and in general adhesions, tissue thicknings of every kind cannot be otherwise than favourably influenced by a combined local and general emanation treatment. Advantageous results, he says, after radiation with radium preparations in cases of myoma and disturbances in menstruation, have quite recently been reported from the Freiburg clinic for women. In these cases the radiation with radium rays took the place of radiation with X-rays. A histologically demonstrable influencing of the ovaries, and also occurrence of miscarriage after mere drinking of emanation water, have already been experimentally ascertained. The X-ray treatment of myoma might, in the authors' opinion, be replaced by radium radiations, for the latter possess two intrinsic advantages: the dose can be measured more accurately, and the gamma rays are more penetrating. Testimony as to the value of emanation treatment in arthritis deformans is to be found in the report of the Radium Institute (British Medical Journal, January 25, 1913):

"This extremely obstinate, progressive, and crippling malady is not infrequently strikingly benefited by the daily drinking of 250 cc of radium emanation solution of a strength of 1–2 millicuries per litre. The treatment must, however, be persisted in for quite a long time, and at least six weeks are likely to elapse before any change is noted. In a favourable case the articular and muscular pains are lessened or disappear, the movements of the affected joints become much freer, and are accompanied by less grating; the muscles controling the joints regain much of their lost tone, and the general health of the patients is greatly improved. With the majority of the patients the emanation solution produces a definite diuresis, and with a few it acts slight laxative. Up to the present only 21 patients have been treated, but the results obtained are sufficient to warrant the hope that radium emanation solution will prove a most valuable addition routine medical treatment."

Cases of emanation treatment and its therapeutical effects, which are to be found in literature till 1911, are given in the following table:

Table IX.

Summary.

No.	Name of Disease	Number of Treatment	of which		in per cent	
			cured	benefited	cured	benefited
1	Anaemia	11	1	10	9,09	90,9
2	Ankylosis	1	—	1	—	100
3	Acne	1	—	1	—	100
4	Asthma bronchiale	1	—	1	—	100
5	Anaesthesia and paraesthesia in the fifth nerve	1	—	1	—	100
6	Apoplexie	11	—	10	—	90,9
7	Apoplexia cerebri	1	—	1	—	100
8	Arteriosclerosis (stenocordie)	5	—	4	—	80
9	Arthritis urica	125	38	63	30,5	50,4
10	Arthritis chronica	13	3	9	23,07	69,23
11	Arthritis rheumat. chron.	27	18	5	66,6	17,7
12	Arthritis urica	2	—	2	—	100
13	Arthritis subacuta	10	7	3	70	30
14	Arthritis rheum. subacuta	10	3	5	30	50
15	Arthritis rheumatica	42	18	16	42,86	38,09
16	Arthritis deformans	91	12	52	13,2	57,1
17	Arthritis chron. deformans	7	—	7	—	100
18	Arthritis tbc.	2	—	2	—	100
19	Bronchial catarrh	67	—	56	—	84
20	Bronchitis chron.	3	1	2	33,30	66,6
21	Carc. mam. inop.	4	—	1	—	25
22	Carc. oesoph. inop.	3	—	1	—	33
23	Catarrh of frontal sinus and super. maxil.	11	10	1	90.9	9,1
24	Cephalaea	1	—	1	—	100
25	Cephalaea traumat.	1	—	1	—	100
26	Cephalaea rheumat., etc.	1	1	—	100	—
27	Cystitis chronica	1	1	—	100	—
28	Dercum's disease	1	—	1	—	100
29	Diabetes insipidus	8	—	1	—	12,5
30	Distorsion (after treatment)	2	—	2	—	100

No.	Name of Disease	Number of Treatment	of which cured	of which benefited	in per cent cured	in per cent benefited
31	Dupuytren's contraction	1	—	1	—	100
32	Eczema	9	1	5	11,1	55.5
33	Exacerb. pains after affect. of acces. sinus	1	1	—	100	—
34	Exsudate of joint	21	9	11	42,86	52,4
35	Gastroenteritis chron.	11	1	6	9,09	54.54
36	Gout	11	4	5	36 4	45.5
37	Glandular growth	2	1	1	50	50
38	Hemicrania	1	—	1	—	100
39	Hydrosalpinx	1	1	—	100	—
40	Hypertrophy of prostate	2	—	2	—	100
41	Laryngitis	1	—	1	—	100
42	Lumbago	21	12	6	57 1	28.6
43	Lymphoma tbc. colli	10	—	9	—	90
44	Malignant swelling	2	—	1	—	50
45	Metritis chronica	7	—	7	—	100
46	Muscular rheumat. of head	4	2	2	50	50
47	Muscular rheumat. of shoulder	10	5	4	50	40
48	Muscular rheumat. of neck	5	4	1	80	20
49	Muscular rheumat. of breast	3	2	1	66,7	33.3
50	Myelitis chronica	4	—	1	—	25
51	Myocarditis	35	—	27	—	77.2
52	Myocarditis chronica	5	—	4	—	80
53	Myositis traumatica	1	—	1	—	100
54	Neuralgia of brachial plexus	8	5	2	62,5	25
55	Neuralgia in the 2 a. 3 branch. of the fifth nerve	4	—	3	—	75
56	Neuralgia and paraesthesia in ramus supraorb. after herpes zoster	1	—	1	—	100
57	Neuralgia (Neuritis)	35	13	15	37,2	42.8
58	Neuritis chron. and traum.	2	—	2	—	100
59	Neurasthenia	58	21	29	36,2	50
60	Omarthritis simpl. and dupl.	8	4	2	50	25
61	Osteomalacia	1	—	1	—	100
62	Ozaena	4	—	4	—	100
63	Psoriasis	3	—	2	—	66,7
64	Paralysis nervi facialis rheumatica	1	—	1	—	100
65	Paralysis infantum	3	—	1	—	33.3
66	Paralysis agitans	5	—	1	—	20
67	Parametritis and perimetritis	15	5	10	33.3	66,7
68	Peritonitis tbc. and chron.	4	2	1	50	25
69	Pyosalpinx	1	1	—	100	—
70	Polyarthritis	19	16	—	84,2	—
71	Polyarthritis rheumatica chron.	25	10	7	40	28
72	Rectum fistula tbc.	2	1	1	50	50
73	Rhynitis chronica	38	19	8	50	21,1
74	Rheumat. musc. acut.	10	4	4	40	40
75	Rheumat. musc. sub. and chronica	40	16	22	40	55
76	Rheumat. artic. chron.	250	93	27	37,2	50 8
77	Rheumat. gonorrh.	5	—	4	—	80
78	Residua after fractur	7	6	—	85,6	—
79	Sciatica	180	95	59	52,8	33
80	Sclerodermie	2	—	2	—	100
81	Tabes dorsalis	66	—	33	—	50
82	Tbc. pulmonum	6	—	2	—	33.3
83	Uterus myomatosus	11	—	11	—	100
84	Vaginitis	1	—	1	—	100
85	Vitium cordis	8	—	3	—	37.5

The Thorium Emanation.

The thorium emanation is given off more or less freely from the compounds of thorium, the best source, according to Prof. Soddy, being a preparation of radiothorium in a moist condition. Radiothorium is derived from thorium through two intermediate products named respectively methothorium No. 1 and methothorium No. 2. Methotorium No. 1 is produced as a by-product in the manufacture of gas-mantles ; it resembles radium in its chemical nature, and cannot be separated from it ; it disintegrates into methothorium No. 2. The latter radiates beta and gamma rays, and yields radiothorium. From the latter thorium X is produced, and from thorium X the thorium emanation. The emanation has a life of about 26 seconds. It radiates alpha rays, and leaves an active deposit called thorium A. This integrates into thorium B, this into thorium C, and this into thoriom D. The important members of this group, from the medical point of view, are methothorium, thorium X, and its emanation.

The thorium emanation would also probably be found of use in the same class of cases in which the radium emanation has proved of value. The class of cases referred to include gout and rheumatism and other general diseases for which natural mineral waters are prescribed. It has been found that these waters are as a rule radio-active, and that with the smallest mineral content are the most radio-active. W. His states that radio-active baths and waters owe their therapeutic value to the emanation of radium. After three years' experience observations have been taken on over 100 cases of gout, and the large majority have been so obviously benefited that the results cannot have been due to chance. The emanation decomposes uric acid into urea and carbonic acid. Löwenthal states that the emanation stimulates the body ferments and increases the gaseous exchange.

Use of Radio-active Earths.—Reference has already been made to the production and use of the emanation. It can also be administered by the employment of radio-active earths. One of the best known of these is obtained in the process of uranium extraction ; it contains certain oxides of iron, aluminium, uranium, and manganese, and traces of actinium, radium, and polonium. Of the latter, actinium is the most important. Pure actinium is estimated bys ome physicists (pure actinium has not been isolated, but it is believed that it would show an activity comparable with that of radium—Rutherford) to be ten times as radio-active as radium, the quantity present in the earth suffices to confer upon it a radio-activity of 0,15 as compared to 2,000,000 in the case of radium.

The following is a table of comparative radio-activities (Claude) :

Actinium	about 20,000,000	Uranium	about 1
Radium	about 2,000,000	Earth	about 0,15

One centigramme of the earth spread over one square centimeter yields a radiation about one-seventh the strength of that of uranium. The earth is an extremely weak radio-active preparation, which yields alpha, beta, and gamma rays, and an emanation. It is, however, relatively to radium, very cheap, a kilogramme costing thirteen shillings.

The earth has been employed for some time by Dr. Claude and others in the hospitals of Paris in the treatment of arthritis deformans, subacute and chronic rheumatism, and gonorrhœal rheumatism, also for neuralgia and certain cutaneous (pruritus) and gynæcological affections.

The affected joint having been cleansed, the moistened earth is spread in the form of a compress around it, and maintained in position by a piece of oil-silk and a bandage. It must not be allowed to become dry. No emanation would be given off if it became dry. The plaster can be left on all night, and applied on alternate nights for ten days.

It should always be remoistened and made quite plastic and soft before application. It does not lose its strength. In some cases it may be advisable to sterilize it by heat (open sores, introduction into the cavities of the body) ; this will not affect its activity.

Dr. Guyenot prepares radio-active earth or mud by mixing powdered pitchblende with twice its volume of hot water. This is applied direct to the part to be treated, and can be left on several hours under a piece of waterproof. This mud exercises a sedative effect, and is believed to promote the absorption of exsudations. It does not irriate the skin, its radio-activity is permanent ; but when it has been used, it must be allowed to dry for a fortnight before it is used again.

Another method of employing the earth is to make the use of baths. 250 grm of the earth are mixed with the warm water of the bath ; more may be used if desired, but this is the usual strength. The patient can remain in the bath for half an hour, and have a series of a dozen in a fortnight or longer.

Good results are claimed to have been obtained by Claude and Teulière in arthralgia and subacute forms of arthritis. The pain, redness, and swelling, usually disappear with great rapidity, but affections of the lower limb appear to be more rebellious than those of the upper limb. The best results appear to have been obtained in subacute gonorrhœal rheumatism.

Mud baths have been for a long time in vogue at certain health resorts in Europe; it is possible that the beneficial results may have depended upon the presence of traces of radio-active substances.

Chapter IX

DETERMINATION OF RADIUM EMANATION.

For measuring the radio-activity of mineral waters, Schmidt's electrometer (made by Spindler and Hoyer, Göttingen) was employed. It has been standardized with a radium solution of known strength. In our tests the so-called bubbling method was employed. The water for examination was carefully poured into a vessel. After the circulating system was completed, air was bubbled through the water by means of a circulation rubber bulb, in order that the greater part of the emanation should be taken up by the air. The air was then freed from its humidity by a calcium chloride tube and pressed into the ionisation chamber. Great care was taken to have the emanation equally distributed in the whole circulation system. On the stop-cocks of the ionisation chamber being closed the quantity of emanation was determined in the usual way from the diminution in the charge after the maximum current had been reached. Here the leaf of the electrometer was always charged negatively, so as to concentrate the active deposit on the inner electrode.

As by this method only a part of the emanation present in the water was determined, the leak therefore was multiplied with a factor in order to get the leak of the total emanation contained in 1 litre of spring water.

The results of measurements of radium emanation have unfortunately been expressed in a great variety of units, and as a natural consequence it is impossible to compare some reports of radio-activity with others. In England and America it is customary to express radio-activity as an equivalent of radium or of uranium, a radio-active substance; on the Continent it is customary to express the results in electrostatic units. It is quite general, irrespective of the unit, to report the radio-activity per litre of water or per litre of the gas in the water. The quantity of emanation in equilibrium with 1 gram of radium is known as a curie of emanation, but as this is a very large unit estimates are expressed in fractional parts of a curie; thus, $516{,}87 \times 10^{-10}$ curies per litre means that one litre of the water contains 516,87 ten-billionths of the quantity of emanation in equilibrium with 1 gram of radium. The Mache's unit, frequently encountered in reports of radio-activity, is defined as the saturation ionization current due to the radium emanation, free from decay products from a litre of water or gas, expressed in electrostatic units (i) multiplied by 1000; and 1 curie of emanation per litre equals a concentration of 2,75 billion Mache's units.

The Mache's unit being recognized and still in general use amongst medical circles, we have recalculated our result (as expressed in the international unit) by using the following factor:

The saturation current produced by the radiation from one curie (international unit) of emanation by itself is $2{,}75 \times 10^{6}$ e. s. units, (Rutherford's "Radio-active Substances and their Radiations," 1913, p. 502).

So we have

$$2{,}75 \times 10^{9} \text{ Mache's units} = 1 \text{ curie},$$

so that

$$1 \times 10^{-10} \text{ curies} = 0{,}275 \text{ Mache's units}.$$

For simplicity of manipulation, the original fontactoscope of C. Engler and H. Sieveking (made by Günther and Tegetmeyer, Braunschweig) or sometimes the same modified by Kohlrausch and

Löwenthal was employed in most cases of our determination instead of Schmidt's electrometer. The determination was carried on exactly according to the authors' original instructions. The corrections for the absorption of emanation in water, and for the absorption of the radiation by the walls of the ionisation chamber were made taking also the effect of active deposit into consideration. The gas evolving with the spring which was examined, was collected over the spring water by replacement as usual and was examined practically by the same method as adopted with the water. The volume of gas was reduced to the normal temperature, though the correction due to the atmospheric pressure was neglected as its observation were not made.

Those spring waters impregnated with considerable quantities of gas, for example, carbonic acid, hydrogen sulphide, etc., were previously treated with a sufficient quantity of caustic soda, whereat the eventual loss of emanation due to occlusion by precipitates was not taken into consideration.

As for the measurement of the volume of the circulation system, (excepting bottle for spring water to be examined) we have adopted the replacement method. The air in the system in question (ionisation chamber, circulation rubber bulb, calcium chloride tube, rubber tubes for connection, etc.) was first replaced with pure dried carbonic acid gas, the latter being introduced into a weighed potash bulb by a current of dried air free from carbonic acid, and then the quantity of carbonic acid absorbed was from this gravimetrically determined. From the quantity of carbonic acid gas the volume of the space which occupies the system can be easily calculated, taking into account variation of volume of gas due to temperature and atmospheric pressure.

The general opinion that most spring waters do not contain radium itself, but radium emanation derived from contact with radium-bearing minerals, is logically based on the fact that nearly all spring waters gradually lose their radio-activity after being removed from the source, whereas a solution of a radium salt, after having once reached equilibrium, continues to drive off radium emanation. There are, as far as we know, only a few cases of mineral waters, where the radio-activity is due to the presence of dissolved radium salt :—

The spring water of *Kreuznach* has proved to have rest-activity of radium. 8 litres of the thermal spring in *Gastein* caused after being removed of emanation yet a discharge of 0,5–0,8 volt per minute after 14 days, while in a test of *Carlsbad* waters a discharge of $1{,}065 \times 10^{-3}$ electrostatic units was observed after 25 days (Dora).

It is probable that the thorium emanation also has a share along with that of radium in radio-activity of mineral waters, but the former generally escapes our usual method of measurements. We know only that thorium emanation was found in some spring waters in *Homburg v. d. Höhe* (Kaiserbrunnen and Elisabethbrunnen).

Observation has as not yet been made upon the thorium emanation of the spring waters of Japan.

Table X.

Absorption of the Radium Emanation by Water (Boyle).

Temperature	Coefficient of Absorption, α	Temperature	Coefficient of Absorption, α
0° C	0,507	20,3° C	0,250
4,3° C	0,424	26,8° C	0,206
5,7° C	0,398	31,6° C	0,193
10,0° C	0,340	34,8° C	0,176
14,0° C	0,303	39,1° C	0,160
17,6° C	0,280		

Table XI.

Decay of Radium Emanation.

Time t (in hrs.)	$e^{-\lambda t}$	Time t (in days)	$e^{-\lambda t}$	Time t (in days)	$e^{-\lambda t}$
0	1,000	1	0,835	20	0,027
1	0,993	2	0,698	21	0,023
2	0,985	3	0,583	22	0,019
3	0,978	4	0,487	23	0,016
4	0,970	5	0,407	24	0,013
5	0,963	6	0,340	25	0,011
6	0,956	7	0,284	26	(2) 928
7	0,949	8	0,237	27	(2) 775
8	0,942	9	0,198	28	(2) 647
9	0,935	10	0,165	29	(2) 541
10	0,928	11	0,138	30	(2) 452
11	0,921	12	0,115	40	(3) 747
12	0,914	13	0,096	50	(3) 123
13	0,907	14	0,081	60	(4) 204
14	0,900	15	0,067	70	(5) 337
15	0,894	16	0,056	80	(6) 558
16	0,887	17	0,047	90	(7) 922
17	0,880	18	0,039	100	(7) 152
18	0,874	19	0,033		
19	0,867				
20	0,861				
21	0,854				
22	0,848				
23	0,842				

The numbers in brackets, e. g. (6) refer to the number of o's before the first significant figure.

DETERMINATION OF ELECTRIC CONDUCTIVITY.

As the physiological effect of mineral waters may be regarded as due to the action of ions contained in them, it is necessary to extend our investigation of the springs in this direction.

In mineral waters, which contain, as a rule, only a small amount of salts, we find that the greatest part of the dissolved substances is contained as ions and not as salt molecules. To obtain a gauge for degree of dissociation, we have to determine (1) electric conductivity, (2) depression of freezing point, or (3) elevation of boiling point. We have taken the first, as it can be easily measured even while travelling through the field. This determination was made with Pleissner's portable apparatus, made by Bosse & Co., Berlin. Observations were usually made at 18° C. as the normal temperature, necessary corrections were made for those at other temperatures.

Chapter X

THE SINTER DEPOSITS OF MINERAL SPRINGS.

A. On a small Sinter-Cone* formed by the Geyser of Obama, Hizen.

Obama Hot Springs are reached by steamers in about four hours from Mogi, a hamlet in Hizen Province, well known for its pliocence plant fossils described by Nathorst. (Contributions à la flore fossile du Japon. Kongl. Svenska Vetenskaps-Akademiens Handlingar, Bandet 20, No. 2, 1883.)

* Denzō Satō—Beiträge zur Mineralogie von Japan, Nr. 4, p. 139, 1912.

Obama belongs to a region of hornblende-andesite, erupted from the isolated volcano *Unzen-dake*. One of the springs, called "*Funtō-yu*," is a geyser from a bore-hole protected by an iron pipe about 25 meters in length and 6 cm. in diameter. Here small sinter-cones are being formed at the bottom of a wooden tank placed above the bore-hole, from which the water is conducted by a pipe into the baths.

see Plate 4, fig. 1 The cone, shown in Plate 4, fig. 1, is a good specimen of typical form, taken in 1900 and exhibited at present in the Mineral Museum of the Imperial Geological Survey (Tōkyō).

Denzō Satō who described the one of the cones writes as follows:—

"The whole time required for its deposition seems to have been about five months, so that the daily precipitation amounts ca. 43 grm., which nearly coincides with that of the sinter-cones of *see Plate 4, fig. 2 a. 3* Yuzawa. The water of this geyser is slightly alkaline and faintly salty in taste. The temperature is 100° C. (at air temperature 15°), flow of water about 39 hectolitres in 24 hours. The geyser is of intermittent nature and there is a single greater ejection in a number of smaller ones. The latter, which throws the water to a height of about 3 meters, occur every second, while the greater one, which sends it up to about 4,5 meters, takes place every five seconds.

Analysis made in the Geological Survey is as follows:—

Total residue per litre of water: 9,2. Specific gravity: 1,006 at 15,5° C.

$NaCl$	5,6634	$CaCO_3$	0,3215
KCl	1,6339	$CaCl_2$	0,2754
Na_2SO_4	0,6358	SiO_2	0,2180
$MgCl_2$	0,5358	$FeCO_3$	0,0163

Thus the water has nearly the same composition as that of Yuzawa Hot Springs.

The cone from Obama is snow-white, and so loose that it can be scratched with the finger nail. The cone consists of:—

CaO	38,28 %	Cl	1,03 %
CO_2	23,28 „	Na_2O	0,89 „
SiO_2	16,59 „	Fe_2O_3	0,41 „
Ign. loss	10,46 „	K_2O	0,20 „
MgO	7,28 „	Al_2O_3	0,18 „
MnO	1,80 „		

The cone is flat and symmetrical, gently sloping, with a broad truncation, and a central orifice about 6 cm. in diameter. The slope is about 50° near the top, about 35° in the middle, and about 20° near the base. The peculiar surface sculpture consists of radial valleys, narrowed and deepened towards the bottom, instead of towards the top as is usually the case on volcanoes. Between the valleys there are rounded ridges cut across by broad grooves. The formation of those valleys is probably due to the erosive action of the hot water flowing down the slopes. The specimen, represented in the figure, weighs about 6,457 grm., and measures about 13,7 cm. in height and about 37 cm. in diameter at the base."

B. The Tufa Cones* formed at the Kuriyama Hot Spring in the Province of Shimozuke.

Regular cones of sinter are being produced at Yuzawa in Kuriyama-mura, Shimozuke Province, a place deep in the mountain and seldom visited by men. This locality lies about 19,5 m. N. W. of Nikkō, on an affluent of the upper course of the Kinu-gawa.

All the vicinity of Yuzawa is composed of liparite from which several hot springs gush out. The same rock standing on the western side of the Yuzawa waterfall has a long horizontal crevice, about 10 ft. above the river-level, with hot waters rushing out horizontally. From a cliff near by, *see Plate 4, fig. 4* almost on the same level, are found two other geysers, which are ejecting hot waters vertically to a height of about 10 ft. The horizontal as well as vertical geysers form cones around their jets, which grow naturally larger in the latter than in the former. These vertical sinter-cones consist of carbonate of lime, with a very small quantity of silica and sulphur. The inner part is of compact

* Prof. Wataru Watanabe Nippon Kōgyō-Kwai-shi (Journ. of the Mining Institute of Japan) No. 194, p. 865, 1909.

aragonite. The compact part has the hardness 3 and specific gravity 3,017 (a little higher than ordinary aragonite). The sinter cones are provided with a central canal, the wall of which is covered to unequal thickness with sharp-pointed crystals, slightly reddish by the presence of manganous carbonate. The canal becomes thus narrower, as the cone increases in height; and the emission of hot water decreases in force.

On account of the depression of pressure and temperature of the spring water, after gushing out from the ground, a part of calcium bicarbonate contained in solution loses carbonic acid and forms the neutral carbonate which forms a deposit on the jets of spring, increasing gradually in size and compactness. The sinter cone, shown in Plate 4, fig. 2, is the one, which has been formed during a period of about ten months (304 days) from Aug. 26th., 1907, to June 25th., 1908. and consisting of a white crystalline mass with a conical canal. Height: 2 ft. Diameter at the base: 1 ft. Weight: 3,7 *kwamme* (13,85 kilograms). Amount of daily precipitation: 12,1 *momme* (45,4 grams). The other one, fig. 3, has been formed during a period of about nine and half months (286 days) from Aug. 27th., 1908, to June 9th., 1909, at the same jet of geyser, showing a similarity to Mt. Fuji with the explosion-crater of Hō-eizan. This cone has two narrow canals opening at the top. The cone is white, but looks yellowish on the outside, by presence of floury sulphur. Height: about 8 inches. Diameter at the base: 1 ft. Weight: 3,25 *kwamme* (12,2 kilograms), Amount of daily precipitation: 11,3 *momme* (42,4 grams). The idea of preservation of scientifically interesting natural objects being quite rudimentary among ordinary sightseers, they damage these beautiful cones as soon as they grow up, apparently without any purpose of utilization. A cone, which has been grown to a height of more than 5 ft. and regarded as one of the largest ever found, was said to have been destroyed by an inundation of Sept., 1904.

see Plate 4, fig. 2

see Plate 4, fig. 3

The water of the geysers is transparent and colourless, weak salty in taste, and the temperature of spring measured at the orifice is 94° C. The flow of water amounts to 4,26 litres per minute. Analysis of water made by Prof. M. Kawakita, in the Engineering College of Tōkyō Imperial University, in 1909, gave the following results:— Specific gravity: 1,02.

In 1 kilogram of water are contained:

Sodium	0,5293	Chlorine	0,7065
Potassium	0,0238	Sulphuric acid	0,0883
Calcium	0,0640	Silicic acid	0,1266
Magnesium	small quantity	Carbonic acid	0,2076
Aluminium	,,	Total	1,7461
Iron	,,		

Hypothetical form of combination.

Sodium chloride	1,1642	Magnesium carbonate	small quantity
Calcium carbonate	0,1600	Ferrous carbonate	,,
Silica	0,1266	Manganous carbonate	,,
Sodium bicarbonate	0,1241	Alumina	,,
Sodium sulphate	0,1134	Total	1,7414
Potassium sulphate	0,0531		

C. Sinter-coated Leaves, Sinter Balls, and other Sinter Deposits.

Some of the mineral springs, especially the earthy carbondioxated springs, produce more or less abundant sinter deposits at the source and on the creek bed on which they flow, besides in the conduit and at the bathing-place. The deposits vary in form, structure, texture, colour, etc., according to the composition and temperature of the water, as well as the velocity of flow and other conditions. All these determine also the rate of growth of different sinters. Some of the sinter shows a considerable growth in a short time, that the wooden conduits ought to be replaced by new ones, every four or five years, unless the crust formed on the inner wall is removed from time to time.

Plate 1, fig. 2 shows a piece of the regularly stratified calcite sinter, 5 cm. in thickness, formed at the Shigaku Hot Springs, Shimane Prefecture, in a wooden conduit running along the slope of Mt. Sambe-yama, from the source lying about 0,6 m. off the bathing resort. The breadth of the surface in contact with hot water is 11,0 cm. and that of the face in contact with the wood is 18,5 cm. The whole thickness of this specimen, (5 cm.), is told to be the growth in less than eight years.

see Plate 1 fig

The colour is yellowish-brown, varying in intensity in different layers, which differ from one another also in compactness.

see Plate 1, fig. 3 Fig. 3 is a pair of weights made of the same sinter, for the hanging picture in Japanese rooms, just for the object of *souvenir* sold to visitors. Each of the pieces, about 45 grm. in weight, is in *see Plate 1, fig. 1* the form of a short hexagonal prism, 45 mm. in length, and 30 mm. in diameter, with a longitudinal canal right through the middle.

Plate 1, fig. 1 shows the same kind of the grayish-white sinter, deposited in a wooden conduit of the *Akakura* Hot Springs, Echigo Province. The hot water flows down over a distance of more than 4 miles, along a steep mountain path on the middle slope of Mt. Myōkō. The upper figure (a) shows the lower surface of a fragment of the deposit, 24,3–28,0 cm. in length and 20,0–22,5 cm. in breadth, weighing 7,65 kilograms and showing the impression of the grain of wood. (b) is a fracture surface of the same, measuring 7,3 cm. in breadth. This specimen was produced in a conduit with a comparatively low gradient, and shows such a loose texture as to be easily scratched with the finger nail. Those found in one of a steeper gradient is generally thinner, but harder and more compact.

Sinter-coated leaves occur on the creek-bed, near the *Masutomi* Mineral Springs in Kai Province, with the water of "*Kinsen-tō*" flowing in. They are represented in natural sizes in Plate 2, fig. 1. *see Plate 2, fig. 1* The largest and most complete leaf measures about 12,0 cm. in length and 5,5 cm. in the broadest part, and 3,0–3,5 mm. in thickness. The deposits are yellowish-brown in colour, but are sometimes coated with green algae.

The sinter, fig. 2, was collected in the neighbourhood of the hot waterfall at the source of the *see Plate 2, fig. 2* *Ogawa* Hot Springs, Etchū Province. We find there root of plants covered with sinter, consisting chiefly of very minute crystal individuals of calcite lying one upon another.

The sinter-balls of calcite, fig. 3, are collected from the basin of the hot waterfall of Ogawa. *see Plate 2, fig. 3* Some of them are almost perfectly spherical, but all the others are more or less irregular in shape. In some specimens, the surface is quite smooth and lustrous but in others it is slightly drusy. The colour of the balls is yellowish-brown, as in the other sinter deposits above mentioned. The largest specimen in the figure is about 22 mm. in diameter, and about 13,8 grm. in weight, while the smallest one is 10 mm. in diameter and about 3,5 grm. in weight.

Chapter XI

A FEW WORDS ABOUT THE RADIO-ACTIVE MINERALS IN JAPAN.

The occurrence of radio-active minerals is already known in Japan, but none of them affords good quantity. The following species have up to the present been found.

1. HOKUTŌLITE.

Hokutōlite is the new radio-active mineral, found in streamlets of the Hokutō Spring in the island of Taiwan (Formosa) and at the Shibukuro Spring on the Yake-yama Volcano in the Province of Ugo. This mineral name was given by Prof. Kotora Jimbō. (See List of New Minerals, in Mineralogical Magazine, London, Vol. XVI, p. 362, 1913.) The mineral is a mixture of $BaSO_4$ and $PbSO_4$, crystallized in minute rhombic platy crystals of a yellowish-gray or brown colour and a resinous luster.

Hokutō, Taiwan. This well known place with its hotels and baths is situated on the south-western side of Mt. Shichisei-zan, which forms a part of the Daiton Volcano Group in Northern Taiwan. There are a number of solfataras with a considerable quantity of sulphur deposits and an explosion-crater having a perfectly flat bottom. Hot springs of 80° to 90° C. issue out of the bottom of this crater, and unite in forming a creek, here not more than half a meter in depth, and only about three meters in width. Almost all of the hotels use this water for bathing purpose, an exception being one large modern bath which is fed from a different source. The explosion-crater as is usual shows rocks bleached and decomposed to earthy matter, carrying efflorescence of a white soluble substance, accompanied by a small quantity of floury sulphur. The following analytical result was obtained with water from this creek, taken at the seat of a common bath now out of use, where the creek bed is already broad and suddenly descends, making a low waterfall, as if cut across by a fault line. *see Plate 3, fig. 3*

Na_2SO_4	19,055	$MgSO_4$	2,024
$NaCl$	9,990	$Al_2(HPO_4)_3$	0,012
KCl	7,130	$BaSO_4$	0,007
$Al_2(SO_4)_3$	6,588	$PbSO_4$	trace
NH_4Cl	6,073	H_2SiO_3	2,174
$CaSO_4$	4,787	HBO_2	0,710
$FeSO_4$	trace	Free acid (HCl)	19,596
$Fe_2(SO_4)_3$	5,420		

This water is colourless and almost free from suspended matter. The taste is strongly acid and the smell of sulphuretted hydrogen is noticeable. The above analysis perfectly coincides with that of the water obtained at the spot where the streamlets on the crater bottom finally unite together on the western side, and therefore it is most probable that the waters at the original spring have the same composition as this. It must be emphasized that there is observed no deposition of *hokutōlite* at the point of origin, the temperature of water being possibly too high. The gravel in the creek is mostly of andesite, more or less decomposed on the surface, sometimes one meter in diameter, but usually not larger than a man's head. These blocks are cemented together by the river sand, and a yellow or brown ferruginous substance. The gravels, as well as the consolidated sand, are covered with a thin fibrous crust of *hokutōlite*, the outer part of which forms druses of rhombic tabular crystals. In the following tables are given (I) the analysis of the crystalline crust, and (II) that of its well crystallized external part :— *see Plate 3, fig. 1*

	I	II		I	II
PbO	21,96	19,38	K_2O	0,00	0,14
BaO	32,04	42,27	Na_2O	0,53	1,53
SrO	0,93	trace	H_2O	2,53	—
CaO	0,51	0,17	Ign. loss	—	2,74
SO_3	30,81	31,70	P_2O_5	0,01	0,00
Fe_2O_3	3,93	0,43	SiO_2	1,27	0,97
Al_2O_3	0,88	0,48	Total	96,44	100,09
MgO	1,04	0,28			

Fluorine is present in I, but its quantity was not determined. The mineral contains, moreover, three radio-active elements, ionium, polonium and radium, besides 2 per cent of CeO_2 and La_2O_3, taken together. It is most noticeable that this mineral contains no uranium. It is also remarkable that the deposition of *hokutōlite* is almost entirely restricted to those parts of stones now covered with hot water. Considering that $BaSO_4$ and $PbSO_4$ exist only in an extremely small quantity in the water, it is doubtful whether this mineral is really deposited by the present spring water or not.

At the water line, a dirty gray compact crust is formed with no crystal formation and no radio-activity, and of following composition, quite different from *hokutōlite* :— *see Plate 3, fig. 2*

SiO_2	77,10	Na_2O	0,73
SO_3	2,48	K_2O	0,14
Al_2O_3	2,27	TiO_2	trace
Fe_2O_3	2,11	P_2O_5	trace
CaO	0,13	Ign. loss	14,94
MgO	0,30	Total	100,20

The colour of *hokutōlite* varies from brown or brownish-yellow to almost white. The crystals are in minute thick rhombic plates, about 2,5 mm. in diameter and half as much in thickness; and there are besides the prism and the base, minute pyramidal faces. The plates mostly form a subparallel growth on the basal pinacoid, which is the direction of distinct cleavage. Hardness is about 3,5 and specific gravity nearly 6.

Radio-activity is well noticeable.

Shibukuro, Ugo. On the volcano Yake-yama, a hot spring water is issuing, distinguished by its exceedingly thick deposit of floury sulphur, collected and sold for use in medical baths. The bottom so this hot water shows scanty deposits of *hokutōlite*, but the mineral forms a deposit of about 6 cm. in thickness at a distance of about 2,640 ft. (800 meters) lower down the creek, where the water is not very high in temperature. Close to the bathing hut, there is a deposit of *hokutōlite* in an old dried-up bed of a creek formerly supplied with hot water. The mineral from the Shibukuro Spring is apparently identical with that of *Hokutō*, but the gray-coloured deposit found on the water line is missing at *Shibukuro*.

Radio-activity is less distinct than that of hokutōlite from Hokutō.

Ryōichi Ōhashi, lecturer at the Akita Mining College, in 1913, using a small piece of Hokutōlite found at the *Shibukuro* Hot Springs, Ugo Province, observed the radio-activity of the mineral by the photographic effect.

The specimen is a radial-concentric crust with the nucleus of a conglomerate, with alternate zones of white opaque and dull yellow; and blow-pipe tests indicate the presence of a comparatively large quantity of lead in the former, while in the latter a very small amount of it. The test specimen was cut and polished perpendicular to the concentric shells. After having been sufficiently dried a sensible photographic plate (Lion-special rapid), with the film upwards, was placed on the polished surface of the mineral, a sheet of paraffin paper interposed between the plate and the object.

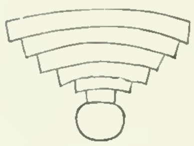


Fig. 1 shows a photograph of this kind obtained after exposure for three weeks, giving a different impression of different layers of the crust. The photograph of the same section of the specimen, is shown below the radiograph of the same for comparison (Fig. 2).

It may be easily seen from the figure that the outer part of the crust affects the plate generally more sensibly than the inner part, and the white layer presents stronger radio-activity than that of the dull yellow colour. It is noticeable that the mineral has only a weak power of penetration, as the rays emitted are relatively very easily stopped, a single sheet of paraffin paper intercepting them.

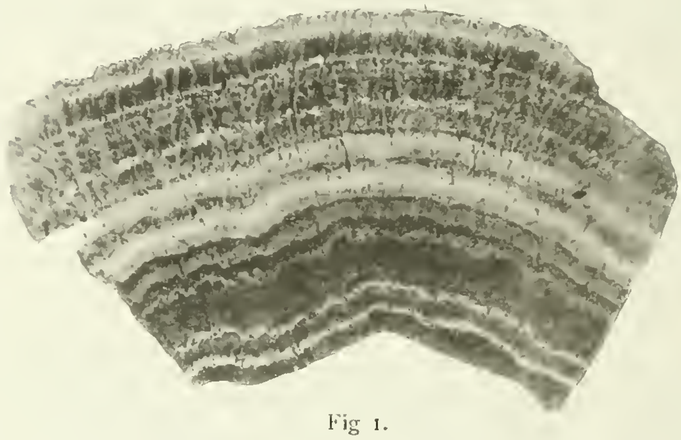


Fig 1.

Hokutōlite containing radio-active elements, photographed by its own rays.

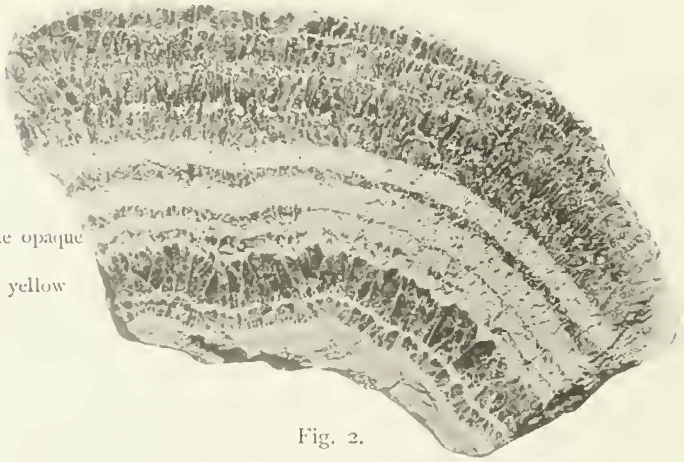


Fig. 2.

The same in natural size and state.

If the mineral be applied directly to the plate without any screen, it will be observed that the exposure may be shortened to two weeks in order to obtain the radiograph of the same intensity as shown in the figure, while a piece of red paraffin paper is sufficient to stop their rays almost completely.

Care must be taken for taking radiograph of the mineral to desiccate it well, as even a faint trace of water weakens considerably the sensibility of the plate for radiation.

2. RADIOBARITE.

Shibukuro, Ugo. The white to reddish-white *radiobarite* of the Shibukuro Spring is collected only from the heap of rock dug out of the hot water creek with *hokutōlite*. Crystals are thick rhombic fabular, parallel to the basal pinacoid and generally 2–3 mm. in the longest diameter. The faces observed are the basal, pinacoid, the unit prism and the unit pyramid. Hardness is about 3.

Radio-activity is weak.

3. NAËGITE.

Naëgite is a mineral nearly identical with zircon. The name was given by Tsunashirō Wada after its locality, **Naegi**, in the Province of Mino, where it is collected in tin placers together with *beryl, tourmaline, quartz,* etc. *Naëgite* is greenish or brownish in colour and forms imperfect globular aggregates, sometimes more than 2,5 cm. in diameter, upon whose surface the terminal faces of crystal individuals are distinguishable. Single crystals varying from 3 to 5 mm. in length are not rare. The fresh crystals are generally highly vitreous in lustre. The crystal habit is often pyramidal but generally prismatic; the faces are the protoprism and a proto-pyramid, besides a very subordinate face of the other prism. Hardness is about 7,5 and specific gravity 4,09. The crystals are not uniform in colour throughout, the terminal portion being often turned to reddish-brown, while the inner part is grass-green. Extinction is straight. Refraction is strong but double refraction is weak. The result of chemical analysis is as follows:—

ZrO_2	55,30	Nb_2O_5 } Ta_2O_5 }	7,69
ThO_2	5,01		
SiO_2	20,58	Yt_2O_3	9,12
UO_3	3,03	Total	100,73

Radio-activity is strong.

4. ZIRCON.

Zircon in good macroscopic crystals are of rare occurrence in Japan, being found in well developed but minute crystals in the gold placers near Kiirun (Keelung) in Taiwan (Formosa); and as large crystals in a graphite deposit of Chōsen (Korea).

Placers near Kiirun. *Zircon* is found there in minute columnar crystals, not more than 1 mm. in length, and shows the tetragonal prism, and ditetragonal and tetragonal pyramids. Crystals are sometimes beautifully red, but also yellow, brown, gray, violet or colourless. The red colour of the mineral fades away on ignition. Specific gravity is 4,7 and hardness is 7,5. *Distinctly radio-active.*

Shimpyō-ri, Chōsen (*Korea*). The zircon crystals, which are found at this place, are dark violet-red and translucent, and prismatic in habit, with two kinds of tetragonal pyramids and the unit prism. The individuals attain 7 cm. in length and 2,5 cm. in width. The chemical analysis is as follows:—

SiO_2	33,06	TiO_2	0,00
ZrO_2	63,32	Residue	0,29
Fe_2O_3	3,33	Total	100,00

Radio-activity is indistinct.

5. MONAZITE.

Monazite occurs in gold placers and in the mother-rock pegmatite of **Ishikawa-yama** in the Province of Iwaki, as yellow to brownish, semi-transparent crystals of a thick tabular form showing the faces of the orthopinacoid, two domes, the unit prism and the base. The individuals are minute and rarely exceed half a centimeter in the longest diameter. *Radio-activity is well noticeable.*

A red crystal badly developed within a topaz crystal of **Tanokami-yama** in the Province of Omi, shows strong similarity to *monazite*. It runs up to 6 mm. in the longest diameter.

6. COLUMBITE.

Columbite occurs in pegmatite as well as in diluvial sand deposits, near Ishikawa-yama in the Province of Iwaki, and in pegmatite at Yamano-o in the Province of Hitachi.

Ishikawa-yama, Iwaki. The black crystals, sometimes attaining the length of 9 cm. and the width of 5 cm., show the two vertical pinacoids prevailing and well developed, besides the base, prisms and pyramids. Cleavage is parallel to the macropinacoid. The mineral is there found embraced by *beryl, quartz* or *feldspar. Radio-activity is distinct.*

Yamano-o, Hitachi. Some small crystals of this mineral were collected there. The chemical composition is as follows:—

Nb_2O_5	57,95	MgO	2,26
Ta_2O_5	22,19	SnO_2	0,49
FeO	10,81	WO_3	trace
MnO	7,06	Total	99,89
CaO	1,13		

Radio-activity is indistinct.

7. FERGUSONITE.

The mineral is found in a scanty amount, in the river sand of the environs of Naegi in the Province of Mino.

Naegi. The crystal individual is irregularly columnar, tapering on one end, showing hemihedral faces (the pyramid, prism and the base), usually not more than half a centimeter in length. Colour of the mineral varies from dark-gray to light-gray. The faces are rough and curved, except the pyramid. Specific gravity is 4,3. The chemical analysis gave the following result:—

SiO_2	2,10	Yt_2O_3, Er_2O_3	35,60
Nb_2O_5, Ta_2O_5	48,39	Fe_2O_3	1,04
UO_3	2,95	H_2O	4,12
CeO_2	5,69	Total	99,89

Conspicuously radio-active.

8. ORTHITE.

Macroscopically visible crystals of *orthite* are found in the biotite granite of **Mt. Hiei-zan** near Kyōto. They are minute, columnar, almost black, and with a vitreous luster. The observed faces are the base, the orthopinacoid, pyramids and the unit prism. The crystals are as usual elongated in *b* axis, and developed on both ends; they measure sometimes nearly 1 cm. in length and a few mm. in width. Zonal structure is almost wanting, while pleochroism is very strong. *Radio-activity is distinct.*

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Chapter XII

ON THE GEYSER IN ATAMI.

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PHYSICAL LABORATORY, IMPERIAL UNIVERSITY TOKYO, December 28, 1905.

Different from other geysers, the geyser of Atami in the Province of Izu is characterised by the regularity of the eruption, which consists in alternate projections of hot water and steam, usually five times in succession. The water projected does not return to the orifice as it does in several other geysers. The orifice, which originally opened vertically upward, has been covered by a heap of stones to prevent the dangers caused by the eruption. At present three orifices are exposed, among which one is distinguished as the principal opening. Besides, there is another mouth hidden underground; the water projected by these orifices is distributed to several bath-houses by conduits. The water is of a strong saline taste, containing about ½ per cent. of sodium chloride, *i. e.*, about one fifth of that contained in the sea water. The mouth of the geyser is not far from the sea coast and about 22 meters above the sea-level.

The eruption occurs usually five times in a day and night. During the time of repose, we see only a small quantity of steam rising from the mouth. As the time of the eruption approaches, a rumbling sound is heard underneath. The boiling water appears just inside the mouth. It soon retires and again appears. This state continues for about three quarters of an hour. Next a small quantity of hot water flows out intermittently. This is followed by an intermittent stream of moderate quantity with a longer period. The activity soon attains its maximum. A torrent of hot water gradually increasing in force is torn into a violent splash and projected with a great velocity by steam which gradually increases with the diminising water. When the roaring sound of steam reaches the maximum, the water almost disappears. The steam now diminishes and is soon followed by the second gush of water. After these states have been repeated five or six times, the activity ends with the last steam which gradually subsides into an inconsiderable amount as seen at the beginning. It takes above two hours from the beginning to the last stage of the eruption. The time of repose is a little less than three hours on the average. These regular recurrences are often interrupted by an abnormal outburst, called *nagawaki*, at which the water and steam come out incessantly for above twelve hours and after which a long repose follows as a rule. In years rich in this anomaly it occurred almost monthly, whereas in the last few years only once or twice.

Our excursion to Atami was undertaken to make detailed observations as to the manner of eruption and if possible to get an insight into the internal mechanism of the geyser. Arrangements were contrived to keep records of the manner of each successive eruption.

A pendulum consisting of a brass rod and a heavy lead ball was hung before the principal orifice. The water and steam, projected nearly horizontally, deviate the pendulum by the impulsive pressure. The motion of the pendulum was transmitted by a cord and pulley to a recording pen guided by two vertical pillars with grooves, in which roll two friction-wheels attached to the penholder. The vertical displacement of the pen was recorded on a cylinder making one revolution every two hours. The pendulum was afterward removed to a position where the impulsive action of vapor and splash was shielded off and the flow of water only could be recorded.

To record the manner in which the steam is ejected, an arrangement was used which was nothing more than an air-thermograph. A small cylinder of sheet zinc was introduced into a mouth neighboring to the principal orifice, where it was possible to find a position such that the bulb was exposed to the heating of the steam only. This orifice, being a smaller branch of the main one, could be considered as representing the main one on a reduced scale. The bulb was connected by a fine copper capillary tube to one of the arms of a U-tube containing mercury. The motion of the mercury meniscus in another arm was recorded on a cylinder by a pen mounted on a float on the mercury and guided by two vertical pillars with grooves and two friction-wheels attached to the penholder. To determine the temperature of the water and steam a maximum thermometer was used.

To take continuous records of the exact time of eruption, and also the general manner of each eruption, a mercury tide-gauge, constructed after Mr. Nakamura's design,* was used. The lead pipe of the instrument was inserted to the neck of the geyser. The pressure of the projected water at the neck during each eruption was recorded on a cylinder revolving once every 24 hours. The automatic records of daily eruptions have been taken during the last two years.

In the following lines, a brief account of our results of observation is given.

I. Ordinary Eruption.

An ordinary eruption consists of three distinct series, termed conventionally the first, the second and the third, differing in period and force and succeeding one another very regularly. Fig. 1 is a reproduction of one of the records obtained by our pendulum recorder. The abscissa represents the time, and the ordinate the deflection of the pendulum by the pressure of water. The dotted line shows the velocity of the steam obtained by our air-thermograph. The first series, which begins the outburst, consists of a small quantity of water appearing with an average period of 1 minute and 40 seconds. After this intermittence has been repeated a score of times the second series follows. A moderate quantity of water comes out three or four times with a mean period of six minutes. The water increases in quantity and force till at last the third or principal series sets in. On the first outburst of the third series we see very often the superposition of the last one of the second series. The third series is to be distinguished from the previous series by its violence and the quantity of water and steam. The sequence of the water and steam occurs usually five or six times with a mean period of about 11 minutes. Fig. 2 is a record obtained by the mercury tide-gauge, and shows regular periodic sequence of eruptions with a mean period of 24/5 hours.

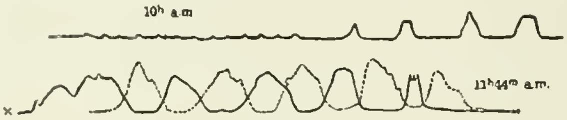

Fig. 1.

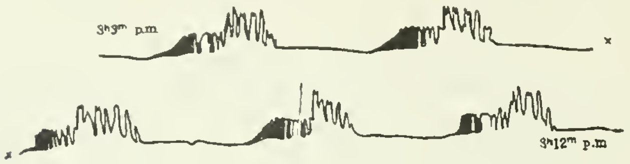

Fig. 2.

II. Abnormal Eruption; Nagawaki.

The first *nagawaki* recorded by our arrangement began at 4 : 30 A. M. on January 14, 1905, from the fourth eruption of the third series. During two or three days before the *nagawaki*, the period of successive eruptions seems to have been slightly diminished; but in such a degree that may be found not seldom in our records without leading to either *nagawaki*, or anything extraordinary. The *nagawaki* began, as it were, almost suddenly in the midst of an ordinary eruption. The flow of hot water continued without interruption, gradually decreasing in quantity and mixed with steam. At 7 : 40 P. M., it came to a sudden repose; at 2 : 40 A. M. on the 15th, an intermittent flow of hot water resembling the second series of an ordinary eruption began and continued for about three hours. After a repose of four hours ordinary eruptions at last set in, but with the period remarkably shortened and the activity strikingly reduced. The number of eruptions per day was ten, a remarkable contrast to the ordinary frequency of five. The frequency decreased afterward very slowly with the time, and recovered its original value after the lapse of about a month.

The second *nagawaki*, which occurred on May 26, was quite similar to the previous one in its general aspects, though it took place in conjunction with the extraordinary decrease of the general activity.

It is an interesting coincidence that the two *nagawakis* of January and May began at the same phase of the ordinary eruption at nearly the same hour of day, and that a center of low atmospheric pressure was approaching from the Pacific in each case.

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* S. Nakamura, Proceedings of the Tokyo Physico-Mathematical Society, Vol. I., No. 15, p. 123, 1902.

III. Influence of Atmospheric Pressure.

Examining our records of long observation, we found a remarkable fact that low atmospheric pressure *retards* and high atmospheric pressure *accelerates* the eruption of the geyser. This curious fact may be seen from Fig. 3. Times of the successive eruptions are plotted as the ordinates corresponding to each day which is laid off as abscissa; corresponding points for successive days are connected into five broken curves (*b*)–(*f*). Curve (*a*) represents the daily change of the mean atmospheric pressure. The probable cause of the strange coincidence would be given later.

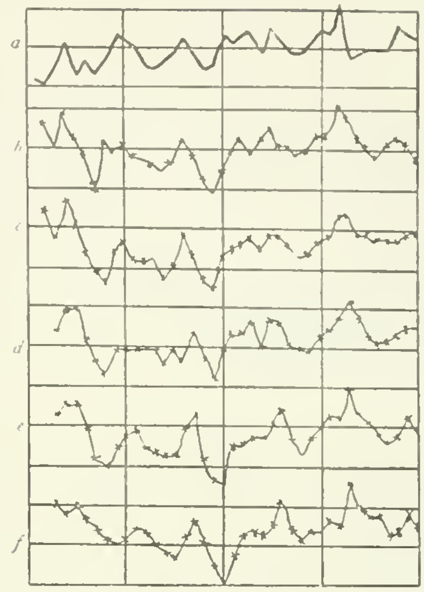


Fig. 3.

IV. Temperature of Hot Water during Eruption.

A maximum thermometer was placed about 1,5 meters inside the orifice and the temperature has been read daily since last April. It was found that the temperature at this depth was almost invariably 103°–104° C. At the orifice, however, it was about 100° C., indicating a rapid cooling of the hot water. Hence it may easily be conjectured how hot the underground water would be at a depth of some ten meters.

V. Velocities of Water and Steam.

The pressures of water and steam upon the bob of a special pendulum arrangement were recorded on the cylinder, and estimated afterward by the substitution of known weights. The total pressure upon a sphere is known to be approximately equal to one half of that upon a circular disk of the same diameter. Hence

$$p = \frac{\pi r^2 \rho v^2}{2}, \quad \text{or} \quad v^2 = \frac{2p}{\pi r^2 \rho},$$

where p is the pressure, r the radius of the bob, ρ the density and v the velocity of water or steam.

For the water we obtained, at the mouth,

$$v = 1.5\text{–}2.0 \text{ meters per second,}$$

and for the steam

$$v = 18\text{–}24 \text{ meters per second,}$$

the velocities varying within the limits according to the phase of each eruption. In this calculation, we took for the value of ρ the density of saturated vapor under ordinary atmospheric pressure.

VI. Quantities of Water and Steam.

For the rough estimation of the quantity of water thrown out in an eruption, we measured directly the amount supplied to a number of tanks and calculated the total from the sections of several conduits. The quantity thus estimated amounts to 45 cubic meters.

The rough estimation of the quantity of steam was carried out in the following way:

Let the quantity of steam be denoted by Q. Then

$$Q = \int S v \rho dt,$$

when S is the area of the orifice. If V be the ordinate in the curve representing the relation of velocity of steam to time, obtained by our special thermograph above referred to, we may put

$$v = kV, \quad \therefore \quad Q = S\rho k \int V dt.$$

Since v was determined by the pendulum experiment, and the corresponding V from the thermograph curve, k can easily be known; by calculation, it was found to be 500. S was estimated to be 200 cm.^{2}; for an instance, we obtained

$$\int Vdt = 6500, \quad \therefore \quad Q \doteqdot 500 \; kg,$$

the number must be considered as giving only the order of magnitude.

VII. Extraordinary Decrease of Activity.

During the course of the last few years, several wells have been bored in this district. Most of them give a moderate quantity of hot water only by pumping. Since the last year, the number of wells was greatly increased, amounting to about twenty in all. Sawaguchi's well, bored on March 27 of this year, burst out with great violence, throwing up a column of hot water about 8 meters high. On May 22, another one, Yonekura's well, of greater activity, has been opened within a few hundred meters of the geyser, giving hot water at a rate of 310 cubic meters per day. Two days afterwards another one, Higuchi's well, of not much less activity, was bored. After the boring of the Sawaguchi's a slight decrease in the frequency of the geyser was observed; on May 20 it was reduced to 4.4, though the force of each eruption presented no appreciable change. After the boring of the other two the frequency remarkably decreased; it was 3.6 on May 26. Moreover, the first and second series of each eruption became considerably longer and the principal series was considerably lessened in force. After the *nagawaki* of May 27, the frequency was temporarily increased; but on June 11, it fell again to 3.2. As shown in Fig. 4, the first and second series lasted for three and a half hours and the third was reduced to only three weak eruptions. Consequent decrease in the quantity of hot water caused trouble to several bath-houses supplied by the geyser, and therefore the above three wells were all stopped—Yonekura's on June 12, Sawaguchi's on the next day and Higuchi's on July 12. The frequency of eruption has gradually increased since then, and in the middle of August, it attained 4.5 which is yet somewhat short of the original value. As for the mode of each eruption, it has quite recovered in force.

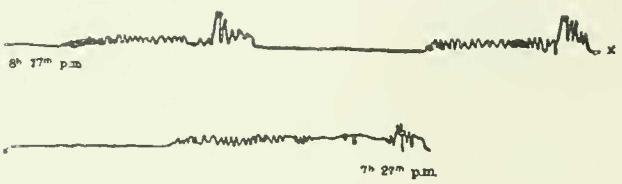


Fig. 4.

VIII. Level Change and Temperature of Wells.

Level change of two wells near the geyser were recorded by means of Honda's limnimeter. Nomura's well, which is within 200 meters of the geyser and quite high above the sea-level, shows a regular up and down motion corresponding to the eruption and repose of the neighboring geyser. Effects of the tidal and atmospheric pressure are also recognizable, but not very remarkably. (Fig. 5.) The temperature of the water of this well is 50°–60° C. In Suzuki's well, which is more remote from the geyser than Nomura's, the effect of the geyser is not observed, but the level rises and falls with the tide. (Fig. 6.) The head of the water is 22 meters above the sea-level. Temperature measurement with a maximum thermometer was made in Abo's well, which is situated in the midway between the geyser and Yonekura's well. The results are tabulated as follows:

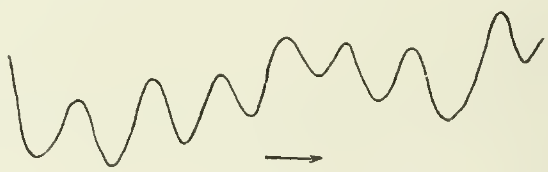


Fig. 5.


Fig. 6.

At the surface of water,		62°.0 C.
23.0 meters below,		95°.5
28.5	,,	98°.3
29.7	,,	104°.7
31.0	,,	118°.2

Thus, a remarkably high temperature was found to exist in the surface layer of the district.

IX. Explanation of the Phenomena.

Existing theories on geysers fail to explain the exact manner of eruption of the geyser of Atami. After a series of experiments with several forms of models, we arrived at a theory which we hope may fairly explain the phenomena of the geyser in question.

Referring to fig. 7, *A* is a cavity lying in a considerable depth; *a* is the vertical pipe and *b* a canal which supplies the water to *A*. We conceive a side canal *c* intermediate between *A* and *a*, which leads to a second cavity *C*, not shown in the figure. The temperature of the water in *a* and *c* is supposed to be lower than the corresponding boiling point. Water in *A* is heated by the wall of the cavity, the temperature of which is supposed to be decidedly higher than the boiling point at the depth. The source of the heat is probably to be attributed to the hot water and steam running through numerous veins and canals extending in the depth of the district. When the tension of the vapor in the cavity attains a critical value, the water is thrown off and then the steam follows. When a certain amount of steam is given off, the pressure in the neck is reduced to such a degree that the water flows in from the side canal and stops the eruption momentarily. Soon the downward pressure of the water column is overcome by the tension of vapor and the second gush follows. These eruptions are repeated several times, till the vapor pressure is so reduced as to admit the comparatively colder water from the feed canal *b* and also from *c*. Thus the activity is quenched for a while till the next eruption begins. A model (Fig. 8) constructed according to this view, worked very satisfactorily. The manner of eruption was imitated in many details. The number of intermittences in an eruption increases with the temperature of the water in *c*.

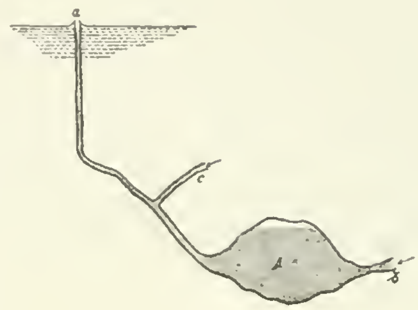


Fig. 7.

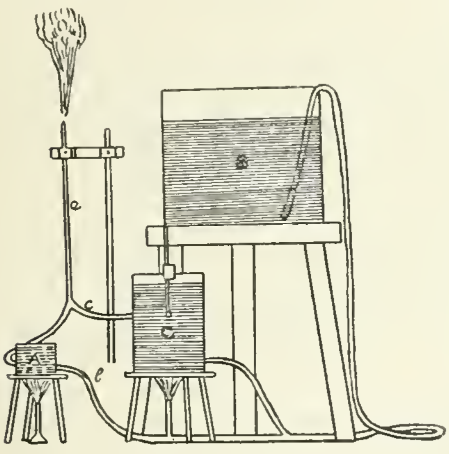


Fig. 8.

The phenomena of *nagawaki* may be explained partly by the supposition that the underground temperature is raised above its normal value and so the temperature of the cavity *C* becomes higher than the ordinary case. If the temperature of the cavity *C* in our model be raised to a certain value, the eruption corresponding to *nagawaki* begins. It resembles the actual one even in some details. The cause of this occasional change of temperature is probably the change of the subterranean volcanic activity which keeps the underground temperature in this district considerably above the boiling point of water.

The fact that the frequency of eruptions immediately after *nagawaki*, is nearly doubled, may partly be explained, if we consider that the temperature of the heating cavity was raised during the course of the *nagawaki* by the incessant flowing of superheated water from a great depth. It may be added as a very suggestive fact that if in our model, a quantity of air be blown into the heating cavity, the frequency of eruption increases at first remarkably and gradually decreases with the gradual expulsion of air by successive eruptions; even the weakness of activity in the actual case is imitated with great faithfulness. During a few hours after *nagawaki*, the cavities as well as the canals leading to the orifice remain drained out, so that it is possible that air or other gases may enter into the cavities and cause the increased frequency of the eruption.

It is a common fact of observation that the temperature of some ordinary hot springs rises with low atmospheric pressure. This is undoubtedly due to the increase of flow due to the enhanced circulation of water caused by the reduction of the pressure. If in the supposed heating cavity of the geyser, the interchange of water due to the slow circulation through numerous veins and fissures (not shown in the figure), be accelerated by some cause, the time required for the sufficient heating for eruption must necessarily be prolonged. This consideration seems to explain partly the influence of atmospheric pressure on the period of eruption above mentioned. Again, the possible influence of well-boring on the geyser, may be explained on the same basis. Such a well may increase the circulation of underground water in its vicinity and result in the retardation of the eruption of the geyser in a similar manner. Moreover, it is quite natural that the hot water should find its easier vent through a new passage opened with a less resistance, at the expense of the quantity originally given out by the old one alone. The prolongation of the first and second series of an eruption, suggests the slowness with which the pressure in the heating cavity approaches the critical value. The careful investigation of the variation of the frequency in connection with the boring and stopping of the wells, leads us to the strong belief that the striking coincidence of the well-boring and the decrease of the activity of the geyser, is a necessary, and not an accidental one. If the frequency of eruption does not yet quite attain its former value long after the stopping of the wells, we need not wonder at all, since some irreversible change in the subterranean mechanism might have happened during the period of the anomaly.

Chapter XIII

A. CLASSIFICATION OF MINERAL SPRINGS

As for the classification of the mineral springs, we have adopted the new system, which was proposed lately by the German chemists, Prof. Dr. E. Hintz and Dr. L Grünhut in Wiesbaden. The classification is made according to their chemical constitution, based on the modern physico-chemical theory of solution.

According to the system the springs are classified as below : (The quantity of dissolved solid constituents given in this article is always that contained in 1 kilogram of the spring water).

1. **Simple (indifferent) thermals.** Simple (indifferent) thermals may be defined as those which issue from the earth at a higher temperature than 37° C. throughout the whole year, and at the same time are poor in free carbon dioxide and also in dissolved solid constituents. The quantity of free carbon dioxide should be less than 1 gram.

The *simple earthy thermals* may also be included in this division.

2. **Simple carbondioxated springs.** Simple carbondioxated springs contain more than 1 gram of free carbon dioxide, but less than 1 gram of the dissolved solid constituents.

Should springs contain less than 10 milligram-equivalents of ferrous or ferric ions and their presence still give the water a pharmacodynamic value, they may also be included under this heading, as far as the above condition applies.

3. **Earthy carbondioxated springs.** Earthy carbondioxated springs contain more than 1 gram of both free carbon dioxide and the dissolved solid constituents, as anions hydrocarbonate ions predominating and as cations calcium and magnesium ions. (Therefore calcium bicarbonate and magnesium bicarbonate appear as predominating constituents besides free carbon dioxide in the salt calculation).

4. **Alkaline springs.** Alkaline springs contain more than 1 gram of dissolved solid constituents, as anions hydrocarbonate ions predominating and as cations alkaline ions. When these spring waters are boiled, the carbonic acid gas evolves and the hydrocarbonate ions are changed into carbonate ions, which combine partly with the alkaline earth metal ions to form precipitates, while the greater part of the hydrocarbonate ions remains unchanged. Its hydrolysis causes the alkaline reaction of the water. When the quantity of free carbon dioxide exceeds 1 gram, we call the springs *alkaline carbondioxated springs.*

Should chlorine, sulphate, or alkaline earth metal ions be present in a predominating quantity, we call the springs *alkaline muriated, alkaline saline, alkaline muriated saline*, or *alkaline earthy springs* respectively, instead of *pure alkaline springs.*

5. **Common salt springs.** Common salt springs (*muriated springs*) contain more than 1 gram of dissolved solid constituents, chlorine ions being the predominating anions, and sodium ions the main cations. (Thus common salt appears to be present in the salt calculation as the most predominating constituent).

These springs may be called *simple (weak) common salt springs*, when the quantity of chlorine ions as well as that of sodium ions is less than 260 milligram-equivalents (or 15 gram of common salt in the salt calculation), but *concentrated common salt springs* when of larger quantities.

When the quantity of free carbon dioxide exceeds 1 gram, we call the springs *carbondioxated common salt springs*. When hydrocarbonate or sulphate ions are present in a predominating quantity, the common salt springs are not called real ones, but *alkaline, saline*, or *alkaline saline common salt springs* respectively. But when alkaline earth metal ions, or these and hydrocarbonate ions, or alkaline earth metal and sulphate ions predominate, the springs are called *earth-muriated, earthy* or *sulphated common salt springs* respectively.

6. **Bitter springs.** Bitter springs contain more than 1 gram of dissolved solid constituents, the sulphate ions predominating among anions. Should the sodium, calcium or magnesium ions be the principal cations, the springs are classified as *saline bitter springs, sulphated bitter springs*, or *real bitter springs*, as the case may be. If chlorine ions be present in addition to one of these three cations, the springs are named *muriated saline, muriated sulphated* or *muriated real bitter springs* respectively.

7. **Iron carbonate springs.** Iron carbonate springs contain generally more than 0,01 gram of ferrous ions with hydrocarbonate ions.

8. **Vitriol springs.** Vitriol springs contain generally more than 0,01 gram of ferrous or ferric ions with sulphate ions.

9. **Alum vitriol springs.** Alum vitriol springs contain generally more than 0,01 gram of ferrous or ferric ions with sulphate ions. The quantity of aluminium ions exceeds 10 milligram-equivalents.

10. **Acid vitriol springs.** Acid vitriol springs contain generally more than 0,01 gram of ferrous or ferric ions besides sulphate and hydrogen ions.

11. **Acid alum springs.** Acid alum springs may be defined as those which contain sulphate and hydrogen ions, and in which the quantity of aluminium ions exceeds 10 milligram-equivalents.

12. **Acid alum vitriol springs.** Acid alum vitriol springs contain generally more than 0,01 gram of ferrous or ferric ions, with sulphate and hydrogen ions, and more than 10 milligram-equivalents of aluminium ions.

13. **Sulphur springs.** Sulphur springs are those which contain hydrosulphide ions and sometimes free hydrogen sulphide in addition. Whether the springs contain free carbon dioxide, and consequently also free hydrogen sulphide, or not, we call them *hydrogen sulphide springs* or *sulphur springs* in the strict sense.

14. **Acid hydrogen sulphide springs.** Acid hydrogen sulphide springs contain free hydrogen sulphide with hydrogen ions.

B. KINDS OF MEDICINAL SPRINGS AND THEIR INDICATIONS.*

1. Simple Cold Springs.

Internal use of cold water stimulates peristaltic motion of the stomach and intestines, which causes as a result promotion of stool (evacuation of the bowels), especially when somewhat larger quantities of cold water are taken to the empty stomach in the morning. It is necessary for assisting rapid evacuation of the bowels to favour the action by adequate bodily exercise.

If one aims at the local specific action of waters, they should be taken warm.

The spas with cold mineral springs are therefore recommended to patients, who are disposed to take cold, also reconvalescents on the one hand, and those who suffer nervous, neurasthenic, hypochonderic complaints with congestion, but without any advanced organic disturbance, on the other hand.

Cold baths may be regarded also as one of the fat lowering systems. Adequate diet and the exercise cure are both essential in assisting the action.

Thus they are contra-indicated for the patients, when temperature of the body and fat deposit must be economized, such as is the case with nervous subjects and reconvalescents.

* Concerning the indications of mineral springs and the use of baths we cannot do better than quote the remarks of other authors. Thus the following lines were taken, partly from "Deutsches Bäderbuch," partly from "The Principles and Practice of Medical Hydrology" by Fortescue Fox, 1913.

The actual effects of cold baths must obviously depend on their duration and temperature in each case.

2. Simple Thermals.

The healing property of this class of springs is based only on the action of water and its temperature, it being simply the local influence upon or through the outer surface of the skin.

3. Simple Carbondioxated Springs.

The therapeutical effect of the waters of this class is based on the hyperbolic action of water, as well as carbon dioxide, especially in the sense of local stimulation. The waters are used both internally or externally, but for external use as baths far the more frequently. Some of these waters are exported exclusively as table water, not being employed locally in any way for medical purposes.

Internal use: (1). If taken cold, the water promotes peristaltic action of the stomach and consequently cleansing and clearing it of its contents. (2). Local stimulation by carbon dioxide causes the dilatation of vessels of the mucous membrane and thus leads to an increased secretion and accelerated reabsorption of water thus influencing the amount of nutriment taken up; therefore if drunk in moderate quantity with or preferably after a meal, it promotes nutritive digestive action of the stomach and also drives off oppressive flatulency or sensation of fullness found sometimes after a generous meal.

When taken too frequently or in too large quantities, the gastric juice is diluted too strongly on the one hand, and, also as carbon dioxide leads to importunity, when it causes the stomach to dilate, disturbs its function on the other hand.

For the same reason it is unsuitable to use table water which is impregnated with an excess of carbon dioxide, as is used with artificial carbonic acid waters, unless it is drunk after dilution. When taken moderately, the water is beneficial in alleviating slight disturbance of digestion, atony, dyspesia, catarrhs of stomach and the upper intestines, and also for patients suffering from urinary, kidney and bladder diseases, as well as disturbance of assimilation, gout, uric acid diathesis, and poisonings, etc. As for the action of elimination it surpasses the simple waters, both cold and warm, owing to its influence in accelerating the absorption of water. It is advisable to associate the milk cure in the first place with the treatment, taking some milk suitably warmed with the spring water.

4. Earthy Carbondioxated Springs.

These waters can be used as carbonic acid baths, owing to their content of free carbon dioxide, like the simple carbondioxated springs, when they are protected against loss of carbonic acid at heating. The presence of earth-alkaline metals invests them also with a feeble astringent property, which proves to be useful for the treatment of some diseases of the skin.

In the case of internal use also the action of carbonate of calcium and magnesium equally joins in those of water and carbonic acid, just as with the simple carbodioxated springs. They are recommended for chronic diarrhoea, gout, urine concrement, catarrh of the bladder and urinay passage.

5. Alkaline Springs.

The nature of the action of these baths is not well known or understood up to the present.

When the water contains a considerable quantity of carbonic acid, it stimulates the skin, as is the case with simple carbondioxated springs, and suitable temperature of bath is often beneficious for the catarrhic state of the female genital organs. The drink cure is contra-indicated for loss of vitality. The use of alkaline beverages is generally injurious when a little amount of acid is present in the gastric juice and the disposition of the stomach and intestines to catarrh is observed, such as in atonic dyspepsia of anaemia, clorose and convalescence. Against phtisis pulmonum, malicious tumors, and every kind of invalidity, the use of stronger alkaline waters should absolutely be avoided. It is stated that the continual use of such mineral waters in large quantities may cause emaciation, atonic dyspepsia and at last cachexie even upon healthy person. The habit of many gouty patients to drink strongly alkaline waters for a long period as a diatetic beverage is therefore dangerous.

Consequently the quantity of water which is to be taken, and the duration of cure should be controlled by spa physician. On the contrary, weak alkaline waters containing carbonic acid gas can be used as a daily beverage for healthy person.

It may be, however, not hygienically advantageous, when such mineral water is impregnated with too large quantities of carbonic acid gas for such to be used as a table water. The volume of gas needs not exceed one and a half to one of water, the best waters of this class containing this amount of carbonic acid in the natural state; if three to four volumes of carbonic acid be added to the water, such a product must be regarded as injurious. The stomach of the drinker becomes swollen and by habitual use permanent dilatation of the stomach may be the result.

6. Common Salt Springs.

Baths of common salt springs of 0,5 to 25 per cent common salt content may be used with good result for: mal-nutrition, diseases of the blood and lymph, diseases of the bones and medulla, swelling of the spleen and the liver, exsudate formation, compensatory disturbance of the circulatory system, habitual abortus, gout, rheumatism, general adipositas, diabetes mellitus, a large number of diseases of the skin and scar formation.

For the drink cure also secondary constituents such as lithium, iron, Glauber's salt, etc., must be taken into consideration. The common salt springs, which are suitable for drinking (of about 25 per cent common salt content), have stimulating influence on the secretion of gastric juice and act in accelerating the proteid digestion. In the same manner also the motility of the stomach is stimulated. Moreover the common salt can be easily absorbed and acts then diuretically, while waters containing common salt have the further action of promoting peristaltic of the intestines and seem to act with stimulation upon the bile secretion, thus proving to be advantageous for bile stasis in the liver.

Hence the common salt springs are recommendable for cases of mal-nutrition, disturbance of the motility and secretion of the stomach, retarded function of the intestines, further for a large number of metabolism-anomalies, for which also other secondary constituents are probably efficacious. Besides these, the drink cure may be used for such afflictions as swelling of the liver and the spleen, inflammatory diseases of pancreas, and in the first place for exsudate formation in the body cavity.

Another curative method adopted at common salt spring resorts is by inhalation. It is recommendable for every form of chronic catarrh of respiratory organs, chronic bronchitis, catarrh of larynx, secondary diseases after catarrh of lung, callosity formation, atelectasis, and lastly also for scrofulous diseases of conjunctiva and chronic diseases of the nose and pharynx (rhinitis, ozaena). For the last mentioned diseases the nose douche, and gargling are also advisable.

7. Bitter Springs.

By the use of waters of this class the evacuation of the excrement increases and the dark colour of the latter proves a strong secretion of bile. When the drink cure is stopped, the evacuation of the bowels usually decreases very rapidly, so that constipation follows usually for a few days after the use of the water, while the increase of urine, which takes place during the use of bitter waters, also has its reaction lasting a few days, after the taking of the bitter waters ceases. The secretion of urea and sodium chloride increase, but that of uric acid on the contrary decreases. The influence of the water upon the mucous membranes of the stomach and intestines, *i. e.* the stimulation for their secretion, may be voluntarily regulated by the quantity of water; if taken in smaller quantities (250 grm.), the action is weakly diuretic, but in larger quantities (500 grm.), very strongly. Larger quantities of the water, if taken for a long duration, may cause sometimes heavy dyspepsia, or catarrhic phenomena, while smaller quantities do not disturb the function of the stomach, but may produce even an accelerating influence on its mobility and absorption, but results are somewhat different from the above when the waters are taken in much smaller quantities.

In the use of less than about 50 grm., though taken a few times daily, the bitter waters can be absorbed, but sometimes cause constipation even in the case of already existing catarrh of the intestines. A part of the sulphates decompose in its passage into sulphides and hydrogen sulphide. The recommendation of the waters to suit each particular ailment differs according to the contents being sodium, calcium or magnesium ion, or chlorine ion present in predominant quantities. As a general rule the taking of the bitter waters are advisable for habitual constipation of a strong and well nourished person, nervous stages of abdomen and bowels with their secondary condition, and for excessive fat formation; equally a number of nervous disturbances which accompany congestion may be favourably treated. Also diabetes and gout may be benefited by the drink cure. In the case of these diseases, especially diabetes, the defective power of the organs for oxidation finds considerable assistance, evidently due to the influence of the sulphates. Smaller quantities of water can be used with greater frequency over an extended period in cases of stasis of liver, and for laziness of intestines during pregnancy when organic heart trouble is present.

8. Iron Springs.

The therapeutically most important constituent of the iron springs is, as the name denotes, of course iron. It is almost equivalent in its action in organism, whether it is contained in the form of ferric or ferrous ion in water. Iron spring waters are now regarded as one of the most suitable forms of introducing iron into the system, as we find by practical experience that it is able to supply the requisite iron to the blood by means of natural spring water for a longer duration without any interference of digestion or disturbance on the part of the stomach, and thus preferable to any other form of iron tonic remedy. Besides the iron the presence of free acids in these waters must be taken into consideration as highly valuable and efficacious constituents. These are hydrocarbonate ion and free carbonic acid, in the case of vitriol springs sulphate ion and in some few cases besides these, free sulphuric acid.

Iron carbonate and vitriol springs are used therapeutically for both drinking and bathing.

The drink cure is advocated in the first place for various kinds of anaemia and clorose, furthermore the iron waters containing arsenic are used for chronic nervous diseases and functional neurosis: hysteria, neurasthenia; the local action of the waters upon the mucous membrane of the stomach and intestines being beneficially utilized for chronic dyspepsia, and the waters of vitriol springs are specially applicable in cases of chronic diarrhoea. As in the bath cure the absorption of iron (or arsenic) into the body through the skin is naturally out of question, only the carbonic acid free or set free is under consideration as an active agent. For this reason the water to be used for bathing purpose should be carefully warmed. They are equally as with baths containing carbonic acid recommended for cases of functional neurosis, *viz.* neurosis of the heart, affections of the female genital organs, especially for irregularity or period disturbance, chronic inflammation, disposition to abortus, functional sterility and affections of the masculine genital organs: Spermatorrhoea, pollution, impotence caused by weakness.

The bath cure with vitriol springs containing no carbonic acid is applicable only for treatment of diseases of the skin when the waters contain a large quantity of arsenic.

9. Sulphur Springs.

All sulphur waters are easily decomposable. Though clear greenish or bluish when pouring forth from springs they quickly become cloudy on atmospheric contact and then sooner or later appear milky owing to deposited sulphur produced by the oxidation of hydrogen sulphide or sulphides. Even in closed bottles oxidation follows in a course of time. In consequence of this quick decomposition sulphur waters should be drunk at the spring, or taken only when fresh bottled.

In most sulphur springs the sulphur discharge varies in its proportion. The cause of this unstableness may be due to the variation of the pressure of the atmosphere. Under a higher pressure of air more hydrogen sulphide gas remains in the water than under a lower.

The origin of sulphur springs is various and in its details still only a little explained. In contrast with the sulphur content in thermal springs from yonger formations, that in hot sulphur springs issueing from the crystalline schists, and between these and the transition formation, *i. e.* from granite, schists or crystalline limestones, may be derived from the decomposition of metal sulphides by hot water. Hydrogen sulphide in sulphur springs, both cold or warm, from younger formations, with more or less gypsum beds containing fossil remains of extinct plants or animals, is probably formed by decomposition of sulphates by organic matter in the wet way. Especially, when water containing calcium sulphate comes into contact with organic remains for a long time do we find organic substances are exidized at the expense of oxygen in gypsum and changed into carbonic acid. On the other hand, the sulphate is reduced to calcium sulphide by the carbon and hydrogen in organic substances. One part of calcium sulphide is, however, decomposed in the presence of the carbonic acid and water ; and calcium carbonate is produced and the hydrogen sulphide liberated.

As all these decomposed products actually occur in sulphur springs from younger formations rich in fossil remains, we accept the afore mentioned explanation for the formation of hydrogen sulphide.

Sulphur waters are for drink cures, baths, douches, and also as a supplement of mud baths and inhalation.

The physiological action of sulphur waters by internal or external use is not yet sufficiently investigated ; with regard to this subject we are directed for the most part to supposition and hypothesis.

The indications of sulphur springs concerned has been found quite empirically. In the drink cure with a sulphur spring water it seems to be of no importance whether sulphur is contained in the form of free hydrogen sulphide or of sulphides. In both cases sulphur is absorbed from the stomach and intestines. In the use of water for baths it is assumed that hydrogen sulphide enters into the body through the skin. In the blood, iron sulphide will be, it is assumed, formed through the iron of the blood and consequently a normal reformation of blood globules, formation taking place constantly, be quickened and the assimilation stimulated. At the same time a strong influence takes place upon the liver, the bile secretion being greatly increased. One part of the sulphur compounds, which are entered into the blood, is oxidized by oxygen which is present in the blood in abundance and this forms sulphates thrown off later in the urine.

Not all hydrogen sulphide absorbed is decomposed in the body, a small part of it departs unchanged through the skin and lungs. The evident influence on the respiration and the blood circulation is only partly attributed to the local action of gas upon the lungs. It seems that hydrogen sulphide acts by the mediation of the vagus, on the nerve centres of respiration and blood circulation.

With excessive application of strong sulphur waters, anaemia and weakening of the heart action may be the result. The therapeutical action of the drink cure with strong sulphur waters for furunculose is believed to be probably based on its antiseptic action. By the secondary constituents of sulphur waters (calcium, silicic acid, etc.), mineral nutriment can be given to the system.

One drinks from 100 to 1,000 ccm. of water daily this being divided into morning and afternoon potions and taken cold or warm, sometimes with warm milk. One should drink slowly and with long pauses and also take some form of physical exercise. One soon gets accustomed to the taste and smell of the water.

The baths are taken at the temperature of 33° to 36° C. and of different duration, between 10 and 40 minutes. Prolonged baths for three hours as are usual in some health resorts in Switzerland are not given in Germany, although it is said that they have an antimicrobic effect and so the prolonged sulphur baths have had high reputation for ages as a valuable remedy for wounds and ulcus, but we would not recommend prolonged baths in this water. After every sulphur bath, one hour's rest in bed is advisable.

One bathing course consists of 21 to 28 baths ; but as patients always take a rest after several bathing days, 4 to 5 weeks are calculated for a cure.

For douching it is best to use a movable pipe, by which one can make the sulphur water act upon any part of body one may choose and under any desired pressure (as at Aachen, Nenndorf and other baths).

The douches are given in various degrees, moderate or weak, and at the same time lukewarm, warm or hot, and usually combined with sulphur plunge baths.

In the sulphur water inhalation it is not necessary to spray fluid upon the body, but merely to take in the liberated gases thrown into the room. Therefore the apparatus seen in celebrated sulphur gas institutions is an arrangement consisting of a flat fountain basin with a sulphur water spring in the centre, rising up in many fine sprays ; the agitated particles falling giving off gas to the atmosphere. In such an inhalation house the patients remain usually from a quarter to one hour.

According to York Schwartz, who analyzed the air of the sulphur gas inhalatorium at Nenndorf (Archiv der Pharmazie, Bd. 26, S. 761, 1888) the sulphur is not, as one formerly thought, contained in form of hydrogen sulphide, but as thiosulphuric acid. Schwartz explained the chemical process of the decomposition of sulphur waters as follows :

The main part of hydrogen sulphuide will be oxidized to thiosulphuric acid, probably because hydrogen superoxide, in consequence of the strong evaporation of water produced in the inhalation room, acts as oxidizing agent. Schwartz found on an average 1,5 grm. thiosulphuric acid in 1 cubic metre of inhalation air, but only a small quantity hydrogen sulphide on the contrary. When sulphur water was sprayed around, the characteristic smell disappeared in the inhalation room, all hydrogen sulphide becoming quickly transformed into water and sulphur in consequence of this fine dispersion, without producing any intermediate product.

The sedative effect of inhalation, especially for coughs and dyspnoea, is attributed to the other spring gases, such as carbonic acid, nitrogen, etc., but its antibacterial action is due to the thiosulphuric acid produced from hydrogen sulphide. Therefore we hold the inhalation of sulphur water especially good for infectious catarrhs of the respiratory organs.

For sulphur gas baths, small rooms heated to 28° C., are filled with sulphur gas by means of the hydrogen sulphide fountain, in the same manner as above mentioned. The nude patient sits on a cane chair, so that the gas may operate freely on all parts of the body surface. Such baths are especially prescribed for itching cutaneous diseases, sensibility neurosis, chronic catarrh of the respiratory organs and asthma nervosum.

In some sulphur thermals, sweating boxes and inhalation rooms are provided, being filled with vapour direct from springs. Gargling and nose douching with sulphur water is of great value for several chronic diseases of the mouth, pharynx, and nose.

The high credit of sulphur waters as a remedy is founded on old experience.

For a combined drink and bath cure, under circumstances in connection with sulphur gas inhalation or sulphur gas plunge baths come into consideration :

Gout (arthritis uratica) in every stage and in all forms, as Hufeland has stated, "perhaps the good effect lies here in the influence of sulphur water on the liver," which may be considered as the place of the uric acid formation.

Congestive hyperaemie of the liver, where swelling of the affected organs can easily and quickly be reduced by a sulphur water drink cure.

Formation of biliary calculus, as a much richer and diluter bile flows during and after the drink cure.

Haemorrhoids and abdominal plethora.

Diseases of respiratory organs, especially old cases of catarrh of the nose, pharynx, larynx, trachea, and bronchus, besides bronchial asthma, and even the first stage of phtisis pulmonum.

Subacute and chronic rheumatism of the joints and muscles, for which the sulphur mud bath is especially effective.

Arthritis deformans.

Neuralgia of various neurvous stems and branches (ischias, lumbago, intercostal neuralgia, prosopalgia, etc.).

Neurosis, as chorea minor (chorea St. Viti) of rheumatic origin, neurasthenia and hysteria.

Paralysis of a rheumatic, goutic, and traumatic nature, also paralysis deriving from mercurialism ; but not such, where organic destruction in the brain or spinal cord underlies. In the first stage of tabes dorsalis sulphur mud baths are of value in alleviating lancinating pains, but they cannot affect the course of the illness or prevent its development.

Blood dyscrasia. Several cases of chlorose, especially those where the iron treatment proves to be ineffective, are beneficially treated with the sulphur water drink cure.

Chronic metal poisonings of mercury or lead.

Diseases of the skin : Sulphur baths have stood for years in high reputation for these diseases. The best result is to be obtained especially for chronic eczema (wet and dry lichen), acne vulgaris (face pimples), acne rosacea (copper pimples, copper nose), psoriasis vulgaris, pitiosis versicolor, furunculosis (disposition to furunkel and carbunkel formation), atonic ulcus crusis. On prurigo, pruritus cutaneus (skin itching) and ichtyosis an improvement is noticeable.

Diseases of women : Especially for catarrhs of uterus and vagina, disturbances or irregularities, perimetritic and parametritic exsudates, chronic ovarial inflammation, metritis and endometritis, adhesive process in Fallopian tube and ovary, and also for complaints arising during klimakterium, sitz-baths and plunge-baths of sulphur water and sulphur mud baths are of great benefit.

Complaints which arise after wounds of soft parts of bones through shot, bruise or sting, suppurated wounds, bone pains after fracture, painful scars, etc.

Bone diseases.

Syphilis and their sequela. In these cases sulphur cures are combined with inunction treatment with mercury.

10. Alum Springs.

It is quite noticeable that hot springs containing comparatively large quantities of alum are not seldom met with in Japan, especially in volcanic districts. In most of these waters are present also ferric or ferrous compounds, but some of them contain only a trace of iron.

Alum waters are used internally for acute and chronic catarrhs and haemorrhage of the stomach and intestines, anaemia, neuralgia, haemorrhoids, etc. They are indicated as baths for catarrhs of mucous membrane of the female genital organs, mal-nutrition, rheumatism, and convalescence after various diseases.

Baths of alum waters are given at *Kusatsu*, *Myōban-Onsen* near Beppu, etc., in Japan.

11. Acid Springs.

Certain thermal waters, particularly the geyser springs of New Zealand and America, are distinguished by the presence of free acids. Free hydrochloric acid is present in considerable quantities in the Lemonade Spring, in California, at Tuscarora in Sour Spring, and in some of Canada.

Japan is rich in acid springs which contain considerable quantities of free mineral acids, with or without iron compounds. Those thermals, which issue in volcanic regions, belong to this class in most cases. *Kusatsu*, *Nasu*, *Gōra* in Hakone, *Shibu*, *Noboribetsu*, *Kirishima*, *Unzen*, *Aso*, *Hokutō*, etc., are good examples of acid waters.

One of the most remarkable of acid springs is to be found among the Oak Orchard Springs, in New York State, which is said to contain free sulphuric acid in the proportion of 40 per cent. of its total mineral content. The same acid exists, with or without hydrochloric acid, in the "acid sulphur waters" of Rotorua (New Zealand), to the amount of from 4 to 22 gr. per gallon. These waters and geyser springs of the Yellow Stone National Park (America), and of Iceland, contain certain large quantities of silicic acid. There is in Europe nothing comparable to this class of waters. They are not employed internally. In the bath their action is stated to be powerfully rubefacient and decongestive.

C. KINDS OF BATHS AND THEIR USE.

1. Subthermal Baths.

The temperature of the baths is somewhat near the point of thermal indifference 32,2° to 34° C. (90°–93° F.), ranging between 36,6° and 26,7° C. (98°–80° F.), or a little lower. Moreover the climatic character, the traditions and genious of the spa, promote and intensify the sedative action of the bath. Schlangenbad, Néris, Bains-les-Bains, Baden-Weiler, Ragatz, Plombières, Buxton, are stations of this kind.

Subthermal baths are both sedative and stimulating, and have a very large place in spa treatment. They withdraw heat to a moderate extent, and by reducing peripheral tone invite the blood into the extremities and the skin. The cardiac action is increased in force and markedly slowed; nervous excitation, whether peripheral or central, is diminished by the massive and equable impression of the water. These baths are, therefore, indicated in irritability of the vascular and nervous system, as well as in general debility and motor weakness, and in peripheral and incipient and reflex paralyses, in hyperaesthesia, nervous insomnia and neuralgias. They favour nutrition, moderate senile changes, and are much used in degenerative arthritis, atonic gout and rheumatism, and nervous exhaustion and convalescence.

Prolonged Subthermal Baths.—Immersion in waters at the point of thermal indifference may be prolonged for many hours or even day without discomfort. At the sub-alpine spa Loèche-les-Bains (4600 ft.) baths at 33,7° to 23,9° C. (93°–75° F.) are commonly prolonged for from one to six hours; and similar baths are taken at Néris (1150 ft.), Schinznach (1140 ft.), Bagnères de Bigorre (1800 ft.), at La Bourboule (2780 ft.), at certain subthermal spas in Japan such as *Yunogō*, *Tochiomata*, *Shimobe*, etc., and elsewhere. Their effect is both sedative and intensive.

Besides their value for some intractable skin affections, they are useful in a variety of nervous disorders, visceral, and especially entero-colic neuralgias, sciatica, spastic arterial hypertension, and occasionally in exophthalmic goitre.

2. Hyperthermal Baths.

Such baths range in temperature from 40° to 54,4° C. (104°–130° F.). They are of necessity so limited in duration that the late and enervating effects of heat should not be developed.

Hyperthermal baths freely open the surface arterial system, accelerate the pulse and, after an initial rise, diminish the blood pressure. Always taken with very short immersions, one, two or three minutes, they constitute a very useful means of treatment for many cases. The hyperthermal baths supplies the powerful primary stimulation of heat, without its dangerous reactions.

Japan and New Zealand furnish typical examples of natural hyperthermal baths. At *Kusatsu* the temperature of the water is from 54,4° to 71° C. (130°–160° F.). It is reduced by splashing to 48,9° C. (120° F.). Hot water is poured over the head before entering the bath, and the bather remains in the water for three or four minutes. The bodily temperature rises to 40° C. (104° F.) in six or eight minutes, and returns to normal in half an hour. Cold affusions are used after the bath. Hundreds of syphilitic and leprous patients are submitted to the treatment.

At Teplitz, Hammâu-Meskoutine, and elsewhere various degrees of high temperature treatment are employed. It should be applied in practice with much care. The brief intensive and stimulating effect of these baths is helpful in many of the conditions enumerated in the last section, particularly in torpid skin and circulation. The hyperthermal footbath (*pediluvium*) is a valuable form of derivative treatment in many chronic ailments, especially in poor circulation with weak heart, in neuralgia, catarrhs, and constipation ; and is insufficiently employed at the British spas. These and other hyperthermal applications induce locally arterial hyperaemia and raise the temperature of the part. They stimulate the oxidizing processes in chronic disease and may be used with much benefit where, as in arthritis, the arterial circulation is defective.

3. Vapour Baths (Ital. *Stufe*; Fr. *Étuve*).

Steam baths, natural or artificial, have been used in medicine from ancient times. The Romans utilized the vapour of the hot springs in their *thermæ*; and there are many natural vapour baths, like the cave at Monsummano (temperature 33,3° to 35° C. (92°–95° F.)). In the island of Ischia there are hotter *stufe*, such as San Lorenzo 51° C. (124° F.) and Castiglione 56° C. (133° F.), and a similer one at the Bagni di Nerone, near Pozzuoli.

The ancient Roman hyperthermal vapour bath is still in use at Plombières. Warm aqueous vapour softens the skin, induces perspiration and increases the fullness and frequency of the pulse. Both the cutaneous and pulmonary capillaries are dilated. Hot vapour baths soften and stimulate the harsh, hard, thickened, and inactive skin. In sensitive subjects the regulation of temperature is essential. When a sedative and tranquillising influence is sought, the moisture must predominate over the heat (as at Monsummano). It may be stated as a general law that the heat of every thermal application should bear an inverse proportion to the febrile excitement or nervous sensibility of the patient.

Assolini used vapour baths below blood-heat in inflammatory affections of the throat and respiratory passages. In chronic catarrhs a more stimulating vapour—Plombières, Mont Dore, or Ems—can be employed.

Natural, or artificial, vapours may also be applied locally, as at Aix-les-Bains and Luchon (the "Berthollet" bath) and at Bath and elsewhere. In Japan such baths are found at *Beppu*, *Atami*, *Shima*, *Nakabusa*, *Naruko*, etc. In addition to the indications already mentioned, vapour baths are helpful in painful rheumatic and gouty affections (lumbago, sciatica, and neuralgia), and generally in the disorders for which the more stimulating and less sedative hot air bath is employed.

4. Sea Baths.

The sea bath comprises several factors. There is, first, the proper effect of the salt water at the natural temperature, varying according to season and the coast. Then the element of movement in the water.

This again varies from the gentlest undulation to strong mechanical stimulation, equivalent to a rapid succession of douches. The constant movement of water, the impact of the waves and the wind are all to be taken into account. It has been ascertained that the loss of heat in water moving at half a meter per second is one-third more than in a bath of still water. On the other hand, the deposit of salt on the skin from a hypertonic bath inhibits the evaporation of sweat *after the bath*, and this, in addition to the salt stimulus of peripheral nerves, makes the risk of "catching cold" much less after a marine than after a fresh-water bath. Lastly, the local climatic influences modify the effect, in the sense of augmenting or diminishing the stimulus. The sea bath causes an energetic primary contraction of the skin vessels with the "first chill." The circulatory and thermic reactions are more rapid than with ordinary water. Hayem has well said that the reaction is the "therapeutic event most desired and sought for." It is, therefore, important for the bather to leave the water before the "second chill," indicating the failure of reaction, occurs. Sea baths are believed to diminish the elimination of uric acid but to increase that of urea. All the vital actions are stimulated; body weight is increased. It follows that marine baths have their chief medical opportunity in lymphatic and scrofulous affections, local tuberculosis of glands, bones, joints, and in whatever conditions tonic salt baths are indicated. They are inadmissible in cardiac and rheumatic and gouty cases, in renal disease, bronchitis, emphysema, asthma, and in haemorrhagic phthisis and in other congestive states.

5. Effervescent Baths (Carbonated or Gaseous Baths, Luftperlbäder).

Natural effervescing waters owe their acidulous quality to varying proportions of carbonic acid gas. This gas, dissolved under a certain pressure, is uniformly diffused through the water, and exists partly in the dissociated form as ions. When the pressure is reduced, as in the bath, the gas is liberated and attaches itself in minute bubbles to the skin.

Among the thermal waters of this class are: Nauheim, in the Grand Duchy of Hesse 27,8° to 35° C. (82°–95° F.), which contains 2 to 3 per cent. of chloride of sodium; Oeynhausen, in Westphalia 25° to 32,8° C. (77°–91° F.), possessing a muriated water very rich in carbonic acid gas; Soden in the Taunus, and Salins-Moutier, at 35,6° C. (96° F.), with 1,3 per cent. of chloride of sodium. At Royat, in the Auvergne mountains, the Saint Mart and César Springs furnish a valuable thermal effervescing bath, slightly alkaline and salt. Châtel-Guyon, in the same district, has an effervescent alkaline muriated water at 31,7° C. (89° F.), which is employed for "flowing baths."

Among the cold waters there are effervescing chalybeate springs at Spa in Belgium, at Schwalbach, and at St. Moritz; and "gaseous iron baths" are to be had at these more or less tonic stations at subthermal temperatures. Also at Kissingen in Bavaria, Tarasp-Schuls in the Engadine, Marienbad in Bohemia, and elsewhere. *Yunogō* in Japan is one of the baths of this kind.

The peculiar effect of effervescent baths is due to the contained carbonic acid gas, and is to be explained by the fact that the specific heat of this gas is one-fifth that of water whilst its conductivity for heat is only one-fiftieth that of water. The point of thermal indifference for the human skin which is about 33,9° C. (93° F.) for water, is only 23,9° C. (75° F.) for carbonic acid gas, and in an effervescing bath the indifferent point must, therefore, lie somewhere between these two figures.

As a rule, the cooler the water the more gas it will contain, and it is owing to the stimulation of the gas that such baths can be taken much cooler than ordinary baths. In an effervescing bath of say 32,2° C. (90° F.), the body is exposed to thermic stimuli both of cold and heat, coexisting side by side on innumerable minute contiguous areas of the skin and constantly alternating upon the same area, the cold stimulus taking effect where the surface is in contact with the water and the hot stimulus from the bubbles of gas. Some of the carbonic acid gas is absorbed ; and, acting upon the sensory nerve endings, and directly or indirectly upon the blood vessels, alters and increases the circulation. On entering an effervescing bath below skin temperature there is, therefore, a momentary chilliness, soon succeeded by a sense of prickling or warmth, due to the collection of innumerable bubbles on the skin. The increasing feeling of warmth soon overcomes the feeling of cold, because the relative heat of the carbonic acid gas [Indifferent point 23,9° C. (75° F.)] more than neutralises the relative coolness of the water. The vaso-constrictor action of the water is an antagonised by the vaso-dilator action of the gas, the arterioles relax, and there is a more or less vivid reddening of the surface. The activity of the surface action is shown by the comparative pallor of those parts of the body not immersed in the bath.

Following the direct effect upon the skin, there is an indirect result upon the distribution of the blood, known as " decongestion of the viscera," in obedience to the law of inverse relation between the circulation of deep and superficial parts. The heart's action becomes less frequent to the existence of perhaps four to six or ten beats less per minute, the systole stronger, and the pulse more ample, from dilatation of the artery. The effect of the blood pressure varies. It is reduced in baths above the skin temperature, where the vaso-dilator action of the gas has overcome the vaso-constriction of cold, and in all cases where the peripheral vascular dilatation is marked. At lower temperatures, any below 31° C. (88° F.), the blood pressure may be raised, but the action is not the same in all persons and depends partly on the duration of the bath. Many observers have noted by percussion or by the X-rays, a diminution in the cardiac area, especially on the right side, after effervescing baths.

The total effect of these baths depends not only on their temperature and duration but on their saline and gaseous contents. A brief bath is usually purely stimulant whilst a prolonged bath is sedative and tonic. Diaphoresis and diuresis are reflexly encouraged. The effect on the nervous system is that of a mild, continuous subthermal stimulation, passing into sedation. Owing to the thermic stimulation of the gas these baths appear to be warmer than they really are. Consequently their action may be said to be twofold : (1) they favour an increased loss of heat, corresponding to their actual temperature and so induce the direct and indirect results of cooling baths ; (2) they produce an active dilatation of the surface vessels such as results from thermal baths, but without application of positive heat or any elevation of the temperature of the body. The merit of effervescing baths, therefore, is that they combine the tonic and antipyretic effect of cool temperatures with an active peripheral stimulation. The presence of sodium chloride with the gas accelerates and enhances the peripheral effect. In addition to cardiac affections effervescing baths are employed for the sedative and tonic action in many conditions of nervous weakness, in the convalescence from influenza and other debilitating illness, in Graves's disease, also in anaemia, amenorrhoea, and congestive dysmenorrhoea. They are contra-indicated in advanced aortic disease and cardiac dyspnoea, but may be used with good results in many cases of angina pectoris.

Peat Baths (Moor- und Schlammbäder).

Peat, or moor, baths are prepared from the brown organic deposit underlying, often to the considerable depth, the more fibrous " fuel peat " in many northern peat mosses or bogs. This material consists largely of humus derived from the decomposition of sphagnum moss, and contains resins, silica, free sulphuric acid, and generally carbonate of iron and various salts. When exposed to the action of the heat, formic and other volatile acids are produced. Peats are usually classed as ferruginous, saline, or sulphuretted ; and at many spas are fortified by mixture with the mineral water or with " mother lye."

During the last century the use of these baths has been especially developed in Bohemia. They were first used at Franzensbad, and employed there by Dr. Pöschmann in 1810 to 1815. Not long afterwards they were introduced at Marienbad. They are now given extensively in Germany, at Pyrmont, Schwalbach and other chalybeate baths, at Spa in Belgium and at Ronneby in Sweden. They were first employed in Great Britain in 1889 at Strathpeffer, and afterwards at Harrogate and Buxton.

The area of the peat deposits at Franzensbad is near a little extinct volcano outside the town. The moor is traversed by mineral springs containing iron. When first cut in the winter time it has a greyish lardaceous appearance with an odour of sulphuretted hydrogen. After cutting it is exposed to the air for several months, during which time the sulphides of iron are converted into sulphates and the moor acquires an acid reaction. The "iron mineral-moor" of Franzensbad is said to contain as much as 32 per cent. of protosulphate of iron. It is friable, of a dark brown colour with a bituminous odour and an inky taste. When dry it is ground in a mill, treated with hot mineral water and stirred by hand. The temperature is adjusted by injecting steam into the bath. A single bath is said to contain nearly one pound of formic acid and other volatile substances.

Dr. Paul Cartellieri, the first writer on peat baths (1841) proved that the heat-conducting power of peat was less than that of water. For this reason the peat bath given at a temperature above the point of thermal indifference 33,9° C. (93° F.) does not feel so hot as water, and if given below that point does not abstract heat to the same extent as water does. The specific heat of peat is much lower than that of water. Upon entering the bath the layer of peat nearest to the skin rapidly cools to about the skin temperature. In the case of both mud and peat baths there is no constant changing of the particles which are in contact with a body. The layer next to the skin maintains a more or less constant temperature during the whole period of the bath, and the presence of this comparatively cool and non-conducting layer moderates and equalises the effects of heat. The point of thermal indifference for the peat bath is considerably higher than that of water, and has been placed by Kisch as high as 38,9° C. (102° F.). To the thermal effects must be added the stimulation due to constant chemical action taking place at the surface of the body, the astringent effect of the iron compounds and the antiseptic action of some of the acids. Lastly, the weight and comparative immobility of the peat or mud bath and the friction of the semi-solid poultice-like mass exert certain pressure on the surface circulation and impede muscular movements, especially those of respiration.

In suitable cases peat baths may be given at temperatures ranging from 37,8° to 44,4° C. (100°–112° F.), and the higher temperatures are well borne if the bath is followed by cold affusion, as at Strathpeffer. When the heart's action or breathing are at all embarassed, and always in baths of high temperature, the peat should not cover the front of the chest. A cold compress should be always applied to the head. Half baths or three-quarter baths are in these circumstances to be preferred. Local applications of peat, at from 46,1° to 48,9° C. (115°–120° F.) are often used, principally as a poultice to the abdomen or as foot baths.

They furnish a convenient form of thermal treatment with marked cutaneous stimulation. They are prescribed for torpidity of the skin and circulation, in neuralgia and neuritis, especially of the peripheral nerves, in disorders of common sensation, inc hronic rheumatic affections, and to promote the absorption of morbid deposits, as in pelvic peritonitis. In conjunction with chalybeate waters they are used for dysmenorrhoea and amenorhhoea in anaemic subjects, as at Schwalbach and Strathpeffer. They are also employed locally at high temperatures to the feet and legs, the arms or abdomen, either for their derivative effect, or to set up active hyperaemia in chronic arthritis, etc.

Mud Baths (Bains de Boue, Fango).

At many thermal sulphur spas soft, "butter-like" deposits are obtained from the vicinity of the springs, which are used as an application, often at high temperatures. At Pöstyen and Mehadia, in Hungary, and at the northern Italien spas (Vinadio, Acqui, Battaglia, Abano), as well as at Baden, near Vienna, a sulphuretted mud, or fango, is extensively employed. It is also imported into England for local applications, as at Matlock.

The mud bath may be given at 40° C. (104° F.), and at much higher temperatures 48,9° to 50° C. (120°–122° F.) applied locally. These deposits, besides containing various mineral and organic matter, often exhibit a high degree of radio-activity. Sulphuretted mud baths are extensively used at Saint Amand in France and a similar mud is obtained from river deposits at Dax, near Bordeaux. In Germany sulphur mud baths are used at Eilsen and Nenndorf, and in Sweden at Loka, in combination with massage.

In Japan the mineral mud bath can be had only at *Kamegawa*, near Beppu.

A second variety of mud baths is prepared from sea, or salt, mud, such as those of the Baltic provinces, of the "Limans" on the Black Sea coast, and of Saki and others in the Crimea. The salt mud is heated by the sun, or artificially, to a high temperature, and plastered over the body, either wholly or partially. Similar salt muds are used at Laurvik, Modum, and Sandefjord, in

Norway, at Ischl and at Arensburg, in Livonia. Mud baths are essentially a hyperthermal treatment. The actions and indications are otherwise much the same as for peat baths, but the strong salt muds, like those of the Limans are especially valued for chronic rheumatism, for scrofulous conditions, and as an accessory treatment for syphilis. The pressure exerted by the mud has been regarded as helpful for the relief of varicose veins (as at Saint Amand).

Sand Baths (Arenation).

This ancient method of thermal treatment consists in immersing the body, wholly or in part, in sand, heated—by the sun or otherwise—to from 43,3° to 54,4° C. (110°–130° F.). Profuse perspiration ensues; the skin becomes reddened and encrusted with sand; and, the normal loss of heat being reduced, the body temperature may rise three or more degrees. These baths have been used since Roman times in the island of Ischia, and recently at Lavey, in Switzerland, and Koestritz, in Germany. They are employed sometimes, together with sun baths, for their special thermal effects in chronic diseases of the joints, especially degenerative arthritis. Cold, moist sand baths are also used as a vascular and nervous tonic in neurasthenia.

D. NOTABLE MINERAL SPRINGS ARRANGED ACCORDING TO CHEMICAL COMPOSITION.

1. Simple cold springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.
1	Komono 菰野	Mie-ken	2500	29°	0,14
2	Murasugi 村杉	Niigata-ken	400	25,6°	0,35
3	Shimobe 下部	Yamanashi-ken	—	34°–36°	0,46
4	Takayama 高山	Gifu-ken	1200	10°–13°	0,12
5	Nekonaki 猫啼	Fukushima-ken	—	22°	—
6	Fukuroda 袋田	Ibaraki-ken	—	34°	0,3
7	Koshiki-iwa-shinden 越木岩新田	Hyōgo-ken	—	11°–19°	—
8	Sekine-Yunosawa 關根湯澤	Yamagata-ken	—	28°	—
9	Kaidani 栢谷	Okayama-ken	—	14,5°	—

2. Simple thermals.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.
1	Yumoto—Tōnosawa 湯本—塔之澤	Kanagawa-ken	150	42°–47,3°	0,50–0,81
2	Ubako 姥子	„	2877	40°	0,65
3	Dōgo 道後	Ehime-ken	35	42°–47°	0,78–0,83
4	Beppu 別府	Ōita-ken	50	40°–66°	0,68–0,93
5	Itō 伊東	Shizuoka-ken	—	46°–47,8°	0,98
6	Takeo 武雄	Saga-ken	100	49°	0,77
7	Kami and Shimo-Suwa 上下諏訪	Nagano-ken	2500	47,5°–83°	—
8	Iizaka 飯坂	Fukushima-ken	550	50°–70°	0,92–0,95
9	Nasu 那須	Tochigi-ken	4000-5000	38°–71°	0,58–0,85
10	Nagaoka 長岡	Shizuoka-ken	—	44°–53°	0,70
11	Asama 淺間	Nagano-ken	1600	36,5°–53°	0,44–0,45
12	Andai 安代	„	1643	55°–56°	0,95
13	On-yō 溫陽	Chōsen	—	38°–48°	0,21
14	Goshiki 五色	Yamagata-ken	3000	38,5°–44,5°	0,78
15	Ao-ne 青根	Miyagi-ken	1800	43°–52°	0,54

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.
16	Tōgō 東郷	Tottori-ken	—	40°–49°	0,93
17	Tochiomata 栃尾又	Niigata-ken	920	38°–39°	0,28
18	Hatage 畑毛	Shizuoka-ken	—	38°–40°	0,64–0,90
19	Ko-na 古奈	,,	—	52°	—
20	Tawarayama 俵山	Yamaguchi-ken	1000	40°–42°	0,08
21	Hokutō 北投	Taiwan	—	43°–68,5°	0,21–1,09
22	Arifuku 有福	Shimane-ken	900	44.5°–49°	0,29
23	Misasa 三朝	Tottori-ken	50	67°–71,5°	0,86–0,87
24	Kashi 甲子	Fukushima-ken	3000	48.5°–51°	—
25	Innai-Yunosawa 院内湯澤	Akita-ken	679	39.5°–41°	0,13
26	Kamikōchi 上高地	Nagano-ken	4725	53,5°	—
27	Ōyu 大湯	Niigata-ken	900	53°–57°	0,38
28	Karurusu カルルス	Hokkai-dō	1120	48°–60°	0,96
29	Yumura 湯村	Shimane-ken	600	43°	0,32
30	Shuotsu 朱乙	Chōsen	4000	50°	0,18

3. Simple carbondioxated springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents
						free CO_2 in grm.
1	Beppu 別府	Ōita-ken	50	48.5°–67°	0,69–0,97	1,12–2,51
2	Arima—Jigokudani 有馬—地獄谷	Hyōgo-ken	1155	16,5°–17,4°	0,16–0,31	1,12–1,20
3	Takarazuka 寶塚	,,	82	14.7°–18,5°	0,58	1,54
4	Funagoya 船小屋	Fukuoka-ken	—	17.5°–21,0°	0,17	1.94
5	Kōbe—Zyareyama 神戸—砂連山	Hyōgo-ken	—	21,5°	0,75	1,14
6	Su-ō 蘇澳	Taiwan	—	23°	0,14	1.57
7	Ōshio 大鹽	Fukushima-ken	—	cold	0,08	3,07
8	Amabe 餘戸	Gifu-ken	—	15°	0.43	1,00
9	Gutchan 倶知安	Hokkai-dō	—	cold	0,43	1,31

4. Earthy carbondioxated springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:		
						free CO_2 in grm.	$Ca(HCO_3)_2$ in grm.	$Mg(HCO_3)_2$ in grm.
1	Shiraya 白矢	Nara-ken	—	cold	1.74	1,42	1,44	0,12
2	Sawaguchi 澤口	Akita-ken	—	,,	4,00	1.46	1,71	0,06
3	Shōseidō 椒井洞	Chōsen	—	,,	1,26	2,04	0,93	0.57

5. Alkaline springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:	
						$NaHCO_3$ in grm.	Other constituents in grm.
		a. Alkaline springs.					
1	Shiobara 鹽原	Tochigi-ken	1150	51.5°–60°	0.97–1,16	0,49–0,79	
2	Otari 小谷	Nagano-ken	3785	46,1°–59°	1,82–2,42	2,42–2,84	

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents :		
						$NaHCO_3$ in grm.	Other constituents in grm.	
				b. Alkaline carbondioxated springs.				
1	Isobe 磯部	Gumma-ken	1200	13,5°–15,5°	15,60–28,64	5,97–9,49	free CO_2	0,97–1,18
2	Sedo-no-Kanayama 瀬戸鉛山	Wakayama-ken	—	42°–60°	4,09–5,07	2,57–4,17	"	0,94–1,56
3	Inakamado 稲竈	Kyōto-fu	—	cold	4,83	4,00	"	1,87
4	Yumura 湯村	Hyōgo-ken	150	90,5°–9,5°	0,99	0,37	"	1,24
				c. Alkaline muriated springs.				
1	Shiobara 鹽原	Tochigi-ken	1150	15°–70°	1,35–2,23	0,52–0,77	NaCl	0,62–0,88
2	Ureshino 嬉野	Saga-ken	400	95°	1,55	1,30	"	0,38
3	Kasagi 笠置	Kyōto-fu	205	13,6°	5,08	4,28	"	1,61
				d. Alkaline earthy springs.				
1	Shirahone 白骨	Nagano-ken	3750	48°–52°	1,35	0,29	$Ca(HCO_3)_2$ $Mg(HCO_3)_2$	0,46 0,28

6. Common salt springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents :	
						NaCl in grm.	Other constituents in grm.
				a. Weak common salt springs.			
1	Miyanoshita 宮ノ下	Kanagawa-ken	1123	36°–81°	1,08–2,35	0,71–1,05	
2	Sokokura 底倉	"	1123	64°–76°	1,83–2,19	1,15–1,61	
3	Dōgashima 堂ヶ島	"	790	46°	1,46–1,79	0,97–1,39	
4	Beppu 別府	Oita-ken	50	56°–60°	2,57–3,33	1,72–2,26	
5	Shiobara 鹽原	Tochigi-ken	1150	42°–71,5°	1,41–3,84	0,69–2,33	
6	Yugawara 湯河原	Kanagawa-ken	350	41°–88,5°	1,38–2,42	0,85–1,45	
7	Ōwani 大鰐	Aomori-ken	248	62°–80°	2,93–3,33	1,78–2,56	
8	Shima 四萬	Gumma-ken	3000	55°–84°	2,48	1,49	
9	Kuradate 藏舘	Aomori-ken	248	56°–78°	2,32–3,14	1,27–2,13	
10	Ikariga-seki 碇ヶ關	"	680	54°–62°	1,25–1,62	0,75–1,36	
11	Oyu 大湯	Akita-ken	572	46°–70,5°	1,62–2,10	1,12–1,54	
12	Kamegawa 龜川	Oita-ken	50	57°	1,22	0,68	
13	Tamatsukuri 玉造	Shimane-ken	—	64°	1,58	0,91	
14	Misasa 三朝	Tottori-ken	50	72°	1,16	0,71	
15	Shigaku 志學	Shimane-ken	1500	46,5°	2,39	1,52	
16	Masutomi 増富	Yamanashi-ken	3000	16°–21,5°	2,18	1,40	
				b. Simple common salt springs.			
1	Katayamazu 片山津	Ishikawa-ken	—	61°–79°	15,79	7,28	
2	Senami 瀬波	Niigata-ken	—	102°	4,19	3,38	
3	Tōrai 東萊	Chōsen	—	50°–53°	5,50	2,96	
4	Noboribetsu 登別	Hokkai-do	600	76°–94°	4,51	3,01	
5	Yoshida 吉田	Miyazaki-ken	—	42°	4,90	—	

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents: NaCl in grm.	Other constituents in grm.
				c. Concentrated common salt springs.			
1	Arima 有馬	Hyōgo-ken	1155	37,5°–53,4°	19,56–65,70	14,72–43,21	
2	Isobe 磯部	Gumma-ken	1200	15,5°–17,2°	26,91–29,75	19.43–21,05	
3	Yashio 八鹽	„	—	cold	19,65–30,28	14,53–22,84	
4	Oshio 大鹽	Fukushima-ken	—	„	20,40	15,30	
5	Kashio 鹿鹽	Nagano-ken	—	„	28,57	25,85	
6	Haraichi 原市	Gumma-ken	—	„	27,60–27,86	19,25 19,87	
7	Mukosan 武庫山	Hyōgo-ken	—	12,8°	22,7	17,06	
				d. Carbondioxated common salt springs.			
1	Takarazuka 寶塚	Hyōgo-ken	82	18,5°	13,76	11,13	free CO_2 0,93
2	Isobe 磯部	Gumma-ken	1200	15.5°	15,60–28,64	11,01–28,64	„ 0,97–1,18
3	Hirano 平野	Hyōgo-ken	—	27°	4.59–7,10	2,57–4,31	„ 1,17–1,19
4	Yashio 八鹽	Gumma-ken	—	cold	8 90–30,28	6,19–22,84	„ 1,06–1,46
5	Haraichi 原市	„	—	„	27,86	19,87	„ 1.51
				e. Alkaline common salt springs.			
1	Isobe 磯部	Gumma-ken	1200	15.5°–17,2°	15,60–29,75	11 01–21,05	$NaHCO_3$ 5,97–11,88
2	Hirano 平野	Hyōgo-ken	—	27°	2,59–7,10	1.36–4,31	„ 0,94–1.74
3	Ogawa 小川	Toyama-ken	—	49°–60°	1,08–1,22	0,59–0,67	„ 0,25–0,31
4	Kwanshirei 關仔嶺	Taiwan	—	44°–80°	7,91–8,51	3,62–4,18	„ 3,58–3.78
5	Yashio 八鹽	Gumma-ken	—	cold	5,80–30,28	3,69–22,84	„ 1,58–5.99
6	Haraichi 原市	„	—	„	27,60–27,86	19,25–19,87	„ 6,03–11,19
				f. Saline common salt springs.			
1	Shuzenji 修善寺	Shizuoka-ken	250	55°–77°	1,08–1,21	0,46–0,58	Na_2SO_4 0,22–0,45
2	Kamasaki 鎌先	Miyagi-ken	600	37°–48°	5,03–5,19	2,41–2,47	„ 1,50–1,69
				g. Earth-muriated common salt springs.			
1	Atami 熱海	Shizuoka-ken	—	77°–108°	8,1 – 9,87	4.79–5,66	$CaCl_2$ 2,57 3.19
2	Arima 有馬	Hyōgo-ken	1155	37,8°–38,3°	19,56 19,66	14,72–43,21	„ 2,90–11.30
3	Kinosaki 城崎	„	—	44,2°–60,3°	5.32 5,91	3,02	„ 1.59
4	Wakura 和倉	Ishikawa-ken	—	70,5°–93°	20,93–21,55	11,03–18.67	„ 8,61–8.94
5	Obama 小濱	Nagasaki-ken	—	59°–101°	6,47–8,84	4,00–5,43	$CaCl_2$ 1,01–1,26 $MgCl_2$ 0,60–0,91
6	Awara 蘆原	Fukui-ken	—	53°–76°	10,03–10,33	5.90–6,13	$CaCl_2$ 3,09–3,29
7	Akayu 赤湯	Yamagata-ken	700	42°–58°	2,91–3,07	1.90–2,06	„ 0,50–0.55
8	Onogawa 小野川	„	1000	65 5°–73,5°	5,67	3 90	„ 1,16
9	Yunogō 湯郷	Okayama-ken	240	37,7°–38°	2,25–2,27	1,17 1,18	„ 0,94 0,95
10	Yunokawa 湯川	Hokkai-do	—	50°	7,03	4,40	—
11	Matsunoyama 松之山	Niigata-ken	1200	44°–73°	13,87–15,08	7,93–8,68	$CaCl_2$ 5,05–5.33
12	Yunohama 湯野濱	Yamagata-ken	—	43°–47,2°	4.71–5,69	2,79	„ 1,51
13	Atsushio 熱鹽	Fukushima-ken	1200	46°	11,50	7,85	„ 2,24
14	Morigasaki 森ケ崎	Tokyo-fu	—	17°	6,08	3,83	$CaCl_2$ 0,00 $MgCl_2$ 0,93
15	Yunomoto 湯ノ本	Nagasaki-ken (Iki Prov.)	—	43°–47°	16,39–21,64	11,56–14,51	$CaCl_2$ 0,82–1,74 $MgCl_2$ 0,82–1,29
16	Oshio 大鹽	Fukushima-ken	—	cold	20,40	15.30	$CaCl_2$ 1.90 $MgCl_2$ 1,20

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents: NaCl in grm.	Therapeutically essential constituents: Other constituents in grm.
	h. Earthy common salt springs.						
1	Yunokawa 湯川	Hokkai-dō	—	40,5°-50°	—	—	—
2	Atsushio 熱鹽	Fukushima-ken	1200	35°-78°	4.55- 5,11	2,65- 3,26	$Ca(HCO_3)_2$ 0,48-1,21 $Mg(HCO_3)_2$ 0,17 0,26
3	Akagi-Nashiki 赤城梨木	Gumma-ken	1490	20°	2,25	1,08	$Mg(HCO_3)_2$ 0,82
4	Aoyama 青山	Hokkai-dō	—	42°-44°	2,97	1,72	$Ca(HCO_3)_2$ 0,39 $Mg(HCO_3)_2$ 0,29
5	Masutomi 增富	Yamanashi-ken	3000	15°-24,5°	5,98- 9,86	3,84- 6,49	$Ca(HCO_3)_2$ 0,96-1,29 $Mg(HCO_3)_2$trace-0,49
	i. Sulphated common salt springs.						
1	Shibu [Hirao] 澁 [平穩]	Nagano-ken	6950	45°-76°	1,21	0,53	$CaSO_4$ 0,36
2	Shima 四萬	Gumma-ken	3000	62°	1,47	0,72	,, 0,45
3	Atsumi 溫海	Yamagata-ken	50	45°-70°	3,51	2,35	,, 0,81
4	Yunotsu 溫泉津	Shimane-ken	—	46°-50°	7,06	4,79	,, 1,10
5	Yuwaku 湯涌	Ishikawa-ken	1300	41°	3,31	2,15	,, 0,71
6	Ōmaki 大牧	Toyama-ken	850	49°	3,29	1,86	,, 0,82
	j. Hydrogen sulphide common salt springs.						
1	Ōyuzawa 大湯澤	Akita-ken	700	33,5°-45,5°	11,31-14,78	7,00-11,03	H_2S 0,23
	k. Common salt springs containing bromine or iodine.						
1	Arima 有馬	Hyōgo-ken	1155	38,3°-47°	19.56-65,70	14,72-43,21	Br 0,0116-0,0854
2	Kinosaki 城崎	,,	—	58,3°	5,32	3,02	,, 0,0005
3	Isobe 磯部	Gumma-ken	1200	13,5°-15,5°	26,91-29.75	19,43-21,05	Br 0,0113-0,0298 I 0,0020-0,0047
4	Mukosan 武庫山	Hyōgo-ken	—	cold	7,40	5,97	I 0,0026
5	Shikanoda 鹿野田	Miyazaki-ken	—	,,	16,04	14.43	Br 0,0784 I 0,0294
6	Ōsedo 大瀬戶	,,	—	,,	3,69	2,22	Br 0,0155 I 0,0075
7	Nanatsu-ido 七ッ井戶	Chiba-ken	—	,,	16,01	13.76	I 0,0476
8	Shita 志太	Shizuoka-ken	—	,,	11,80	9,36	,, 0,0127
9	Miyagaki-uchi 宮垣內	Wakayama-ken	—	,,	12,03	8,29	Br 0,0039 I 0,0008
	l. Common salt springs containing boric acid.						
1	Isobe 磯部	Gumma-ken	1200	15,5°	26,91	19.43	HBO_2 1,00
2	Haraichi 原市	,,	1200	cold	27,86	19,87	,, 5,54
3	Jōhōji 淨法寺	Aomori-ken	—	,,	16,83	10,17	,, 3.03

7. Bitter springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents in grm.
	a. Bitter springs.					
1	Kaminoyama 上ノ山	Yamagata-ken	574	56°-61,5°	2,58	
2	Shido-daira 志戶平	Iwate-ken	700	76°	1,26	
3	Ushio 海潮	Shimane-ken	300	41,5°	1,22	

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents in grm.	
		b. Saline bitter springs.					
1	Shiobara 鹽原	Tochigi-ken	1150	55°–57,5°	1,49	Na_2SO_4	0,84
2	Higashiyama 東山	Fukushima-ken	850	34°–61°	1,95	,,	0,69
3	Yoshina 吉奈	Shizuoka-ken	360	41°–50°	1,15–1,24	,,	0,62
4	Funabara 船原	,,		35°–47°	1,09	,,	0,47
5	Iwai 岩井	Tottori-ken	40	46°–60°	1,96–2,00	,,	1,07–1,10
6	Yujiku 湯宿	Gumma-ken	—	37,2°–79°	1,42	,,	0,64
		c. Sulphated bitter springs.					
1	Ikao 伊香保	Gumma-ken	2500–2700	45°–47°	0,96–1,34	$CaSO_4$	0,18–0,45
2	Izusan 伊豆山	Shizuoka-ken	42	60°	1,42	,,	0,75
3	Iwai 岩井	Tottori-ken	40	45°–58,5°	1,83–1,91	,,	0,96–0,98
4	Asamushi 淺蟲	Aomori-ken	—	61,5°–79°	1,15–1,34	,,	0,31–0,63
5	Yugashima 湯ヶ島	Shizuoka-ken	625	41°–64°	1,7	—	
6	Tohi 土肥	,,	30	36°–66°	1,37–1,69	$CaSO_4$	0,89–1,11
7	Tochinoki 栃木	Kumamoto-ken	450	39°–45°	2,08	-	
		d. Muriated saline bitter springs.					
1	Yoshikata 吉方	Tottori-ken	—	24,4°–47,5°	4,03–4,62	NaCl Na_2SO_4	1,42–1,69 1,49–1,78
2	Kachimi 勝見	,,	—	51,5°–56°	1,12–1,36	NaCl Na_2SO_4	0,10–0,49 0,39–0,65
3	Hamamura 濱村	,,	—	45°–49°	1,07	NaCl Na_2SO_4	0,40 0,32
		e. Muriated sulphated bitter springs.					
1	Yudanaka 湯田中	Nagano-ken	1643	74°–76°	1,53	NaCl $CaSO_4$	0,70 0,65

8. Iron carbonate springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:		
						$Fe(HCO_3)_2$ in grm.	Other constituents in grm.	
		a. Iron carbonate springs.						
1	Beppu 別府	Ōita-ken	50	57,5°	0,85	0,0383		
2	Kwankaiji 觀海寺	,,	200	57°	0.77	—		
3	Shibaseki 芝石	,,	200	69°	1,59	0,2207		
		b. Iron carbonate common salt springs.						
1	Arima 有馬	Hyōgo-ken	1155	37,8°–47°	19,66–65,70	0,6088–0,8980	NaCl	14,72–43,16
2	Arimura (Sakurajima) 有村(櫻島)	Kagoshima-ken	—	38,9°–45°	5,38–5,70	0,0952–0,2286	,,	4,03–4,07
3	Anamori 穴守	Tokyō-fu	—	17°	9,38	0,0445	,,	7,48
4	Koyabara 小屋原	Shimane-ken	900	38,2°	5,28	0,0324	,,	3,91
		c. Iron carbondioxated common salt springs.						
1	Hirano 平野	Hyōgo-ken	—	27°	4,59–5,50	0,0302–0,0342	NaCl free CO_2	2,57–3,33 1,10
2	Yashio 八鹽	Gumma-ken	—	cold	8,90	0,0779	NaCl free CO_2	0,10 1,06

9. Vitriol springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituent
						$FeSO_4$ in grm.
1	Rokuyō 鹿野園	Nara-ken	—	20,5°	3,79	2,923
2	Michi-no-o 道之尾	Nagasaki-ken	—	24°	—	—
3	Hisomo-e 紕霜燃	Kagoshima-ken	2706	78,9°	0,36	0,0400

10. Alum vitriol springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:		
						$FeSO_4$ in grm.	$Fe_2(SO_4)_3$ in grm.	$Al_2(SO_4)_3$ in grm.
1	Yunomoto 湯ノ本	Nagasaki-ken (Iki Prov.)	—	43°-47°	19,84-21,64	0,2882-0,2969	—	0,650-0,669
2	Isobe 磯邊	Toyama-ken	—	cold	20,52-31,33	4,1420-12,1192	0-2,1063	13,596-16,461
3	Yoshima 好間	Fukushima-ken	—	„	18,75	4,5196	—	9,784
4	Uchiyama 內山	Nagano-ken	—	„	10,28	7,0320	—	2,048
5	Hyūgayama 日向山	„	—	„	8,77	3,6602	0,3965	3,247

11. Acid vitriol springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:		
						HCl (free) in grm.	H_2SO_4 (free) in grm.	Fe (SO_4) in grm.
1	Kusatsu 草津	Gumma-ken	3740	60°-63,9°	4,07-4,71	0,7461-0,8485	2,6186-2,2868	0,1663-0,2688
2	Unzen 溫泉	Nagasaki-ken	2145	65°	1,20	—	1,2887	0,2530
3	Kowakidani 小涌谷	Kanagawa-ken	2000	35,6°	1,13	—	0,1920	0,3982
4	Kannawa 鐵輪	Ōita-ken	150	89°-90,5°	2,67-3,51	0,2214-0,7910	—	0,0451-0,3513
5	Noboribetsu 登別	Hokkai-dō	600	71,5°	0,81	—	0,2316	0,0650
6	Naruko 鳴子	Miyagi-ken	—	92°	—	—	0,3397	$Fe_2(SO_4)_3$ 0,0878
7	Renge 蓮華	Niigata-ken	4500	36°-39°	0,80	—	0,0845	0,0524
8	Noroshi 狼煙	Ishikawa-ken	—	15°	1,16	—	0,2893	0,6582
9	Shimoburo 下風呂	Aomori-ken	—	17°	4,03	—	0,3674	0,0364

12. Acid alum springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:		
						HCl (free) in grm.	H_2SO_4 (free) in grm.	$Al_2(SO_4)_3$ in grm.
1	Takayu 高湯	Fukushima-ken	2640	45°-49°	1,52-1,70	0-0,1012	0,1152-0,2722	0,5645-0,9702
2	Tōgeshita 峠下	Hokkai-dō	—	cold	3,89	—	0,0112	1,8459

13. Acid alum vitriol springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents: HCl (free) in grm.	H_2SO_4 (free) in grm.	$FeSO_4$ in grm.	$Fe_2(SO_4)_3$ in grm.	$Al_2(SO_4)_3$ in grm.
1	Kusatsu 草津	Gumma-ken	3740	43°–64,4°	0,31–7,25	0,2664–14,8861	0–2,1674	0,2177–1,5603	—	0,720 –4,749
2	Beppu 別府	Oita-ken	50	—	6,65	—	1,1833	0,2130	5,2100	1,120
3	Myōban 明礬	,,	400	63°–97°	2,52	—	1,9870	0,1590	0,3150	0,863
4	Hokutō 北投	Taiwan	—	48,5°–94°	9,21	2,3737	—	0,3745	—	0,989
5	Isobe 磯邊	Toyama-ken	—	cold	5,01–42,00	0–0,0499	0–1,5648	0–7,1060	0–29,0544	1,780–11,067
6	Mikamanuma 御釜沼	Miyagi-ken	—	—	15,63	4,0300	0,2621	1,1800	—	7,390
7	Shibu-kuro 澁黑	Akita-ken	2700–2800	—	2,65–5,02	1,2681–2,5497	0,1254–0,4247	0–0,6746	0–0,1712	0,549 –0,608
8	Taki-no-iri 瀧ノ入	Nagano-ken	—	cold	27,03	0,0157	3,5791	13,7179	—	7,326
9	Yama-no-kamizawa 山ノ神澤	,,	—	,,	15,07	—	3,2454	7,0859	—	4,5289
10	Fukuzawagami 福澤神	,,	—	,,	19,91	0,0779	5,2010	10,7539	—	3,3967

14. Sulphur springs.

No.	Spa		Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents: H_2S in grm.	Other constituents in grm.
	a. Sulphur springs.							
1	Musashi	武藏	Fukuoka-ken	—	41°–46°	0,72	0,00226	
2	Hotta	堀田	Oita-ken	300	36°	—	—	
3	Awazu	粟津	Ishikawa-ken	—	47°–58°	2,23–2,24	0,0054–0,0173	
4	Nozawa	野澤	Nagano-ken	993	41°–82°	0,70–0,98	0,0119–0,3230	
5	Myoban	明礬	Oita-ken	400	98°	—	—	
6	Amibari	網張	Iwate-ken	2517	95°	0,76	—	
7	Naruko	鳴子	Miyagi-ken	—	40,5°	—	—	
8	Sekigane	關金	Tottori-ken	500	42°–46°	0,52–0,56	0,0002–0,0023	
9	Nakabusa	中房	Nagano-ken	5300	59,5°	0,55	0,0090	
10	Futami	二見	Toyama-ken	650	64,5°–95°	0,50–0,61	0,0004–0,00028	
11	Tsubame	燕	Niigata-ken	3000	42°–48°	—	—	
12	Tarutama	垂玉	Kumamoto-ken	850	57°–64°	—	—	
13	Sagayu	酸湯	Aomori-ken	4000	60°	0,60	—	

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:	
						H_2S in grm.	Other constituents in grm.
	b. Hydrogen sulphide springs.						
1	Nikkō-Yumoto 日光湯本	Tochigi-ken	5088	22°–69°	0,88–1,44	0,0268–0,0506	
2	Nasu-Yumoto 那須湯本	"	3000	28°	0,62	0,0292	
3	Iwōdani 硫黄谷	Kagoshima-ken	3343	48,7°–59,5°	0,47	0,0522	
4	Ei-no-o 榮之尾	"	2410	34°–39°	1,02	0,2374	
5	Tateyama 立山	Toyama-ken	4627	63°	1,39	0,0022	
6	Shiono-e 鹽ノ江	Kagawa-ken	713	17°	0,47	0,0021	
7	Ōyuzawa 大湯澤	Akita-ken	700	33,5°–45,5°	11,31–14,78	0,2246	NaCl 7,00–11,03
	c. Alkaline sulphur springs.						
1	Akakura 赤倉	Niigata-ken	3000	55,5°–62°	1,19	0,0268	
2	Naruko 鳴子	Miyagi-ken	—	103°	3,52	—	
3	Nakabusa 中房	Nagano-ken	5300	74°–96°	0,46–1,14	0,0039–0,0070	
	d. Muriated sulphur springs.						
1	Takedao 武田尾	Hyōgo-ken	340	19,5°–23,5°	1,13	0,0014	NaCl 0,73
2	Misasa 三朝	Tottori-ken	50	56,5°	1,24	0,0023	" 0,71
3	Yumoto 湯本	Fukushima-ken	—	48,9°	3,16–3,20	0,0164–0,0195	" 2,05
4	Sawatari 澤渡	Gumma-ken	2200	38,9°–52,8°	1,23–2,71	0,0255	" 1,23
	e. Saline sulphur springs.						
1	Yamashiro 山代	Ishikawa-ken	—	59°–71,5°	1,66–1,74	0,00102–0,00545	Na_2SO_4 0,69
2	Yunomine 湯ノ峯	Wakayama-ken	630	87,5°–92°	1,38	0,01014	" 0,70
	f. Sulphated sulphur springs.						
1	Yamanaka 山中	Ishikawa-ken	240	49°	1,65	0,0010	$CaSO_4$ 0,93
2	Kawarayu 川原湯	Gumma-ken	2160	28,9°–70,7°	1,52–1,72	0,0034–0,0091	—

15. Acid hydrogen sulphide springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:		
						HCl (free) in grm.	H_2SO_4 (free) in grm.	H_2S (free) in grm.
1	Kusatsu 草津	Gumma-ken	3740	58°–64,6°	2,38–5,60	0,3085–0,8742	1,8334–2,1674	0,0041–0,0055
2	Unzen 溫泉	Nagasaki-ken	2145	38°–65°	0,36–1,20	small quantity	0,1860–1,2887	0,0012–0,0041
3	Nasu-Yumoto 那須湯本	Tochigi-ken	3000	43°–74,5°	0,72–1,91	0,0838–0,2140	0,2171–0,4580	0,240–0,264
4	Yunohanazawa 湯之花澤	Kanagawa-ken	3300	40°	0,7	—	0,0180	0,1205
5	Manza 萬座	Gumma-ken	5180	50,6°–81,7°	0,95–1,54	0–0,0865	0,0990–0,4535	0,0527–0,3256
6	Takayu 高湯	Fukushima-ken	2640	45°–49°	1,52–1,77	0,1012–0,1114	0,1152–0,2294	0,0447–0,0840
7	Numajiri 沼尻	"	—	63°	1,94	0,5185	0,1698	0,1271
8	Shibu [Suwa] 澁 [諏訪]	Nagano-ken	6950	27°	0,86	—	0,6692	0,0167

16. Acid springs.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituents:	
						HCl (free) in grm.	H_2SO_4 (free) in grm.
1	Unzen 溫泉	Nagasaki-ken	2145	56° 74°	0,36–0,37	trace	0,0735–0,1176
2	Dake 岳	Aomori-ken	2500	45°–83,9°	1,90	—	0,9564

17. Boric acid spring.

No.	Spa	Prefecture	Altitude in ft.	Temperature in C.	Total residue in grm.	Therapeutically essential constituent:
						HBO_2 in grm.
1	Takaizumi 高泉	Gumma-ken	—	—	2,16	1 43

While the foregoing has been passing through the press, fresh data have come to hand, and these are appended here by way of supplement.

APPENDIX A.

ON THE GEYSER AT ONIKŌBE, MIYAGI PREFECTURE.

By Dr. K. Honda and Mr. T. Sone.

The Onikōbe Geyser, or "*Fuki-age*," as it is called among the natives, is situated at Onikōbe, Tamatsukuri-gōri, Miyagi Prefecture, and is one of the hot springs that are scattered along the eastern side of the Central Group of the Northern Mountain Range in Japan Proper. The geyser lies in the valley of the river Arao, a tributary to the river Kitakami, and this district is extremely irregular and undulating in topography, being intersected by steep mountain chains and deep gorges alternately. Hot springs are exceedingly numerous in the neighbourhood, and are indeed counted by hundreds, a sure evidence of the existence of some fissures in the earth crust running through this district. Visitors to this district will certainly be surprised to see columns of dense vapour rising everywhere and tepid water flowing down in torrents. It is also interesting to note that some springs spout hot water from the bottom of the stream, while others situated in cavities make noises resembling peals of distant thunder.

Turning to the left across a small bridge and then proceeding a short distance along the course of the river Arao, one can notice a cataract of some ten feet in height shooting over the precipice. To the right, one can also perceive clouds of dense vapour hanging over a mountain-side which indicates the site of the well-known "*Fuki-age*" Geyser. The upper part of the cataract forms a flat rock-bed, on which at the foot of an impending cliff on its western edge lies the basin of the geyser.

The orifice of the geyser opens at the south-western end of the basin and leads obliquely deep into the rock-bed. When the pool thoroughly dries up, as it does after an eruption, a full sight can be obtained of the mouth of the subterranean canal. The interior of the canal forms a curve and is completely shut out from view. The mouth of the orifice is five inches by one feet. There are two stones and a piece of timber lying in front of the orifice and are said to be a relic of the abnormal overflow of the streams in the vicinity on the occasion of a flood in 1910. Formerly there was another orifice near the south-eastern rim of the basin, but it has now been blocked, leaving vestiges of its mouth no longer in action. (Fig. 1 and 2)

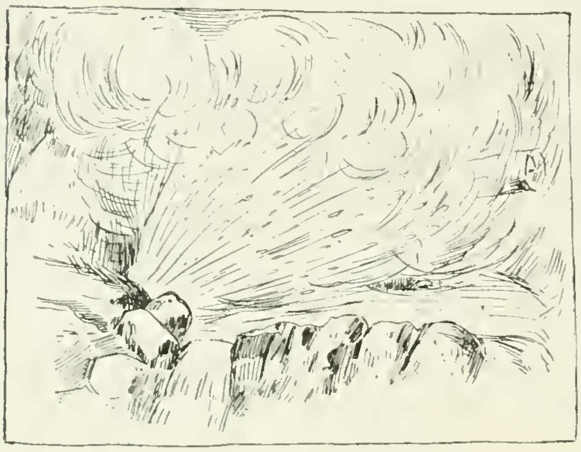


Fig. 1

Fig. 2

According to tradition, the "*Fuki-age*" Geyser is said to have been known as far back as the era of the Emperor Ōjin, a sovereign in the remote period of the history of Japan. Upwards of 1080 years ago, the north-eastern part of Japan was visited by tremendous earthquakes lasting for several days, when, we are told, a number of mountains crumbled down, and several hot springs made their appearance. Towards the beginning of the 19th century, a certain Ōba, a native of Akita Prefecture, settled down near the basin of the geyser, and later on, his descendants erected a bath-room for the convenience of bathers in general.

At that time there were two orifices, one called "*Kōbō*" and the other "*Fudō*." It was always "*Kōbō*" or the left orifice that first burst in eruption, and as soon as its activity ceased, the "*Fudō*" or the right orifice followed in action. This order was seldom disturbed. The "*Kōbō*" was copious in volume of the outflow, but it shot up only a little over ten feet in height, while the "*Fudō*" with smaller mouth shot up to a height of between 30 and 40 feet. Tradition goes that on one occasion the eruption blighted branches of some trees growing over the cliff. This tale taken as a fact may be explained by the supposition that the activity of the geyser must have shown a secular variation, allowing the trees to grow fully in the epoch of comparative inactivity and blasting them when in later years the eruption acquired its full intensity. It is also said that the source of the spring was lined with stone all around so as to collect the water into a pool which was partially dammed up by wooden boards, and that, at the request of visitors, the basin could be drained and the eruption thus excited artificially.

Down to fifty or sixty years ago, the two orifices remained in activity, repeating eruptions three times in a day and night *i. e.* about at 7 a. m., noon and 5 p. m. The ejection from the one orifice attained a height of over 10 feet and lasted in action for a minute or so, and after the lapse of half a minute the other commenced activity, shooting up to a height of between 24 and 25 feet with a terrific vigour for an interval of about two minutes. Later on, the geyser began to lose its force by degrees, and especially since, in May 1875, the Miyazawa spring in the vicinity has burst in a sudden explosion and killed 39 persons, even the height of the "*Fudō*" decreased to 14 or 15 feet.

When in 1894 Mr. Juzō Iwasaki made a visit to the region, he found the two orifices still in activity, the frequency of the eruption being 7 times in a day and night with the interval of 3 hours and 25 minutes on the average.

The observations of Mr. Iwasaki were subsequently published in the "Chishitsu-gaku Zasshi" (vide No. 15, Vol. II) which are quoted below with few corrections as regards the dimensions of the orifices.

"The two orifices, the larger and the smaller, are located along the major axis of the pool, the smaller one near the stream and the larger at some distance from it. The larger aperture shoot up columns of hot water as high as above 20 feet for a period of 3 minutes. After that the water vanishes from the basin, leaving heaps of stones and sands very hot to touch. After the lapse of about two minutes, a faint sound is heard far from the bottom of the smaller orifice, when all of a sudden water bursts out of it, rising to an altitude of 30 feet. The eruption lasts 2 or 3 minutes. Then the basin is again drained of its contents. Half an hour later, the water appears again inside the mouth of the smaller orifice, and fills up the basin as well as the larger orifice."

After 1898–9 the smaller orifice gradually declined in activity. In August 1910 the district was devastated by a flood of a very disastrous description, and the bath-house which had been run for generations by the Ōbas was washed away, causing the loss of 23 lives. Since then the geyser has been greatly lessened in force, its height diminishing to between 7 and 8 feet, though it increased a good deal in frequency.

The following is an extract of the observations made by Mr. Denzō Satō in July, 1913:—

"Directly after the eruption, the basin is found completely dried up, leaving only heaps of stones, but in a few moments the water gradually begins to fill up the orifice, and makes its appearance in the bottom of the basin till, after the lapse of half an hour, it brims over and finds its way out over the depressed part of the south-eastern rim. Just at this moment effervescence is observed to take place near the orifice and this is succeeded by ebullition, the overflow gaining in volume at the same time. Still the eruption is not yet set in. Meanwhile the ebullition grows in intensity and after a certain interval of time the outflow shows a sudden increase in volume until it overflows the southern rim, too, as if it were pushed by some unknown agency underneath. There is, however, no noise heard yet. At the same time the water in ebullition presents a state of extraordinary agitation, followed by a sudden eruption torn into violent splashes, rising up first to the height of 5 or 6 inches, then to 1 or 2 feet and ultimately reaching the climax of 4 or 5 feet. The splashes attain the height of even more than 7 feet. Taken altogether, it is to be remarked that the eruption has considerably decreased in altitude compared with previous years. After continuing in action for some forty seconds, the spouts become lower and lower and finally collapse, when, almost simultaneously, the water in the basin disappears in the orifice, leaving heaps of stones thoroughly dried up. As the water is being drained into the aperture, a faint rumbling sound is heard. It takes one minute and a half from the beginning to the last stage of the display. After the quiescence of one hour and five minutes the next eruption sets in."

The above may, in substance, be taken as a fairly accurate description of the present state of the geyser, and it entirely coincides with the results of our personal observations made last year.

To investigate the period of eruption and its variations corresponding to different external influences, we constructed a kind of self-recording air-thermometer, the bulb of which was fixed in front of the orifice. The apparatus proved very trustworthy in keeping record of the successive eruptions which were repeated 22 or 23 times in 24 hours with fairly regular intervals. A closer examination, however, showed that the periods of eruptions during the course of a day varied within a certain range.

Considering that the period of eruption may be affected by the pressure, we carried out experiments by raising the level of the water artificially. The embanking the basin all around so as to dam up the issuing water, the water level was raised by about 60 mm., and several observations were carried out.

It was ascertained that the period of the eruption which recorded about 70 minutes at the normal level of water, was prolonged to about 75 minutes when the level was raised by roughly 60 mm.

Next the relations between the variation in atmospheric pressure and the period of eruption demanded our attention. The results of our observations showed that a rise of about 4 mm. in the mercury column which corresponds to about 60 mm. in the water level, brought about a prolongation of the period by approximately 10 minutes.

Now in the foregoing experiments relating to the artificial elevation of water level, a prolongation of only 5 minutes was brought about by an increase of 60 mm. in the water level, so that the explanation based on the assumption that the increase of the atmospheric pressure is simply equivalent to the elevation of water level and brings about the rise of boiling point, is inadequate to account for this phenomenon. The explanation must be sought elsewhere.

It is a well-known fact that the temperature of some ordinary hot springs rises with low atmospheric pressure. The explanation generally accepted is that the reduction of pressure facilitates the flow of the underground water and hence retards the cooling of water as it circulate through the surface layer of the earth crust. This phenomenon must be taken into account as affecting the period of eruption in the case of the Onikōbe geyser. Strange to observe, in the case of the Atami geyser, low pressure is noted to prolong the period of eruption, a phenomenon which is quite contrary to the case under notice. This apparent contradiction must assuredly be attributed to the difference of internal structure and arrangements between the two geysers, the applausible assumption being that the subterranean cavity at Atami lies at a greater depth, while that at Onikōbe is nearer the surface of the earth. In support of this hypothesis, we may note the fact that in the latter the difference of water level affects the period of eruption in no small measure. If the cavity lies deep in the earth, the wall surrounding the cavity will generally maintain higher temperature than the subterranean water, and supplies heat to water flowing into it, while in the case of a cavity seated in a smaller depth where the earth crust is not high in temperature, the water in the cavity will, on the contrary, get heated by the flow of the subterranean water of relatively higher temperature. In short, the process that the water in the cavity is heated will be different according as the supply of heat comes from the surrounding wall or is derived from the superheated subterranean water flowing into it. Thus, at the time of low pressure which causes vigorous circulation of water, the heating of the water in the cavity will be slow in the former case and quick in the latter. This may suffice to explain why the low pressure brings about the prolongation of the period of eruption at Atami and to shorten it at Onikōbe. The conclusion we have arrived at is entirely different from the view set forth by Messrs. Iwasaki and Shimizu who regarded that the surrounding wall as heating the water in the cavity.

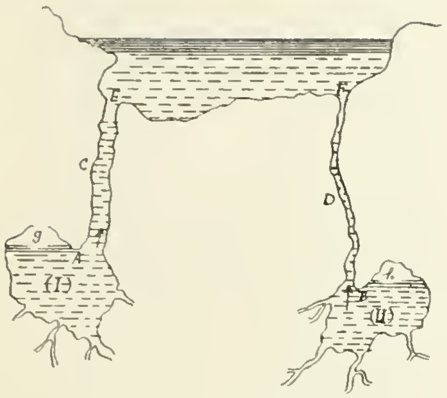
In order to estimate the quantity of water issuing from the orifice, we measured the overflow with a tub, by receiving in it the water as it flows out of the outlet in the embankment erected around the pool to that special end in view. The quantity thus obtained measured about 37 litre per minute at 20 minutes and 39 litre at between 2 and 3 minutes before eruption, indicating thereby that hot water always gushes out at practically fixed rates.

The temperature of the water at the mouth of the orifice stood at 97° C. both in autumn and winter, and as for its temperature in the canal, we measured it by inserting, at the time of repose, a maximum thermometer 2 or 3 metres deep into it, and found it reading 104,5° C. It was impossible to push the thermometer any further into the canal as it was found to curve inward, but it was sufficient to indicate that the cavity must generally maintain a pretty high temperature.

Explanation of the Phenomena.

The results of our observations afore mentioned lead to the following consideration with regard to the construction of the geyser, by which the characteristic phenomena of the eruption may be explained :—

In the past period, in which two orifices have been still active, two cavities, one with the larger neck (I) and another with the smaller one (II), must have been connected with the pool by the vertical channels C and D respectively, both opening side by side at the bottom of the pool. These cavities receive hot water heated in the deeper part of the earth crust flowing up from several narrow canals and the water ascends into the pool through the channels, heating in the mean time the water present in the cavities.



The position of the cavities may be considered to be either nearly at the same level under the surface of the ground or in the depths, somewhat different from one another, provided only that the amount of water supplied to the cavity (II) is always considerably smaller than that to (I).

It can be easily seen according to the above consideration that the waters in the cavities are heated chiefly by the subterranean water of high temperature coming forth from the underground, because the temperature of the wall of the cavities lying not very deep under the ground may not be sufficiently high, and the water in the cavity (I) will be as necessary consequence heated more rapidly than that in (II). Therefore, even when the cavity (I) has attained a definite high temperature and the gradually increasing tension of vapor occupying the upper part of the cavity above the water level causes at last an eruption of hot water from the larger orifice, the vapor tension in the cavity (II) is not yet sufficient to urge the water to eruption. As soon as the water of the pool is sucked in by the cavity (I) after the eruption from the larger orifice, the ebullition of water in the smaller cavity is brought about owing to the decreases of pressure under which it has been subjected and the water vapor generated will accumulate in its upper portion (*g*).

As the latent heat necessary for the evaporation of water must be supplied from the hot subterranean water flowing into the cavity and the increase of vapor tension in the space requires a definite time in order to attain its full strength sufficient for eruption, it follows that the eruption from the smaller orifice takes place in a definite lapse of time after that from the larger. It seems that the interval between the eruption from the larger orifice and the beginning of that from the smaller one has varied according to ages to some extent, *i. e.* about 30 seconds to 2 minutes.

The fact that the water level at the larger orifice does not descend after the eruption, holding a certain height for some time, agrees well with the above explanation.

Moreover, the volume of the cavity (I) may be considered to be somewhat larger than that of (II), as the determination of the amount of ejected water actually shows. As for the difference of the heights of water column thrown up into the air from two orifices, we may explain it by the presence of some obstacles near the orifices.

As for the recent quiescence of eruption from the smaller orifice there are of course several causes to be considered, but it is most probable that the narrow canals leading to the cavity (II) have become gradually narrower by deposition of mineral sinter, so that the hot water cannot heat the cavity to a degree sufficient to cause eruption.

Also the period of eruption has a tendency to become shorter in the course of time, *i. e.* the period of about 5 hours which was observed 50–60 years ago, has decreased to 3,5 hours in 1895, and at present again to only 1 hour and 6 minutes.

The decrease of the amount of jets as well as the activity of eruption of this geyser may probably be explained if we assume that the gradual erosion of the projected parts of the neck of the cavities, A and B, has decreased the effective volume of the cavity available for eruption, for the activity of intermittent eruption does not depend on the total volume of the cavity, but only on that portion (*g* and *h*) occupying its upper part; the erosion of the neck must cause not only the decrease of the effective volume of the cavity, but also the decrease of the period as well as the activity of eruption.

If these considerations be correct, the intermittent spring of Onikobe will gradually shorten its period of eruption in the course of time and at last be deprived of its intermittent character after several decades.

APPENDIX B.

LIST OF NOTABLE MINERAL SPRINGS IN OTHER COUNTRIES.

Great Britain.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
			1. Indifferent thermals.				
1	Buxton	Derbyshire, England	Ca $(HCO_3)_2$, Mg $(HCO_3)_2$, rich in N-gas	27,8°C. (82°F.)	1000 highest town in England	gout, rheumatism, sciatica, lumbago; also affections of stomach, liver, kidneys, and nerves.	radio-active; stimulating and sub-thermal treatment; favourite resort for the air-cure; bracing climate.
2	Matlock Bath	„ „	fixa 0,47 ‰, chiefly lime salt	21,1°C. (70°F.)	300–1300	rheumatism, gout, rheumatoid arthritis, catarrhs, bronchial gastric or enteric, nervous disorders and hysteria, anæmia, chlorosis and cardiac asthma, chronic diseases of liver and kidneys, and digestive and bilious disorders.	for the douche-massage.
3	Bath	Somersetshire, „		see also calcareous water			
4	Malvern (St. Anne's Well)	Worcestershire, „	not mineralized			acts by lixiviation of the tissues and promotes the powers of elimination.	curative place of its own (low rainfall, keen air, and absence of currents of air).
			2. Sulphur waters.				
1	Harrogate	Yorkshire, England	Na_2S(0,7‰), H_2S(37 vol. ‰),	cold	400-600	anæmia, sciatica, obesity, skin diseases, dyspepsia and gastric catarrh, chronic uterine complaints, functional disorders of the liver, gouty and rheumatic tendencies.	the chief English sulphur spa; dry and bracing climate; July temp. about 60° F.
2	Strathpeffer	Ross-shire, Scotland	pure sulphur; H_2S 40–69 vol. ‰, fixa 1–1,6 ‰		150-300	tropical ailments, after-effects of enteric fever, gout and allied complaints, skin diseases.	sheltered, cool and bracing with its tonic-sedative pure northern air.
3	Llandrindod	Radorshire, Wales	1–14 vol. ‰ H_2S		700	mucous troubles, gastritis, scrofula.	Lithia spring is said to be the finest in Europe.
4	Llanwrtyd	„	strong sulphuretted; H_2S 36 vol. ‰		700–800	asthma, skin diseases, dyspepsia, calculi, insomnia, liver and kidney disorders, rheumatism.	quiet spa, pleasant and equable.
5	Builth	Brecknockshire	muriated sulphur		400		
6	Moffat	Annandale, Scotland	weak salt sulphur; NaCl 0,9 ‰, H_2S 3 vol. ‰	9,5°C.(49°F.)	370	diuretic; useful in skin affections, eczema, acne, liver and kidney troubles, chronic bronchitis.	agreeable and sheltered climate.
7	Lisdoonvarna	County Clare, Ireland	weak sulphuretted; H_2S 5–6 vol. ‰, fixa trace		430	rheumatic, gouty and digestive disorders.	westernmost of the British spas; mild, equable and tonic-sedative.
8	Lucan	near Dublin, „	weak sulphuretted				mild equable and tonic-sedative.
9	Leamington	Warwickshire, England	sulphurous	see also muriated water			

3. Muriated waters.

1	Droitwich	Worcestershire, England	saturated brine (307 ‰ of salts)		200	rheumatism, gout, sciatica, lumbago, neuralgia, neuritis, paralysis, nervous and certain forms of cardiac affections.	
2	Woodhall Spa	Lincolnshire, „	NaCl 20 ‰, little of chlorides of Ca, Mg, and iodides and bromides			chiefly rheumatoid arthritis, also gout, muscular rheumatism, sciatica, neurasthenia, eczema, women's diseases.	dry and rather warm summer climate: some of springs are most powerful of the bromoiodine waters.
3	Cheltenham	Gloucestershire, „	moderate amount of salts (Na_2SO_4 and $MgSO_4$)	cold	150	dyspepsia and plethoric conditions, intestinal catarrh, anæmia, circulatory troubles, mucous membrane affections, lung diseases, asthma.	
4	Leamington (Royal Leamington Spa)	Warwickshire, „	NaCl 10‰, saline, gypsum, etc.	„	200	diuretic; tonic to the gastric mucous membrane, also chronic and rheumatic gout, articular and muscular rheumatism, lumbago, sciatica, scrofula, anæmia, tropical disorders of liver.	
5	Bridge of Allan	near Stirling, Scotland	$CaCl_2$ (4,4 ‰), Fe, Mg; some sulphates and carbonates; great preponderance of $MgBr_2$			dyspepsia, chronic constipations, liver, complaints, uric acid diathesis, and nerve troubles.	eminently suited to those who need rest and to convalescents.
6	Llangammarch	Brecknockshire, Wales	also $CaCl_2$, $BaCl_2$ (ca. 0,1 ‰)		600	certain forms of cardiac affections, dyspepsia, chronic gout, and rheumatism.	restful spa; bracing and moorland climate.
7	Ashby-de-la-Zouche	Leichestershire, England	also hypertonic salt with $CaSO_4$ (2,5 ‰)			scrofula and rheumatism.	

Also Nantwich, Northwich (both in Cheshire, England). Saltburn-by-the-Sea, and Stattford, etc.

4. Alkaline water.

1	Cheltenham	Gloucestershire, England	$NaHCO_3$	see also muriated water			believed to be the only "alkaline-water" in the British Isles.

5. Chalybeate waters.

1	Tunbridge Wells	Kent, England	$FeCO_3$(0,06 ‰) with free CO_2	13,9°C. (57°F.)	400-500		
2	Flitwich	Bedfordshire	$Fe_2(SO_4)_3$ (2 ‰)				only to be had bottled.
3	Trefriw	on the river Conway, Wales	$Fe_2(SO_4)_3$ (2,4–5,4 ‰), lime, silica				mild climate.

Also Harrogate, Buxton, Strathpeffer, Llandrindod, Leamington and Moffat, etc.

6. Calcareous waters.

1	Bath	Somersetshire, England	$CaSO_4$, $CaCO_3$ (1,3 ‰), N-gas	40°–48,9° C. (104°–120°F.)	600	gout, chronic rheumatism, arthritis, sciatica, digestive and nervous troubles, anæmia, etc.	radio-active; typical thermal spa (with all kinds of baths; thermal and sedative treatment.

Belgium.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Chaudfontaine	in the valley of Vesdre	indifferent thermals containing NaCl and $CaCO_3$	35,6°C. (96°F.)		rheumatism, neuralgia and hepatic disorders.	
2	Spa	at the junction of the Rivers Wayai and Picherotte	gaseous chalybeate	10°C.(50°F.)	1000	simple anæmia and atonic conditions, especially in women, with leucorrhœa, menorrhagia, or sterility, in convalescence and circulatory disorders.	very complete Bath Establishment; inhalation, electro-therapy, massage, medical mechano-therapy. Hydrotherapic Institute. Fango treatment and moor baths.
3	Haarlem		chalybeate				

France.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
			1. Indifferent waters.				
1	Plombières	Vosges	silicate, arsenic	25°–68,3°C. (77°–155°F.)	1300	gastralgia, enteritis, chronic diarrhœa, functional nervous disorders, and appendicities.	radio-active.
2	St. Amand	near Lille		21,1°–26,1°C. (70°–79°F.)	100	rheumatism, diseases of the joints, neuralgia, and chronic skin affections.	silicious sulphuretted mud baths.
3	Néris	near Montluçon	soft, faintly alkaline ($NaHCO_3$) and saline	46,1°–52,2°C. (115°–126°F.)	1150	nervous excitation, gastralgia, enteralgia, diseases of spinal cord, neuralgia, rheumatism, dysmenorrhœa, constipation, and diseases of uterus.	radio-active, sedative.
4	Mont Dore	Auvergne	weak alkaline with a trace of As_2O_3 and $Fe(HCO_3)_2$	40°–46,7°C. (104°–116°F.)	3400	bronchitis, asthma, laryngitis, rheumatism, and chlorosis.	mountain spa.
5	Dax	near Bayonne		31,1°–63,9°C. (88°–147°F.)	130	chronic rheumatic and joint affections, gout, neuralgia.	an important resort, both for summer and winter.
6	Bagnères de Bigorre	Pyrenees	calcareous ($CaSO_4$, $MgSO_4$, Na_2SO_4)	21,1°–50,6°C. (77°–123°F.)	1800	rheumatism, anæmia, disorders of the nervous system, catarrhal conditions of alimentary, respiratory, and genito-urinary systems.	mild climate.
			2. Muriated waters.				
1	Châtel Guyon	Auvergne	(some of the springs highly chalybeate with CO_2-gas)		1300	dyspepsia, chronic, gastric, and intestinal catarrh, chronic constipation, congestion of the liver, tropical diseases.	
2	Bourbon l'Archambault	near Moulins	also Na_2CO_3, $CaCO_3$ and $FeCO_3$	48,9°C. (120°F.)	870	rheumatism, scrofula, and nervous diseases.	
3	Bourbon Lancy	Le Morvan	(some of the springs are saline)	27,8°–57,8°C. (82°–136°F.)	1780	chronic rheumatism, chronic heart disease, and nervous conditions.	radio-active.

4	Bourbonne-les-Bains	Plateau de Langres	also LiCl, $CaSO_4$, NaBr, and trace of Fe, Mn	43,3°–65,6°C. (110°–150°F.)	900	scrofula, rheumatism, sciatica, ulcers, chronic septic conditions, and traumatism.	
5	La-Motte-les-Bains	Isère	also $CaSO_4$, NaBr	51,1°–58,3°C. (124°–137°F.)		chronic rheumatism, sciatica, neuralgia, and uterine affections.	
6	Balaruc	l'Etang de Thau	strong muriated	12,2°–47,8°C. (54°–118°F.)		sciatica, rheumatism, scrofula, locomotor ataxy, and other paralyses.	mud baths.
7	Salins	Juras, on the River Furieuse	also $MgCl_2$, Na_2SO_4, K_2SO_4 and little of KBr and KI	cold	1200	scrofula, lymphatic affections, and constitutional weaknesses in women and children.	

Also La Bourboule, Salins-Moutiers, etc.

3. Alkaline waters.

1	Vichy	by the River Allier	strong alkaline ($NaHCO_3$: more than 4‰) with trace of As, F and free CO_2, some of the springs contain Fe	cold and thermal	780	dyspepsia, liver and bladder diseases, gall-stones, gout, diabetes, uterine disorders and anaemia.	
2	Vals	on the Volane	much free CO_2 and little Fe	cold	790	kidney and bladder diseases, dyspepsia and gastric catarrh, diabetes, gout and rheumatism.	
3	Royat	Auvergne	gaseous with NaCl, Ca salts, little Fe and trace of As	20°–35°C. (68°–95°F.)	1480	anaemia, gout, dyspepsia, laryngitis, bronchitis, nervous diseases, cardiac affections, and diseases of women.	
4	St. Nectaire	„	gaseous	10°–43,9°C. (50°–111°F.)	2500	chronic rheumatism, neuralgia, dyspepsia, anaemia, albuminuria, and diseases of women.	
5	La Bourboule	Dordogne, „	muriated alkaline with Na_3AsO_3	thermal	2780	respiratory diseases, scrofula, diabetes, malaria, rheumatism, gout, and cutaneous diseases.	the most radio-active of French waters.
6	Evian-les-Bains	on the L. Geneva	weak alkaline, contain $CaCO_3$	cold	1240	gout, gastralgia, and affections of urinary organs.	a bright and gay resort

Also Pougues-les-Eaux, Lamalou, etc.

4. Sulphated muriated waters.

1	Brides-les-Bains	in the valley of Doron	sulphated saline	35°C.(95°F.)	1860	chronic constipations, dyspepsia, chronic intestinal catarrh, haemorrhoids, especially obesity.	grand mountain views.
2	Salins-Moutiers	near Bride-les-Bains	saline, brine; charged with CO_2-gas	35,6°C. (69°F.)	1600	scrofula, anaemia, and skin affections; useful for certain forms of rheumatism and heart disease, also in convalescence.	radio-active, "flowing baths" used for lymphatic and circulatory disorders, terrain cure.
3	St. Gervais-les-Bains	near Mont Blanc	weak sulphated salt	39,5°–42,2°C. (103°–108°F.)	2075	chronic rheumatism, skin affections, and dyspepsia.	sedative, mountain spa, grand excursion.

5. Calcareous waters.

1	Contrexéville	Plateau of Monts Faucilles, Vosges	$CaCO_3$, $Ca(HCO_3)_2$, trace of Fe, As	cold	1150	gravel, calculus, gout, arthritis, diseases of liver and genito-urinary organs.	
2	Pougues-les-Eaux	by the River Loire, 7 m. from Nevers	gaseous alkaline; $Ca(HCO_3)_2$, $Mg(HCO_3)_2$, $NaHCO_3$ and free CO_2-gas	„	650	dyspepsia, intestinal disorders, gout, gravel, and urinary affections.	

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
3	Cransac	near the Volcano le Montet			980		there are also natural sulphurous vapour baths.
4	Martigny-les-Bains	Plateau of Monts Faucilles, Vosges	$CaSO_4$ with Li		1246	gout, gravel, diabetes, and liver and kidney derangements.	
5	Vittel	Vosges	"Grande Source," alkaline (diuretic); "Source Salée," (laxative)	cold	1100	"Grande Source"—uric acid diathesis, gout gravel, neurasthenia, neuritis, neuralgia, sciatica, hysteria, and albuminuria. "Source Salée"—constipation, congestion of the liver, gall-stones, and bronchial catarrh.	2 principal springs, "Grande Source" and "Source Salée."

6. Chalybeate waters.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Lamalou	Cevennes	chalybeate and weak alkaline	15°–43,3°C. (59°–110°F.)	620	rheumatism, sciatica, neuralgia, locomotor ataxy, chlorosis, and anæmia.	
2	Rennes-les-Bains	6 m. from Couiza-Montazels	chalybeate and saline	thermal	1000	chronic rheumatism, anæmia, and scrofula.	
3	Prezza	Larne Island	gaseous				

Also some springs in Châtel Guyon, etc.

7. Sulphur waters.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Aix-les-Bains	near L. Bourget, Savoy	Two chief springs; one contains alum, the other is simple sulphur spring	4,28°–44,5°C. (109°–112°F.)	860	gout, rheumatism, arthritis, neuritis, skin diseases, and affections of the mucous membranes.	alum sulphur water used externally and the other for inhalation and spray rooms. Aix douche massage is celebrated for treating stiff joints arising from injuries or chronic disease.
2	Marlioz	near Aix-les-Bains, "	very strong sulphur	cold		laryngeal and bronchial affections.	for inhalation.
3	Challes-les-Eaux	3 m. from Chambéry,	very strong sulphur; 5‰ Na_2S with Br, I	"	800	chronic catarrh of throat, chronic bronchitis, scrofula.	for internal use.
4	Bagnères de Luchon	Pyrenees					
5	Cauterets	"	(also alkaline springs); Na_2S 0,01–00,2‰	39,5°–53,3°C. (103°–128°F.)	3200	chronic laryngitis and bronchitis, phtisis, gastric catarrh, rheumatism, and uterine derangements.	radio-active.
6	Eaux Bonnes	"		21,1°–32,2°C. (70°–90°F.)	2460	chronic bronchitis, laryngitis, and pulmonary catarrh.	radio-active.
7	Eaux Chaudes	"	weak sulphur	25°–26,1°C. (77°–79°F.)	2200	sterility, rheumatism, respiratory and nervous disorders.	radio-active.
8	Barèges	"		27,2°–43,9°C. (81°–111°F.)	4200	osteo-myelitis and diseases of the bones and joints, chronic suppurative conditions, scrofula, syphilis, and anæmia.	
9	St. Sauveur	"		33,9°C. (93°F.)	2500	all diseases of women, and functional and organic nervous diseases.	
10	Aix-les-Thermes	"		17,2°–77,2°C. (63°–171°F.)	2350	rheumatism, scrofula, syphilis, chronic dry eczema, and other skin diseases.	

11	Amélie-les-Bains	,,	alkaline sulphur	21,1°–62,8°C. (70°–145°F.)	920	rheumatism, skin diseases, bronchitis, asthma, and chronic catarrh of the respiratory system.	mild in winter.
12	Uriage	,,	saline sulphur	27,2°–55°C. (81°–131°F.)	1350	chronic skin diseases, scrofulous and rheumatic conditions, and constitutional weakness.	suitable for air-cure.
13	Vernet-les-Bains	,,	,,	7,8°–73,9°C. (46°–165°F.)	2000	affections of the throat and chest, rheumatism, gout, sciatica, dyspepsia, anæmia, neurasthenia.	
14	Guagno	Corsica		thermal			
15	Pietrapola	,,		,,			

Germany.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
			1. Indifferent waters.				
1	Wildbad	Black Forest	rich in N-gas	32,8°–40°C. (91°–104°F.)	1410	chronic rheumatism and gout, diseases of spinal cord and urinary tract, chronic gastritis, diseases of women and skin diseases.	
2	Schlangenbad	near Mainz	rich in gases (N and O)	27,8°–32,2°C. (82°–90°F.)	950	nervous erethism, overstrain, dyspepsia, neurasthenia, diseases of women, and chronic skin eruptions, and also as an "after cure."	restful and sedative.
3	Baden-Weiler	Black Forest	Na_2SO_4, $CaCO_3$, LiCl, N-gas	25°–26,7°C. (77°–80°F.)	1450	affections of throat and lungs, convalescence, neurasthenia, neuralgia, rheumatism.	
4	Landeck	Prussian Silesia (Reichensteiner range)	Na_2S, H_2S	20°–28,3°C. (68°–83°F.)	1500	chronic rheumatism, nervous affections, and diseases of women (specially visited for the latter).	highly radio-active.
5	Warmbrunn	,,		25°–42,8°C. (77°–109°F.)	1140	gout, rheumatism, skin diseases, and respiratory affections.	
			2. Muriated waters.				
1	Nauheim	near Frankfort-on-the-Main	effervescing; 1–3‰ salt, rich in CO_2	27,8°–35,3°C. (82°–95,5°F.)	470	chronic cardiac disease, neurasthenia, gout, rheumatism, anæmia, leucorrhœa, and other diseases of women.	radio-active
2	Kreuznach	near Mainz	NaCl 1‰, $CaCl_2$ 0,1‰; trace of Ba	cold	340	scrofula, rickets, gout, rheumatism, obesity, chronic inflammation and catarrh, and skin diseases.	radio-active, typical salt sp.
3	Homburg	near Frankfort-on-the-Main	effervescing; (some of the springs are salt chalybeate)	,,	630	constipation, dyspepsia, catarrh of stomach and intestines, portal congestion, obesity, rheumatism, diabetes, chronic cardiac and pulmonary conditions, nervous and uterine disorders.	
4	Wiesbaden	near Mainz	gaseous	37,8°–68,9°C. (100°–156°F.)	380	chronic gout and rheumatism, bronchial catarrh, dyspepsia, and syphilis.	radio-active.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
5	Kissingen	Bavaria	effervescing: $CaCl_2$ and little $FeCO_3$	cold	650	plethora and gastric disorders, congestion of the liver, chronic cardiac diseases.	
6	Baden-Baden	Black Forest	also LiCl and trace of As	45°–70°C. (113°–158°F.)	650	rheumatism, gout, gastric and bronchial catarrh, genito-urinary, and skin diseases.	radio-active, beautiful surroundings.
7	Oeynhausen	Westphalia	strong effervescing	25°–33,1°C. (77°–91,5° F.)	230	chronic diseases of spinal cord, tabes dorsalis, rheumatism and bone diseases.	mild refreshing climate.
8	Soden	Taunus	(also saline springs with CO_2-gas)	subthermal	460	chronic catarrhal affections of the respiratory organs, emphysema, scrofula, dyspepsia, and chronic heart disease.	
9	Ems	Prussia			see also alkaline waters		
			3. Alkaline waters.				
1	Neuenahr	Rhine	gaseous	30°–48,9°C. (86°–120°F.)	260	liver and kidney affections, Bright's diseases, gout, hysteria, and chronic gastritis, especially diabetes and uric acid troubles.	14000 visitors per annum.
2	Salzbrunn	Prussian Silesia	saline, highly charged with CO_2-gas; $NaHCO_3$ 2‰	10°C.(50°F.)	1320	acute and chronic catarrh of the respiratory organs, emphysema, and asthma; diseases of the digestive organs, kidneys, and bladder; gout, diabetes, and after influenza.	
3	Ems	Prussia	muriated-alkaline	26,7°–48,9°C. (80°–120°F.)	260	chronic catarrh, gout, rheumatism, diseases of the digestive system and urinary organs, and uterine disorders.	
4	Elster	Saxony	gaseous alkaline sulphated and chalybeate	cold	1550	anæmia and chlorosis, hepatic dyspepsia and gout.	bracing spa.
			4. Calcareous waters.				
1	Wildungen	Hessen	gaseous, with $Ca(HCO_3)_2$, $Mg(HCO_3)_2$ and $Fe(HCO_3)_2$	cold	980	catarrh of the bladder, calculus, gravel, gout, and chronic nephritis.	pleasant surroundings.
2	Lippspringe	Westphalia	weak	21,1°C. (70°F.)	450	pulmonary and other catarrhal conditions and phtisis.	
3	Eilsen	Saxony	(some of the springs are strong sulphuretted)	cold	230	see also sulphur waters.	
			5. Chalybeate waters.				
1	Schwalbach		gaseous	cold	950	same as for Spa (Belgium) p. 80.	
2	Kudowa	Prussian Silesia	alkaline		1310		
3	Driburg	Westphalia	gaseous		730		
4	Rippoldsau	Black Forest	"	cold	1870	nervous diseases, rheumatism, gout, dyspepsia, and anæmia.	amidst typical Black Forest scenery.
5	Pyrmont	Westphalia	" $Fe(HCO_3)_2$, $Ca(HCO_3)_2$, $CaSO_4$ and $MgSO_4$	"	420	anæmia, debility, chlorosis, scrofula, nervous affections and diseases of women.	one of the oldest spas in Europe, climate mild and healthy.

6. Sulphur waters.

1	Aix-la-Chapelle	Aachen	strongly impregnated with sulphur	45,6°–74,5°C. (114°–166°F.)		chronic rheumatism, diseases of the skin, gout, paralysis, syphilis, sciatica, and neuralgia.	
2	Weilbach	Taunus	weak alkaline	cold	440	portal congestion, hæmorrhoids, gout, diseases of urinary tract, and respiratory affections.	
3	Nenndorf	Prussia	strong sulphuretted		230		sulphurous mud baths.
4	Meinberg	Lippe, Westphalia		cold			
5	Eilsen	Saxony	strong sulphuretted	„	230	gouty and skin affections.	„

Switzerland.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
			1. Indifferent waters.				
1	Ragaz-Pfäffers		rich in N-gas	31,7°–33,9°C. (89°–93°F.)	2000	chronic rheumatism, sciatica, uric acid diathesis, digestive and nervous disorders, and uterine disorders.	radio-active; Pfäffers 525 ft. above Ragaz, quiet and restful place; Ragaz waters being brought in pipes from Pfäffers, 3 m. away.
2	Louéche-les-Bains	Leukerbad	$CaSO_4$	33,9°–51,1°C. (93°–124°F.)	4600	psoriasis, eczema, and other skin diseases, osteo-arthritis, chronic rheumatism, and neuralgia.	high Alpine climate
			2. Muriated waters.				
1	Rheinfelden		strong muriated (nearly saturated brine)		866	anæmia, scrofula, rheumatism, gout, catarrh, diseases of women.	
2	Schweizerhalle						
3	Bex	Rhone Valley	strong muriated		1400	chiefly for delicate women, and children of tuberculous diathesis, anæmia, chlorosis, rheumatism, and functional nervous diseases.	
	Also Tarasp-Schuls has muriated waters.						
			3. Alkaline waters.				
1	Passugg		alkaline-saline		2925	anæmia, certain kinds of dyspepsia, chronic catarrh of the stomach, constipation, chronic arthritis, gout, kidney and urinary catarrh, debility, and obesity.	
2	Tarasp-Schuls	Lower Engadine	muriated effervescing chalybeate, strong alkaline	cold	3900	dyspepsia, kidney and liver disorders, rheumatism, catarrhs, and nervous weakness.	

4. Chalybeate waters.

1	St. Moritz	betw. Lake St. Moritz and Lake Campfer	impregnated with CO_2-gas	cold	5820	debility, anæmia, catarrh, nervous affections, and chest complaints.	pure air, magnificent scenery.
2	Acquarossa		Fe, As, Li			gout, rheumatism, anæmia, amenorrhœa, and diseases of women.	
3	San Bernardino						

Some of the springs in Tarasp-Schuls belong to this class.

5. Sulphur waters.

1	Baden			36,7°–52,2° C. (98°–126°F.)	1230	chronic rheumatism and gout, neuritis, sciatica, lumbago, muscular rheumatism, and inhalations for chronic respiratory catarrh.	known since Roman times.
2	Schinznach		strong sulphuretted	35°C.(95°F.)	1140	chronic eczema, rheumatism, gout, catarrhal conditions, scrofula, rickets and syphilis, especially skin affections.	
3	Lavey	Rhone Valley	weak sulphur	33,3°-47,8°C. (92°–118°F.)	1350	rheumatism, scrofula, chronic eczema, and other skin diseases.	brine and hot sand baths.
4	Yverdon		alkaline sulphur	23,9°C. (75°F.)	1430	sciatica, chronic rheumatism, peripheral neuritis, pulmonary catarrh, leucorrhœa, and other diseases of women.	
5	Lenk		strong sulphuretted, ($Ca\ SO_4$)	cold	3630		

6. Calcareous water.

1	Weissenburg		weak	26,1°C. (79°F.)		affections of the respiratory organs and pulmonary tuberculosis (early stage).	used for drinking only.

Austria.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
			1. Indifferent waters.				
1	Gastein	Bohemia		25,6°–49,5°C. (78°–121°F.)	3400	nervous diseases, gout, rheumatism, general debility, hypochondriasis and other functional derangements; also employed as an "after cure."	the most radio-active of all thermals in Austria.
2	Teplitz	"		28.3°–45.6°C. (83°–114°F.)	730	chronic rheumatism and gout, sciatica, lumbago, neuralgia, functional nervous disorders; also chronic skin diseases and sepsis, and after-results of severe injuries.	radio-active
3	Johannisbad	"	(some of the springs are chalybeate)	29,5°C. (85°F.)	2070	nervous diseases and neurasthenia, convalescence.	

			2. Muriated waters.				
1	Ischl	Upper Austria	strong muriated		1550	bronchitis, chronic arthritis, scrofula, and neuralgia.	
2	Herkulesbad	Hungary	(some of the springs are sulphuretted)	71,1°–62,8°C. (70°–145°F.)	570	rheumatism, sciatica, arthritis, chlorosis, nervous exhaustion, diseases of the stomach and kidneys.	
			3. Alkaline waters.				
1	Bilin	Bohemia	gaseous	15°C.(59°F.)	645	gastric and alimentary conditions, diabetes, gout, gravel, and chronic bronchial catarrh.	
2	Gleichenberg	Styria	saline-alkaline		980	chronic affections of the respiratory organs, and dyspepsia.	sheltered on the N. by the neighbouring hills.
3	Karlsbad	Bohemia	alkaline-sulphated with CO_2-gas	35°–72,2°C. (95°–162°F.)	1230	diseases of stomach and intestines, gravel, renal calculus, hæmorrhoids, obesity, diabetes, gout, rheumatism, urinary disorders, and sciatica.	radio-active; 70,000 bathers per annum.
4	Marienbad	”	”	cold	vide chalybeate and arsenical waters.		
5	Franzensbad	”	effervescent; (some springs are sulphated and chalybeate)	”	”		
6	Teplitz	”	alkaline-saline	28,3°–45,6°C. (83°–114°F.)	vide indifferent waters.		
			4. Sulphated waters.				
1	Franz-Joseph	Hungary	$MgSO_4$ and Na_2SO_4				
2	Hunyadi-Janos	”					
3	Apenta	”					
4	Æsculap	”					
5	Pullna	Bohemia	weak	10°C.(50°F.)			
6	Seidlitz	”	weak, no sodium salt	”			
			5. Chalybeate, ferruginous and arsenical waters.				
1	Franzensbad	Bohemia	chalybeate and arsenical, highly charged with CO_2-gas	cold	1500	dyspepsia, anæmia, amenorrhœa, and uterine disorders, heart disease, gout, and rheumatism; effervescing moor and gas baths, employed in cardio-vascular and functional nervous disorders, leucorrhœa and affections of the pelvic organs.	moor baths.
2	Marienbad	”	arsenical and chalybeate	cold and thermal	2090	obesity, gout, gastric and hepatic congestion, heart disease, leucorrhœa, menorrhagia, and other diseases of women.	ferruginous peat baths, vapour, and many other baths are also given.
3	Katres	Tyrol	arsenical and ferruginous				
4	Mitterbad	”	”				
5	Levico	Valsugana, Tyrol	”	cold	1640	disorders of the blood, lymphatic glands and spleen, nervous diseases, amenorrhœa, and skin affections.	
6	Roncegno	Tyrol	” (exceedingly rich in arsenic)	”	1750	anæmia and diseases of women, neurosis, skin diseases, rheumatism, gout, and malaria.	dry and invigorating air.

Italy.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1. Indifferent waters.							
1	Bormio	near Stervio Pass	$CaCO_3$, $CaSO_4$, $MgSO_4$	32,2°–40,6°C. (90°–105°F.)	4500	gout, rheumatism, nervous and skin diseases.	Alpine spa.
2	Battaglia	near Padua, Prov. of Venetia	little quantity of salt	60°–71.1°C. (140°–160°F.)	1900	rheumatism, gout, bronchial catarrh (the latter treated by inhalation of the water).	radio-active, natural vapour and fango baths.
3	Monsummano "Grotto Giusti"	in Val-di-Nievole		subthermal		rheumatism, gout, lumbago, sciatica, and neuralgia.	Grotto Giusti is a large cave warmed by thermal water and forms a natural vapour bath itself.
2. Muriated waters.							
1	Abano	near Padua	weak muriated	37,8°–83,9°C. (100°–183°F.)	100	chronic joint affections.	radio-active, an organic fango bath.
2	Salsomaggiore		brine (130‰) water, rich in Br and I	cold	520	scrofula, gout, rheumatism, bronchitis and pulmonary catarrh, diseases of women, anæmia, and nervous affections.	called "Italian Carlsbad."
3	Montecatini	near Pistoia	weak	21,1°–31,1°C. (70°–88°F.)	920	diseases of stomach and intestines, dyspepsia, diabetes, obesity, and gout.	
3. Chalybeate and arsenical waters.							
1	Pisciarelli	near Pozzuoli	arsenical and chalybeate				
2	Cereosole Reale	Piedmont	"		5290		Alpine spa: bracing air.
3	Sciacca	Sicily	alkaline chalybeate	27,8°–37,8°C. (82°–100°F.)	260	see also sulphur water.	
4. Muriated alkaline waters.							
1	Pozzuoli	Puteoli (Bay of Naples)	weak muriated	26,7°C. (80°F.)			famous solfatara (an ancient crater) and numerous fumeroles (crevices of hills) and natural vapour baths (Stufe).
2	Bagnoli						
3	Casamicciola	Ischia		up to 65°C. (149°F.)		gout, rheumatoid arthritis, and osteo-arthritis.	"Old Roman Spring" (muriated alkaline) at Lacco Ameno in Ischia is known at present as the most radio-active hot spring in the world.
4	Castellamare di Stabia	Bay of Naples	(some of the springs are ferruginous)	cold			sea baths.
5. Calcareous waters.							
1	Lucca						
2	Chianciano						

6. Sulphur waters.

1	Acqui	20 m. from Alessandria	$CaSO_4$ and I	75°C. (167°F.)	450	arthritis, peripheral neuritis, rheumatism, scrofula.	climate free from damp.
2	Vinadio	Piedmont					
3	La Porretta	Bologna	NaCl with trace of I, Br and As, also sulphuretted and carburetted hydrogen-gas	32,8°–35°C. (91°–95°F.)	1100	internal: hæmorrhoids, abdominal plethora; external: skin diseases, scrofula, rheumatism.	
4	Acireale	Sicily					
5	Acque Albule	Province of Rome					
6	Viterbo	"					
7	Sciacca	Sicily	saline sulphur	50°–51,7°C. (122°–125°F.)	260		curious vapour baths are at Monte San Calogero, 3 m. East.

Spain and Portugal.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
			1. Indifferent waters.				
1	Fitero	Province of Navarra, Spain	practically indif., feebly sulphurous	46,1°C. (115°F.)			
2	Caldas-de-Gerez	Spain		"			
			2. Muriated waters.				
1	Caldas-de-Montbuy	Barcelona, Spain		48,9°–71,1°C. (120°–160°F.)	720	rheumatism, neuralgia, sciatica, and some paralytic lesions, and chronic septic conditions.	
			3. Bitter sulphated waters.				
1	Rubinat and Condal	near the boundary of France and Spain					
			4. Calcareous and chalybeate waters.				
1	Urberoago de Alzola	near Plasenzia		thermal			

5. Alkaline waters.

1	Vidago	N. Portugal	strong alkaline				
2	Panticosa	Pyrenees, Spain	some sulphur	25°–28,2°C. (77°–84,5° F.)	5600	see also sulphur water.	

6. Sulphur waters.

1	Panticosa	Pyrenees, Spain	Na_2S 0,02 ‰; (some of the springs are alkaline)	25°–28,2°C. (77°–84,5° F.)	5600	chronic pulmonary, tuberculosis and respiratory troubles, dyspepsia, and skin diseases.	
2	Carrtraca	near Malaga, „					
3	Montemayor y Bejar	near Salamanca, „			2600		
4	Ledesma	„		thermal	2600	rheumatism, sciatica, neuralgia, skin diseases, bronchitis, and syphilis.	
5	Caldas da Rainha	Portugal					

Sweden, Norway and Iceland.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Barestrand Syssel	Iceland	indifferent	103,3C. (218°F.)			
2	Medewi	Sweden	chalybeate				
3	Porla Brunn	„	„				
4	Daneverd	near Upsala, Sweden	„				mud baths.
5	Gustafsberg	near Uddevalla, „	„				„
6	Modum (St. Olafs)		effervescent chalybeate				
7	Sandefjord	near Christiania, Norway	sulphurous chalybeate				
8	Laurvick	„	„				
9	Randamel	Iceland	ferruginous				
10	Loka	on the L. Lersjo, Sweden					mud baths.

Russia.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Schelnesa-Wodsk	Caucasus	alkaline ferruginous		1800		
2	Pjätigorsk	„	some springs sulphurous, others ferruginous or alkaline	thermal			

3	Kütschenowa	near Moscow	effervescent chalybeate				
4	Odessa	Black Sea coast					sea mud baths.
5	Astrakhan	on the Caspian Sea					bituminous and brine mud baths.
6	Oesel	in Livonia on the Baltic Sea					sea and muriated mud baths.
7	Ciechocinek	Poland	strongly muriated				
8	Borgum	Caucasus	strong sulphurous alkaline				
9	Kemmern	near Riga	sulphur	cold			peat and sea baths.
10	Stolypin	on the Kuschum	saline sulphur				
11	Busk	near Crakow	muriated sulphur				peat baths.

Turkey, Bulgaria, etc.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Salonichi	Macedonia	sulphur	thermal			mud baths.
2	Callirrhoe	Palestine	,,	,,			,,
3	Gadara	,,	,,				
4	Feredschik	Roumelia	,,	thermal			mud baths at high temperature used by Arabs.
5	Lidja	Anatolia	,,				
6	Saparèvo	Bulgaria	sulphur with organic matter	88°C. (190,4°F.)		scrofula (praised for its stimulate action), inveterate and hereditary syphilis, chronic skin affections and metallic poisoning.	the hottest of the Bulgarian waters.
7	Varshetz	,,		subthermal		skin affections, rheumatism, wounds and injuries.	one of the most famous of the Balkan spas.
8	Sofia (vicinity of)	,,	sulphurous and calcareous	thermal			
9	Banki	,,		subthermal		said to resemble in their action those of Néris (France) and Schlangenbad (Germany).	
10	Kniajèvo and Panitcherèvo	,,				hyperchlorhydria, catarrh of the stomach, uratic gravel, and sterility.	
11	Gornia Bania and Docna Bania	,,	sulphurous	thermal			
12	Hissar	near Phillipopolis, Bulgaria		,,			
13	Meritchlèri	Stara-Zagora, Bulgaria					the waters are sometimes likened to those of Carlsbad.
14	Smyrna	Turkey	sulphur	thermal			
15	Ahiolo	near Constantinople, Turkey	muriated and ferruginous	,,			
16	Brussia	Asia Minor, Turkey					one of the finest balneary establishment.

Greece.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Epidaurus		bitter				
2	Hellopia	Epirus	sulphuretted	thermal			
3	Adepsos	Is. of Eubœa	,,	,,			
4	Lesbos		,,	,,			
5	Thermopylæ		,,	,,			
6	Lepanto		saline sulphur				
7	Katharsion	Lesbos	,,				
8	Ikaria	in Is. of Ægean Sea		thermal			
9	Kythmos	,,		,,			

Africa.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Helouan-les-Bains	near Cairo	muriated and muriated sulphur	32,2°C. (90°F.)	200	chronic gouty, rheumatic conditions, anæmia, and chlorosis.	
2	Bains-de-la-Reine	near Oran, Algiers	muriated	54,4°C. (130°F.)			
3	Hammâm-Melouan	,,	,,	54,4°C. (130°F.)			
4	Hammâm-r'Irha	,,	calcareous and chalybeate	hyper-thermal	1800	gout, rheumatism.	
5	Hammâm-Meskoutin	,,		95°C.(203°F.)	1000		the "Cones" formed by the masses of $CaCO_3$ are a unique feature of these baths, some of them over 40 ft. high.
6	Mara	Abyssinia	bitter				
7	Okme	Nubia	sulphur	warm			

India.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Salt Range	Punjaub	muriated				
2	Nageonda	Simla	chalybeate				
3	Danera		sulphur				

4	Sona	near Delhi	„				
5	Munnikarn	Jalandhar Doab	„ (some sp. contain I or Br)	97,2°C. (207°F.)	5587		boiling fountain.
6	Jawala Mukki	Kangra District of the Punjaub	„ (some sp. contain I)	thermal			also called "Flames Mouth."
7	Cannea	Ceylon	„				
8	Malacca		„				

New Zealand.

No.	Spa	Location	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
1	Te Aroha	Auckland, N. Island	sulphuretted, muriated alkaline, and effervescing carbonated				
2	Tampo	„	the Crow's Nest Spring[1] is muriated, the Rushini[2] contains free acid, the others[3] are sulphurous or alkaline silicious	76,7°C.[1] (170°F.) 87,8°C.[2] (190°F.) thermal[3]	1500		
3	Piscinæ	„	"Rachel's Bath" soft saline silicious	95,6°C. (194°F.)			said as the finest bath in the S. hemisphere.
4	Rotorua	S. shore of L. Rotorua, „	silicious				
5	Ohinemutu	Rotorua, „	sulphuretted silicious, of which, some are strongly alkaline, while the others contain free H_2SO_4	thermal	962	acid waters are only used externally and have a rubefacient and derivative action on the skin.	some of the springs are geysers.
6	Hanmer	S. Island	muriated, containing carburetted and sulphuretted hydrogen				

United States of America.

No.	Spa	Location (State)	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
			1. Muriated waters.				
1	Ojo Caliente	California	weakly muriated alkaline	37,8°C. (100°F.)			
2	Saratoga "Vichy"	New York	„	cold			

No.	Spa	Location (State)	Composition of water	Temperature of water	Altitude in ft.	Indications	Remarks
3	Hawthorn	New York	brine and muriated				
4	Blue Lick Spring	Kentucky	,,				
5	St. Catharine's Well	Ontario	,,				
6	Caledonia Springs	,,	,,				
	2. Sulphated or bitter waters.						
1	Crab Orchard	Kentucky					
	3. Sulphuretted waters.						
1	Richfield	New York					inhalation is used.
2	The Salt Sulphur Spring	W. Virginia					
3	Paroquet Spring	Kentucky					
4	Sharon and White Sulphur Springs	New York					
5	Sandwich Springs	Ontario					
	4. Acid waters.*						
1	Oak Orchard Spring	New York	free H_2SO_4	hot			
2	Yellowstone National Park	Wyoming	free HCl	,,	7000		also calcareous, carbonated, silicious, and arsenic.
3	California Geyser (Lemonade Spring)	California	,,	,,			

* Texas has some strong acid springs, and also Tuscarora in Canada.

PART II (A)

(I) The Tables of Analyses, Radio-activity, Electric Conductivity, Flow of Water, etc., of Mineral Springs, arranged geographically.

NOBORIBETSU

Location.—Noboribetsu-mura, Horobetsu-gun, Province Iburi, Hokkaidō.

The springs issue from the Tufaceous Clay.

The hot spring "Taki-no-yu"

Analysis (calculated from the original numbers).

Analysed by The Tōkyō Imperial Hygienic Laboratory. 1910.

Specific gravity: 1,0001 at 14° C. Temperature: *71,5° C.

Total residue: ca. 0,81. Flow of water: ca. 54000 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Hydrogen ion ($H^{\cdot}$)	0,00241	2,38703	**2,38703**
Potassium ion ($K^{\cdot}$)	0,01302	0,33597	0,33597
Sodium ion ($Na^{\cdot}$)	0,07791	3,38004	3,38004
Ammonium ion ($NH^{\cdot}_4$)	0,00662	0,36615	0,36615
Calcium ion ($Ca^{\cdot\cdot}$)	0,02669	0,66725	1,33450
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00682	0,27997	0,55994
Ferric ion ($Fe^{\cdot\cdot\cdot}$)	**0,01818**	0,32464	0,97392
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,01420	0,52399	1,57197
			10,90952
Anions.			
Chlorine ion (Cl')	0,05730	1,61636	1,61636
Hydrosulphate ion (HSO_4')	0,23157	2,38560	2,38560
Sulphate ion (SO_4'')	0,33177	3,45378	**6,90756**
	0,78649	15,72078	10,90952
Boric acid (meta) (HBO_2)	0,00227		
Silicic acid (meta) (H_2SiO_3)	0,22671		
	1,01547		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,02481
Sodium chloride (NaCl)	0,05368
Ammonium chloride (NH_4Cl)	0,01960
Sodium sulphate (Na_2SO_4)	0,17502
Calcium sulphate ($CaSO_4$)	0,09078
Magnesium sulphate ($MgSO_4$)	0,03371
Ferric sulphate [$Fe_2(SO_4)_3$]	0,06495
Aluminium sulphate [$Al_2(SO_4)_3$]	0,09001
Free sulphuric acid (H_2SO_4)	0,23157
Boric acid (meta) (HBO_2)	0,00227
Silicic acid (meta) (H_2SiO_3)	0,22671
	1,01311

The spring thus may be classified as "**acid vitriol spring**".

Radio-activity. **0,18** Mache's units in 1 litre of water at 14,5° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 16, 1913).

Electric conductivity. $\kappa_{18} \times 10^{-4} = 14,58$.

*The temperature of the water was measured at the uppermost end of conduit, about 1·3 m. up from the bath.

The hot spring "Ōkawa-no-yu"

Analysis (calculated from the original numbers).

Analysed by The Tōkyō Imperial Hygienic Laboratory. 1910.

Specific gravity: 1,0011 at 13° C. Temperature: 61° C.

Total residue: ca. 0,88. Flow of water: ca. 450 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,01719	0,43908	0,43908
Sodium ion ($Na^{\cdot}$)	0,10580	4,59002	4,59002
Ammonium ion ($NH_4^{\cdot}$)	0 00037	0,02046	0,02046
Calcium ion ($Ca^{\cdot\cdot}$)	0,07534	1,88350	3,76700
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00717	0,29434	0,58868
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00028	0,00500	0,01000
			9,41524

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,03276
Sodium chloride (NaCl)	0,23231
Ammonium chloride (NH_4Cl)	0,00110
Sodium sulphate (Na_2SO_4)	0,04400
Calcium sulphate ($CaSO_4$)	0,17445
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,09741
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,04300

Anions.			
Chlorine ion (Cl')	0,15708	4,43103	4,43103
Sulphate ion (SO_4'')	0,15289	1,59161	3,18322
Hydrocarbonate ion (HCO_3')	0,10988	1,80099	1,80099
	0,62600	15,05603	9,41524
Boric acid (meta) (HBO_2) . .	0,00057		
Silicic acid (meta) (H_2SiO_3) .	0,25523		
	0,88180		
Free carbon dioxide (CO_2) .	0,00153 . . 0,03477		
	0,88333		

Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00089
Boric acid (meta) (HBO_2)	0,00057
Silicic acid (meta) (H_2SiO_3)	0,25523
	0,88181
Free carbon dioxide (CO_2)	0,00153
	0,88334

The spring thus may be classified as "**simple thermal**".

Radio-activity. **0,30** Mache's units in 1 litre of water at 15,6° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 16, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 7,78$.

The hot spring "Manju-no-yu" No. 1.

Analysis (calculated from the original numbers).

Analysed by The Tōkyō Imperial Hygienic Laboratory. 1910.

Specific gravity: 1,0009 at 14,5° C. Temperature: 50° C.

Total residue: ca. 0,84. Flow of water: ca. 540 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Ōkawa-no-yu", may be classified as "**simple thermal**".

Radio-activity. **0,39** Mache's units in 1 litre of water at 16° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 16, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 7,44$.

The hot spring "Shio-no-yu (Shimo-no-yu)"

Analysis (calculated from the original numbers).

Analysed by The Tōkyō Imperial Hygienic Laboratory. 1910.

Specific gravity: 1,0041 at 15° C. Temperature: 76° C.

Total residue: ca. 4,51. Flow of water: ca. 630 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,09535	2,43550	2,43550
Sodium ion ($Na^{\cdot}$)	1,18642	51,47158	**51,47158**
Ammonium ion ($NH_4^{\cdot}$) . . .	0,00177	0,09790	0,09790
Calcium ion ($Ca^{\cdot\cdot}$)	0,32809	8,20225	16,40450
Magnesium ion ($Mg^{\cdot\cdot}$)	0,02135	0,87644	1,75288
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00028	0,00500	0,01000
			72,17236
Anions.			
Chlorine ion (Cl')	2,43286	68,62793	**68,62793**
Hydrocarbonate ion (HCO_3')	0,21625	3,54443	3,54443
	4,28237	135,26103	72,17236
Boric acid (meta) (HBO_2) . .	0,00114		
Silicic acid (meta) (H_2SiO_3)	0,25605		
	4,53956		
Free carbon dioxide (CO_2).	0,00804 . . 0,18273		
	4,54760		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,18169
Sodium chloride ($NaCl$)	3,01122
Ammonium chloride (NH_4Cl)	0,00524
Calcium chloride ($CaCl_2$)	0,81065
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,14455
Magnesium bicarbonate [$Mg(HCO_3)_2$]. . .	0,12831
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00086
Boric acid (meta) (HBO_2)	0,00114
Silicic acid (meta) (H_2SiO_3)	0,25605
	4,53971
Free carbon dioxide (CO_2)	0,00804
	4,54775

Besides these trace of sulphate ion.

The spring thus may be classified as "**common salt spring**".

Radio-activity. **0,46** Mache's units in 1 litre of water at 13,8° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 16, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 49,80$.

Table 1.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^4$	Date when the water was taken	Examined by
1	Taki-no-yu *	acid vitriol	71,5°	ca. 54000	**0,18**	14,5°	K.&L.	14,58	Oct. 16, 1913	Y. Kinugasa
2	Ōkawa-no-yu *	simple	61,0°	450	**0,30**	15,6°	,,	7,78	,,	,,
3	Manju-no-yu *No. 1* *	,,	50,0°	540	**0,39**	16,0°	,,	7,44	,,	,,
4	,, *No. 2* *	sulphur	48,0°	—	**0,21**	15,0°	,,	6,07	,,	,,
5	Shio-no-yu (*Kami-no-yu*)	common salt	94,0°	180	**0,68**	14,5°	,,	4,27	,,	,,
6	,, (*Shimo-no-yu*)	,,	76,0°	630	**0,46**	13,8°	,,	49,80	,,	,,
7	Me-no-yu	vitriol	97,0°	324	—	—	—	—	—	—

* These springs are for the public use.

KARURUSU

Location.—Noboribetsu-mura, Horobetsu-gun, Province Iburi, Hokkaidō.

The hot spring "Tsuru-no-yu"

Analysis (calculated from the salt table).

Analysed by The Tōkyō Imperial Hygienic Laboratory. 1900.

Total residue: ca. 0,96.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0107	0,2734	0,2734
Sodium ion ($Na^{\cdot}$)	0,1722	7,4707	7,4707
Calcium ion ($Ca^{\cdot\cdot}$)	0,0718	1,7905	3,5810
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0012	0,0493	0,0986
			11,4237
Anions.			
Chlorine ion (Cl')	0,0996	2,8096	2,8096
Sulphate ion (SO_4'')	0,3091	3,2188	6,4376
Hydrocarbonate ion (HCO'_3)	0,1330	2,1800	2,1800
	0,7976	17,7923	11,4272
Silicic acid (meta) (H_2SiO_3)	0,2038		
	1,0014		
Free carbon dioxide (CO_2)	0,1525	3,4659	
	1,1539		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,1644
Potassium sulphate (K_2SO_4)	0,0238
Sodium sulphate (Na_2SO_4)	0,3312
Calcium sulphate ($CaSO_4$)	0,1024
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,1684
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0074
Silicic acid (meta) (H_2SiO_3)	0,2038
	1,0014
Free carbon dioxide (CO_2)	0,1525
	1,1539

Besides these a small quantity of ferrous, aluminium ion and trace of hydrophosphate ion.

The spring thus may be classified as "**simple thermal**".

Table 2.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Tsuru-no-yu *Vent No. 1*	simple	60,0°	ca. 216	**0,38**	15,2°	K.&L.	11,10	Oct. 15, 1913	Y. Kinugasa
2	" " *No. 2*	"	58,0°	216	**0,57**	13,1°	"	11,10	"	"
3	Matsu-no-yu	"	59,0°	—	**0,47**	14,4°	"	9,69	"	"
4	Kame-no-yu	"	52,0°	108	**0,37**	13,6°	"	10,60	"	"
5	Tsuru-no-yu *Vent No. 3*	"	48,0°	—	—	—	—	10,73	"	"

JŌZANKEI

Location.—Hiragishi-mura, Toyohira-machi, Sapporo-gun, Province Ishikari, Hokkaidō.
The springs issue from the Liparite.

The hot spring "Moto-no-yu"

Analysis.

Analysed by The Sapporo Hospital. 1889. Temperature: 91° C.
Total residue: ca. 3,21. Flow of water: ca. 378 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium (K)	0,031
Sodium (Na)	1,064
Calcium (Ca)	0,150
Magnesium (Mg)	0,013
Iron (Fe)	0,006
Chlorine (Cl)	1,560
Sulphuric anhydride (SO_3)	0,054
Silica (SiO_2)	0,052

Hypothetical form of combination.

	Grams
Sodium chloride (NaCl)	2,570
Sodium sulphate (Na_2SO_4)	0,067
Patassium carbonate (K_2CO_3)	0,050
Sodium carbonate (Na_2CO_3)	0,070
Sodium silicate (Na_4SiO_4)	0,068
Calcium carbonate ($CaCO_3$)	0,371
Magnesium carbonate ($MgCO_3$)	0,071
	3,267

The spring may be classified as "**common salt spring**".

Radio-activity. **0.92** Mache's units in 1 litre of water at 14,1° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 12, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4}$ = **50,67.**

Table 3.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Moto-no-yu	common salt	91,0°	ca. 378	**0,92**	14,1°	K.&L.	50,67	Oct. 12, 1913	Y. Kinugasa
2	Naka-no-yu	simple	80,0°	810	**0,77**	14,8°	"	36,27	"	"
3	Shika-no-yu	"	82,0°	1458	—	—	—	—	—	—

AOYAMA

Location.—Minami-shiribetsu-mura, Isoya-gun, Province Shiribeshi, Hokkaidō.

The hot spring "Furōkaku-no-yu" No. 1.

Analysis.

Analysed by K. Saiki, apothecary of Sapporo. 1910.

Specific gravity: 1,00248 at 15° C. Temperature: 44° C.

Total residue: ca. 2,97. Flow of water: ca. 2772 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	0,18593
Sodium chloride ($NaCl$)	1,72372
Sodium bicarbonate ($NaHCO_3$)	0,30642
Calcium sulphate ($CaSO_4$)	0,23215
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,38653
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,29244
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,01350
Silica (SiO_2)	0,14500
	3,28569
Free carbon dioxide (CO_2)	0,24364
	3,52933

The spring may be classified as "**earthy common salt spring**".

Radio-activity. **1,39** Mache's units in 1 litre of water at 11,5° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 18, 1913).

Electric conductivity. $\varkappa_{18}\times 10^{-4}$ = **36,17.**

Table 4.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18}\times 10^{-4}$	Date when the water was taken	Examined by
1	Furōkaku-no-yu *No. 1*	earthy comon salt	44,0°	ca. 2772	**1,39**	11,5°	K.&L.	36,17	Oct. 18, 1913	Y. Kinugasa
2	,, *No. 2*	,,	42,0°	—	**1,93**	10,5°	,,	25,03	,, 19, ,,	,,
3	Miyagawa-no-yu	,,	42,0°	1530	**0,54**	11,5°	,,	24,45	,, 18, ,,	,,
					Emanation per litre of gas at 0° C.				Date when the gas was collected	
	Gas evolving from Miyagawa-no-yu				**3,54** * **4,08** † **4,16** ‡		E.&S.		,, 19, ,,	,,

* Determined according to the authors' original direction.
† Correction for the absorption of the radiation by the wall of the ionisation chamber was made.
‡ Correction for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was also made.

YUNOKAWA

Location.—Yunokawa-mura, Kameda-gun, Province Oshima, Hokkaidō.

The springs issue from the Liparite overlaid by Alluvial Sand.

The hot spring "Taki-no-yu"

Analysis.

Analysed by Prof. Dr. J. Shimoyama, K. Kumasaka and Y. Kumasaka.

Specific gravity: 1,0051 at 15° C. Temperature: 50° C.

Total residue: ca. 7,03. Flow of water: ca. 216 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium (K)	0,064	Sulphuric anhydride (SO_3)	0,761
Sodium (Na)	1,735	Silica (SiO_2)	0,054
Calcium (Ca)	0,644	Organic substances	0,065
Magnesium (Mg)	0,177	Free carbon dioxide (CO_2)	0,615
Chlorine (Cl)	3,409		

Besides these trace of iron and phosphoric acid.

The spring may be classified as "**earth-muriated common salt spring**".

Radio-activity. **7,35** Mache's units in 1 litre of water at 16,9° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 8, 1913).
82,31‡ Mache's units in 1 litre of gas at 0° C.
(Eng.-Siev. fontact.; Y. Kinugasa, Oct. 10, 1913).

Electric conductivity. $\varkappa_{18}\times 10^{-4}$=**83,38**.

Table 5.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres.	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18}\times 10^{-4}$	Date when the water was taken	Examined by
1	Taki-no-yu (*Rinchō-kwan*)	earth-muriated common salt	50,0°	ca. 216	**7,35**	16,9°	K.&L.	83,38	Oct. 8, 1913	Y. Kinugasa
2	Shin-yu *No. 1* (*Rinchō-kwan*)	earthy common salt	48,0°	—	**8,48**	13,9°	,,	56,07	,, 9, ,,	,,
3	,, *No. 2* (*Rinchō-kwan*)	,,	50,0°	—	**6,51**	9,0°	,,	70,63	,,	,,
4	Chōju-yu (*Rinchō-kwan*)	,,	49,0°	—	**8,21**	18,2°	,,	74,25	,, 8, ,,	,,
5	Senshin-kwan-no-yu *No. 1*	,,	40,5°	—	**11,24**	15,0°	,,	45,11	,, 10, ,,	,,
6	,, *No. 2*	,,	48,0°	—	**13,21**	14,6°	,,	50,02	,, 11, ,,	,,
7	Hōmei-kwan-no-yu	,,	46,0°	216	**11,32**	15,2°	,,	69,67	,,	,,
8	Toyokawa-no-yu	,,	42,5°	216	**7,96**	14,5°	,,	42,04	,, 10, ,,	,,
9	Tōyō-kwan-no-yu	,,	45,0°	216	**3,02**	18,5°	,,	59,21	,, 8, ,,	,,
10	Mura-yu	,,	50,0°	216	**7,47**	12,7°	,,	76,87	,, 10, ,,	,,
11	Rikuzō-no-yu §	,,	66,0°	—	**5,54**	18,4°	,,	83,28	,, 8, ,,	,,
12	Taishō-kwan-no-yu §	,,	43,5°	—	**3,55**	17,4°	,,	76,35	,,	,,
13	Yoshikawa-no-yu §	,,	63,5°	—	—	—	—	84,83	,,	,,
	Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Taki-no-yu (*Rinchō-kwan*)				**70,04** * **80,76** † **82,31** ‡		E.&S.		,, 10, ,,	,,
2	Shin-yu *No. 2* (*Rinchō-kwan*)				**63,14** * **72,78** † **74,17** ‡		,,		,,	,,
3	Rikuzō-no-yu				**85,97** * **99,14** † **101,03** ‡		,,		,, 9, ,,	,,

* Determined according to the authors' original direction.
† Correction for the absorption of the radiation by the wall of the ionisation chamber was made.
‡ Correction for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was also made.
§ These springs are located on the sea beach of Nezaki, about 1/2 m. distant from Yunokawa.

ASAMUSHI

Location.—Nonai-mura, Higashi-tsugaru-gun, Province Mutsu, Aomori-ken.

The springs issue from the Andesite overlaid by Alluvium.

The hot spring "Hadaka-no-yu"

Analysis (calculated from the salt table).

Analysed by The Medical Department of the Army. Temperature: 61,5° C.

Flow of water: ca. 360 hectolitres in 24 hours. Total residue: ca. 1,34.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0082	0,2097	0,2097
Sodium ion ($Na^{\cdot}$)	0,1895	8,2213	8,2213
Calcium ion ($Ca^{\cdot\cdot}$)	0,1844	4,5985	9,1970
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0050	0,2053	0,4106
			18,0386
Anions.			
Chlorine ion (Cl')	0,1988	5,6079	5,6079
Sulphate ion (SO_4'')	0,5914	6,1565	12,3130
Hydrocarbonate ion (HCO_3')	0,0058	0,0951	0,0951
	1,1831	25,0943	18,0160
Silicic acid (meta) (H_2SiO_3)	0,0792		
	1,2623		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,3280
Potassium sulphate (K_2SO_4)	0,0182
Sodium sulphate (Na_2SO_4)	0,1860
Calcium sulphate ($CaSO_4$)	0,6250
Magnesium sulphate ($MgSO_4$)	0,0189
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0070
Silicic acid (meta) (H_2SiO_3)	0,0792
	1,2623

Besides these trace of ferrous, hydrophosphate ion and boric acid.

The spring thus may be classified as "**sulphated bitter spring**".

Radio-activity. 0,77 Mache's units in 1 litre of water at 19,7°C.

(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 6, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 13,72$.

The hot spring "Ō-yu"

Analysis.

Analysed by R. Minami, apothecary of Aomori. 1909. Temperature: 66° C.

Flow of water: ca. 270 hectolitres in 24 hours. Total residue: ca. 1,15.

The spring, being in its composition nearly the same as that of "Hadaka-no-yu", may be classified as "**bitter spring**".

Radio-activity. 1,73 Mache's units in 1 litre of water at 16,9° C

(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 6, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 11,01$.

The hot spring "Tsubaki-no-yu" No. 1.

Analysis.

Analysed by The Hirosaki Garrison Hospital. 1912. Specific gravity: 1,00442 at 15° C.

Temperature: 79° C. Total residue: ca. 1,23.

The spring, being in its composition nearly the same as that of "Hadaka-no-yu", may be classified as "**sulphated bitter spring**".

Radio-activity. 1,13 Mache's units in 1 litre of water at 16° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 6, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 13,25$.

The hot spring "Yanagi-no-yu"

Analysis.

Analysed by The Hirosaki Garrison Hospital. 1912.

Specific gravity: 1,00418 at 15° C. Temperature: 63° C.

Total residue: ca. 1,25. Flow of water: ca. 360 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Hadaka-no-yu", may be classified as "**sulphated bitter spring**".

Radio-activity. **0,47** Mache's units in 1 litre of water at 15,8° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 6, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{13{,}82}$.

Table 6.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{4}$	Date when the water was taken	Examined by
1	Hadaka-no-yu (*Public bath*)	sulphated bitter	61.5°	ca. 360	**0,77**	19.7°	K.& L.	13.72	Oct. 6, 1913	Y. Kinugasa
2	O-yu (*Public bath*)	bitter	66,0°	270	**1,73**	16.9°	,,	11.01	,,	,,
3	Tsubaki-no-yu *No. 1*	sulphated bitter	79.0°	} 519	**1,13**	16,0°	,,	13,25	,,	,,
4	,, *No. 2*	,,	68,5°		—	—	—	11,94	,,	,,
5	Yanagi-no-yu	,,	63,0°	360	**0,47**	15,8°	K.& L.	13,82	,,	,,
6	Udō-no-yu	,,	72,0°	—	**1,00**	16,9°	,,	14,48	,, 7, ,,	,,
7	Nambuya-no-yu (*Shin-yu*)	,,	68,0°	—	**1,15**	18,0°	,,	14.36	,,	,,
8	Botan-yu	,,	70,0°	180	—	—	—	—	—	—

ŌWANI

Location.—Ōwani-mura, Minami-tsugaru-gun, Province Mutsu, Aomori-ken.

The springs issue from the Liparite Dyke and Alluvium.

The hot spring "Umeka-no-yu"

Analysis.

Analyst: Unknown. Temperature: 62° C. Flow of water: ca. 126 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,02280	Calcium bicarbonate [$Ca(HCO_3)_2$]	0,07990
Sodium chloride ($NaCl$)	2,12000	Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,35000
Ammonium chloride (NH_4Cl)	0,03000	Aluminium phosphate ($AlPO_4$)	0,00266
Sodium sulphate (Na_2SO_4)	0,06320	Ferric oxide (Fe_2O_3)	0,00130
Sodium bicarbonate ($NaHCO_3$)	0,01500	Silica (SiO_2)	0,00380
Calcium sulphate ($CaSO_4$)	0,43850		3,12716

The spring may be classified as "**common salt spring**".

Radio-activity. **10,28** Mache's units in 1 litre of water at 20,1 °C.

(Kohl.-Löw. fontact.; Y. Kinugasa, Oct. 20, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{45{,}42}$.

The hot spring "Yamabuki-no-yu"

Analysis.

Analyst: Unknown. Temperature: 67° C. Flow of water: ca. 108 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Umeka-no-yu", may be classified as "**common salt spring**".

Radio-activity. 7,50 Mache's units in 1 litre of water at 18,4° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 20, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 44{,}38$.

Table 7.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Umeka-no-yu (*Public bath*)	common salt	62,0°	ca. 126	10,28	20,1°	K. & L.	45,42	Oct. 20. 1913	Y. Kinugasa, T. Saitō
2	Yamabuki-no-yu (*Public bath*)	"	67,0	108	7,50	18,4°	"	44,38	"	"
3	Wakamatsu-no-yu (*Netsu-no-yu*)(*Public bath*)	salt	62,5°	144	8,77	20,7°	"	40,06	" 21, "	"
4	" (*Hie-no-yu*)	"	63,0°	144	9,69	17,3°	"	43,66	" 20, "	"
5	Kawara-no-yu (*Public bath*)	"	76,0°	—	0,74*	17,1°	"	34,73	"	"
6	Kagasuke-no-yu	"	69,0°	126	9,27	20,0°	"	40,96	" 21, "	"
7	Aoyagi-no-yu (*Public bath*)	"	77,0°	171	—	—	—	—	—	—

* As the source of the spring did not admit to take sample of water for examination without loss of emanation, the real quantity must be much larger than observed.

KURADATE

Location.—Kuradate-mura, Minami-tsugaru-gun, Province Mutsu, Aomori-ken.

The springs issue from the Alluvium.

The hot spring "Shimo-no-yu"

Analysis.

Analysed by E. Ōkawa, apothecary of Hirosaki. 1909. Temperature: 72,5° C.

Flow of water: ca. 450 hectolitres in 24 hours. Total residue: ca. 2,38.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,1354	Ferric oxide (Fe_2O_3)	0,0030
Sodium chloride ($NaCl$)	1,2650	Boric acid (H_3BO_3)	trace
Calcium sulphate ($CaSO_4$)	0,6304	Silica (SiO_2)	0,1412
Magnesium sulphate ($MgSO_4$)	0,0816		2,2916
Aluminium phosphate ($AlPO_4$)	0,0350		

The spring may be classified as "**common salt spring**".

Radio-activity. 2,86 Mache's units in 1 litre of water at 18° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 21, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 29{,}60$.

The hot spring "Ō-yu"

Analysis.

Analyst: Unknown. Temperature: 72° C
Total residue: ca. 2,32. Flow of water: ca. 540 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Shimo-no-yu", may be classified as "**common salt spring**".

Radio-activity. **2,60** Mache's units in 1 litre of water at 19,4° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 21 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 28{,}22$.

The hot spring "Hoyōen-no-yu"

Analysis.

Analysed by E. Ōkawa, apothecary of Hirosaki. 1912. Temperature: 78° C.
Specific gravity: 1,0023 at 15° C. Total residue: ca. 2,39.

The spring, being in its composition nearly the same as that of "Shimo-no-yu", may be classified as "**common salt spring**".

Radio-activity. **1,87** Mache's units in 1 litre of water at 12,2° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 21, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 29{,}63$.

Table 8.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Shimo-no-yu (*Public bath*)	common salt	72,5°	ca. 450	2,86	18,0°	K &L.	29,60	Oct. 21, 1913	Y. Kinugasa T. Saitō
2	Ō-yu (*Public bath*)	"	72,0°	540	2,60	19,4°	"	28,22	"	"
3	Kami-no-yu (*Public bath*)	"	69,0°	—	4,38	17,5°	"	27,72	"	"
4	Hoyōen-no-yu	"	78,0°	—	1,87	17,2°	"	29,63	"	"
5	Kawabata-no-yu	"	56,0°	—	—	—	—	28,48	"	"
6	Netsu-no-yu	"	71,0°	—	—	—	—	28,77	"	"

IKARIGASEKI

Location.—Ikariga-seki-mura, Minami-tsugaru-gun, Province Mutsu, Aomori-ken.

The springs issue from the Volcanic Ash.

The hot spring "Netsu-no-yu"

Analysis.

Analyst: Unknown. Temperature: 61° C.
Total residue: ca. 1,25. Flow of water: ca. 558 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained :

	Grams
Potassium chloride (KCl)	0,06952
Sodium chloride ($NaCl$)	1,01255
Potassium sulphate (K_2SO_4)	0,00211
Calcium sulphate ($CaSO_4$)	0,07718
Magnesium sulphate ($MgSO_4$)	0,00381
Ferrous sulphate ($FeSO_4$)	0,00225
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,02108
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00225
Aluminium phosphate ($AlPO_4$)	0,00250
Silica (SiO_2)	0,12690
	1,32015
Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,06900
	1,38915

Besides these trace of bromine, iodine and boric acid.

The spring may be classified as "**common salt spring**".

Radio-activity. **1,20** Mache's units in 1 litre of water at 16,6° C.
(Kohl.-Löw. fontact. ; Y. Kinugasa and T. Saitō, Oct. 22, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 18{,}37$.

The hot spring "Fuji-no-yu (Kuzuya-no-yu)"

Analysis.

Analysed by the Hirosaki Garrison Hospital. 1902.
Temperature : 55° C. Total residue : ca. 1,30.

The spring, being in its composition nearly the same as that of "Netsu-no-yu", may be classified as "**common salt spring**".

Radio-activity. **0,92** Mache's units in 1 litre of water at 18,2° C.
(Kohl.-Löw. fontact. ; Y. Kinugasa and T. Saitō, Oct. 22, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 16{,}73$.

The hot spring "Taki-no-yu"

Analysis.

Analysed by the Hirosaki Hospital. 1907. Temperature : 61° C.
Total residue : ca. 1,62. Flow of water : ca. 630 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Netsu-no-yu", may be classified as "**common salt spring**".

Radio-activity. **1,27** Mache's units in 1 litre of water at 18,5° C.
(Kohl.-Löw. fontact. ; Y. Kinugasa and T. Saitō, Oct. 22, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 18{,}75$.

Table 9.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Netsu-no-yu (*Public bath*)	common salt	61,0°	ca. 558	**1,20**	16,6°	K.&L.	18,37	Oct. 22, 1913	Y. Kinugasa, T. Saitō
2	Hie-no-yu (*Onna-yu*) (*Public bath*)	„	54,0°	360	**0,63**	17,3°	„	16,66	„	„
3	Fuji-no-yu (*Kuzuya-no-yu*)	„	55,0°	—	**0,92**	18,2°	„	16,73	„	„
4	„ (*Bunkwan-no-yu*)	„	62,0°	—	**1,39**	14,4°	„	18,15	„	„
5	Taki-no-yu (*Shibata-no-yu*)	„	61,0°	630	**1,27**	18,5°	„	18,75	„	„

DAI

Location.—Yumoto-mura, Hienuki-gun, Province Rikuchū, Iwate-ken.

The springs issue from the Diluvium.

Table 10.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water		Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
					in Mache's units	at (temp. in C.)				
1	Tsuru-no-yu (*Public bath*)	simple	67,5°	ca. 108	1,15	17,2°	K.&L.	11,08	Oct. 4, 1913	Y. Kinugasa, T. Saitō
2	Suzume-no-yu (*Public bath*)	,,	54,0°	72	0,53	15,9°	,,	10,37	,,	,,
3	Ō-yu (*Public bath*)	acid	58,0°	126	0,43	17,4°	,,	10,33	,,	,,
4	Yakushi-no-yu (*Public bath*)	,,	53,0°	108	0,18	16.5°	,,	9,65	,,	,,
5	Matsu-no-yu (*Public bath*)	,,	78,0°	162	0,95	15,9°	,,	13,40	,,	,,
6	Kin-no-yu	salt	68,0°	135	—	—	—	—	—	—
7	Gorō-no-yu	,,	62,0°	144	—	—	—	—	—	—
8	Taka-no-yu	,,	74,0°	135	—	—	—	—	—	—
9	Taki-no-yu	simple	84,0°	270	—	—	—	—	—	—
10	Senshō-no-yu	salt	62,0°	108	—	—	—	—	—	—
11	Shin-suzume-no-yu	,,	54,0°	108	—	—	—	—	—	—
12	Hotokezawa-no-yu	,,	62,0°	90	—	—	—	—	—	—
13	Me-suzume-no-yu	,,	58,0°	90	—	—	—	—	—	—

SHIDODAIRA

Location.—Yuguchi-mura, Hienuki-gun, Province Rikuchū, Iwate-ken.

The spring issues from the Tertiary.

The hot spring "Warabi-no-yu"

Analysis.

Temperature: 76° C. Total residue: 1,26.

Flow of water: ca. 389 hectolitres in 24 hours.

From the result of an old analysis made in 1881, the spring seems to be "**bitter spring**".

Radio-activity. 0,64 Mache's units in 1 litre of water at 18,8° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 3, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 14{,}54$.

ŌSAWA

Location.—Yuguchi-mura, Hienuki-gun, Province Rikuchū, Iwate-ken.

The springs issue from the Tertiary.

Table 11.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Ō-yu *Vent No. 1*	simple	51°	ca. 544 (Nos. 1 and 2)	**0,72**	18,2°	K.&L.	7,31	Oct. 3, 1913	Y. Kinugasa, T. Saitō
2	" *Vent No. 2*	"	51°		**0,43**	18,2°	"	7,31	"	"
3	Taki-no-yu	"	51°	312	—	—	—	—	—	—

ŌYUZAWA

Location.—Yatate-mura, Kita-akita-gun, Province Ugo, Akita-ken.

The springs issue from the Diluvium.

The hot spring "No. 38 (Ō-yu)"

Analysis.

Analysed by the Hygienic Laboratory of Akita-ken. 1893. Temperature: 45,5 C.
Flow of water: ca. 270 hectolitres in 24 hours. Total residue: ca. 14,78.

In 1 kilogram of the mineral water are contained:

	Grams
Sodium chloride ($NaCl$)	11,0306
Magnesium sulphate ($MgSO_4$)	0,8880
Ferrous sulphate ($FeSO_4$), Aluminium sulphate [$Al_2(SO_4)_3$]	0,5377
Calcium bicarbonate [$Ca(HCO_3)_2$]	2,2125
Silica (SiO_2)	0,1060
	14,7748
Free hydrogen sulphide (H_2S)	0,2246
	14,9994

The spring may be classified as "**hydrogen sulphide common salt spring**".

Radio-activity. **0,86** Mache's units in 1 litre of water at 10,9° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 24, 1913).
5,35 ‡ Mache's units in 1 litre of gas at 0° C.
(Eng.-Siev. fontact.; Y. Kinugasa and T. Saitō, Oct. 24, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{91,62}$.

The cold spring "No. 39"

Analysis.

Analysed by the Hygienic Laboratory of Akita-ken. 1912.
Specific gravity: 1,0073 at 15° C. Temperature: 33,5° C.
Total residue: ca. 11,31. Flow of water: ca. 180 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "No. 38 (Ō-yu)", may be classified as "**hydrogen sulphide common salt spring**".

Radio-activity. **0,98** Mache's units in 1 litre of water at 12,2° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 24 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{100,42}$.

‡ Correction for the absorption of the radiation by the wall of the ionisation chamber and also for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was made.

Table 12.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	No. 38 (*Ō-yu*)	hydrogen sulphide common salt	45,5°	ca. 270	**0,86**	10,9°	K. & L.	91,62	Oct. 24, 1913	Y. Kinugasa, T. Saitō
2	No. 39	"	33,5°	180	**0,98**	12,2°	"	100,42	"	"
3	Shimonaizawa-no-yu	simple	34,0°	—	**1,24**	10,5°	"	8,58	" 23, "	"
4	Aka-yu	iron carbonate	32,0°	650	**0,90**	9,9°	"	145,03	"	"
	Gas evolving from No. 38 (*Ō-yu*)				Emanation per litre of gas at 0° C.: **4,55** *, **5,25** †, **5,35** ‡		E. & S.		Date when the gas was collected: Oct. 24, 1913	"

* Determined according to the authors' original direction.
† Correction for the absorption of the radiation by the wall of the ionisation chamber was made.
‡ Correction for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was also made.

ŌYU

Location.—Ōyu-mura, Kazuno-gun, Province Rikuchū, Akita-ken.
The springs issue from the Pumice Layer in Quaternary System.

The hot spring "Shimo-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Akita-ken. 1913.
Specific gravity: 1,00139 at 15° C. Temperature: 69,5° C.
Total residue: ca. 2,04. Flow of water: ca. 414 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium (K)	0,01630	Chlorine (Cl)	0,92500
Sodium (Na)	0,66673	Sulphuric anhydride (SO_3)	0,13551
Calcium (Ca)	0,09087	Phosphoric anhydride (P_2O_5)	trace
Magnesium (Mg)	very small quantity	Boric acid (H_3BO_3)	small quantity
Ferric oxide (Fe_2O_3)	"	Silica (SiO_2)	0,06975
Alumina (Al_2O_3)	0,12475	Carbon dioxide (CO_2)	small quantity

The spring may be classified as "**common salt spring**".

Radio-adtivity. **0,89** Mache's units in 1 litre of water at 15,4° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 25, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 28,65$.

The hot spring "Kawara-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Akita-ken. 1913.
Specific gravity: 1,00141 at 15° C. Temperature: 70,5° C.
Total residue: ca. 2,10. Flow of water: ca. 634 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Shimo-no-yu", may be classified as "**common salt spring**".

Radio-activity. **0,66** Mache's units in 1 litre of water at 16,5° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 25. 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 28{,}19$.

The hot spring "Kami-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Akita-ken. 1913.

Specific gravity: 1,001 at 15° C. Temperature: 58° C.

Total residue: ca. 1,62. Flow of water: ca. 630 hecto itres in 24 hours.

The spring, being in its composition nearly the same as that of "Shimo-no-yu", may be classified as "**common salt spring**".

Radio-activity. **0,98** Mache's units in 1 litre of water at 16,8° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 25, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 19{,}85$.

The hot spring "Arase-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Akita-ken. 1913.

Specific gravity: 1,00888 at 15° C. Temperature: 46° C.

Total residue: ca. 2,03. Flow of water: ca. 619 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Shimo-no-yu", may be classified as "**common salt spring**".

Radio-activity. **0,81** Mache's units in 1 litre of water at 15,9° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 25, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 16{,}61$.

Table 13.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Shimo-no-yu (*Public bath*)	common salt	69,5°	ca. 414	0,89	15,4°	K.&L.	28.65	Oct. 25, 1913	Y. Kinugasa, T. Saitō
2	Kawara-no-yu (*Public bath*)	,,	70,5°	634	0,66	16,5°	,,	28.19	,,	,,
3	Kami-no-yu	,,	58,0°	630	0,98	16.8°	,,	19,85	,,	,,
4	Arase-no-yu	,,	46,0°	619	0,81	15.9°	,,	16,61	,,	,,

ŌDAKI

Location.—Jūnisho-machi, Kita-akita-gun, Province Ugo, Akita-ken.

The springs issue from the Soil in Quaternary System.

The hot spring "Tsuru-no-yu"

Analysis.

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Temperature. 61° C.

Flow of water: ca. 6012 hectolitres in 24 hours. Total residue: ca. 2,28.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	0,17572
Sodium chloride (NaCl)	0,84384
Sodium sulphate (Na_2SO_4)	0,36612
Sodium carbonate (Na_2CO_3)	0,03832
Calcium sulphate ($CaSO_4$)	0,76541
Magnesium sulphate ($MgSO_4$)	0,00801
Silica (SiO_2)	0,04214
Boric acid (H_3BO_3)	trace
	2,23956
Hydrogen sulphide (H_2S)	0,00216
	2,24172

The spring may be classified as "**sulphur spring**".

Radio-activity. **0,93** Mache's units in 1 litre of water at 12,0° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 24, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{23{,}37}$.

Table 14.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Tsuru-no-yu (*Public bath*)	sulphur	61,0°	ca. 6012	**0,93**	12,0°	K.&L.	23,37	Oct. 24, 1913	Y. Kinugasa T. Saitō
2	Susuki-no-yu (*Public bath*)	bitter	62,0°	—	**0,71**	12,3°	"	21,62	"	"

SHIBUKURO

Location.—Tazawa-mura, Senhoku-gun, Province Ugo, Akita-ken.

The springs issue from the Augite Andesite.

The hot spring "Shibukurozawa-no-yu"*

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1912. Specific gravity: 1,0030 at 19° C.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Hydrogen ion ($H^{\cdot}$)	0,07500	74,25743	**74,25743**
Potassium ion ($K^{\cdot}$)	0,02491	0,63627	0,63627
Sodium ion ($Na^{\cdot}$)	0,04415	1,91540	1,91540
Ammonium ion ($NH_4^{\cdot}$)	0,00011	0,00608	0,00608
Calcium ion ($Ca^{\cdot\cdot}$)	0,04870	1,21750	2,43500
Magnesium ion ($Mg^{\cdot\cdot}$)	0,01483	0,60878	1,21756
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,24846**	4,43679	8,87358
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,09622	3,55055	**10,65165**
			99,99297
Anions.			
Chlorine ion (Cl')	2,69729	76,14358	**76,14358**
Hydrosulphate ion (HSO_4')	0,42034	4,33028	4,33028
Sulphate ion (SO_4'')	0,93776	9,76223	**19,52446**
	4,60777	176,86489	99,99832
Boric acid (meta) (HBO_2)	0,04244		
Silicic acid (meta) (H_2SiO_3)	0,37022		
	5,02043		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0475
Sodium chloride (NaCl)	0,1121
Ammonium chloride (NH_4Cl)	0,0003
Calcium chloride ($CaCl_2$)	0,1350
Magnesium chloride ($MgCl_2$)	0,0580
Ferrous sulphate ($FeSO_4$)	0,6746
Aluminium sulphate [$Al_2(SO_4)_3$]	0,6078
Boric acid (meta) (HBO_2)	0,0424
Free hydrochloric acid (HCl)	2,5497
Free sulphuric acid (H_2SO_4)	0,4247
Silicic acid (meta) (H_2SiO_3)	0,3702
	5,0223

Besides these a small quantity of organic substances.

The spring thus may be classified as "**acid alum vitriol spring**".

* The waters of "Suka-yu", an acid vitriol spring near by, contain trace of barium and lead ion.

INNAI-YUNOSAWA

Location.—Innai-machi, Okachi-gun, Province Ugo, Akita-ken.

The springs issue from the Tertiary.

The hot spring "Yunosawa-Onsen"

Analysis.

Analysed by Dr. R. Ishizu and Y. Kuzuoka. 1904.

Specific gravity: 1,0004 at 15° C. Temperature: 40,5° C.

Total residue: ca. 0,13. Flow of water: ca. 24624 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Hypothetical form of combination	Grams
Potassium oxide (K_2O)	0,011203	Potassium chloride (KCl)	0,008950
Sodium oxide (Na_2O)	0,011700	Sodium chloride ($NaCl$)	0,011050
Calcium oxide (CaO)	0,025206	Calcium sulphate ($CaSO_4$)	0,024055
Magnesia (MgO)	0,004424	Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,002674
Ferric oxide (Fe_2O_3)	0,002403	Calcium bicarbonate [$Ca(HCO_3)_2$]	0,044264
Alumina (Al_2O_3)	trace	Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,016147
Chlorine (Cl)	0,010851	Silica (SiO_2)	0,040103
Nitric anhydride (N_2O_5)	trace		0,147243
Sulphuric anhydride (SO_3)	0,014150		
Silica (SiO_2)	0,040103		
Carbon dioxide (CO_2)	0,017532		

The spring may be classified as "**simple thermal**".

Radio-activity. **1,06** Mache's units in 1 litre of water at 13,6° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 27, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 1,24$.

Table 15.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: a (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{4}$	Date when the water was taken	Examined by
1	Yunosawa-Onsen	simple	40,5°	ca. 24624	1,06	13,6°	K.&L.	1,24	Oct. 27, 1913	Y. Kinugasa, T. Saitō
2	Taki-no-yu	„	41,0°	—	.21	13,7°	„	1,25	„	„

ONIKŌBE

Location.—Onikōbe-mura, Tamatsukuri-gun, Province Rikuzen, Miyagi-ken.

The springs issue from the Tertiary.

The hot spring "Todoroki-no-yu"

Analysis.

Temperature: 53° C. Total residue: ca. 0,35

Flow of water: ca. 270 hectolitres in 24 hours.

From the result of an old analysis made in 1881, the spring seems to be "**simple thermal**".

Radio-activity. **0,49** Mache's units in 1 litre of water at 20,3° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 1, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 4,99$.

TAMATSUKURI

Location.—Yuizumi-mura, Tamatsukuri-gun, Province Rikuzen, Miyagi-ken.
The springs of Naruko, Shin-kuruma, Moto-kuruma and Aka-yu issue from the Pyroxene Andesite, but that of Kawatabi from the Tertiary.

Table 16.

	No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{4}$	Date when the water was taken	Examined by
Naruko	1	Taki-no-yu *No. 1*	sulphur	40,5°	ca. —	**1,01**	20,0°	K. & L.	15.39	Sept. 29, 1913	Y. Kinugasa, T. Saitō
	2	" *No. 2*	"	92,0°	—	**0,24**	19,3°	"	44,80	Oct. 1, "	"
	3	Unagi-no-yu	alkaline sulphur	100,0°	—	**0,13**	18,4°	"	14,60	Sept. 29, "	"
	4	Shin-unagi-no-yu	alkaline	93,0°	—	**0,17**	20,2°	"	21,32	" 30, "	"
	5	Genzō-no-yu	sulphur	51,0°	270	**0,32**	18,0°	"	42,24	" 29, "	"
	6	Kawara-no-yu	salt	48,0°	54	**0,30**	20,3°	"	15.29	Oct. 1, "	"
	7	Tamamono-no-yu	carbonated	70,0°	99	—	—	—	—	—	—
	8	Uba-no-yu	"	70,0°	81	—	—	—	—	—	—
Shin-kuruma	9	Moto-yu	salt	67,5°	—	**0,56**	19,2°	K. & L.	11,31	Sept. 30, 1913	Y. Kinugasa, T. Saitō
	10	Mushi-yu	"	79,5°	—	—	—	—	9,09	"	"
	11	Takashige-no-yu	"	54,0°	—	**0,54**	20,2°	K. & L.	13,77	"	"
	12	Kame-no-yu	"	48,0°	90	—	—	—	—	—	—
Moto-kuruma	13	Ubuchi-no-yu	"	86,5°	—	**0,34**	19,0°	K. & L.	15,96	Sept. 30, 1913	Y. Kinugasa, T. Saitō
	14	Yamane-no-yu	"	73,0°	—	—	—	—	22.51	"	"
	15	Senshin-no-yu	"	78,0°	90	—	—	—	—	—	—
	16	Reisen-no-yu	"	78,0°	90	—	—	—	—	—	—
Akayu	17	Goten-no-yu	carbonated	58,0°	—	**0,28**	18,8°	K. & L.	8,17	Oct. 1, 1913	Y. Kinugasa, T. Saitō
	18	Taki-no-yu (*Public bath*)	"	58,0°	—	—	—	—	6,47	"	"
Kawatabi	19	Ō-yu.	"	50,0°	648	—	—	—	8.13	"	"
	20	Suzuki-no-yu	"	42,5°	—	**0,53**	20,6°	K. & L.	7,16	Sept. 30, 1913	"
	21	Fuji-no-yu	—	48,0°	—	—	—	—	8,14	"	"
	22	Me-no-yu	—	43,0°	—	—	—	—	7,74	"	"
	23	Naka-no-yu (*Public bath*)	carbonated	45,0°	864	—	—	—	7,44	Oct. 3, 1913	"
	24	Mayu-no-yu	"	46,0°	648	—	—	—	7.56	" 1, "	"

KAMASAKI

Location.—Fukuoka-mura, Katta-gun, Province Iwaki, Miyagi-ken.
The springs issue from the Pyroxene Andesite and its Agglomerate.

The hot spring "Ichijō-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1909.

Specific gravity: 1,0046 at 14° C. Temperature: 48° C.

Total residue: ca. 5,03. Flow of water: ca. 3150 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,05215	1,33206	1,33206
Sodium ion ($Na^{\cdot}$)	1,43355	62,19306	**62,19306**
Ammonium ion ($NH_4^{\cdot}$) . . .	0,00021	0,01162	0,01162
Calcium ion ($Ca^{\cdot\cdot}$)	0,22988	5,74700	11,49400
Magnesium ion ($Mg^{\cdot\cdot}$)	0,01193	0,48974	0,97948
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,00106	0,03911	0,11733
			76,12755
Anions.			
Chlorine ion (Cl')	1,50624	42,48914	**42,48914**
Sulphate ion (SO_4'')	1,35337	14,08880	**28,17760**
Hydrophosphate ion (HPO_4'')	0,00103	0,01073	0,02146
Hydrocarbonate ion (HCO_3')	0,33185	5,43935	5,43935
	4,92127	131,84061	76,12755
Boric acid (meta) (HBO_2) . .	0,28250		
Silicic acid (meta) (H_2SiO_3).	0,00414		
	5,20791		
Free carbon dioxide (CO_2) .	0,06169 . .	1,40199	
	5,26960		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0994
Sodium chloride ($NaCl$)	2,4070
Ammonium chloride (NH_4Cl)	0,0006
Sodium sulphate (Na_2SO_4)	1,4962
Calcium sulphate ($CaSO_4$)	0,4785
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,3612
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0717
Aluminium sulphate [$Al_2(SO_4)_3$]	0,0054
Aluminium phosphate [$Al_2(HPO_4)_3$]	0,0012
Boric acid (meta) (HBO_2)	0,2825
Silicic acid (meta) (H_2SiO_3)	0,0041
	5,2078
Free carbon dioxide (CO_2)	0,0617
	5,2695

Besides these trace of ferrous ion.

The spring thus may be classified as "**saline common salt spring**".

Radio-activity. 0,87 Mache's units in 1 litre of water at 16,4° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 26, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 51,43$.

The hot spring "Mogamiya-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory, 1912. Specific gravity: 1,0048 at 15° C.

Temperature: 38,5° C. Total residue: ca. 5.19.

The spring, being in its composition nearly the same as that of "Ichijō-no-yu", may be classified as "**saline common salt spring**".

Radio-activity. 1,83 Mache's units in 1 litre of water at 18,4° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 26, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 44,20$.

The hot spring "Kimuraya-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory, 1912. Specific gravity 1,0051 at 13° C.

Temperature: 43° C. Total residue. ca. 5,15.

The spring, being in its composition nearly the same as that of "Ichijō-no-yu", may be classified as "**saline common salt spring**".

Radio-activity. 0,80 Mache's units in 1 litre of water at 19,9° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 27, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 48,79$.

Table 17.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Ichijō-no-yu	saline common salt	48,0°	ca. 3150	**0,87**	16,4°	K.&L.	51,43	Sept. 26, 1913	Y. Kinugasa T. Saitō
2	Mogamiya-no-yu	,,	38,5°	—	**1,83**	18,4°	,,	44,20	,,	,,
3	,, *A*	,,	37,0°	—	—	—	—	51,28	,, 27, ,,	,,
4	Kimuraya-no-yu	,,	43,0°	—	**0,80**	19,9°	K.&L.	48,79	,,	,,

ATSUMI

Location.—Atsumi-mura, Nishi-tagawa-gun, Province Uzen, Yamagata-ken.

The springs issue from the Tertiary Conglomeratic Tuff.

The hot spring "Yu-atsumi-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1886.

Specific gravity: 1,003. Total residue: ca. 3,51.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0477	1,2183	1,2183
Sodium ion ($Na^{\cdot}$)	0,9251	40,1344	**40,1344**
Calcium ion ($Ca^{\cdot\cdot}$)	0,2612	6,5162	**13,0324**
			54,3851
Anions.			
Chlorine ion (Cl')	1,5052	42,4598	**42,4598**
Sulphate ion (SO_4'')	0,5726	5,9608	**11,9216**
	3,3118	96,2895	54,3814
Silicic acid (meta) (H_2SiO_3)	0,1064		
	3,4182		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0910
Sodium chloride (NaCl)	2,3480
Calcium chloride ($CaCl_2$)	0,0610
Calcium sulphate ($CaSO_4$)	0,8118
Silicic acid (meta) (H_2SiO_3)	0,1064
	3,4182

Besides these trace of magnesium, hydrophosphate ion, hydrogen sulphide and boric acid.

The spring thus may be classified as "**sulphated common salt spring**".

Radio-activity. **4,04** $\times 10^{-10}$ curies in 1 litre of water* at 24,2° C.

(Schmidt's electrom.; H. Kakehi, June 2, 1914).

1,01 Mache's units (recalculated).

* Measurement has been made with the sample brought to the laboratory by applicant, taking into account decay of radium emanation with the time.

KAMINOYAMA

Location.—Kami-no-yama-machi, Minami-murayama-gun, Province Uzen, Yamagata-ken.

The springs issue from the Liparite.

Table 18.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Atatamari-yu (*Public bath*)	bitter	61,0°	ca. 3944	1,70	13,8°	K. & L.	30,00	Oct. 28, 1913	Y. Kinugasa, T. Saitō
2	Hie-no-yu (*Public bath*)	„	62,0°	3944	1,83	13,8°	„	27,40	„	„
3	Kawashimaya-no-yu *No. 2*	„	61,5°	488	2,17	13,5°	„	28,72	„	„
4	„ *No. 1*	„	56,0°	—	—	—	—	31,73	„	„
	Gas evolving from Hie-no-yu				Emanation per litre of gas at 0° C.: 13,45*, 15,51†, 15,80‡		E. & S.		Date when the gas was collected: Oct. 28, 1913	„

* Determined according to the authors' original direction.
† Correction for the absorption of the radiation by the wall of the ionisation chamber was made.
‡ Correction for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was also made.

AKAYU

Location.—Akayu-machi, Higashi-okitama-gun, Province Uzen, Yamagata-ken.

The springs issue from the Tertiary.

The hot spring "Tamba-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory, 1903.

Specific gravity: 1,0015 at 13,5° C. Temperature: 50° C.

Total residue: ca. 2,95. Flow of water: ca. 207 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0252	0,6437	0,6437
Sodium ion ($Na^{\cdot}$)	0,7966	34,5597	34,5597
Calcium ion ($Ca^{\cdot\cdot}$)	0,2836	7,0723	14,1446
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0013	0,0534	0,1068
			49,4548

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0480
Sodium chloride ($NaCl$)	1,8076
Sodium bicarbonate ($NaHCO_3$)	0,1785
Calcium chloride ($CaCl_2$)	0,5437
Magnesium chloride ($MgCl_2$)	0,0051

Anions.

Chlorine ion (Cl')	1,5239	42,9873	**42,9873**
Sulphate ion (SO_4'')	0,2085	2,1705	4,3410
Hydrocarbonate ion (HCO_3')	0,1296	2,1242	2,1242
	2,9687	89,6111	49,4525
Silicic acid (meta) (H_2SiO_3)	0,0519		
	3,0206		
Free carbon dioxide (CO_2)	0,0208	0,4727	
	3,0414		

Calcium sulphate ($CaSO_4$)	0,2958
Silicic acid (meta) (H_2SiO_3)	0,0519
	3,0206
Free carbon dioxide (CO_2)	0,0208
	3,0414

Besides these trace of ferrous, aluminium, iodine, hydrophosphate ion and boric acid.

The spring thus may be classified as "**earth-muriated common salt spring**".

Radio-activity. **1,33** Mache's units in 1 litre of water at 16,6° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 29, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 36,29$.

The hot spring "Ō-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1907.

Specific gravity: 1,0025 at 15° C. Temperature: 58° C.

Total residue: ca. 3,07. Flow of water: ca. 908 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Tamba-no-yu", may be classified as "**earth-muriated common salt spring**".

Radio-activity. **1,45** Mache's units in 1 litre of water at 16,6° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Oct. 29, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 44,40$.

The hot spring "Ama-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1903.

Specific gravity: 1,0015 at 13,5° C. Temperature: 49° C.

Total residue: ca. 2,91. Flow of water: ca. 179 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Tamba-no-yu", may be classified as "**earth-muriated common salt spring**".

Radio-activity. **1,38** Mache's units in 1 litre of water at 16,1° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō Oct. 29, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 40,83$.

Table 19.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emauation per litre of water: in Mache's units	Emauation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Tamba-no-yu (*public bath*)	earth-muriated common salt	50,0°	ca. 207	**1,33**	16,6°	K.&L.	36,29	Oct. 29, 1913	Y. Kinugasa, T. Saitō
2	Ō-yu (*public bath*)	"	58,0°	908	**1,45**	16,6°	"	44,40	"	"
3	Ama-yu (*public bath*)	"	49,0°	179	**1,38**	16,1°	"	40,83	"	"
4	Mori-no-yu	"	42,0°	195	**0,78**	16,4°	"	46,15	"	"

ONOGAWA

Location.—Misawa-mura, Minami-okitama-gun, Province Uzen, Yamagata-ken.

The springs issue from the Tertiary.

The hot spring "Onogawa-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tôkyō Imperial Hygienic Laboratory. 1906.

Specific gravity: 1,0045 at 15° C. Temperature: 66° C. Total residue: ca. 5,67.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,1310	3,3461	3,3461
Sodium ion ($Na^{\cdot}$)	1,5369	66,6767	**66,6767**
Calcium ion ($Ca^{\cdot\cdot}$)	0,4644	11,5801	**23,1602**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0110	0,4516	0,9032
			94,0862
Anions.			
Chlorine ion (Cl')	3,2252	90,9788	**90,9788**
Sulphate ion (SO_4'')	0,0929	0,9671	1,9342
Hydrocarbonate ion (HCO_3')	0,0714	1,1703	1,1703
	5,5328	175,1707	94,0833
Silicic acid (meta) (H_2SiO_3)	0,1229		
	5,6557		
Free carbon dioxide (CO_2)	0,0156	0,3545	
	5,6713		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,2496
Sodium chloride (NaCl)	3,9007
Calcium chloride ($CaCl_2$)	1,1629
Calcium sulphate ($CaSO_4$)	0,1318
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0217
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0661
Silicic acid (meta) (H_2SiO_3)	0,1229
	5,6557
Free carbon dioxide (CO_2)	0,0156
	5,6713

Besides these trace of iodine, hydrophosphate ion and boric acid.

The spring thus may be classified as "**earth-muriated common salt spring**".

Table 20.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18}\times 10^{-4}$	Date when the water was taken	Examined by
1	Taki-no-yu (*Public bath*)	earth-muriated common salt	70,0°	—	**5,78**	14,3°	K. & L.	65,76	Oct. 30, 1913	Y. Kinugasa, T. Saito
2	Ama-no-yu (*Public bath*)	,,	73,5°	—	**1,95**	11,6°	,,	71,47	,,	,,
3	Ōgiya-no-yu *No. 1*	,,	65,5°	—	**0,92**	12,6°	,,	49,31	,,	,,
4	,, *No. 2*	,,	66,5°	—	**2,23**	10,3°	,,	49,71	,, 31, ,,	,,
5	Suzuki-no-yu	,,	68,0°	—	**3,45**	12,2°	,,	73,66	,, 30, ,,	,,

SEKINE-YUNOSAWA

Location.—Yamakami-mura, Minami-okitama-gun, Province Uzen, Yamagata-ken.

The spring issues from the Gneiss.

The cold spring "Yunosawa-Onsen"

Temperature: 28° C.

No accurate analysis has ever been made, but the spring seems to be "**simple cold spirng**".

Radio-activity. **2,64** Mache's units in 1 litre of water at 6,6° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 1, 1913).

Electric conductivity. $\varkappa_{18}\times 10^{-4}$=**5,01**.

NAMEGAWA

Location.—Yamakami-mura, Minami-okitama-gun, Province Uzen, Yamagata-ken.

The spring issues from the Tertiary.

The hot spring "Namegawa-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Yamagata-ken. 1909.

Specific gravity: 1,00069. Temperature: 55° C. (air temp. 22° C.).

Total residue: ca. 1,43. Flow of water: ca. 340 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,1109	Magnesium carbonate ($MgCO_3$)	0,0730
Sodium chloride ($NaCl$)	0,5364	Aluminium phosphate ($AlPO_4$)	0,0416
Calcium chloride ($CaCl_2$)	0,5067	Silica (SiO_2)	0,0450
Calcium sulphate ($CaSO_4$)	0,1457		1,7357
Calcium carbonate ($CaCO_3$)	0,2764		

The spring may be classified as "**earth-muriated common salt spring**".

GOSHIKI

Location.—Yamakami-mura, Minami-okitama-gun, Province Uzen, Yamagata-ken.

The springs issue from the Tertiary.

The hot spring "Goshiki-Onsen" No. 1

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1904.

Specific gravity: 1,001 at 14° C. Temperature: ca. 44,5° C.

Total residue: ca. 0,87. Flow of water: ca. 778 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0316	0,8072	0,8072
Sodium ion ($Na^{\cdot}$)	0,2329	10,1041	**10,1041**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0580	1,4464	2,8928
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0020	0,0838	0,1676
			13,9717
Anions.			
Chlorine ion (Cl')	0,1644	4,6375	4,6375
Sulphate ion (SO_4'')	0,0416	0,4331	0,8662
Hydrocarbonate ion (HCO_3')	0,5166	8,4680	**8,4680**
	1,0471	25,9801	13,9717
Silicic acid (meta) (H_2SiO_3)	0,0805		
	1,1276		
Free carbon dioxide (CO_2)	0,3762	8,5500	
	1,5038		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0602
Sodium chloride ($NaCl$)	0,2241
Sodium bicarbonate ($NaHCO_3$)	0,5274
Calcium sulphate ($CaSO_4$)	0,0475
Magnesium sulphate ($MgSO_4$)	0,0101
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,1779
Silicic acid (meta) (H_2SiO_3)	0,0805
	1,1277
Free carbon dioxide (CO_2)	0,3762
	1,5039

Besides these trace of ferrous, aluminium, hydrophosphate ion and boric acid.

The spring thus may be classified as "**alkaline spring**".

Radio-activity. 1,25 Mache's units in 1 litre of water at 6,1° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 1, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 10{,}22$.

Table 21.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Goshiki-Onsen *No. 1*	alkaline	44,5°	ca. 778	1,25	6,1°	K. & L.	10,22	Nov. 1, 1913	{ Y. Kinugasa T. Saitō
2	„ *No. 3*	„	38,5°	—	1,95	6,5°	„	8,04	„	„
3	Shin-goshiki-Onsen	simple	40,5°	346	0,82	6,5°	„	10,17	„	„

YUNO

Location.—Yuno-mura, Date-gun, Province Iwashiro, Fukushima-ken.

The springs issue from the Tertiary.

The hot spring " Hashimoto-no-yu "

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1897. Temperature: 56° C.

Flow of water: ca. 2160 hectolitres in 24 hours. Total residue: ca. 0,90.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0038	0,0971	0,0971
Sodium ion ($Na^{\cdot}$)	0,2183	9,4707	9,4707
Calcium ion ($Ca^{\cdot\cdot}$)	0,0332	0,8279	1,6558
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0012	0,0493	0,0986
			11,3222
Anions.			
Chlorine ion (Cl')	0,1208	3,4076	3,4076
Sulphate ion (SO_4'')	0,3801	3,9569	7,9138
	0,7574	17,8095	11,3214
Silicic acid (meta) (H_2SiO_3)	0,1055		
	0,8629		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,1993
Potassium sulphate (K_2SO_4)	0,0085
Sodium sulphate (Na_2SO_4)	0,4315
Calcium sulphate ($CaSO_4$)	0,1124
Magnesium sulphate ($MgSO_4$)	0,0057
Silicic acid (meta) (H_2SiO_3)	0,1055
	0,8629

Besides these a small quantity of ferrous and aluminium ion and trace of hydrophosphate ion and boric acid.

The spring thus may be classified as "**simple thermal**".

Radio-activity. 0,38 Mache's units in 1 litre of water at 19° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 25, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 10{,}51$.

The hot spring " Kiri-no-yu "

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1897. Temperature: 57° C.

Flow of water: ca. 432 hectolitres in 24 hours. Total residue: ca. 0,79.

The spring, being in its composition nearly the same as that of "Hashimoto-no-yu", may be classified as "**simple thermal**".

Radio-activity. 0,39 Mache's units in 1 litre of water at 18,1° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 25, 1913)

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 10{,}84$.

The hot spring "Kitsune-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1898. Temperature: 49° C.
Flow of water: ca. 540 hectolitres in 24 hours. Total residue: ca. 0,64.

The spring, being in its composition nearly the same as that of "Hashimoto-no-yu", may be classified as "**simple thermal**".

Radio-activity. **0,36** Mache's units in 1 litre of water at 16,8° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 25, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{10{,}93}$.

Table 22.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Hashimoto-no-yu (*Public bath*)	simple	56,0°	ca. 2160	**0,38**	19,0°	K. & L.	10,51	Sept. 25, 1913	Y. Kinugasa / T. Saitō
2	Kiri-no-yu (*Public bath*)	„	57,0°	432	**0,39**	18,1°	„	10,84	„	„
3	Kitsune-yu (*Public bath*)	„	49,0°	540	**0,36**	16,8°	„	10,93	„	„
4	Anabara-no-yu (*Public bath*)	„	58,5°	432	**0,92**	17,4°	„	—	„ 24, „	„
5	Inariya-no-yu	„	55,0°	432	—	—	—	10,37	„ 25, „	„
6	Izumiya-furu-yu	„	68,5°	108	—	—	—	11,24	„	„
7	Izumiya-shin-yu	„	56,5°	—	—	—	—	10,98	„	„
8	Wataya-no-yu	„	55,0°	216	—	—	—	10,45	„	„
9	Matsubaya-no-yu *No. 1*	„	48,0°	432	—	—	—	9,23	„	„
10	„ *No. 2*	„	51,0°	—	—	—	—	10,63	„ 24, „	„

IIZAKA

Location.—Iizaka-machi, Shinobu-gun, Province Iwashiro, Fukushima-ken.

The springs issue from the Tertiary.

The hot spring "Hako-yu"

Analysis.

Analyst: Unknown. 1891.

Specific gravity: 1,006. Temperature: 56,5° C.
Total residue: ca. 0,95. Flow of water: ca. 108 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride ($NaCl$)	0,20695	Sodium silicate (Na_4SiO_4)	0,12860
Sodium sulphate (Na_2SO_4)	0,11150	Calcium sulphate ($CaSO_4$)	0,46920
Potassium silicate (K_4SiO_4)	0,04320		0,95945

The spring may be classified as "**simple thermal**".

Radio-activity. **0,50** Mache's units in 1 litre of water 18,7° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 25, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{10{,}60}$.

Table 23.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^4$	Date when the water was taken	Examined by
1	Hako-yu (*Public bath*)	simple	56,5°	ca. 108	**0,50**	18,7°	K. & L.	10,60	Sept. 25, 1913	Y. Kinugasa T. Saito
2	Taki-no-yu (,,)	,,	59,0°	180	**0,68**	15,8°	,,	12,28	,, 24, ,,	,,
3	Shin-sabako-no-yu (,,)	,,	70,0°	—	**0,52**	18,0°	,,	12,32	,, 25, ,,	,,
4	Spring (Sanatorium of II Division, Army)	,,	56,5°	—	**0,67**	16,3°	,,	10,14	,, 24, ,,	,,
5	Tennōji-yu (*Public bath*)	,,	50,0°	144	**0,71**	16,2°	,,	11,58	,,	,,
6	Kin-taki-no-yu	,,	56,0°	108	—	—	—	10,66	,, 25, ,,	,,
7	Akagawa-yu	,,	—	144	—	—	—	—	—	
8	Senshū-kaku-no-yu	,,	63,0°	—	—	—	—	12,24	,, 25, ,,	Y. Kinugasa T. Saitō
9	Kwasui-kwan-no-yu (*Right side*)	,,	55,5°	—	—	—	—	12,08	,,	,,
10	,, (*Left side*)	,,	53,5°	—	—	—	—	12,11	,,	,,
11	Horikiri-no-yu (*Kamasaki-no-yu*)	,,	68,0°	—	—	—	—	11,65	,,	,,

HIGASHIYAMA

Location.—Higashiyama-mura, Kita-aizu-gun, Province Iwashiro, Fukushima-ken.

The springs issue from the Tertiary or the Quartz Augite Andesite.

The hot spring "Sugi-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1902.

Specific gravity: 1,000 at 15° C. Temperature: 59° C. Total residue: ca. 1,95.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0921	2,3525	2,3525
Sodium ion ($Na^{\cdot}$)	0,3898	16,9111	**16,9111**
Calcium ion ($Ca^{\cdot\cdot}$)	0,1797	4,4813	8,9626
			28,2262
Anions.			
Chlorine ion (Cl')	0,3408	9,6135	9,6135
Sulphate ion (SO_4'')	0,8937	9,3036	**18,6072**
	1,8961	42,6620	28,2207
Silicic acid (meta) (H_2SiO_3)	0,0357		
	1,9318		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,1755
Sodium chloride ($NaCl$)	0,4247
Sodium sulphate (Na_2SO_4)	0,6866
Calcium sulphate ($CaSO_4$)	0,6093
Silicic acid (meta) (H_2SiO_3)	0,0357
	1,9318

Besides these trace of magnesium, hydrophosphate ion and boric acid.

The spring thus may be classified as "**saline bitter spring**".

Radio-activity. **3,14** Mache's units in 1 litre of water at 9,6° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 3, 1913).

Electric conductivity. $\varkappa_{18} \times 10^4 =$ **20,94**.

Table 24.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Electric conductivity $x_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Sō-yu (*Public bath*)	saline bitter	56,5°	ca. 180	**3,23**	8,7°	K.&L.	21,14	Nov. 3, 1913	Y. Kinugasa / T. Saitō
2	Sugi-no-yu	„	59,0°	—	**3,14**	9,6°	„	20,94	„	„
3	Sazanami-no-yu	„	58,0°	180	**3,02**	9,2°	„	22,15	„	„
4	Saru-no-yu	„	43,0°	180	**3,20**	8,1°	„	—	„	„
5	Fudō-no-yu	„	42,0°	—	**4,59**	10,6°	„	16,19	„	„
6	Nuru-yu	„	34,0°	—	**5,30**	10,0°	„	14,64	„	„
7	Takino-yu	„	48,0°	360	—	—	—	—	—	—
8	Suga-no-yu	„	61,0°	360	—	—	—	—	—	—
9	Kitsune-no-yu	„	38,0°	180	—	—	—	—	—	—
10	Mujina-no-yu	„	43,0°	180	—	—	—	—	—	—
11	Sumi-no-yu	„	58,0°	180	—	—	—	—	—	—
12	Me-arai-no-yu	„	58,0°	180	—	—	—	—	—	—
13	Ana-yu	„	58,0°	180	—	—	—	—	—	—
14	Koga-no-yu	„	60,0°	180	—	—	—	—	—	—

KASHI

Location.—Nishigō-mura, Nishi-shirakawa-gun, Province Iwaki, Fukushima-ken.

The springs issue from the Granite.

Table 25.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Electric conductivity $x_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Moto-yu	simple	51,0°	—	**4,59**	10,2°	K.&L.	12,63	Nov. 5, 1913	Y. Kinugasa / T. Saitō
2	Tengu-no-yu	„	48,5°	—	**2,86**	10,6°	„	12,28	„	„
3	Yujin-no-yu	„	50,0°	—	**3,38**	8,9°	„	11,37	„	„

NEKONAKI

Location.—Ishikawa-machi, Ishikawa-gun, Province Iwaki, Fukushima-ken.

The springs issue from the Gneiss.

Table 26.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water			Apparatus employed	Date when the water was taken	Examined by
					in 10^{-10} curies	in Mache's units	at (temp. in C.)			
1	Nekonaki-no-yu	simple	—	ca. 22	21,47	5,91	16,0°	Schm.	Sept. 24, 1914	S. Hanzawa and H. Yanagisawa
2	Tomaki-no-yu	,,	13,0°	—	3,21	0,88	16,0°	,,	,, 30, ,,	
3	Tomaki-furu-yu	,,	—	—	—	2,18	17,0°	K. & L.	,,	
4	Spring *A* (*Chōraku-en*)	,,	—	—	—	4,08	16,5°	,,	,,	
5	Spring *B* (*Chaya*)	,,	—	—	—	1,82	19,0°	,,	,, 25, ,,	
6	Spring *C* (*Yakōji temple*)	,,	—	—	—	3,18	16,0°	,,	,, 29, ,,	
7	Spring *D*	,,	—	—	—	1,95	15,5°	,,	,, 24, ,,	
8	Spring *E*	,,	—	—	—	3,07	19,0°	,,	,, 25, ,,	

BOBATA

Location.—Bobata-mura, Ishikawa-gun, Province Iwaki, Fukushima-ken.

The springs issue from the Gneiss.

Table 27.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water			Apparatus employed	Date when the water was taken	Examined by
					in 10^{-10} curies	in Mache's units	at (Temp. in C.)			
1	Shimo-no-kyū-yu	simple	—	ca. —	—	0,49	21,0°	K. & L.	Sept. 28, 1914	S. Hanzawa and H. Yanagisawa
2	Spring *A* (*Ch. Yabe*)	,,	—	—	—	1,52	15,7°	,,	,,	
3	Shimo-no-yu *No. 1*	,,	27,0°	285	21,05	3,31	24,0°	Schm.	,,	
4	,, *No. 2*	,,	—	—	—	2,36	21,0°	K. & L.	,,	
5	Toi-no-kuchi	,,	—	—	—	1,89	18,5°	,,	,, 26, ,,	
6	Spring *B* (*K. Watanabe*)	,,	—	—	—	9,69	20,8°	,,	,,	
7	Naka-no-yu *No. 1*	,,	—	—	8,58	2,36	15,0°	Schm.	,, 29, ,,	
8	,, *No. 2*	,,	—	—	—	2,94	19,0°	K. & L.	,, 27, ,,	
9	Kami-no-moto-yu	sulphur	14,0° (air temp. 17°)	130	43,48	11,96	19,0°	Schm.	,, 26, ,,	
10	Kami-no-shin-yu	simple	—	—	11,41	3,14	16,0°	,,	,, 27, ,,	
11	Spring *C*	,,	—	—	—	0,18	21,0°	K. & L.	,, 25, ,,	

SENAMI

Location.—Senami-machi, Iwafune-gun, Province Echigo, Niigata-ken.

The hot spring "Senami-Funtō"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1905.

Specific gravity: 1,0035 at 14° C. Temperature: 102° C.

Total residue: ca. 4,19. Flow of water: ca. 9000 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0786	2,0077	2,0077
Sodium ion ($Na^{\cdot}$)	1,3333	57,8438	**57,8438**
Calcium ion ($Ca^{\cdot\cdot}$)	0,1323	3,2993	6,5996
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0003	0,0127	0,0254
			66,4765
Anions.			
Chlorine ion (Cl')	2,1162	59,6954	**59,6954**
Sulphate ion (SO_4'')	0,2759	2,8722	5,7444
Hydrocarbonate ion (HCO_3')	0,0632	1,0359	1,0359
	3,9998	126,7670	66,4757
Silicic acid (meta) (H_2SiO_3)	0,1928		
	4,1926		
Free carbon dioxide (CO_2)	0,1596	3,6273	
	4,3522		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,1497
Sodium chloride ($NaCl$)	3,3748
Sodium bicarbonate ($NaHCO_3$)	0,0132
Calcium sulphate ($CaSO_4$)	0,3910
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0695
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0016
Silicic acid (meta) (H_2SiO_3)	0,1928
	4,1926
Free carbon dioxide (CO_2)	0,1596
	4,3522

Besides these a small quantitiy of ferrous and aluminium ion and trace of ammonium, nitrate, hydrophosphate ion and boric acid.

The spring thus may be classified as "**common salt spring**".

Radio-activity. **0,22** $\times 10^{-10}$ curies in 1 litre of water at 28,0° C.

(Schmidt's electrom.; Y. Kinugasa and T. Saitō, Aug. 23, 1914).

0,06 Mache's units (recalculated).

ONNAGAWA

Location.—Onnagawa-mura, Iwafune-gun, Province Echigo, Niigata-ken.

The hot spring "Takanosu-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1904.

Specific gravity: 1,002 at 15° C. Temperature: 63° C. (air temp. 31° C.)

Total residue: ca. 2,45. Flow of water: ca. 979 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0414	1,0575	1,0575
Sodium ion ($Na^{\cdot}$)	0,6836	29,6573	**29,6573**
Calcium ion ($Ca^{\cdot\cdot}$)	0,1376	3,4314	6,8628
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0020	0,0821	0,1642
			37,7418

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0788
Sodium chloride ($NaCl$)	1,3032
Sodium sulphate (Na_2SO_4)	0,5250
Calcium sulphate ($CaSO_4$)	0,2984

Anions.

Chlorine ion (Cl′)	0,8271	23,3315	23,3315
Sulphate ion (SO_4'')	0,5732	5,9671	11,9342
Hydrocarbonate ion (HCO_3')	0,1511	2,4768	2,4768
	2,4160	66,0037	37,7425
Silicic acid (meta) (H_2SiO_3)	0,0980		
	2,5140		
Free carbon dioxide (CO_2)	0,1418	. . 3,2227	
	2,6558		

Magnesium sulphate ($MgSO_4$)	0,0094
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,2007
Silicic acid (meta) (H_2SiO_3)	0,0980
	2,5140
Free carbon dioxide (CO_2)	0,1418
	2,6558

Besides these trace of hydrophosphate ion.

The spring thus may be classified as "**common salt spring**".

Radio-activity. **4,00** Mache's units in 1 litre of water at 27,0° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 25, 1914).

Table 28.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Takanosu-Onsen	common salt	63,0° (air temp. 31°)	ca. 979	—	**4,00**	27,0°	K.&L.	Aug. 25. 1914	Y. Kinugasa, T. Saitō
2	Takase-no-yu (*Kirara-no-yu*)	salt	72,0° (32°)	504	**15,13**	**4,16**	27,8°	Schm.	,,	,,
3	Yuzawa: Moto-yu	,,	50,0° (28°)	65	**11,27**	**3,10**	26,6°	,,	,, 24. ,,	,,
4	Yuzawa: Takahashi-kwan-no-yu	,,	52,0° (28°)	—	—	**3,20**	26,6°	K.&L	,,	,,
5	Yuzawa: Sugai-no-yu	,,	48,0° (27,5°)	—	—	**3,60**	25,7°	,,	,,	,,

MURASUGI

Location.—Sasaoka-mura, Kita-kambara-gun, Province Echigo, Niigata-ken.

The springs issue from the Granite.

The cold spring "Murasugi-Kōsen" No. 1

Analysis (calculated from the original numbers).

Analysed by the Niigata Higher Medical School. 1914.

Specific gravity: 1,0034 at 15° C. Temperature: 25,6° C. (air temp. 30° C.)

Total residue: ca. 0,35. Flow of water: ca. 530 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Sodium ion ($Na^·$)	0,10417	4,51931	4,51931
Calcium ion ($Ca^{··}$)	0,00810	0,20200	0,40400
Magnesium ion ($Mg^{··}$)	0,00177	0,07266	0,14532
			5,06863
Anions.			
Chlorine ion (Cl′)	0,02127	0,60000	0,60000
Sulphate ion (SO_4'')	0,20209	2,10379	4,20758
Hydrocarbonate ion (HCO_3')	0,01525	0,24996	0,24996
	0,35265	7,74772	5,05754

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,03525
Sodium sulphate (Na_2SO_4)	0,25973
Sodium bicarbonate ($NaHCO_3$)	0,02084
Calcium sulphate ($CaSO_4$)	0,02754
Magnesium sulphate ($MgSO_4$)	0,00885
	0,35221

The spring thus may be classified as "**simple cold spring**".

Radio-activity. **180,41** × 10^{-10} curies in 1 litre of water at 28,9° C.

(Schmidt's electrom.; Y. Kinugasa and T. Saitō; Aug. 20, 1914).

49,61 Mache's units (recalculated).

Discharge of Radium Emanation.

Spring	Temp. of spring in C.	Conduit: Distance (source—bath) in feet	Conduit: Material	Per minute: Flow of water in litres	Per minute: Emanation in 10^{-8} curies	Per minute: Emanation in Mache's units	Per hour: Flow of water in hectolitres	Per hour: Emanation in 10^{-7} curies	Per hour: Emanation in 10^{5} Mache's units	Per day (24 hours): Flow of water in hectolitres	Per day (24 hours): Emanation in 10^{-6} curies (microcuries)	Per day (24 hours): Emanation in 10^{3} Mache's units	Remarks
Murasugi-Kōsen *No. 1*	25,6°	ca. 48	bamboo and wooden pipes	36,8	66	*1826*	22	3984	*110*	530	956	*2629*	heated for bathing

Table 29.

No.		Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Murasugi	Murasugi-Kōsen *No. 1*	simple	25,6° (air temp. 30°)	ca. 530	180,41	49,61	28,9°	Schm.	Aug. 20, 1914	Y. Kinugasa, T. Saitō
2	Murasugi	„ *No. 2*	„	26,0° (31,5°)	—	176,61	48,57	27,6°	„	„ 21, „	„
3	Murasugi	„ *No. 3*	„	13,5° (30°)	—	—	40,28	26,0°	K. & L.	„	„
4		Shiroyama-Kōsen	„	22,5° (30°)	—	—	13,74	26,3°	„	„	„
5		Imaita-Kōsen *No. 1* *	„	18,7° (32°)	—	—	7,45	26,9°	„	„ 20, „	„
6		„ *No. 2* *	„	16,0° (32°)	—	—	4,19	26,8°	„	„	„
7		Uba-yu *	„	14,0° (28°)	—	—	3,26	27,0°	„	„ 22, „	„
		Gas evolving from Murasugi-Kōsen *No. 2*	—	—	—	Emanation per litre of gas at 0° C.: —	169,98	—	„	Date when the gas was collected: Aug. 21, 1914	„

* The geological structure of the place, where the spring gushes out, is not yet examined.

DEYU

Location.—Sasaoka-mura, Kita-kambara-gun, Province Echigo, Niigata-ken.

The springs issue from the Granite.

Table 30.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at temp. (in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Chōsenkutsu-no-yo	car-bonated	39.5° (air temp. 26°)	ca. 830	12,09	3,33	30,1	Schm.	Aug. 22, 1914	V. Kinugasa, T. Saitō
2	Tōshundai-no-yu *No. 1*	„	33,0° (27°)	—	—	11,57	26,1	K. & L.	„	„
3	„ *No. 2*	„	31,0° (25°)	—	—	11,31	26,4°	„	„	„
4	Shiraneya-no-yu	„	33.5° (29.5°)	—	—	6,99	26,3°	„	„	„
	Gas evolving from Chōsenkutsu-no-yu				Emanation per litre of gas at 0° C. 14,60			„	Date when the gas was collected Aug. 22, 1914	„

TOCHIOMATA

Location.—Yunotani-mura, Kita-uo-numa-gun, Province Echigo, Niigata-ken.

The springs issue from the Granite.

The hot spring "Tochiomata-no-yu" No. 1

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1896. Total residue: ca. 0,28.

Flow of water: ca. 1800 hectolitres in 24 hours. Temperature: 39° C. (air temp. 24,5° C.)

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0013	0,0332	0,0332
Sodium ion ($Na^{\cdot}$)	0,0266	1,1540	1,1540
Calcium ion ($Ca^{\cdot\cdot}$)	0,0435	1,0847	2,1694
			3,3566
Anions.			
Chlorine ion (Cl')	0,0161	0,4541	0,4541
Sulphate ion (SO_4'')	0,1394	1,4511	2,9022
	0,2269	4,1771	3,3563
Silicic acid (meta) (H_2SiO_3)	0,0308		
	0,2577		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,0265
Potassium sulphate (K_2SO_4)	0,0029
Sodium sulphate (Na_2SO_4)	0,0501
Calcium sulphate ($CaSO_4$)	0,1474
Silicic acid (meta) (H_2SiO_3)	0,0308
	0,2577

Besides these a small quantity of ferrous and aluminium ion and trace of nitrate and hydrophosphate ion

The spring thus may be classified as "**simple thermal**".

Radio-activity. **94,03** $\times 10^{-10}$ curies in 1 litre of water at 25,7° C.

(Schmidt's electrom.; Y. Kinugasa and T. Saitō, Aug. 27, 1914)

25,86 Mache's units (recalculated).

Discharge of Radium Emanation.

No.	Spring	Temp. of spring in C.	Conduit: Distance (source—bath) in feet	Conduit: Material	Per minute: Flow of water in litres	Per minute: Emanation in 10^{-8} curies	Per minute: Emanation in Mache's units	Per hour: Flow of water in hectolitres	Per hour: Emanation in 10^{-8} curies	Per hour: Emanation in 10^{3} Mache's units	Per day (24 hours): Flow of water in hectolitres	Per day (24 hours): Emanation in 10^{-6} curies (microcuries)	Per day (24 hours): Emanation in 10^{3} Mache's units	Remarks
1	Tochiomata-no-yu *No. 1*	39°	0	—	125	118	*3233*	75	7052	*194*	1800	1693	*4655*	bath-tank is direct upon the source
2	Jizai-kwan-uchi-yu *No. 1*	36°	180	iron pipes	16,4	27	*730*	10	1590	*44*	236	382	*1050*	

Table 31.

No.		Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Tochiomata	Tochiomata-no-yu *No. 1*	simple	39,0° (air temp. 24,5°)	ca. 1800	94,03	25,86	25,7°	Schm.	Aug. 27, 1914	Y. Kinngasa, T. Saitō
2	Tochiomata	,, *No. 2*	,,	39,0° (26°)	—	—	23,33	27,6°	K. & L.	,, 29, ,,	,,
3	Tochiomata	,, *No. 3*	,,	35,5° (26°)	—	—	27,18	26,2°	,,	,, 27, ,,	,,
4	Tochiomata	,, *No. 4*	,,	28,5° (24,5°)	—	—	56,41	25,3°	,,	,, 29, ,,	,,
5	Tochiomata	Jizaikwan-uchi-yu *No. 1*	,,	36,0° (27,5°)	236	161,74	44,48	26,5°	Schm.	,,	,,
6	Tochiomata	,, *No. 2*	,,	38,0° (24,5°)	236	—	24,05	28,1°	K. & L.	,,	,,
7	Ōyu	Ō-yu (*Otoko-yu*)	,,	57,0° (33°)	1170	11,25	3,09	29,8°	Schm.	,, 28, ,,	,,
8	Ōyu	,, (*Onna-yu*)	,,	56,0° (33°)	—	—	3,52	27,5°	K. & L.	,,	,,
9	Ōyu	Sakashita-no-yu	,,	56,0° (33°)	—	—	3,62	26,3°	,,	,,	,,
10	Ōyu	Yakushi-no-yu	,,	53,0° (33°)	—	—	3,43	24,2°	,,	,,	,,
11	Ōyu	Kawagashi-no-yu *No. 1*	,,	56,0° (33°)	—	—	4,14	29,0°	,,	,,	,,
12	Ōyu	,, *No. 2*	,,	56,0° (33°)	—	—	3,83	23,7°	,,	,,	,,

YUZAWA

Location.—Yuzawa-mura, Minani-uo-numa-gun, Province Echigo, Niigata-ken.

The springs issue from the Misaka Series.

Table 32.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Moto-yu	salt	45,0° (air temp. 29,5°)	—	1,61	29,3°	K. & L.	Aug. 31, 1914	Y. Kinugasa, T. Saitō
2	Chūbu-no-yu	"	42,0° (29,5°)	—	1,30	29,1°	"	"	"
3	Tamago-no-yu	"	41,5°	—	1,23	26,7°	"	" 30, "	"
4	Kami-no-yu	"	45,0° (29,5°)	—	1,45	29,6°	"	" 31, "	"
5	Shin-yu	"	43,0° (29,5°)	—	1,23	29,3°	"	"	"
6	Kiridōshi-no-yu	"	37,0°	—	2,73	27,8°	"	"	"

AKAKURA

Location.—Nakayama-mura, Nakakubiki-gun, Province Echigo, Niigata-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Akakura-Onsen"

Analysis.

Analysed by the Takata Hospital. 1896. Temperature: 62° C. (air temp. 20° C.)
Total residue: ca. 1,19. Flow of water: ca. 7200 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium oxide (K_2O)	0,0544
Sodium oxide (Na_2O)	0,6560
Calcium oxide (CaO)	0,1431
Magnesia (MgO)	0,0378
Ferric oxide (Fe_2O_3)	0,0034
Chlorine (Cl)	0,0284
Sulphuric anhydride (SO_3)	0,2603
Combined carbon dioxide (CO_2)	0,2533
Silica (SiO_2)	0,1678
Organic substances	0,1785
Free carbon dioxide (CO_2)	0,5384
Hydrogen sulphide (H_2S)	0,0268
	2,3482

Hypothetical form of combination

	Grams
Sodium chloride ($NaCl$)	0,0468
Potassium carbonate (K_2CO_3)	0,0961
Sodium carbonate (Na_2CO_3)	0,1088
Calcium sulphate ($CaSO_4$)	0,3688
Ferrous carbonate ($FeCO_3$)	0,0070
Calcium carbonate ($CaCO_3$)	0,0865
Magnesium carbonate ($MgCO_3$)	0,1323
Silica (SiO_2)	0,1678
Organic substances	0,1785
	1,1926
Free carbon dioxide (CO_2)	0,5384
Hydrogen sulphide (H_2S)	0,0268
	1,7578

Besides these trace of aluminium and phosphoric acid.

The spring may be classified as "**earthy alkaline sulphur spring**".

Table 33.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Akakura-Onsen *Jet No. 1*	earthy alkaline sulphur	55,5° (air temp.)	**0,33**	21,2°	K. & L.	July, 29, 1913	Dr. R. Ishizu
2	„ *Jet No. 2*	„	62,0° (20°)	**1,04**	22.6°	„	Aug. 13, 1914	Y. Kinugasa
3	„ *Jet No. 3*	„	62.0° (20°)	**0,54**	23,0°	„	„	„
4	Tsubame-Onsen* *Jet No. 1*	sulphur	48.0° (22,5°)	**0,09**	27,2°	„	July, 29, 1913	Dr. R. Ishizu
5	„ *Jet No. 2*	„	44.0° (25.5°)	**0,23**	27,5°	„	„	„
6	„ *Jet No. 3*	„	42,0° (23,5°)	**0,74**	26.3°	„	„	„

* Tsubame, located at *Sekiyama-mura*, about 2,5 m. N. from Akakura, is grouped for convenience in this table.

MATSUNOYAMA

Location.—Matsu-no-yama-mura, Higashi-kubiki-gun, Province Echigo, Niigata-ken.

The springs issue from the Tertiary.

The hot spring "Netsu-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1895.

Temperature: 63° C. Total residue: ca. 15,08.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,1025	2,6181	2,6181
Sodium ion ($Na^{\cdot}$)	3,4211	148,4208	**148,4208**
Calcium ion ($Ca^{\cdot\cdot}$)	1,9645	48,9800	**97,9600**
			248,9989
Anions.			
Chlorine ion (Cl')	8,7581	247,0550	**247,0550**
Sulphate ion (SO_4'')	0,0938	0,0765	1,9530
	14,3400	448,0504	249,0080
Silicic acid (meta) (H_2SiO_3)	0,0896		
	14,4296		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,1952
Sodium chloride ($NaCl$)	8,6831
Calcium chloride ($CaCl_2$)	5,3286
Calcium sulphate ($CaSO_4$)	0,1331
Silicic acid (meta) (H_2SiO_3)	0,0896
	14,4296

Besides these trace of bromine, iodine, hydrophosphate ion, boric acid and organic substances. The spring thus may be classified as "**earth-muriated common salt spring**".

NASU

Location.—Nasu-mura, Nasu-gun, Province Shimotzuke, Tochigi-ken.

The springs issue from the Augite Andesite.

YUMOTO

The hot spring "Shika-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory, 1881.

Temperature: 74,5° C. Total residue: ca. 1,91.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Hydrogen ion ($H^{\cdot}$)	0,0118	11,6832	**11,6832**
Potassium ion ($K^{\cdot}$)	0,0071	0,1814	0,1814
Sodium ion ($Na^{\cdot}$)	0,0367	1,5922	1,5922
Calcium ion ($Ca^{\cdot\cdot}$)	0,0611	1,5237	3,0474
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0609	2,5000	5,0000
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0219**	0,3918	0,7836
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0507	1,8708	5,6124
			27,9002
Anions.			
Chlorine ion (Cl')	0,2080	5,8674	5,8674
Hydrosulphate ion (HSO_4')	0,5551	5,7186	5,7186
Sulphate ion (SO_4'')	0,7828	8,1491	**16,2982**
	1,7961	39,4782	27,8842
Silicic acid (meta) (H_2SiO_3)	0,2530		
	2,0491		
Free hydrogen sulphide (H_2S)	**0,0240**		
	2,0731		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium sulphate (K_2SO_4)	0,0158
Sodium sulphate (Na_2SO_4)	0,1133
Calcium sulphate ($CaSO_4$)	0,2072
Magnesium sulphate ($MgSO_4$)	0,3045
Ferrous sulphate ($FeSO_4$)	0,0595
Aluminium sulphate [$Al_2(SO_4)_3$]	0,3209
Free hydrochloric acid (HCl)	0,2140
Free sulphuric acid (H_2SO_4)	0,5609
Silicic acid (meta) (H_2SiO_3)	0,2530
	2,0491
Free hydrogen sulphide (H_2S)	0,0240
	2,0731

Besides these trace of hydrophosphate ion and organic substances.

The spring thus may be classified as "**acid hydrogen sulphide vitriol spring**".

Radio-activity. **0,41** Mache's units in 1 litre of water at 13,9° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 7, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 37{,}57$.

The hot spring "Komatsu-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken, 1912. Specific gravity: 1,0013 at 15° C.

Temperature: 43° C. Total residue: ca. 0,72.

The spring, being in its composition nearly the same as that of "Shika-no-yu", differing only in the smaller proportion of iron from the latter, may be classified as "**acid hydrogen sulphide spring**".

Radio-activity. **0,56** Mache's units in 1 litre of water at 13,8° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 7, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 23{,}47$.

The hot spring "Kiraku-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken, 1912. Specific gravity: 1,0011 at 15° C.

Temperature: 28° C. Total residue: ca. 0,62.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride ($NaCl$)	0,0356	Silica (SiO_2)	0,1303
Potassium sulphate (K_2SO_4)	0,0294		0,6248
Sodium sulphate (Na_2SO_4)	0,0092	Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,1078
Sodium carbonate (Na_2CO_3)	0,0740	Free hydrogen sulphide (H_2S)	0,0292
Calcium sulphate ($CaSO_4$)	0,2308		0,7618
Magnesium carbonate ($MgCO_3$)	0,1082		
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,0073		

Besides these a very small quantity of phosphoric acid and trace of organic substances.

The spring may be classified as "**hydrogen sulphide spring**".

Radio-activity. **1,08** Mache's units in 1 litre of water at 13,0° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 7, 1913)

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 6{,}31$.

KITA

The hot spring "Ai-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken. 1912. Specific gravity: 1,0010 at 15° C.

Temperature: 54° C. Total residue: ca. 0,64.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,0111	Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,0024
Potassium sulphate (K_2SO_4)	0,0026	Silica (SiO_2)	0,1598
Sodium sulphate (Na_2SO_4)	0,0511		0,6144
Sodium carbonate (Na_2CO_3)	0,1173	Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,3398
Calcium sulphate ($CaSO_4$)	0,2188		0,9542
Magnesium carbonate ($MgCO_3$)	0,0513		

Beside these trace of iodine, phosphoric and boric acid.

The spring may be classified as "**simple thermal**".

Radio-activity. **1,15** Mache's units in 1 litre of water at 15,3° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 7, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 5{,}55$.

BENTEN

The hot spring "Kawa-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken. 1912. Specific gravity: 1,0010 at 16° C.

Temperature: 54° C. Total residue: ca. 0,85.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride ($NaCl$)	0,0410	Alumina (Al_2O_3)	0,0008
Potassium sulphate (K_2SO_4)	0,0096	Silica (SiO_2)	0,1589
Sodium sulphate (Na_2SO_4)	0,1615		0,9171
Sodium bicarbonate ($NaHCO_3$)	0,1044	Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,2705
Calcium sulphate ($CaSO_4$)	0,2770		1,1876
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,1617		
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0022		

Besides these trace of phosphoric and boric acid.

The spring may be classified as "**simple thermal**".

Radio-activity. **2,07** Mache's units in 1 litre of water at 10,2° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 7, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 8{,}13$.

DAIMARU-ZUKA

The hot spring "Sakura-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken. 1911. Specific gravity 1,0009 at 15° C.
Temperature: 71° C. Total residue: ca. 0,75.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium sulphate (K_2SO_4)	0,0389	Silica (SiO_2)	0,2083
Sodium sulphate (Na_2SO_4)	0,1665		0,7540
Calcium sulphate ($CaSO_4$)	0,2174	Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,0190
Magnesium sulphate ($MgSO_4$)	0,0740		0,7730
Magnesium carbonate ($MgCO_3$)	0,0479		
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,0010		

Besides these trace of chlorine, iodine, nitric and phosphoric acid.
The spring may be classified as "**simple thermal**".

Radio-activity. **0,42** Mache's units in 1 litre of water at 13.4° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 7, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 6{,}46$.

SANDO-GOYA

The hot spring "Sando-goya-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken. 1911.
Specific gravity: 1,0005 at 15° C. Temperature: 52° C. (air temp. 18° C.)
Total residue: ca. 0,59. Flow of water: ca. 1800 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride (NaCl)	0,0031	Alumina (Al_2O_3)	0,0014
Sodium sulphate (Na_2SO_4)	0,1837	Silica (SiO_2)	0,3385
Sodium carbonate (Na_2CO_3)	0,0084		0,5973
Calcium sulphate ($CaSO_4$)	0,0006	Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,1449
Magnesium carbonate ($MgCO_3$)	0,0578		0,7422
Ferrous carbonate ($FeCO_3$)	0,0038		

Besides these trace of phosphoric acid.
The spring may be classified as "**simple thermal**".

Composition of the sinter-deposit (analysed in 1912).

In 100 parts of the yellowish powder are found as main constituents:

Sulphur	92,10	Iron oxide, alumina and silica	small quantity
Ignition loss	1,34		
Water	4,20		
	97,64		

Table 34.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1 (Yumoto)	Shika-no-yu (*Public bath*)	acid hydrogen sulphide vitriol	74,5°	ca. —	**0,41**	13,9°	K.&L.	37,57	Nov. 7, 1913	Y. Kinugasa, T. Saitō
2 (Yumoto)	Komatsu-no-yu	acid hydrogen sulphide	43,0°	—	**0,56**	13,8°	„	23,47	„	„
3 (Yumoto)	Kiraku-no-yu	hydrogen sulphide	28,0°	—	**1,08**	13,0°	„	6,31	„	„
4 (Yumoto)	Taki-no-yu (*Public bath*)	„ (?)	74,0°	—	**0,73**	13,8°	„	37,28	„	„
5	Takaomata-no-yu	sulphur	34,0°	—	—	—	—	—	—	—
6 (Kita)	Ai-no-yu	simple	54,0°	—	**1,15**	15,3°	K.&L.	5,55	Nov. 7, 1913	Y. Kinugasa, T. Saitō
7 (Kita)	Tengu-no-yu	„	53,5°	—	—	—	—	—	—	—
8 (Kita)	Izumi-no-yu	„	51,0°	—	—	—	—	—	—	—
9 (Dai-maruzuka Benten)	Kawa-no-yu	„	54,0°	—	**2,07**	10,2°	K.&L.	8,13	Nov. 7, 1913	Y. Kinugasa, T. Saitō
10 (Dai-maruzuka Benten)	Ai-no-yu	„	48,0°	—	—	—	—	8,05	„	„
11 (Dai-maruzuka Benten)	Sakura-no-yu	„	71,0°	—	**0,42**	13,4°	K.&L.	6,46	„	„
12 (Dai-maruzuka Benten)	Ai-no-yu	„	61,5°	—	—	—	—	6,72	„	„
13 (Dai-maruzuka Benten)	Sando-goya-Onsen	„	52,0°	1800	—	—	—	—	—	—
14	Itamuro-no-yu	„	38,0°	540	—	—	—	—	—	—

SHIOBARA

Location.—Shiobara-mura, Shioya-gun, Province Shimozuke, Tochigi-ken.

ŌAMI

The springs issue from the Tertiary.

The hot spring "Ishi-ai-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1912. Specific gravity: 1,0018 at 15° C.

Temperature: 57,5° C. Total residue: ca. 1,49.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,00838	0,21405	0,21405
Sodium ion ($Na^{\cdot}$)	0,28606	12,41041	**12,41041**
Ammonium ion ($NH_4^{\cdot}$)	0,00212	0,11726	0,11726
Calcium ion ($Ca^{\cdot\cdot}$)	0,14571	3,64275	7,28550
			20,02722

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0160
Sodium chloride ($NaCl$)	0,0328
Ammonium chloride (NH_4Cl)	0,0063
Sodium sulphate (Na_2SO_4)	0,8422
Calcium sulphate ($CaSO_4$)	0,4411

Anions.			
Chlorine ion (Cl')	0,03164	0,89252	0,89252
Sulphate ion (SO_4'')	0,88050	9,16615	**18,33230**
Hydrocarbonate ion (HCO_3')	0,04895	0,80233	0,80233
	1,40336	27,24547	20,02715
Boric acid (meta) (HBO_2). .	0,00851		
Silicic acid (meta) (H_2SiO_3).	0,09218		
	1,50405		
Free carbon dioxide (CO_2) .	0,06501 . . 1,47750		
	1,56906		

Calcium bicarbonate [$Ca(HCO_3)_2$].	0,0649
Boric acid (meta) (HBO_2)	0,0085
Silicic acid (meta) (H_2SiO_3)	0,0922
	1,5040
Free carbon dioxide (CO_2) . .	0,0650
	1,5690

The spring thus may be classified as "**saline bitter spring**".

Radio-activity. **4,15** Mache's units in 1 litre of water at 8,0° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 10, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 16,19$.

FUKUWATA

The springs issue from the Tertiary Tuff.

The hot spring "Hadaka-no-yu"

Analysis.

Analysed by the Yokohama Imperial Hygienic Laboratory. 1887. Specific gravity: 1,0014 at 15° C.
Temperature: 50° C. Total residue: ca. 1,41.

In 1 kilogram of the mineral water are contained:

	Grams
Sodium chloride ($NaCl$).	0,7840
Potassium sulphate (K_2SO_4)	0,0653
Sodium sulphate (Na_2SO_4).	0,1460
Sodium carbonate (Na_2CO_3)	0,0326
Calcium carbonate ($CaCO_3$).	0,2655
Magnesium carbonate ($MgCO_3$)	0,0212
Ferrous carbonate $Fe(CO_3)$	0,0015
Alumina (Al_2O_3)	0,0020
Silica (SiO_2).	0,0720
	1,3901
Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,5544
	1,9445

Besides these trace of lithium, strontium, manganese, bromine, iodine, and nitric, phosphoric and boric acid, and organic substances.

The spring may be classified as "**common salt spring**".

Radio-activity. **5,76** Mache's units in 1 litre of water at 12,6° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 8, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 19,63$.

The hot spring "Hie-no-yu"

Analysis.

Analysed by the Yokohama Imperial Hygienic Laboratory. 1887. Specific gravity: 1,0019 at 15° C.
Temperature: 50° C. Total residue: ca. 2,36.

The spring, being in its composition nearly the same as that of "Hadaka-no-yu", may be classified as "**common salt spring**".

Radio-activity. **1,42** Mache's units in 1 litre of water at 9,8° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 8, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 30,16$.

SHIONOYU

The springs issue from the Tertiary Tuff.

The hot spring "Naka-no-yu"

Analysis.

Analysed by the Yokohama Imperial Hygienic Laboratory. 1887. Specific gravity: 1,0029 at 15° C.

Temperature: 71,5° C. Total residue: ca. 3,84.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	0,1114
Sodium chloride (NaCl)	2,3271
Potassium sulphate (K_2SO_4)	0,6645
Calcium chloride ($CaCl_2$)	0,0997
Calcium carbonate ($CaCO_3$)	0,4240
Magnesium carbonate ($MgCO_3$)	0,0386
Ferrous carbonate ($FeCO_3$)	0,0100
Alumina (Al_2O_3)	0,0048
Silica (SiO_2)	0,1306
	3,8059
Carbon dioxide (free and in form of bicarbonates (CO_2)	0,4958
	4,3017

Besides these trace of lithium, strontium, manganese, bromine, iodine, and phosphoric and boric acid, and organic substances.

The spring may be classified as "**common salt spring**".

Radio-activity. 0,87 Mache's units in 1 litre of water at 12,5° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 9, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 51,00$.

HATAORI

The springs issue from the Tertiary.

Analysis of the spring water (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1901. Total residue: ca. 1,35.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0260	0,6641	0,6641
Sodium ion ($Na^{\cdot}$)	0,4028	17,4751	**17,4751**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0571	1,4240	2,8480
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0144	0,5911	1,1824
			22,1694
Anions.			
Chlorine ion (Cl')	0,3780	10,6629	**10,6629**
Sulphate ion (SO_4'')	0,0599	0,6236	1,2472
Hydrocarbonate ion (HCO_3')	0,6261	10,2623	**10,2623**
	1,5643	41,7031	22,1724
Silicic acid (meta) (H_2SiO_3)	0,1716		
	1,7359		
Free carbon dioxide (CO_2)	0,5569	12,6568	
	2,2928		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,6238
Potassium sulphate (K_2SO_4)	0,0580
Sodium sulphate (Na_2SO_4)	0,0413
Sodium bicarbonate ($NaHCO_3$)	0,5234
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,2312
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0866
Silicic acid (meta) (H_2SiO_3)	0,1716
	1,7359
Free carbon dioxide (CO_2)	0,5569
	2,2928

Besides these trace of lithium, ferrous, manganous, aluminium, bromine, iodine and hydrophosphate ion, boric acid, and organic substances.

The spring thus may be classified as "**muriated alkaline spring**".

SUMAKI

The springs issue from the Tertiary.

The hot spring "Taki-no-yu"

Analysis.

Analysed by the Yokohama Imperial Hygienic Laboratory. 1887. Specific gravity: 1,0011 at 15° C.

Temperature: 62,5° C. Total residue: ca. 0,78.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,0097	Alumina	0,0012
Sodium chloride ($NaCl$)	0,2849	Silica (Al_2O_3)	0,1660
Potassium sulphate (K_2SO_4)	0,0575		0,7900
Sodium carbonate (Na_2CO_3)	0,0352	Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,3161
Calcium carbonate ($CaCO_3$)	0,1763		1,1061
Magnesium carbonate ($MgCO_3$)	0,0573		
Ferrous carbonate ($FeCO_3$)	0,0019		

Besides these trace of lithium, strontium, manganese, bromine, iodine, phosphoric acid, boric acid and organic substances.

The spring may be classified as "simple thermal".

Radio-activity. **0,91** Mache's units in 1 litre of water at 9,6° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 10, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 11{,}44$.

MONZEN

The springs issue from the Tertiary.

The hot spring "Kawara-no-yu"

Analysis.

Analysed by the Yokohama Imperial Hygienic Laboratory. 1887. Specific gravity: 1,0012 at 15° C.

Temperature: 54° C. Total residue: ca. 1,33.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,0715	Alumina (Al_2O_3)	0,0010
Sodium chloride ($NaCl$)	0,6745	Silica (SiO_2)	0,2105
Potassium sulphate (K_2SO_4)	0,0051		1,4216
Sodium carbonate (Na_2CO_3)	0,0149	Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,5102
Calcium carbonate ($CaCO_3$)	0,2210		1,9318
Magnesium carbonate ($MgCO_3$)	0,1221		
Ferrous carbonate ($FeCO_3$)	0,0024		

Besides these trace of lithium, strontium, manganese, bromine, iodine, and nitric, phosphoric and boric acid, and organic substances.

The spring may be classified as "common salt spring".

Radio-activity. **0,79** Mache's units in 1 litre of water at 12,0° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 9, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 21{,}01$.

The hot spring "Jirakubō-no-yu"

Analysis.

Analyst: Unknown. Specific gravity: 1,0015 at 15° C.
Temperature: 50° C. Total residue: ca. 1 48.

The spring, being in its composition nearly the same as that of "Kawara-no-yu", may be classified as "common salt spring".

Radio-activity. **1,03** Mache's units in 1 litre of water at 12,1° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 9, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 16{,}09$.

FURUMACHI

The springs issue from the Tertiary.

The hot spring "Gosho-no-yu"

Analysis.

Analysed by the Yokohama Imperial Hygienic Laboratory. 1887. Specific gravity: 1,0013 at 15° C.
Temperature: 51,5° C. Total residue: ca. 1,16.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride (NaCl)	0,2564	Alumina (Al_2O_3)	0,0006
Potassium sulphate (K_2SO_4)	0,1037	Silica (SiO_2)	0,1778
Sodium sulphate (Na_2SO_4)	0,0167		1,2021
Sodium carbonate (Na_2CO_3)	0,4977	Carbon dioxide (free and in form of bicarbonates (CO_2)	0,4080
Calcium carbonate ($CaCO_3$)	0,1023		1,6101
Magnesium carbonate ($MgCO_3$)	0,0466		
Ferrous carbonate ($FeCO_3$)	0,0003		

Besides these trace of lithium, strontium, manganese, bromine, iodine, and nitric, phosphoric and boric acid, and organic substances.

The spring may be classified as "alkaline spring".

Radio-activity. **0,72** Mache's units in 1 litre of water at 12,1 °C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 9, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 14{,}54$.

Composition of the sinter-deposit (analysed in 1908).

Sample 1.

In 100 parts of the grayish coarse grain, slightly soluble in water with a strong acid reaction, are found as soluble constituents:

Free sulphuric acid	10,270 pts.	Calcium oxide	small quantity
Sulphates	0,789 ,,	Potassium oxide	faint quantity
Iron oxide and alumina	0,680 ,,	Sodium oxide	faint quantity
Ignition loss	1,940 ,,	Magnesia	faint quantity
		Chlorine	trace

Sample 2.

In 100 parts of the brownish coarse grain, almost soluble in water with a strong acid reaction, are found:

Insoluble part	20,866 pts.		
Soluble part	79,134 pts.	CaO	0,600 pts.
		Fe_2O_3	4,320 ,,
		Al_2O_3	6,480 ,,
		SO_3	28,465 ,,

Table 35.

No.		Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\times 8 \times 10^{-4}$	Date when the water was taken	Examined by
1	Ōami	Ishi-ai-no-yu	saline bitter	57,5°	4,15	8,0°	K.&L.	16,19	Nov. 10, 1913	Y. Kinugasa, T. Saitō
2	Ōami	Kawara-no-yu	"	55,0°	4,11	8,9°	"	15,51	"	"
3	Fukuwata	Hadaka-no-yu *	common salt	50,0°	5,76	12,6°	"	19,63	" 8, "	"
4	Fukuwata	Hie-no-yu *	"	50,0°	1,42	9,8°	"	30,16	"	"
5	Fukuwata	Awa-no-yu *	"	44,5°	2,36	12,5°	"	25,98	" 9, "	"
6	Fukuwata	Iwa-no-yu *	"	48,0°	2,77	10,9°	"	26,71	"	"
7	Fukuwata	Fudō-no-yu	"	42,0°	—	—	—	—	—	—
8	Shiogama	Fukuwata-uchi-yu	"	—	—	—	—	—	—	—
9	Shiogama	Hashimoto-no-yu *	"	65,0°	—	—	—	—	—	—
10	Shionoyu	Naka-no-yu	"	71,5°	0,87	12,5°	K.&L.	51,00	Nov. 9, 1913	Y. Kinugasa, T. Saitō
11	Shionoyu	Iwa-no-yu	"	69,0°	1,11	12,5°	"	50,80	"	"
12	Shionoyu	Hie-no-yu	"	45,0°	—	—	—	41,16	"	"
13	Hataori	Moto-yu	muriated alkaline	65,0°	—	—	—	19,74	"	"
14	Hataori	Hato-no-yu *	"	57,0°	1,52	11,5°	K.&L.	—	"	"
15	Hataori	Mujina-no-yu *	"	63,5°	1,50	10,4°	"	33,35	"	"
16	Hataori	Hie-no-yu	"	70,0°	—	—	—	—	—	—
17	Hataori	Kawara-no-yu	"	55,0°	—	—	—	—	—	—
18	Sumaki	Taki-no-yu	simple	62,5°	0,91	9,6°	K.&L.	11,44	Nov. 10, 1913	Y. Kinugasa, T. Saitō
19	Monzen	Kawara-no-yu *	common salt	54,0°	0,79	12,0°	"	21,01	" 9, "	"
20	Monzen	Jirakubō-no-yu *	"	50,0°	1,03	12,1°	"	16,09	"	"
21	Monzen	Hana-no-yu	earth-muriated alkaline	—	—	—	—	—	—	—
22	Furumachi	Gosho-no-yu *	alkaline	51,5°	0,72	12,1°	K.&L.	14,54	Nov. 9, 1913	Y. Kinugasa, T. Saitō
23	Furumachi	Asahi-no-yu *	—	48,3°	1,07	11,6°	"	5,33	"	"
24	Furumachi	Takara-no-yu	—	42,0°	0,77	12,1°	"	7,62	"	"
25	Furumachi	Fudō-no-yu	alkaline	60,0°	—	—	—	—	—	—
26	Furu-yumoto	Kajiwara-no-yu	muriated alkaline	—	—	—	—	—	—	—

* These springs are for public use.

NIKKŌ-YUMOTO

Location.—Nikkō-machi, Kami-tsuga-gun, Province Shimozuke, Tochigi-ken.

The springs issue from the Quartz Porphyry.

The hot spring "Gosho-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Temperature: 66° C. Total residue: ca 1,20.

In 1 kilogram of the mineral water are contained :

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0269	0,6871	0,6871
Sodium ion ($Na^{\cdot}$)	0,1452	6,2993	6,2993
Calcium ion ($Ca^{\cdot\cdot}$)	0,1535	3,8279	7,6558
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0061	0,2504	0,5008
			15,1430
Anions.			
Chlorine ion (Cl')	0,0788	2,2228	2,2228
Sulphate ion (SO_4'')	0,5843	6,0827	12,1654
Hydrocarbonate ion (HCO_3')	0,0452	0,7409	0,7409
	1,0400	20,1111	15,1291
Silicic acid (meta) (H_2SiO_3)	0,1168		
	1,1568		
Free carbon dioxide (CO_2)	not determined		
Free hydrogen sulphide (H_2S)	0,0500		
	1,2068		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram :

	Grams
Sodium chloride ($NaCl$)	0,1300
Potassium sulphate (K_2SO_4)	0,0600
Sodium sulphate (Na_2SO_4)	0,2900
Calcium sulphate ($CaSO_4$)	0,4700
Magnesium sulphate ($MgSO_4$)	0,0300
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0600
Silicic acid (meta) (H_2SiO_3)	0,1168
	1,1568
Free carbon dioxide (CO_2)	not determined
Free hydrogen sulphide (H_2S)	0,0500
	1,2068

The spring thus may be classified as "**hydrogen sulphide spring**".

Radio-activity. 1,58 Mache's units in 1 litre of water at 7,0° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 12, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 12,45$.

The hot spring "Ara-yu"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken. 1912. Specific gravity: 1,0010 at 15° C.
Temperature: 69° C. Total residue: ca. 1,16.

In 1 kilogram of the mineral water are contained:

	Grams
Sodium chloride ($NaCl$)	0,1160
Potassium sulphate (K_2SO_4)	0,0429
Sodium sulphate (Na_2SO_4)	0,0302
Sodium carbonate (Na_2CO_3)	0,1111
Calcium sulphate ($CaSO_4$)	0,6552
Magnesium carbonate ($MgCO_3$)	0,0317
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,0058
Silica (SiO_2)	0,1653
	1,1582
Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,1749
Free hydrogen sulphide (H_2S)	0,0289
	1,3620

Besides these a very small quantity of phosphoric acid, trace of iodine and organic substances.

The spring may be classified as "**hydrogen sulphide spring**".

Radio-activity. 0,88 Mache's units in 1 litre of water at 9,2° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 12, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 12,25$.

The hot spring "Tsuru-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken. 1912. Specific gravity: 1,0013 at 15° C.
Temperature: 62° C. Total residue: ca. 0,88.

The spring, being in its composition nearly the same as that of "Ara-yu", may be classified as "**hydrogen sulphide spring**".

Radio-activity. 2,08 Mache's units in 1 litre of water at 8,1° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 12, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = 11,87$.

The hot spring "Kawara-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Tochigi-ken. 1912. Specific gravity: 1,0017 at 15° C.
Temperature: 64° C. Total residue: ca. 1,44.

The spring, being in its composition nearly the same as that of "Ara-yu", may be classified as "**hydrogen sulphide spring**".

Radio-activity. **1,73** Mache's units in 1 litre of water at 8,4° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 12, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{12{,}72}$.

Table 36.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water		Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
				in Mache's units	at (temp. in C.)				
1	Gosho-no-yo *	hydrogen sulphide	66,0°	**1,58**	7,0°	K. & L.	12,45	Nov. 12, 1913	Y. Kinugasa, T. Saitō
2	Ara-yu	„	69,0°	**0,88**	9,2°	„	12,25	„	„
3	Tsuru-no-yu *	„	62,0°	**2,08**	8,1°	„	11,87	„	„
4	Kawara-no-yu *	„	64,0°	**1,73**	8,4°	„	12,72	„	„
5	Donsu-no-yu *	„	42,5°	**0,72**	7,8°	„	11,12	„	„
6	Naka-no-yu *	„	49,0°	—	—	—	—	—	—
7	Uba-no-yu	„	65,0°	—	—	—	—	—	—
8	Taki-no-yu *	„	22,0°	—	—	—	9,26	Nov. 12, 1913	Y. Kinugasa, T. Saitō
9	Tade-no-yu	„	56,0°	—	—	—	—	—	—
10	Sasa-no-yu *	„	62,7°	—	—	—	—	—	—

* These springs are for public use.

KUSATSU

Location.—Kusatsu-machi, Agatsuma-gun, Province Kōzuke, Gumma-ken.

The springs issue from the Volcanic Detritus.

The hot spring "Yubatake-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1913.

Specific gravity: 1,0032 at 18° C. Temperature: 58° C.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Hydrogen ion ($H^{\cdot}$)	0,03086	30,55446	**30,55446**
Potassium ion ($K^{\cdot}$)	0,01703	0,43499	0,43499
Sodium ion ($Na^{\cdot}$)	0,03670	1,59219	1,59219
Ammonium ion ($NH_4^{\cdot}$)	0,00106	0,05863	0,05863
Calcium ion ($Ca^{\cdot\cdot}$)	0,09967	2,49175	4,98350
Magnesium ion ($Mg^{\cdot\cdot}$)	0,03271	1,34278	2,68556
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,11444**	2,04357	4,08714
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,17022	6,28118	**18,84354**
			63,24001
Anions.			
Chlorine ion (Cl')	0,64573	18,21523	18,21523
Hydrosulphate ion (HSO_4')	2,14506	22,09807	22,09807
Sulphate ion (SO_4'')	1,09275	11,37570	**22,75140**
Hydrophosphate ion (HPO_4'')	0,00860	0,08957	0,17914
	4,39483	96,57812	63,24384
Boric acid (meta) (HBO_2)	0,01502		
Silicic acid (meta) (H_2SiO_3)	0,24978		
	4,65963		
Free hydrogen sulphide (H_2S)	**0,00546**		
	4,66509		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0325
Sodium chloride (NaCl)	0,0932
Ammonium chloride (NH_4Cl)	0,0031
Calcium chloride ($CaCl_2$)	0,2763
Magnesium chloride ($MgCl_2$)	0,1279
Ferrous sulphate ($FeSO_4$)	0,3107
Aluminium phosphate [$Al_2(HPO_4)_3$]	0,0102
Aluminium sulphate [$Al_2(SO_4)_3$]	1,0651
Free hydrochloric acid (HCl)	0,3085
Free sulphuric acid (H_2SO_4)	2,1674
Boric acid (meta) (HBO_2)	0,0150
Silicic acid (meta) (H_2SiO_3)	0,2498
	4,6597
Free hydrogen sulphide (H_2S)	0,0055
	4,6652

The spring thus may be classified as "**acid hydrogen sulphide alum vitriol spring**".

Radio-activity. **0,13** Mache's units in 1 litre of water at 14° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, April 8, 1913).
0,83 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, April 5, 1913).

The hot spring "Takino-moto-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Temperature: 64,4° C. Total residue: ca. 5,60.

The spring, being in its composition nearly the same as that of "Yubatake-no-yu", may be classified as "**acid hydrogen sulphide alum vitriol spring**".

The hot spring "Kunshi-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1888.

Specific gravity: 1,0019 at 25° C. Total residue: ca. 2,38.

The spring, being in its composition nearly the same as that of "Yubatake-no-yu", may be classified as "**acid hydrogen sulphide alum vitriol spring**".

The hot spring "Washi-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Temperature: 60° C. Total residue: ca. 4,09.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Hydrogen ion ($H^{\cdot}$)	0,0444	43,9603	**43,9603**
Sodium ion ($Na^{\cdot}$)	0,0778	3,3753	3,3753
Calcium ion ($Ca^{\cdot\cdot}$)	0,1885	4,7007	9,4014
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0466	1,9130	3,8260
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0989**	1,7692	3,5384
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0034	0,1255	0,3765
			64,4779
Anions.			
Chlorine ion (Cl')	0,7252	20,4513	20,4513
Hydrosulphate ion (HSO_4')	2,2633	23,3162	23,3162
Sulphate ion (SO_4'')	0,9871	10,2759	**20,5518**
	4,4352	109,8874	64,3193

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium sulphate (Na_2SO_4)	0,2400
Calcium sulphate ($CaSO_4$)	0,6389
Magnesium sulphate ($MgSO_4$)	0,2331
Ferrous sulphate ($FeSO_4$)	0,2688
Aluminium sulphate [$Al_2(SO_4)_3$]	0,0215
Free hydrochloric acid (HCl)	0,7461
Free sulphuric acid (H_2SO_4)	2,2868
	4,4352

Besides these trace of hydrophosphate ion and organic substances.

The spring thus may be classified as "**acid vitriol spring**".

Radio-activity. **0,13** Mache's units in 1 litre of water at 17,5° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, April 9, 1913).
1,37 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, April 6, 1913).

The hot spring "Goza-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Specific gravity: 1,001 at 15° C.
Temperature: 53,9° C. Total residue: ca. 4,71.

The spring, being in its composition nearly the same as that of "Washi-no-yu", may be classified as "**acid vitriol spring**".

The hot spring "Saino-kawara-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1913. Specific gravity 1,0028 at 19° C.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Hydrogen ion ($H^{\cdot}$)	0,02790	27,62376	**27,62376**
Potassium ion ($K^{\cdot}$)	0,01254	0,32031	0,32031
Sodium ion ($Na^{\cdot}$)	0,03459	1,50065	1,50065
Ammonium ion ($NH_4^{\cdot}$)	0,00106	0,05863	0,05863
Calcium ion ($Ca^{\cdot\cdot}$)	0,08263	2,06575	4,13150
Magnesium ion ($Mg^{\cdot\cdot}$)	0,02923	1,19991	2,39982
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,11169**	1,99446	3,98892
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,15019	5,54207	**16,62621**
			56,64980
Anions.			
Chlorine ion (Cl')	0,55722	15,71848	15,71848
Hydrosulphate ion (HSO_4')	1,97131	20,30813	20,30813
Sulphate ion (SO_4'')	0,98697	10,27452	**20,54904**
Hydrophosphate ion (HPO_4'')	0,00343	0,03573	0,07146
	3,96876	86,64240	56,64711
Boric acid (meta) (HBO_2)	0,01132		
Silicic acid (meta) (H_2SiO_3)	0,21493		
	4,19501		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0239
Sodium chloride ($NaCl$)	0,0878
Ammonium chloride (NH_4Cl)	0,0031
Calcium chloride ($CaCl_2$)	0,2291
Magnesium chloride ($MgCl_2$)	0,1143
Ferrous sulphate ($FeSO_4$)	0,3033
Aluminium phosphate [$Al_2(HPO_4)_3$]	0,0041
Aluminium sulphate [$Al_2(SO_4)_3$]	0,9449
Free hydrochloric acid (HCl)	0,2664
Free sulphuric acid (H_2SO_4)	1,9918
Boric acid (meta) (HBO_2)	0,0113
Silicic acid (meta) (H_2SiO_3)	0,2140
	4,1949

Besides these trace of hydrogen sulphide.

The spring thus may be classified as "**acid alum vitriol spring**".

The hot spring "Jizō-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Temperature: 56,5° C. (air temp. 11,2° C.). Total residue ca. 4,72.

The spring, being in its composition nearly the same as that of "Saino-kawara-no-yu", may be classified as **"acid alum vitriol spring"**.

Radio-activity. **0,14** Mache's units in 1 litre of water at 15° C.

0,65 Mache's units in 1 litre of gas at 0° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, April 5, 1913).

The hot spring "Netsu-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Temperature: 56° C. (air temp. 10,1° C.). Total residue: ca. 4,57.

The spring, being in its composition nearly the same as that of "Saino-kawara-no-yu", may be classified as **"acid alum vitriol spring"**.

Radio-activity. **0,16** Mache's units in 1 litre of water at 17,7° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, April 8, 1913).

0,70 Mache's units in 1 litre of gas at 0° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, April 6, 1913).

The hot spring "Shirane-san-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1891.

Specific gravity: 1,0109 at 15° C. Total residue. ca. 7,25.

The spring, being in its composition nearly the same as that of "Saino-kawara-no-yu", may be classified as **"acid alum vitriol spring"**.

Composition of the sinter-deposit (analysed in 1911).

100 parts of the yellowish sinter-deposit consist of:

Soluble in water		Insoluble in water	
Total soluble matters	0,430 pts.	Sulphur	94,42 pts.
of which		Silica (SO_2)	2,34 ,,
Free acids (as H_2SO_4)	0,098 ,,	Fe_2O_3, Al_2O_3, MgO, CaO	2,01 ,,

Composition of the gas (analysed in 1913).

1000 c.c. of gas* evolving from the spring consist of:

	Shirahata-no-yu	Netsu-no-yu	Jizō-no-yu.
CO_2	730 c.c.	550 c.c.	670 c.c.
O_2	20 ,,	75 ,,	not determined
Hydrocarbons and nitrogen	not determined	not determined	,,

* The analysis is not accurate, the numbers giving only the approximate value.

Table 37.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Yubatake-no-yu	acid hydrogen sulphide alum vitriol	58,0° (air temp. 10,9°)	0,13	14,0°	K. & L.	Apr. 8. 1913	Dr. R. Ishizu
2	Takino-moto-yu	„	64,4°	—	—	—	—	—
3	Kunsiri-no-yu	„	—	—	—	—	—	—
4	Washi-no-yu	acid vitriol	60,0°	0,13	17,5°	K. & L.	Apr. 9, 1913	Dr. R. Ishizu
5	Jizō-no-yu	acid alum vitriol	56.5° (11,2°)	0,14	15.0°	„	„ 5. „	„
6	Goza-no-yu	acid vitriol	63.9°	—	—	—	—	—
7	Saino-kawara-no yu (*Shimo-no-yu*	acid alum vitriol	43.0° (13,7°)	0,18	20.0°	K. & L.	Apr. 7, 1913	Dr. R. Ishizu
8	„ *Kami-no-yu*)	„	49.5° (11,5°)	0,30	29,0°	„	„	„
9	Netsu-no-yu	„	56.0° (10,1°)	0,16	17,7°	„	„ 8. „	„
10	Shirane-san-no-yu	„	—	—	—	—	—	—
11	Shirahata-no-yu	—	58,0° (10,9°)	0,22	18,0°	K. & L.	Apr. 9, 1913	Dr. R. Ishizu
12	Chiyo-no-yu	—	56,0°	0,17	18.0°	„	„ 6. „	„
13	Drinking water	—	—	0,03	10,0°	„	„ 3. „	„
	Gas evolving from:			Emanation per litre of gas at 0° C.			Date when the gas was collected	
1	Yubatake-no-yu	—	—	0,83	—	K. & L.	Apr. 5, 1913	Dr. R. Ishizu
2	Washi-no-yu	—	—	1,37	—	„	„ 6, „	„
3	Jizō-no-yu	—	—	0,65	—	„	„ 5. „	„
4	Netsu-no-yu	—	—	0,70	—	„	„ 6, „	„
5	Shirahata-no-yu	—	—	0,66	—	„	„ 9, „	„
6	Chiyo-no-yu	—	—	0,71	—	„	„ 7, „	„

SHIMA

Location.—Sawada-mura, Agatsuma-gun, Province Kōzuke, Gumma-ken.

The springs issue from the Misaka Series.

The hot spring "Tokiwa-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1913.

Specific gravity: 1,0014 at 15° C. Temperature: 62° C.

Total residue: ca. 1,47. Flow of water: ca. 635 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,01738	0,44291	0,44291
Sodium ion ($Na^{\cdot}$)	0,28261	12,26073	12.26073
Ammonium ion ($NH_4^{\cdot}$)	0 00026	0,01438	0,01438
Calcium ion ($Ca^{\cdot\cdot}$)	0,16477	4,11925	8,23850
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00262	0,10755	0,21510
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00140	0,02500	0,05000
			21,22162

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram.

	Grams
Potassium chloride (KCl)	0,0331
Sodium chloride ($NaCl$)	0,7173
Ammonium chloride (NH_4Cl)	0,0008
Calcium chloride ($CaCl_2$)	0,0787
Calcium sulphate ($CaSO_4$)	0,4539
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0119
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0158

Anions.

Chlorine ion (Cl')	0,50122	14,13879	**14,13879**
Sulphate ion (SO_4'')	0,32048	3,33625	**6,67250**
Hydrocarbonate ion (HCO_3')	0,02503	0,41026	0,41026
	1,31577	34,85512	21,22155
Boric acid (meta) (HBO_2). .	0,05667		
Silicic acid (meta) (H_2SiO_3).	0,10891		
	1,48135		
Free carbon dioxide (CO_2) .	0,04995 . .	1,13523	
	1,53130		

Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0045
Boric acid (meta) (HBO_2)	0,0567
Silicic acid (meta) (H_2SiO_3)	0,1089
	1,4816
Free carbon dioxide (CO_2).	0,0500
	1,5316

The spring thus may be classified as "**sulphated common salt spring**".

Radio-activity. **0,82** Mache's units in 1 litre of water at 10,5° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō; Nov. 15, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{18{,}66}$.

The hot spring "Iwane-no-yu"

Analysis.

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Temperature: 83,5° C.

Flow of water: ca. 526 hectolitres in 24 hours. Total residue: ca. 2,48.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	0,1349
Sodium chloride ($NaCl$)	1,4891
Sodium sulphate (Na_2SO_4)	0,1137
Magnesium chloride ($MgCl_2$).	0,0210
Calcium sulphate ($CaSO_4$).	0,5865
Silica (SiO_2).	0,1373
	2,4825

Besides these trace of iron.

The spring may be classified as "**common salt spring**".

Radio-activity. **1,27** Mache's units in 1 litre of water at 10,4° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 15, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{30{,}66}$.

Table 38.

No.		Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Yamaguchi	Tokiwa-no-yu	sulphated common salt	62,0°	ca. 635	**0,82**	10,5°	K. & L.	18,66	Nov. 15, 1913	Y. Kinugasa, T. Saitō
2		Shinkoku-tō	salt	55,0°	311	**0,87**	10,5°	,,	19,74	,,	,,
3		Tsubame-no-yu	,,	59,0°	311	—	—	—	—	—	—
4		Ōtaki-no-yu	,,	54,0°	234	—	—	—	—	—	—
5		Shio-no-yu	,,	58,5°	94	—	—	—	20,00	Nov. 15, 1913	Y. Kinugasa, T. Saitō
6		Meiji-no-yu	,,	67,0°	208	—	—	—	—	—	—
7	Shin-yu	Shio-no-yu (*Sekizen-kwan*)	,,	74,0°	524	**0,82**	11,7°	K. & L.	28,47	Nov. 15, 1913	Y. Kiuugasa, T. Saitō
8		Furō-sen	,,	74,0°	389	—	—	—	—	—	—
9		Iwane-no-yu	common salt	83,5°	526	**1,27**	10,4°	K. & L.	30,66	Nov. 15, 1913	Y. Kinugasa, T. Saitō
10		Shio-no-yu	salt	77,0°	138	—	—	—	—	—	—
11		Ryugu-no-yu	,,	84,0°	635	**0,64**	10,9°	K. & L.	34,05	Nov. 15, 1913	Y. Kinugasa, T. Saitō
12		Kawara-no-yu	,,	60,0°	285	—	—	—	—	—	—
13	Hinatami	Hinatami-no yu	,,	59,0°	2473	**0,43**	9,4°	K. & L.	10,80	Nov. 15, 1913	Y. Kinugasa, T. Saitō
14		Shimo-no-yu	,,	55,0°	156	—	—	—	10,22	—	,,

Corrigendum to P. 53 :—

This table of analysis is to be exchanged with the corresponding table which is misprinted.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	1,43430	36,63600	36,63600
Sodium ion ($Na^{\cdot}$)	9,82587	426,28503	**426,28503**
Ammonium ion ($NH_4^{\cdot}$)	0,00254	0,14049	0,14049
Calcium ion ($Ca^{\cdot\cdot}$)	0,26901	6,72525	13,45050
Magnesium ion ($Mg^{\cdot\cdot}$)	0,05976	2,45320	4,90640
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00410	0,07321	0,14642
			481,56484
Anions.			
Chlorine ion (Cl')	13,07537	368,83970	**368,83970**
Bromine ion (Br')	0,01133	0,14170	0,14170
Iodine ion (I')	0,00200	0,01577	0,01577
Hydrocarbonate ion (HCO_3')	6,86973	112,60067	**112,60067**
	31,55401	953,91102	481,59784
Boric acid (meta) (HBO_2)	0,99695		
Silicic acid (meta) (H_2SiO_3)	0,02279		
	32,57375		
Free carbon dioxide (CO_2)	**0,96555**	15,82609	
	33,53930		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	2,73304
Sodium chloride ($NaCl$)	19,42517
Sodium bromide ($NaBr$)	0,01460
Sodium iodide (NaI)	0,00236
Ammonium chloride (NH_4Cl)	0,00752
Sodium bicarbonate ($NaHCO_3$)	7,90974
Calcium bicarbonate [$Ca(HCO_3)_2$]	1,08955
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,35913
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,01303
Boric acid (meta) (HBO_2)	0,99695
Silicic acid (meta) (H_2SiO_3)	0,02279
	32,57388
Free carbon dioxide (CO_2)	0,96555
	33,53943

Anions.

Chlorine ion (Cl')	0,50122	14,13879	**14,13879**
Sulphate ion (SO_4'')	0,32048	3,33625	**6,67250**
Hydrocarbonate ion (HCO_3')	0,02503	0,41026	0,41026
	1,31577	34,85512	21,22155
Boric acid (meta) (HBO_2). .	0,05667		
Silicic acid (meta) (H_2SiO_3) .	0,10891		
	1,48135		
Free carbon dioxide (CO_2) .	0,04995 . .	1,13523	
	1,53130		

Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0045
Boric acid (meta) (HBO_2)	0,0567
Silicic acid (meta) (H_2SiO_3)	0,1089
	1,4816
Free carbon dioxide (CO_2).	0,0500
	1,5316

The spring thus may be classified as "**sulphated common salt spring**".

Radio-activity. **0,82** Mache's units in 1 litre of water at 10,5° C.
(Kohl.-Löw. fontact. ; Y. Kinugasa and T. Saitō ; Nov. 15, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} =$ **18,66.**

				Temp	Flow in in 1	Mache' i	a (temp.	Apparat	E conc $\varkappa_{1}$	Date water	Exan
1	Yamaguchi	Tokiwa-no-yu	sulphated common salt	62,0°	ca. 635	**0,82**	10,5°	K. & L.	18,66	Nov. 15, 1913	Y. Kinugasa, T. Saitō
2		Shinkoku-tō	salt	55,0°	311	**0,87**	10,5°	,,	19,74	,,	,,
3		Tsubame-no-yu	,,	59,0°	311	—	—	—	—	—	—
4		Ōtaki-no-yu	,,	54,0°	234	—	—	—	—	—	—
5		Shio-no-yu	,,	58,5°	94	—	—	—	20,00	Nov. 15, 1913	Y. Kinugasa, T. Saitō
6		Meiji-no-yu	,,	67,0°	208	—	—	—	—	—	—
7	Shin-yu	Shio-no-yu(*Sekizen-kwan*)	,,	74,0°	524	**0,82**	11,7°	K. & L.	28,47	Nov. 15, 1913	Y. Kinugasa, T. Saitō
8		Furō-sen	,,	74,0°	389	—	—	—	—	—	—
9		Iwane-no-yu	common salt	83,5°	526	**1,27**	10,4°	K. & L.	30,66	Nov. 15, 1913	Y. Kinugasa, T. Saitō
10		Shio-no-yu	salt	77,0°	138	—	—	—	—	—	—
11		Ryugu-no-yu	,,	84,0°	635	**0,64**	10,9°	K. & L.	34,05	Nov. 15, 1913	Y. Kinugasa, T. Saitō
12		Kawara-no-yu	,,	60,0°	285	—	—	—	—	—	—
13	Hinatami	Hinatami-no-yu	,,	59,0°	2473	**0,43**	9,4°	K. & L.	10,80	Nov. 15, 1913	Y. Kinugasa, T. Saitō
14		Shimo-no-yu	,,	55,0°	156	—	—	—	10,22	—	,,

ISOBE

Location.—Isobe-mura, Usui-gun, Province Kōzuke, Gumma-ken.

The springs issue from the Tertiary.

The cold spring "Isobe-Kōsen"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0249 at 10° C.
Total residue: ca. 26,91.

Temperature: 15,5° C. (air temp. 3° C.).
Flow of water: ca. 720 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,14313	3,66360	3,66360
Sodium ion ($Na^{\cdot}$)	9,82587	426,28503	**426,28503**
Ammonium ion ($NH_4^{\cdot}$)	0,00254	0,14049	0,14049
Calcium ion ($Ca^{\cdot\cdot}$)	0,26901	6,72525	13,45050
Magnesium ion ($Mg^{\cdot\cdot}$)	0,05976	2,45320	4,90640
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00410	0,07321	0,14642
			448,59244
Anions.			
Chlorine ion (Cl')	13,07537	368,83970	**368,83970**
Bromine ion (Br')	0,01133	0,14170	0,14170
Iodine ion (I')	0,00200	0,01577	0,01577
Hydroearbonate ion (HCO_3')	4,85816	79,62891	**79,62891**
	28,25157	887,96686	448,62608
Boric acid (meta) (HBO_2)	1,40515		
Silicic acid (meta) (H_2SiO_3)	0,02279		
	29,67951		
Free carbon dioxide (CO_2)	**2,41581**	54 90477	
	32,09532		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chlor'de (KCl)	0,2735
Sodium chloride ($NaCl$)	21,3537
Sodium bromide ($NaBr$)	0,0146
Sodium iodide (NaI)	0 0024
Ammonium chloride (NH_4Cl)	0,0075
Sodium bicarbonate ($NaHCO_3$)	3,7293
Calcium bicarbonate [$Ca(HCO_3)_2$]	1,0896
Magnesium bicarbc late [$Mg(HCO_3)_2$]	0,3591
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0130
Boric acid (meta) (HBO_2)	0,9970
Silicic acid (meta) (H_2SiO_3)	0,0228
	27,8625
Free carbon dioxide (CO_2)	2,4158
	03,2783

Besides these trace of nitrate and sulphate ion.

The spring thus may be classified as "**alkaline carbondioxated concentrated common salt spring**".

Radio-activity. **0,47** $\times 10^{-10}$ curies in 1 litre of water at 15,5° C.
0,13 Mache's units (recalculated). (Schmidt's electrom.: S. Hanzawa, Jan. 30, 1914).
1,41 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
0,39 Mache's units (recalculated). (Schmidt's electrom.; S. Hanzawa, Jan. 31, 1914).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{245{,}12}$.

The cold spring "Ji-no-yu"

Temperature: 9° C. (air temp. 2° C.).

Radio-activity. **3,78** $\times 10^{-10}$ curies in 1 litre of water at 9° C.
1,04 Mache's units (recalculated).
7,42 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
2,04 Mache's units (recalculated).
(Schmidt's electrom.; S. Hanzawa, Feb. 1, 1914).

Electric conductivity. $\varkappa_{18} \times 10^{-4} = \mathbf{34{,}83}$.

Table 39.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Isobe-Kōsen	alkaline carbondioxated concentrated common salt	air temp. 15,5° (3°)	ca. 720	**0,47**	**0,13**	15,5°	Schm.	Jan. 30, 1914	S. Hanzawa
2	Ji-no-yu	—	9,0° (2°)	—	**3,78**	**1,04**	9,0°	,,	Feb. 1, ,,	,,
3	Rokutanda-Kōsen §	alkaline	9,5° (9,5°)	7	—	**0,64*** **0,74†** **0,75‡**	9,0°	E. & S.	Jan. 30, ,,	S. Hanzawa, T. Saitō
4	Ushio-Kōsen §	—	8,0° (9°)	—	—	**0,91*** **1,05†** **1,07‡**	8,5°	,,	,,	,,
5	Yunosawa-Kōsen § (*Kongōji temple*)	—	7,5° (8°)	—	—	**0,82*** **0,95†** **0,97‡**	10,0°	,,	,,	,,
	Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Isobe-Kōsen	—	—	—	**1,41**	**0,39**	—	Schm.	Jan. 31, 1914	,,
2	Ji-no-yu	—	—	—	**7,42**	**2,04**	—	,,	Feb. 1, ,,	,,

* Determined according to the authors' original direction.
† Correction for the absorption of the radiation by the wall of the ionisation chamber was made.
‡ Correction for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was also made.
§ These springs are located in *Matsuida*, 4,1 m. W. from Isobe.

IKAO

Location.—Ikao-machi, Gumma-gun, Province Kōzuke, Gumma-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Nomi-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1903. Specific gravity: 1,0008 at 15° C.

Temperature: 46° C. Total residue: ca. 0,96.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0099	0,2529	0,2529
Sodium ion ($Na^{\cdot}$)	0,0892	3,8699	3,8699
Calcium ion ($Ca^{\cdot\cdot}$)	0,1224	3,0549	**6,1098**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0274	1,1248	2,2496
Ferrous iron ($Fe^{\cdot\cdot}$)	0,0076	0,1342	0,2684
Manganous ion ($Mn^{\cdot\cdot}$)	0,0017	0,0310	0,0620
			12,8126

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,0468
Potassium sulphate (K_2SO_4)	0,0220
Sodium sulphate (Na_2SO_4)	0,1007
Sodium bicarbonate ($NaHCO_3$)	0,1393
Magnesium chloride ($MgCl_2$)	0,1036
Calcium sulphate ($CaSO_4$)	0,2769
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,1646

Anions.			
Chlorine ion (Cl′)	0,1055	2,9760	2,9760
Sulphate ion (SO_4'')	0,2754	2,8670	5,7340
Hydrocarbonate ion (HCO_3')	0,2498	4,0944	4,0944
	0,8889	18,4051	12,8044
Silicic acid (meta) (H_2SiO_3)	0,2068		
	1,0957		
Free carbon dioxide (CO_2)	0,6757	15,3568	
	1,7714		

Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0053
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0242
Manganous bicarbonate [$Mn(HCO_3)_2$]	0,0055
Silicic acid (meta) (H_2SiO_3)	0,2068
	1,0957
Free carbon dioxide (CO_2)	0,6757
	1,7714

Besides these trace of aluminium, bromine, iodine, hydrophosphate ion and organic substances.

The spring thus may be classified as "**sulphated bitter spring**".

Radio-activity. **0,67** Mache's units in 1 litre of water at 10,1° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 14, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} =$ **10,28**.

The hot spring "Ohaguro-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1903. Specific gravity: 1,001 at 15° C.

Temperature: 47° C. Total residue: ca. 1,34.

The spring, being in its composition nearly the same as that of "Nomi-yu", may be classified as "**sulphated bitter spring**".

Radio-activity. **0,47** Mache's units in 1 litre of water at 11,0° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 14, 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} =$ **13,41**.

The hot spring "Ōseki-no-yu*"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1903.

Specific gravity: 1,0008 at 15° C. Temperature: 44,5° C.

Total residue: ca. 0,98. Flow of water: ca. 25400 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Nomi-yu", may be classified as "**sulphated bitter spring**".

Radio-activity. **0,37** Mache's units in 1 litre of water at 10,1° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Nov. 14 1913).

Electric conductivity. $\varkappa_{18} \times 10^{-4} =$ **10,36**.

Table 40.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Electric conductivity $\varkappa_{18} \times 10^{-4}$	Date when the water was taken	Examined by
1	Nomi-yu	sulphated bitter	46,0°	ca. —	**0,67**	10,1°	K.&L.	10,28	Nov. 14, 1913	Y. Kinugasa, T. Saitō
2	Ohaguro-yu	,,	47,0°	—	**0,47**	11,0°	,,	13,41	,,	,,
3	Ōseki-no-yu	,,	44,5°	25400	**0,37**	10,1°	,,	10,36	,,	,,
4	Fukiage-no-yu	,,	45,0°	—	**0,51**	9,9°	,,	10,53	,,	,,
5	Kurozeki-no-yu	,,	46,0°	—	—	—	—	11,03	,,	,,

* This is the name of hot water in a reservoir, into which all the springs of Ikao flow together.

YUJIKU

Location.—Niiharu-mura, Tone-gun, Province Kōzuke, Gumma-ken.

The springs issue from the Tertiary Tuff.

The hot spring "Sen-tō"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory, 1914. Specific gravity: 1,0007 at 19° C.
Temperature: 67° C. Total residue: ca. 1,42.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,01225	0,31289	0,31289
Sodium ion ($Na^{\cdot}$)	0,28531	12,37786	**12,37786**
Ammonium ion ($NH_4^{\cdot}$)	0,00042	0,02323	0,02323
Calcium ion ($Ca^{\cdot\cdot}$)	0,16417	4,10425	8,20850
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00044	0,01806	0,03612
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00035	0,00625	0,01250
			20,97110
Anions.			
Chlorine ion (Cl')	0,13095	3,69395	3,69395
Sulphate ion (SO_4'')	0,77710	8,08974	**16,17948**
Hydrocarbonate ion (HCO_3')	0,06697	1,09768	1,09768
	1,43796	29,72391	20,97111
Boric acid (meta) (HBO_2)	0,00710		
Silicic acid (meta) (H_2SiO_3)	0,06098		
	1,50604		
Free carbon dioxide (CO_2)	small quantity		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,02334
Sodium chloride ($NaCl$)	0,19644
Ammonium chloride (NH_4Cl)	0,00124
Sodium sulphate (Na_2SO_4)	0,64110
Calcium sulphate ($CaSO_4$)	0,48712
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,08489
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,00264
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00111
Boric acid (meta) (HBO_2)	0,00710
Silicic acid (meta) (H_2SiO_3)	0,06098
	1,50596

The spring thus may be classified as "**saline bitter spring**".

Radio-activity. **2,30** $\times 10^{-10}$ curies in 1 litre of water at 18,0° C.
(Schmidt's electrom.; M. Komori, April 29, 1914).
0,63 Mache's units (recalculated).
33,36 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
9,18 Mache's units (recalculated).
(Schmidt's electrom.; M. Komori, April 30, 1914).

Table 41.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Sen-tō	saline bitter	air temp. 67°	ca. —	**2,30**	**0,63**	18,0°	Schm	Apr. 29, 1914	M. Komori
2	Kubo-yu	„	79° (29°)	648	**2,56**	**0,70**	12,0°	„	„ 30, „	„
3	Kawaburi-yu	„	37,2°	—	**1,50**	**0,41**	13,5°	„	May 2, „	„
4	Ko-daki	„	47°	90	**2,90**	**0,80**	15,5°	„	„ 3, „	„
5	Ō-daki	„	50°	360	**3,11**	**0,86**	14,8°	„	„ 4, „	„
					Emanation per litre of gas at 0° C.				Date when the gas was collected	
—	Gas evolving from Sen-tō				**33,36**	**9,18**		„	Apr. 30, 1914	„

YUBISO—YUBARA

Location.—Minakami-mura, Tone-gun, Province Kōzuke, Gumma-ken.

The springs issue from the Granite.

The hot spring "Yubiso-no-yu" No. 2

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0001 at 16° C. Temperature: 88° C. (air temp. 26° C.).

Total residue: ca. 0,5. Flow of water: ca 974 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,00451	0,11520	0,11520
Sodium ion ($Na^{\cdot}$)	0,09000	3,90455	3,90455
Ammonium ion ($NH_4^{\cdot}$)	0,00026	0,01438	0,01438
Calcium ion ($Ca^{\cdot\cdot}$)	0,05214	1,30250	2,60500
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00022	0,00903	0,01806
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00070	0,01250	0,02500
			6,68219
Anions.			
Chlorine ion (Cl')	0,14650	4,13258	4,13258
Sulphate ion (SO_4'')	0,06295	0,65532	1,31064
Hydrocarbonate ion (HCO_3')	0,07568	1,24045	1,24045
	0,43296	11,38651	6,68367
Boric acid (meta) (HBO_2)	0,02838		
Silicic acid (meta) (H_2SiO_3)	0,08829		
	0,54963		
Free carbon dioxide (CO_2)	0,04542	1,03227	
	0,59505		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,00859
Sodium chloride ($NaCl$)	0,22843
Ammonium chloride (NH_4Cl)	0,00077
Calcium chloride ($CaCl_2$)	0,00546
Calcium sulphate ($CaSO_4$)	0,08916
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,09700
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,00132
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00223
Boric acid (meta) (HBO_2)	0,02838
Silicic acid (meta) (H_2SiO_3)	0,08829
	0,54963
Free carbon dioxide (CO_2)	0,04542
	0,59505

The spring thus may be classified as "**simple thermal**".

Radio-activity. **1,97** Mache's units in 1 litre of water at 19,5° C.

(Kohl.-Löw. fontact.; M. Komori and K. Matsubara, April 30, 1914)

Table 42.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at temp. in C.	Apparatus employed	Date when the water was taken	Examined by
	Yubiso								
1	Yubiso-no-yu *No. 1*	simple	81,0° (air temp. 26°)	ca. 972	**1,32**	19,0°	K.&L.	Apr. 30, 1913	M. Komori K. Matsubara
2	„ *No. 2*	„	88,0° (26°	—	**1,97**	19,5°	„	„	„
	Yubara								
3	Fujiya-no-yu	„	57,0° (21,5°)	—	**1,32**	17,5°	„	„	„
4	Ubukata-no-yu	„	51,5°	—	**0,89**	15,5°	„	„	„

IRINOYU

Location :—Sakamoto-machi, Usui-gun, Province Kōzuke, Gumma-ken.

The springs issue from the Pyroxene Andesite.

The hot spring "Iri-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1890.
Temperature: 37° C. (air temp. 1,5° C.).

Specific gravity: 1,0011 at 15° C.
Total residue: ca. 1,90.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0060	0,1533	0,1533
Sodium ion ($Na^{\cdot}$)	0,6250	27,1150	**27,1150**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0537	1,3392	2,6784
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0094	0,3859	0,7718
			30,7185
Anions.			
Chlorine ion (Cl')	0,9907	27,9464	**27,9464**
Sulphate ion (SO_4'')	0,1333	1,3877	2,7754
	1,8181	58,3275	30,7218
Silicic acid (meta) (H_2SiO_3)	0,0325		
	1,8506		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0039
Sodium chloride ($NaCl$)	1,5864
Potassium sulphate (K_2SO_4)	0,0089
Magnesium chloride ($MgCl_2$)	0,0368
Calcium sulphate ($CaSO_4$)	0,1821
Silicic acid (meta) (H_2SiO_3)	0,0325
	1,8506

Besides these trace of hydrophosphate ion.

The spring thus may be classified as "**common salt spring**".

Radio-activity. **0,77**‡ Mache's units in 1 litre of water at 4,8° C.

(Eng.-Siev. fontact.; S. Hanzawa and T. Saitō, Feb. 1, 1914).

Table 43.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Iri-no-yu	common salt	37,0° (air temp. 1,5°)	0,65 * 0,75 † 0,77 ‡	4,8°	E. & S.	Feb. 1, 1914	S. Hanzawa T. Saitō
2	Me-no-yu	"	33,5° (1,5°)	0,61 * 0,71 † 0,72 ‡	4,1°	"	"	"
3	Kaede-no-yu	"	31,5° (1,5°)	0,63 * 0,73 † 0,74 ‡	4,1°	"	"	"

* Determined according to the authors' original direction.
† Correction for the absorption of the radiation by the wall of the ionisation chamber was made.
‡ Correction for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was also made.

AKAGI-NASHIKI

Location.—Kurohone-mura, Seta-gun, Province Kōzuke, Gumma-ken.

The springs issue from the Volcanic Detritus.

The cold spring "Nashiki-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1908.

Specific gravity: 1,0022 at 15° C. Temperature: 20° C.
Total residue: ca. 2,25. Flow of water: ca. 195 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0525	1,3410	1,3410
Sodium ion ($Na^{\cdot}$)	0,4255	18,4599	**18,4599**
Calcium ion ($Ca^{\cdot\cdot}$)	0.1280	3,1920	6,3840
Magnesium ion ($Mg^{\cdot\cdot}$)	0,1392	5,7143	**11,4286**
			37,6135
Anions.			
Chlorine ion (Cl')	0,9241	26,0677	**26,0677**
Sulphate ion (SO_4'')	0,0211	0,2197	0,4394
Hydrocarbonate ion (HCO_3')	0,6801	11,1474	**11,1474**
	2,3705	66,1420	37,6545
Silicic acid (meta) (H_2SiO_3)	0,1298		
	2,5003		
Free carbon dioxide (CO_2)	0,7901	17,9568	
	3,2904		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,1000
Sodium chloride (NaCl)	1,0800
Calcium chloride ($CaCl_2$)	0,3300
Magnesium chloride ($MgCl_2$)	0,0150
Calcium sulphate ($CaSO_4$)	0,0300
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,8155
Silicic acid (meta) (H_2SiO_3)	0,1298
	2,5003
Free carbon dioxide (CO_2)	0,7901
	3,2904

Besides these trace of ferrous and aluminium ion.

The spring thus may be classified as "**earthy common salt spring**".

TOMOE

Location.—Tomoe-mura, Kashima-gun, Province Hitachi, Ibaraki-ken.

The springs issue from the Diluvium.

The cold spring "Tomoe-Kōsen" No. 1

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1911.

Specific gravity: 1,0012 at 21° C. Temperature: 16,9° C.
Total residue: ca. 3,34. Flow of water: ca. 270 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,03707	0,94687	0,94687
Sodium ion ($Na^{\cdot}$)	1,06633	46,26161	**46,26161**
Ammonium ion ($NH_4^{\cdot}$)	0,00159	0,08794	0,08794
Calcium ion ($Ca^{\cdot\cdot}$)	0,03786	0,94650	1,89300
Magnesium ion ($Mg^{\cdot\cdot}$)	0,06191	2,54146	5,08292
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00224	0,04000	0,08000
			54,35234

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,07064
Sodium chloride (NaCl)	2,66607
Ammonium chloride (NH_4Cl)	0,00471
Sodium sulphate (Na_2SO_4)	0,04903
Calcium sulphate ($CaSO_4$)	0,12878
Magnesium sulphate ($MgSO_4$)	0,10033
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,24981

Anions.

Chlorine ion (Cl')	1,65233	46,61016	**46,61016**
Sulphate ion (SO_4'')	0,20408	2,12451	4,24902
Hydrocarbonate ion (HCO_3')	0.21312	3.49320	3.49200
	3,27653	103,05225	54,35238
Silicic acid (meta) (H_2SiO_3).	0,06544		
	3,34197		
Free carbon dioxide (CO_2) .	0.02135 .	. 0,48523	
	3,36332		

Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00712
Silicic acid (meta) (H_2SiO_3).	0,06544
	3,34193
Free carbon dioxide (CO_2)	0,02135
	3,36328

Besides these a small quantity of boric acid.

The spring thus may be classified as "**common salt spring**".

Radio-activity. **4,72** $\times 10^{-10}$ curies in 1 litre of water at 19,8° C.

(Schmidt's electrom.; M. Komori, April 26, 1914).

1,30 Mache's units (recalculated).

TSUKUBA

Location.—Ishioka-machi, Niiharu-gun, Province Hitachi, Ibaraki-ken.

The springs issue from the Diluvium.

Table 44.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Well (*K. Hasegawa*)	—	16,0° (air temp. 13°)	ca. —	**1,10**	13,0°	K. & L.	Jan. 25, 1914	Dr. R. Ishizu, H. Yanagisawa
2	,, (*T. Hasegawa*)	—	17,0° (14°)	—	**0,49**	13,0°	,,	,,	,,
3	,, (*O. Nakazawa*)	—	14,0° (13,5°)	—	**0,55**	13,5°	,,	,,	,,
4	Spring *A* * (*Kankyo-zan*)	simple	14,0° (14°)	—	**0,28**	13,0°	,,	,,	,,
5	Shibu-ido *Ō-sen* †	—	16,0° (14°)	—	**0,95**	12,0°	,,	,, 26. ,,	,,
6	Tomoe-Kōsen ‡ *No. 1*	common salt	16,9°	**4,72**	**1,30**	19,8°	Schm.	Apr. 26, ,,	M. Komori
7	,, *No. 2*	,,	17,0°	**4,81**	**1,32**	18,6°	,,	,, 25. ,,	,,

* The spring issues from the Granite.
† The spring is located in *Tadate-mura*, 3 m. S. E. from *Ishioka*.
‡ Tomoe-Kōsen, located in *Tomoe-mura*, Kashima-gun, is grouped for convenience in this table.

MORIGASAKI

Location.—Ōmori-machi, Ebara-gun, Province Musashi, Tōkyō-fu.

The springs issue from the Alluvium.

The cold spring "Morigasaki-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1900.

Temperature: 17° C. (air temp. 18° C.). Total residue: ca. 6,08.

Flow of water: ca. 3370 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0866	2,2119	2,2119
Sodium ion ($Na^{\cdot}$)	1,5071	65,3882	**65,3882**
Calcium ion ($Ca^{\cdot\cdot}$)	0,3243	8,0923	**16,1846**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,2780	11,4121	**22,8242**
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0062	0,1109	0,2218
			106,8307
Anions.			
Chlorine ion (Cl')	3,6589	103,2147	**103,2147**
Hydrocarbonate ion (HCO_3')	0,2206	3,6158	3,6158
	6,0819	194,0459	106,8305
Silicic acid (meta) (H_2SiO_3)	0,0656		
	6,1475		
Free carbon dioxide (CO_2)	0,3956	8,9909	
	6,5431		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,1650
Sodium chloride (NaCl)	3,8250
Calcium chloride ($CaCl_2$)	0,8989
Magnesium chloride ($MgCl_2$)	0,9250
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,2482
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0198
Silicic acid (meta) (H_2SiO_3)	0,0656
	6,1475
Free carbon dioxide (CO_2)	0,3956
	6,5431

Besides these trace of sulphate and hydrophosphate ion

The spring thus may be classified as "**earth-muriated common salt spring**".

Radio-activity. **0,40** Mache's units in 1 litre of water at 15,8° C.

(Kohl.-Löw. fontact.; Dr R. Ishizu, Oct. 24, 1913).

ANAMORI

Location.—Haneda-machi, Ebara-gun, Province Musashi, Tōkyō-fu.

The springs issue from the Alluvium.

The cold spring "Anamori-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1896.

Temperature: 17° C. Total residue: ca. 9,38.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0897	2,2912	2,2912
Sodium ion ($Na^{\cdot}$)	2,9468	127,8438	**127,8438**
Calcium ion ($Ca^{\cdot\cdot}$)	0,7183	4,6708	9,3416
Magnesium ion ($Mg^{\cdot\cdot}$)	0,2191	8,9942	17,9884
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0140**	0,2544	0,5088
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0109	0,4002	1,2006
			159,1744
Anions.			
Chlorine ion (Cl')	5,2424	147,8843	**147,8843**
Hydrocarbonate ion (HCO_3')	0,6905	11,3179	11,3179
	9,4007	303,6568	159,2022
Silicic acid (meta) (H_2SiO_3)	0,0701		
	9,4708		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,1708
Sodium chloride (NaCl)	7,4792
Calcium chloride ($CaCl_2$)	0,5188
Magnesium chloride ($MgCl_2$)	0,3424
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,7914
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0445
Aluminium chloride ($AlCl_3$)	0,0536
Silicic acid (meta) (H_2SiO_3)	0,0701
	9,4708

Besides these trace of hydrophosphate ion and boric acid.

The spring thus may be classified as "**iron carbonate common salt spirng**".

Radio-activity. **1,62** $\times 10^{-10}$ curies in 1 litre of water at 21° C.

(Schmidt's electrom., H. Kakehi, June 1. 1914).

0,45 Mache's units (recalculated).

Radio-activity of mineral springs and well waters in Tōkyō, Yokohama and their neighbourhood.

Table 45.

No.	Location	Spring or well	Classification	Temp. of spring or well in C.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Tōkyō (*Honjō-ku*)	Well (*K. Fujii*)	—	air temp. —	1,10	0,30	21,0°	Schm.	July 16, 1914	M. Komori
2	„ (*Ushigome-ku*)	„ (*R. Shibata*)	—	—	2,00	0,55	19,0°	„	May 8, „	H. Kakehi
3	„ (*Shiba-ku*)	„ (*H. Ebizawa*)	—	16,0°	1,81	0,50	15,5°	„	Apr. 9, „	M. Komori
4	„ (*Azabu-ku*)	„ (*S. Okabayashi*)	—	—	—	0,78	18,5°	K. & L.	Dec. 19, 1913	„
5	„ („)	„ (*K. Kobayashi*)	—	—	—	0,75	14,0°	„	Nov. 25, „	I. Wakita
6	Shibuya	„ (*R. Hata*)	—	—	1,27	0,35	15,4°	Schm.	March 3, 1914	H. Kakehi
7	Shinagawa	„ (*Y. Sakurai*)	—	—	1,51	0,41	13,5°	„	Feb. 28, „	M. Komori
8	Ōsaki (*Gotanda*)	„ (*T. Suzuki*)	—	—	—	0,57	18,5°	K. & L.	Oct. 29, 1913	I. Wakita
9	„ (*Minehara*)	„ (*H. Kamada*)	—	—	1,55	0,43	14,0°	Schm.	Feb. 6, 1914	M. Komori
10	Ikegami	„ (*S. Shimizu*)	—	16,0°	1,15	0,32	16,2°	„	Apr. 18, „	H. Kakehi
11	Iriarai	„ (*C. Hirabayashi*)	—	17,0°	1,86	0,51	25,5°	„	Sept. 7, „	„
12	Ōmori	„ (*Seikwa-en*)	—	18,5° (15°)	—	0,44	15,9°	K. & L.	Oct. 24, 1913	Dr. R. Ishizu
13	„	Morigasaki-Kōsen	earth-muriated common salt	17,0° (18°)	—	0,40	15,8°	„	„	„
14	Haneda	Anamori-Kōsen (*Izumi-kwan*)	iron calbonate common salt	17,0°	1,62	0,45	21,0°	Schm.	June 1, 1914	H. Kakehi
15	Kawasaki	Doku-mizu (*Kawasaki-Daishi*)	—	16,0° (16,5°)	—	0,41	18,5°	K. & L.	Oct. 24, 1913	Dr. R. Ishizu
16	Daishigawara	Well (*T. Mizuno*)	—	18 5°	4,75	1,31	22,0°	Schm.	July 13, 1914	M. Komori
17	Ōami	Cold spring *A* (*C. Homma*)	alkaline	—	1,70	0,47	21,0°	„	„ 27, „	„
18	Yokohama (*Koyasu*)	Well (*F. Fukamachi*)	—	—	1,53	0,42	24,0°	„	„ 20, „	„
19	Enoshima	„ (*Ebisu-ya*)	—	—	1,68	0,46	24,5°	„	Aug. 9, „	„
					Emanation per litre of gas at 0° C.				Date when the gas was collected	
	Kawasaki	Gas evolving from Doku-mizu				0,84		K. & L.	Oct. 24, 1913	Dr. R. Ishizu

YUMOTO—TŌNOSAWA

Location.—Yumoto-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Moto-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Temperature: 42° C.
Total residue: ca. 0,57° C. Flow of water: ca. 360 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0128	0,3269	0,3269
Sodium ion ($Na^{\cdot}$)	0,1805	7,8308	7,8308
Calcium ion ($Ca^{\cdot\cdot}$)	0,0128	0,3192	0,6384
			8,7961
Anions.			
Chlorine ion (Cl')	0,1967	5,5487	5,5487
Sulphate ion (SO_4'')	0,1255	1,3065	2,6130
Hydrocarbonate ion (HCO_3')	0,0392	0,6425	0,6425
	0,5675	15,9746	8,8042
Silicic acid (meta) (H_2SiO_3)	0,0327		
	0 6002		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0244
Sodium chloride (NaCl)	0,3055
Sodium sulphate (Na_2SO_4)	0,1856
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0520
Silicic acid (meta) (H_2SiO_3)	0,0327
	0,6002

Besides these trace of magnesium, ferrous ion and organic substances.

The spring thus may be classified as "**simple thermal**".

The other noted hot springs

Spring	Fukuzumi-no-yu	Tamano-o-no-yu	Fujiya-no-yu	Sekiguchi-no-yu
Specific gravity	—	1,000 4 (at 16° C.)	1,000 4 (at 18° C.)	—
Temperature	44,0° C.	47,3° C.	45,5° C.	42,8° C.
Total residue	ca. 0,57	ca. 0,64	ca. 0,62	ca. 0,50
Flow of water (in 24 hours)	ca. 540 hls.	—	—	—

The springs, being in their composition nearly the same as that of "Moto-yu", may be classified as "**simple thermal**".

MIYANOSHITA

Location.—Onsen-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Taikō-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0017 at 15° C. Temperature: 67° C.
Total residue: ca. 2,28. Flow of water: ca. 208 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,07160	1,82886	1,82886
Sodium ion ($Na^{\cdot}$)	0,65505	28,41865	**28,41865**
Ammonium ion ($NH_4^{\cdot}$)	0,00053	0,02931	0,02931
Calcium ion ($Ca^{\cdot\cdot}$)	0,07915	1 97875	3 95750
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00742	0,30460	0,60920
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00210	0,03750	0,07500
			34 91852

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,13643
Sodium chloride (NaCl)	1,66256
Ammonium chloride (NH_4Cl)	0,00157
Calcium chloride ($CaCl_2$)	0,12599
Calcium sulphate ($CaSO_4$)	0,05585
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,07003
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,04459

Anions.

Chlorine ion (Cl')	1,15393	32,55091	**32,55091**
Sulphate ion (SO_4'')	0,03943	0,41047	0,82094
Hydrocarbonate ion (HCO_3')	0,09449	1,54876	1,54876
	2,10370	67,10781	34,92061
Boric acid (meta) (HBO_2)	0,02129		
Silicic acid (meta) (H_2SiO_3)	0,19701		
	2,32200		
Free carbon dioxide (CO_2)	0,02185	0,49659	
	2,34385		

Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00668
Boric acid (meta) (HBO_2)	0,02129
Silicic acid (meta) (H_2SiO_3)	0,19701
	2,32200
Free carbon dioxide (CO_2)	0,02185
	2,34385

The spring thus may be classified as "**common salt spring**".

The other noted hot springs

Spring	Mikazuki-no-yu	Kumano-no-yu	Meiji-no-yu	Yoshida-no-yu
Specific gravity	—	—	1,0017 (at 16°C.)	—
Temperature	51° C.	36° C.	67° C.	45,6° C.
Total residue	ca. 2,06	ca. 1,08	ca. 2,15	ca. 1,01
Flow of water (in 24 hours)	ca. 7 hls.	ca. 20 hls.	ca. 49 hls.	—

Spring	Taki-no-yu	Fuji-no-yu	Shinrei-no-yu
Specific gravity	1,0014 (at 15°C.)	1,00175 (at 15°C.)	1,0011 (at 17° C.)
Temperature	64° C.	81° C.	48,4° C.
Total residue	ca. 2,06	ca. 2,35	ca. 1,51
Flow of water (in 24 hours)	ca. 182 hls.	—	—

The springs, being in their composition nearly the same as that of "Taikō-no-yu", may be classified as "**common salt spring**".

DŌGASHIMA

Location.—Onsen-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The spring issues from the Augite Andesite and its Agglomerate.

The hot spring "Musō-no-yu"

Analysis (calculated from the salt table).

Analysed by the Yokohama Imperial Hygienic Laboratory. 1885.

Specific gravity: 1,001 at 15° C. Temperature: 46° C.

Total residue: ca. 1,46. Flow of water: ca. 450 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0150	0,3831	0,3831
Sodium ion ($Na^{\cdot}$)	0,3820	16,5727	**16,5727**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0690	1,7216	3,4432
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0086	0,3530	0,7060
			21,1050
Anions.			
Chlorine ion (Cl')	0,6696	18,8886	**18,8886**
Sulphate ion (SO_4'')	0,0255	0,2655	0,5310
Hydrocarbonate ion (HCO_3')	0,1030	1,6883	1,6883
	1,2727	39,8728	21,1079
Silicic acid (meta) (H_2SiO_3)	0,1207		
	1,3934		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0285
Sodium chloride ($NaCl$)	0,9696
Calcium chloride ($CaCl_2$)	0,1072
Calcium sulphate ($CaSO_4$)	0,0362
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0794
Magnesium bicarbonte [$Mg(HCO_3)_2$]	0,0518
Silicic acid (meta) (H_2SiO_3)	0,1207
	1,3934

Besides these trace of iodine, hydrophosphate ion, boric acid and organic substances.

The spring thus may be classified as "**common salt spring**".

SOKOKURA

Location.—Onsen-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Onjun-no-yu"

Analysis (calculated from the salt table).

Analysed by the Yokohama Imperial Hygienic Laboratory. 1885. Specific gravity: 1,00192.
Temperature: 72° C. Total residue: ca. 2,19.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0513	1,3103	1,3103
Sodium ion ($Na^{\cdot}$)	0,6332	27,4707	**27,4707**
Calcium ion ($Ca^{\cdot\cdot}$)	0,1144	2,8529	5,7058
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0092	0,3777	0,7554
			35,2422
Anions.			
Chlorine ion (Cl')	1,0204	28,7898	**28,7898**
Sulphate ion (SO_4'')	0,0419	0,4362	0,8724
Hydrocarbonate ion (HCO_3')	0,3412	5,5925	5,5925
	2,2116	66,8301	35,2547
Silicic acid (meta) (H_2SiO_3)	0,1841		
	2,3957		
Free carbon dioxide (CO_2)	not determined		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0978
Sodium chloride ($NaCl$)	1,6071
Calcium sulphate ($CaSO_4$)	0,0595
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,3920
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0552
Silicic acid (meta) (H_2SiO_3)	0,1841
	2,3957

Besides these trace of ferrous, aluminium, iodine and hydrophosphate ion, boric acid, and organic substances.

The spring thus may be classified as "**common salt spring**".

The other noted hot springs

Spring	Reisen-no-yu	Manju-no-yu	Sinrei-no-yu
Specific gravity	1,00176	—	—
Temperature	76,0° C.	70,0° C.	64,0° C.
Total residue	ca. 2,18	ca. 1,92	ca. 1,83
Flow of water (in 24 hours).	ca. 6 hls.	ca. 78 hls.	—

The springs, being in their composition nearly the same as that of "Onjun-no-yu", may be classified as "**common salt spring**".

KIGA

Location.—Miyagino-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Ōdaki-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.
Temperature: 46,7° C. Total residue: ca. 1,39.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Sodium ion ($Na^{\cdot}$)	0 2992	12,9805	**12,9805**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0859	2,1421	4,2842
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0573	2,3525	4,7050
			21,9697
Anions.			
Chlorine ion (Cl')	0,5440	15,3456	**15,3456**
Sulphate ion (SO_4'')	0,1620	1,6864	3,3728
Hydrocarbonate ion (HCO_3')	0,1980	3,2454	3,2454
	1,3464	37,7525	21,9638
Silicic acid (meta) (H_2SiO_3)	0,1532		
	1,4996		

The mineral water corresponds approximately in its composion to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,7595
Magnesium chloride ($MgCl_2$)	0,1125
Calcium sulphate ($CaSO_4$)	0,2297
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0738
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,1709
Silicic acid (meta) (H_2SiO_3)	0,1532
	1,4996

Besides these trace of bromine ion and organic substances.

The spring thus may be classified as "**common salt spring**".

The other noted hot springs

Spring	Kami-no-yu	Shōbu-no-yu	Tani-no-yu	Iwa-no-yu
Temperature	40° C.	45° C.	—	42° C.
Total residue	ca. 1,12	ca. 1,05	ca. 1,06	ca. 0,81
Flow of water (in 24 hrs.)	ca. 35 hls.	—	—	ca. 54 hls.

The springs, except the last one, being in their composition nearly the same as that of "Ōdaki-no-yu", may be classified as "**common salt spring**", but "Iwa-no-yu", containing the smaller proportion of solid matters, as "**simple thermal**".

KOWAKIDANI

Location.—Miyagino-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Kowakidani-Onsen"

Analysis (calculated from the salt table).

Analysed by the Yokohama Imperial Hygienic Laboratory. 1885. Specific gravity: 1,00078.

Temperature: 35,6° C. Total residue: ca. 1,13.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Hydrogen ion ($H^{\cdot}$)	0,0020	1,9801	**1,9801**
Sodium ion ($Na^{\cdot}$)	0,0209	0,9067	0,9067
Calcium ion ($Ca^{\cdot\cdot}$)	0,0348	0,8678	1,7356
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0125	0,5131	1,0262
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,1465**	2,6208	5,2416
Manganous ion ($Mn^{\cdot\cdot}$)	0,0015	0,0616	0,1232
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0295	1,0886	3,2658
			14,2792
Anions.			
Hydrosulphate ion (HSO_4')	0,1900	1,9574	1,9574
Sulphate ion (SO_4'')	0,5877	6,1181	**12,2362**
	1,0254	16,1142	14,1936
Silicic acid (meta) (H_2SiO_3)	0,1324		
	1,1578		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium sulphate (Na_2SO_4)	0,0645
Calcium sulphate ($CaSO_4$)	0,1178
Magnesium sulphate ($MgSO_4$)	0,0624
Ferrous sulphate ($FeSO_4$)	0,3982
Manganous sulphate ($MnSO_4$)	0,0040
Aluminium sulphate [$Al_2(SO_4)_3$]	0,1865
Free sulphuric acid (H_2SO_4)	0,1920
Silicic acid (meta) (H_2SiO_3)	0,1324
	1,1578

Besides these trace of potassium, chlorine, hydrophosphate and hydrosulphide ion, boric acid, and organic substances.

The spring thus may be classified as "**acid vitriol spring**".

YUNOHANA-ZAWA

Location.—Moto-hakone-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The spring issues from the Augite Andesite and its Agglomerate.

The hot spring "Hana-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory.

Specific gravity: 1,0006 at 15° C. Temperature: 40° C.

Total residue: ca. 0,7. Flow of water: ca. 691 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Hydrogen ion ($H^{\cdot}$)	0,0047	4,6530	**4,6530**
Potassium ion ($K^{\cdot}$)	0,0091	0,2324	0,2324
Sodium ion ($Na^{\cdot}$)	0,0213	0,9241	0,9241
Calcium ion ($Ca^{\cdot\cdot}$)	0,0303	0,7556	1,5112
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0194	0,7964	1,5928
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0226	0,8339	2,5017
			11,4152
Anions.			
Hydrosulphate ion (HSO_4')	0,4557	4,6946	4,6946
Sulphate ion (SO_4'')	c,3262	3,3958	6,7916
	0 8893	16,2858	11,4862
Silicic acid (meta) (H_2SiO_3)	0,0180		
	0,9073		
Free hydrogen sulphide (H_2S)	**0,1205**		
	1,0278		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium sulphate (K_2SO_4)	0,0202
Sodium sulphate (Na_2SO_4)	0,0657
Calcium sulphate ($CaSO_4$)	0,1026
Magnesium sulphate ($MgSO_4$)	0,0972
Aluminium sulphate [$Al_2(SO_4)_3$]	0,1432
Free sulphuric acid (H_2SO_4)	0,4604
Silicic acid (meta) (H_2SiO_3)	0,0180
	0,9073
Free hydrogen sulphide (H_2S)	0,1205
	1,0278

Besides these trace of ferrous, chlorine and hydrophosphate ion, and organic substances.

The spring thus may be classified as "**acid hydrogen sulphide spring**".

SENGOKU-BARA

Location.—Sengokubara-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Sengoku-shin-yu"

Analysis (calculated from the salt table).

Analysed by the Yokohama Imperial Hygienic Laboratory. 1885.

Specific gravity: 1,00095 at 15° C. Total residue: ca. 1,87.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0064	0,1635	0,1635
Sodium ion ($Na^{\cdot}$)	0,0999	4,3341	4,3341
Calcium ion ($Ca^{\cdot\cdot}$)	0,2544	6,3441	**12,6882**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0649	2,6642	5,3284
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0014	0,0250	0,0500
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0042	0,1550	0,4650
			23,0292
Anions.			
Sulphate ion (SO_4'')	1,1088	11,5428	**23,0856**
	1,5400	25,2287	23,0856
Silicic acid (meta) (H_2SiO_3)	0,2726		
	1,8126		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium sulphate (K_2SO_4)	0,0142
Sodium sulphate (Na_2SO_4)	0,3083
Calcium sulphate ($CaSO_4$)	0,8625
Magnesium sulphate ($MgSO_4$)	0,3246
Ferrous sulphate ($FeSO_4$)	0,0038
Aluminium sulphate [$Al_2(SO_4)_3$]	0,0266
Silicic acid (meta) (H_2SiO_3)	0,2726
	1,8126

Besides these trace of manganous, chlorine and hydrophosphate ion, and organic substances.

The spring thus may be classified as "**sulphated bitter spring**".

UBAKO

Location.—Moto-hako e-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The spring issues from the Augite Andesite and its Agglomerate.

The hot spring "Ubako-yu"

Analysis (calculated from the salt table).

Analysed by the Yokohama Imperial Hygienic Laboratory. 1885. Specific gravity: 1,0006 at 13° C.

Temperature: 40° C Total residue: ca. 0,65.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0054	0,1379	0,1379
Sodium ion ($Na^{\cdot}$)	0,0284	1,2321	1,2321
Calcium ion ($Ca^{\cdot\cdot}$)	0,0739	1,8429	3,6858
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0198	0,8128	1,6256
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0074	0,2731	0,8193
			7,5007
Anions.			
Sulphate ion (SO_4'')	0,3609	3,7570	7,5140
	0,4958	8,0558	7,5140
Silicic acid (meta) (H_2SiO_3)	0,2031		
	0,6989		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium sulphate (K_2SO_4)	0,0121
Sodium sulphate (Na_2SO_4)	0,0875
Calcium sulphate ($CaSO_4$)	0,2506
Magnesium sulphate ($MgSO_4$)	0,0989
Aluminium sulphate [$Al_2(SO_4)_3$]	0,0467
Silicic acid (meta) (H_2SiO_3)	0,2031
	0,6989

Besides these trace of ferrous, chlorine ion, and organic substances.

The spring thus may be classified as "**simple thermal**".

YUGAWARA

Location.—Tohi-mura, Ashigara-shimo-gun, Province Sagami, Kanagawa-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Kawashita-no-yu"

Analysis.

Analysed by the Tōkyō Imperial Hygienic Laboratory. Temperature: 73° C.

Total residue: ca. 2,36. Flow of water: ca. 1458 hectolitres in 24 hours.

	Grams
Potassium chloride (KCl)	0,0510
Sodium chloride (NaCl)	1,4447
Calcium chloride ($CaCl_2$)	0,0412
Magnesium chloride ($MgCl_2$)	0,0546
Calcium sulphate ($CaSO_4$)	0,5916
Calcium carbonate ($CaCO_3$)	0,0725
Silica (SiO_2)	0,1068
	2,3624
Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,0090
	2,3714

Besides these trace of iron, aluminium, phosphoric acid and boric acid.

The spring may be classified as "**common salt spring**".

Table 46.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water		Apparatus employed	Date when the water was taken	Examined by
					in Mache's units	at (temp. in C.)			
1	Nakanishiya-no-yu	common salt	82,5°	ca. —	**0,22**	22,0°	K. & L.	Feb. 19, 1913	Dr. R. Ishizu
2	Uenoya-no-yu	,,	88,5°	—	**0,18**	9,5°	,,	,,	,,
3	Izuya-no-yu	,,	80,0°	—	**0,14**	10,0°	,,	,, 20, ,,	,,
4	Yuya-no-yu	,,	54,5°	—	**0,15**	19,0°	,,	,, 19, ,,	Y. Kinugasa
5	Ōkura-no-yu	,,	43,0°	—	**0,07**	10,0°	,,	,, 20, ,,	Dr. R. Ishizu
6	Kawashita-no-yu	,,	73,0°	1458	—	—	—	—	—
7	Nangan-no-yu	,,	52,0°	1458	—	—	—	—	—
8	Mamane-no-yu (*Kami-no-yu*)	,,	56,0°	1458	—	—	—	—	—
9	Yakushi-no-yu	,,	34-46°	1458	—	—	—	—	—
10	Shimo-no-yu (*Sō-yu*)	,,	72,5°	1458	—	—	—	—	—
11	Kawanaka-no-yu	,,	72,0°	—	—	—	—	—	—
12	Kawara-no-yu (*Mae-no-yu*)	,,	41,0°	—	—	—	—	—	—

IZUSAN

Location.—Atami-machi, Takata-gun, Province Izu, Shizuoka-ken.

The spring issues from the Augite Andesite and its Agglomerate.

The hot spring "Hashiri-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1901. Temperature: 60° C.

Flow of water: abundant. Total residue: ca. 1,42.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0114	0,2912	0,2912
Sodium ion ($Na^{\cdot}$)	0,2239	9,7137	9,7137
Calcium ion ($Ca^{\cdot\cdot}$)	0,2072	5,1671	**10,3342**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0046	0,1888	0,3776
			20,7167
Anions.			
Chlorine ion (Cl')	0,2620	7,3907	7,3907
Sulphate ion (SO_4'')	0,6403	6,6656	**13,3212**
	1,3494	29,4171	20,7119
Silicic acid (meta) (H_2SiO_3)	0,0494		
	1,3988		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,4323
Potassium sulphate (K_2SO_4)	0,0254
Sodium sulphate (Na_2SO_4)	0,1654
Calcium sulphate ($CaSO_4$)	0,7036
Magnesium sulphate ($MgSO_4$)	0,0227
Silicic acid (meta) (H_2SiO_3)	0,0494
	1,3988

Besides these trace of ferrous, aluminium and hydrophosphate ion.

The spring thus may be classified as "**sulphated bitter spring**".

Radio-activity. **0,10** Mache's units in 1 litre of water at 18,2° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, March 21, 1913).

ATAMI

Location.—Atami-machi, Takata-gun, Province Izu, Shizuoka-ken.

The springs issue from the Augite Andesite and its Agglomerate.

The hot spring "Ō-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Temperature: 108° C.

Flow of water: ca. 1296 hectolitres in 24 hours. Total residue: ca. 9,24.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,1859	4,7484	4,7484
Sodium ion ($Na^{\cdot}$)	2,1312	92,4599	**92,4599**
Calcium ion ($Ca^{\cdot\cdot}$)	1,0831	27,0099	**54,0198**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0037	0,1519	0,3038
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0006	0,0107	0,0214
			151,5533
Anions.			
Chlorine ion (Cl')	5,3053	149,6559	**149,6559**
Sulphate ion (SO_4'')	0,0926	0,9640	1,9280
Hydrocarbonate ion (HCO_3')	0,0014	0,0229	0,0229
	8,8038	275,0236	151,6068
Silicic acid (meta) (H_2SiO_3)	0,6813		
	9,4851		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,3540
Sodium chloride ($NaCl$)	5,4090
Calcium chloride ($CaCl_2$)	2,8930
Magnesium chloride ($MgCl_2$)	0,0145
Calcium sulphate ($CaSO_4$)	0,1313
Ferrous sulphate ($FeSO_4$)	0,0020
Silicic acid (meta) (H_2SiO_3)	0,6813
	9,4851

Besides these trace of manganous, bromine ion and organic substances.

The spring thus may be classified as "**earth-muriated common salt spring**".

Radio-activity. **0,04** Mache's units in 1 litre of water at 15° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, March 23, 1913).

The hot spring "Me-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Specific gravity: 1,007 at 13° C. Temperature: 48° C.

Flow of water: ca. 140 hectolitres in 24 hours. Total residue: ca. 8,10.

The spring, being in its composition nearly the same as that of "Ō-yu", may be classified as "**earth-muriated common salt spring**".

Radio-activity. **0,08** Mache's units in 1 litre of water at 20° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, March 21, 1913).

Table 47.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	Emanation per litre of water at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Ō-yu	earth-muriated common salt	108,0°	ca. 1296	**0,04**	15,0°	K. & L.	March 23, 1913	Y. Kinugasa
2	Me-no-yu	„	48,0°	140	**0,08**	20,0°	„	„ 21, „	„
3	Ozawa-no-yu *No. 2*	„	97,0°	466	**0,14**	18,2°	„	„	„
4	Komatsu-no-yu	„	93,0°	241	**0,08**	20,2°	„	„	„
5	Kawara-no-yu	„	81,0°	—	**0,02**	15,0°	„	„ 22, „	„
6	„ (*Ishi-yu*)	„	77,0°	—	**0,14**	14,2°	„	„	„
7	Furuya-no-yu	„	80,0°	86	**0,18**	14,8°	„	„	„
8	Takasagoya-no-yu	„	91,0°	—	**0,26**	14,2°	„	„	„

ITŌ

Location.—Itō-machi, Takata-gun, Province Izu, Shizuoka-ken.

The springs issue from the Quaternary.

The hot spring "Matsubara-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1889.

Specific gravity: 1,0008 at 15° C. Total residue: ca. 0,98.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0150	0,3831	0,3831
Sodium ion ($Na^{\cdot}$)	0,2585	11,2147	11,2147
Calcium ion ($Ca^{\cdot\cdot}$)	0,0407	1,0150	2,0300
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0057	0,2298	0,4596
			14,0874
Anions.			
Chlorine ion (Cl')	0,2758	7,7799	7,7799
Sulphate ion (SO_4'')	0,3030	3,1545	6,3084
	0,8987	23,7770	14,0883
Silicic acid (meta) (H_2SiO_3)	0,0653		
	0,9640		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram

	Grams
Sodium chloride ($NaCl$)	0,4281
Potassium sulphate (K_2SO_4)	0,0335
Sodium sulphate (Na_2SO_4)	0,2771
Magnesium chloride ($MgCl_2$)	0,0221
Calcium sulpha e ($CaSO_4$)	0,1379
Silicic acid (meta) (H_2SiO_3)	0,0653
	0,9640

Besides these trace of ferrous, aluminium and hydrophosphate ion, and boric acid.

The spring thus may be classified as "**simple thermal**".

Table 48.

No.		Spring	Classification	Temp. of spring in C.	Emanation per litre of water		Apparatus employed	Date when the water was taken	Examined by
					in Mache's units	at (temp. in C.)			
1	Matsubara	Matsubara-moto-yu *	simple	47,8°	0,29	17,0°	K. & L.	Feb. 22, 1913	Dr. R. Ishizu
2	Matsubara	Matsubara-shin-yu *	,,	46,0°	0,16	20,0°	,,	,,	,,
3	Matsubara	Private bath (*Yoshida-gankwa-in*)	—	48,5°	0,31	20,5°	,,	,, 23, ,,	,,
4	Matsubara	,, (*W. Hirose*)	—	48,5°	0,47	13,5°	,,	,,	,,
5	Matsubara	,, (*M. Suzuki*)	—	47,0°	0,27	19,0°	,,	,,	Y. Kinugasa
6	Matsubara	Yumoto-kwan-no-yu	—	50,5°	0,34	13,8°	,,	,,	,,
7	Matsubara	Private bath (*Kobayashi*)	—	43,5°	0,21	13,0°	,,	,,	,,
8	Shishido	Shishido-Onsen *	simple	47,0°	0,45	21,0°	,,	,, 22, ,,	Dr. R. Ishizu
9	Shishido	Wada-Onsen *	salt	37,5°	0,40	20,0°	,,	,,	,,
10	Kusumi	Kusumi-sō-yu (*Onnayu*) *	,,	50,0°	0,46	19,8°	,,	,, 23, ,,	Y. Kinugasa
11	Kusumi	Kusumi-Onsen *	,,	49,5°	0,36	13,5°	,,	,,	Dr. R. Ishizu
12	Kusumi	Me-no-yu *	,,	37,5°	0,33	19,5°	,,	,,	,,
13		Yuda-Onsen *	,,	33,5°	0,11	19,5°	,,	,, 22, ,,	,,
14		Private bath (*S. Kitazato*)	—	34,0°	0,42	20,0°	,,	,,	,,
15		,, (*S. Kumagi*)	—	50,0°	0,48	13,5°	,,	,, 23, ,,	,,
					Emanation per litre of gas at 0° C.			Date when the gas was collected	
		Gas evolving from Matsubara-moto-yu	—	—	1,19	—	,,	Feb. 23, 1913	Y. Kinugasa

* These springs are for public use.

SHUZENJI

Location.—Shuzenji-mura, Takata-gun, Province Izu, Shizuoka-ken.

The springs issue from the Andesite and its Tuff.

The hot spring "Ishi-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1907.

Temperature: 59,5° C. Total residue: ca. 1,13.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0073	0,1865	0,1865
Sodium ion ($Na^{\cdot}$)	0,3183	13,8091	13,8091
Calcium ion ($Ca^{\cdot\cdot}$)	0,0553	1,3791	2,7582
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0006	0,0246	0,0492
			16,8030

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,5646
Potassium sulphate (K_2SO_4)	0,0162
Sodium sulphate (Na_2SO_4)	0,2261
Sodium bicarbonate ($NaHCO_3$)	0,0821
Calcium sulphate ($CaSO_4$)	0,1873

Anions.

Chlorine ion (Cl')	0,3421	9,6502	**9,6502**
Sulphate ion (SO_4'')	0,2958	3,0793	**6,1586**
Hydrocarbonate ion (HCO_3') .	0,0596	0,9769	0,9769
	1,0790	29,1057	16,7857
Silicic acid (meta) (H_2SiO_3) .	0,1063		
	1,1853		
Free carbon dioxide (CO_2) . .	not determined		

Magnesium sulphate ($MgSO_4$)	0,0027
Silicic acid (meta) (H_2SiO_3)	0,1063
	1,1853

Besides these trace of ferrous, manganous, aluminium and hydrophosphate ion, and boric acid.

The spring thus may be classified as "**saline common salt spring**".

Radio-activity. **1,35** Mache's units in 1 litre of water at 9,5° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 25, 1913).

8,73 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 26, 1913).

The hot spring "Dokko-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Temperature: 69° C.

Flow of water: ca. 432 hectolitres in 24 hours. Total residue: ca. 1,12.

The spring, being in its composition nearly the same as that of "Ishi-yu", may be classified as "**saline common salt spring**".

Radio-activity. **0,64** Mache's units in 1 litre of water at 9.7° C.

4,11 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, Feb. 25 1913).

The hot spring "Ma-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Temperature: 64° C. Total residue: ca. 1,21.

The spring, being in its composition nearly the same as that of "Ishi-yu", may be classified as "**saline common salt spring**".

Radio-activity. **0,13** Mache's units in 1 litre of water at 11,0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 26, 1913).

Table 49.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Ishi-yu (*Public bath*)	saline common salt	59,5°	ca. —	1,35	9 5°	K. & L.	Feb. 25, 1913	Dr. R. Ishizu
2	Dokko-no-yu („)	„	69,0°	432	0,64	9 7°	„	„	Y. Kinugasa
3	Ma-yu („)	„	64,0°	—	0,13	11,0°	„	„ 26, „	Dr. R. Ishizu
4	Hako-yu („)	„	64,0°	327	0,64	9,5°	„	„ 25, „	„
5	Chigo-no-yu („)	„	55,0°	519	1,08	9,5°	„	„	„
6	Ayame-no-yu	„	77,0°	1400	0,36	11,0°	„	„ 26, „	„
7	Katsura-no-yu	„	64,0°	—	0,34	12,5°	„	„	„
8	Kikuya-no-yu *No. 1*	„	72,0°	—	0,31	11,0°	„	„	„
9	„ *No. 2*	„	70,0°	—	0,50	9,5°	„	„ 25, „	Y. Kinugasa
10	Sugi-no-yu	„	60,0°	156	0,50	9,5°	„	„	Dr. R. Ishizu
11	Ume-no-yu	„	60,0°	156	0,66	9,0°	„	„	Y. Kinugasa
12	Asabarō-no-yu	„	63,0°	—	0,76	11 0°	„	„ 26, „	Dr. R. Ishizu
13	Meiji-no-yu	„	66,0°	149	0,46	9,5°	„	„ 25, „	„
14	Iwa-no-yu	„	60,0°	529	0,31	11,0°	„	„ 26, „	„
15	Hana-no-yu	„	67,0°	86	0,15	11,0°	„	„	„
16	Taki-no-yu	„	65,0°	—	1,00	11,0°	„	„	„
17	Kawara-no-yu (*Public bath*)	„	63,0°	108	—	—	—	—	—
	Gas evolving from :				Emanation per litre of gas at 0° C.			Date when the gas was collected	
1	Ishi-yu	—	—	—	8,73	—	K. & L.	Feb. 26, 1913	Dr. R. Ishizu
2	Dokko-no-yu	—	—	—	4,11	—	„	„ 25, „	Y. Kinugasa
3	Kikuya-no-yu *No. 2*	—	—	—	7,07	—	„	„ 26, „	Dr. R. Ishizu

NAGAOKA

Location.—Kawanishi-mura, Takata-gun, Province Izu, Shizuoka-ken.

The springs issue from the Tertiary Tuff Breccia.

The hot spring "Nagaoka-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1907.

Specific gravity: 1,0005 at 15° C. Temperature: 52,7° C.

Flow of water: ca. 816 hectolitres in 24 hours. Total residue: ca. 0,70.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^·$)	0,0016	0,0409	0,0409
Sodium ion ($Na^·$)	0,2077	9,0108	9,0108
Calcium ion ($Ca^{··}$)	0,0045	0,1122	0,2244
			9,2761
Anions.			
Chlorine ion (Cl')	0,1137	3,2073	3,2073
Sulphate ion (SO_4'')	0,2653	2,7619	5,5238
Hydrocarbonate ion (HCO_3')	0,0332	0,5442	0,5442
	0,6260	15,6773	9,2753
Silicic acid (meta) (H_2SiO_3)	0,0909		
	0,7169		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,1876
Potassium sulphate (K_2SO_4)	0,0036
Sodium sulphate (Na_2SO_4)	0,3737
Sodium bicarbonate ($NaHCO_3$)	0,0458
Calcium sulphate ($CaSO_4$)	0,0153
Silicic acid (meta) (H_2SiO_3)	0,0909
	0,7169

Besides these a small quantity of aluminium ion, a very small quantity of ferrous, hydrophosphate ion, and boric acid.

The spring thus may be classified as "**simple thermal**".

Table 50.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Nagaoka-Onsen *No. 1*	simple	45,0°	**0,10**	12,0°	K. & L.	March 13, 1913	Y. Kinugasa
2	„ *No. 2*	„	50,0°	**0,19**	14,6°	„	„	„
3	„ *No. 3*	„	49,0°	**0,29**	17,0°	„	„	„
4	„ *No. 4*	„	53,0°	**0,18**	16,3°	„	„	„
5	Tamon-yu *No. 1* (*Private bath*)	„	48,0°	**0,27**	10,4°	„	„ 14, „	„
6	„ *No. 2* („)	„	49,0°	**0,33**	14,6°	„	„	„
7	„ *No. 3* („)	„	48,0°	**0,27**	15,2°	„	„	„
8	„ *No. 4* („)	„	44,0°	**0,51**	13,0°	„	„	„
9	Private bath (*S. Matsumoto*)	„	41,0°	**0,38**	11,0°	„	„	„
10	„ (*S. Sugiyama*)	„	49,0°	**0,26**	13,5°	„	„ 13, „	„
11	Kona-Onsen (*Public bath*)	„	52,0°	**0,17**	15,0°	„	„ 14, „	„
	Gas evolving from:		Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Nagaoka-Onsen *No. 4*	—	—	**1,29**	—	„	March 13, 1913	„
2	Tamon-yu *No. 3*	—	—	**3,34**	—	„	„ 14, „	„

NAKAISHIDA

Location.—Ōoka-mura, Shuntō-gun, Province Suruga, Shizuoka-ken.

The cold spring "Kametsuru-Onsen"

Temperature: 15,0° C. Total residue: ca. 0,14.

No accurate analysis has ever been made, but the spring seems to be "**sulphur spring**".

Radio-activity. 0,14 Mache's units in 1 litre of water at 13,7° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, March 19, 1913).

HATAGE

Location.—Kwan-nami-mura, Takata-gun, Province Izu, Shizuoka-ken.

The hot spring "Hatage-Onsen"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1911.

Specific gravity: 1,000. Temperature: 43,3° C.

Flow of water: ca. 508 hectolitres in 24 hours. Total residue: ca. 0,11.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,00097	0,02478	0,02478
Sodium ion ($Na^{\cdot}$)	0,04025	1,74620	1,74620
Ammonium ion ($NH_4^{\cdot}$)	0,00021	0,01162	0,01162
Calcium ion ($Ca^{\cdot\cdot}$)	0,00771	0,19275	0,38550
			2,16810
Anions.			
Chlorine ion (Cl')	0,01912	0,53935	0,53935
Sulphate ion (SO_4'')	0,04658	0,48491	0,96982
Hydrocarbonate ion (HCO_3')	0,04020	0,65891	0,65891
	0,15504	3,65852	2,16808
Silicic acid (meta) (H_2SiO_3)	0,02701		
	0,18205		
Free carbon dioxide (CO_2)	0,04442	1,00954	
	0,22647		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,00185
Sodium chloride (NaCl)	0,02942
Ammonium chloride (NH_4Cl)	0,00062
Sodium sulphate (Na_2SO_4)	0,06894
Sodium bicarbonate ($NaHCO_3$)	0,02298
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,03122
Silicic acid (meta) (H_2SiO_3)	0,02701
	0,18204
Free carbon dioxide (CO_2)	0,04442
	0,22646

The spring thus may be classified as "**simple thermal**".

Table 51.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Hatage-Onsen *No. 1*	simple	40,0°	0,37	16,4°	K. & L.	March 16, 1913.	Y. Kinugasa
2	" *No. 2*	"	40,0°	0,44	14,2°	"	" 15, "	"
3	" *No. 3*	"	41,0°	0,44	15,4°	"	"	"
4	" *No. 4, a*	"	38,0°	0,35	15,5°	"	" 16, "	"
5	" *No. 4, b*	"	38,0°	0,35	14,8°	"	"	"
6	" *No. 5*	"	39,0°	0,48	11,4°	"	" 15, "	"
7	" *No. 6*	"	39,0°	0,35	16,7°	"	" 16, "	"
8	" *No. 7*	"	40,0°	0,41	16,2°	"	"	"
9	" *No. 8*	"	39,0°	0,39	15,5°	"	"	"

FUNABARA

Location.—Naka-kano-mura, Takata-gun, Province Izu, Shizuoka-ken.

The springs issue from the Andesite.

The hot spring "Kōgyoku-no-yu" No. 1

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1909.

Specific gravity: 1,0006 at 18° C. Temperature: 47° C.

Flow of water: ca. 684 hectolitres in 24 hours. Total residue: ca. 1,09.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0037	0,0939	0,0939
Sodium ion ($Na^{\cdot}$)	0,2682	11,6359	**11,6359**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0742	1,8504	3,7008
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0004	0,0164	0,0328
			15,4634
Anions.			
Chlorine ion (Cl')	0,1754	4,9481	4,9481
Sulphate ion (SO_4'')	0,4926	5,1270	**10,2540**
Hydrocarbonate ion (HCO'_3)	0,0159	0,2613	0,2613
	1,0304	23,9330	15,4634
Silicic acid (meta) (H_2SiO_3)	0,0414		
	1,0718		
Free carbon dioxide (CO_2)	0,0208	0,4727	
	1,0926		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0070
Sodium chloride (NaCl)	0,2840
Sodium sulphate (Na_2SO_4)	0,4662
Sodium bicarbonate ($NaHCO_3$)	0,0192
Calcium sulphate ($CaSO_4$)	0,2516
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0024
Silicic acid (meta) (H_2SiO_3)	0,0414
	1,0718
Free carbon dioxide (CO_2)	0,0208
	1,0926

Besides these a small quantity of ferrous, aluminium ion and trace of boric acid.

The spring thus may be classified as "**saline bitter spring**".

Radio-activity. 0,20 Mache's units in 1 litre of water at 8,0° C.
1,77 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, March 11, 1913).

Table 52.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Kōgyoku-no-yu *No. 1*	saline bitter	47,0°	ca. 684	0,20	8,0°	K. & L.	March 11, 1913	Y. Kinugasa
2	„ *No. 2*	„	35,0°	—	0,23	7,5°	„	„	„
3	„ *No. 3*	„	40,0°	—	0,15	7,0°	„	„	„
4	Kumano-no-yu	salt	46,0°	1530	0,30	5,0°	„	„	„
					Emanation per litre of gas at 0° C.			Date when the gas was collected	
	Gas evolving from Kōgyoku-no-yu *No. 1*	—	—	—	1,77	—	„	March 11, 1913	„

YOSHINA

Location.—Kami-kano-mura, Takata-gun, Province Izu, Shizuoka-ken.

The springs issue from the Andesite.

The hot spring "Yoshina-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1897. Total residue: ca. 1,24.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0090	0,2299	0,2299
Sodium ion ($Na^{\cdot}$)	0,2727	11,8308	**11,8308**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0874	2,1802	4,3604
			16,4211
Anions.			
Chlorine ion (Cl')	0,1105	3,1171	3,1171
Sulphate ion (SO_4'')	0,6390	6,6520	**13,3040**
	1,1186	24,0100	16,4211
Silicic acid (meta) (H_2SiO_3)	0,0867		
	1,2053		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,1823
Potassium sulphate (K_2SO_4)	0,0200
Sodium sulphate (Na_2SO_4)	0,6200
Calcium sulphate ($CaSO_4$)	0,2963
Silicic acid (meta) (H_2SiO_3)	0,0867
	1,2053

Besides these trace of magnesium, ferrous, aluminium and hydrophosphate ion.

The spring thus may be classified as "**saline bitter spring**".

Table 53.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Ō-yu (*Public bath*)	saline bitter	50,0°	ca. 265	0,30	7,0°	K. & L.	March 11, 1913	Y. Kinugasa
2	Tōfuya-no-yu	„	49,0°	126	0,15	7,2°	„	„	„
3	Tōfuya-shin-yu	„	41,0°	—	0,36	7,0°	„	„	„

YUGASHIMA

Location.—Kami-kano-mura, Takata-gun, Province Izu, Shizuoka-ken.

The springs issue from the Andesite and its Tuff.

Table 54.

No.	Spring	Classification	Temp. of sprin in C	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Seko-no-Ō-yu (*Public bath*)	salt	55,0°	ca. 216	1,93	10,5°	K. & L.	March 3, 1913	Y. Kinugasa
2	Seko-no-Moto-yu	„	49,0°	130	0,81	10,5°	„	„	„
3	Kidachi-yu (*Public bath*)	carbonated	41,0°	86	0,15	9,9°	„	„	„
4	Spring *No. 2* („)	—	49,0°	—	0,70	8,5°	„	„	„
5	Yumoto-kwan-no-yu (*Spring No. 7*)	carbonated	50,0°	130	1,27	8,0°	„	„	„
6	Yumoto-kwan-Taki-yu (*Spring No. 8*)	—	55,0°	—	1,09	9,0°	„	„	„
7	Ochiai-rō-no-yu	salt	64,0°	173	1,31	7,5°	„	„ 4, „	„
8	Spring *No. 3* (*S. Adachi*)	—	49,0°	—	1,00	8,3°	„	„ 3, „	„
9	Spring *No. 9* (*K. Adachi*)	—	56,0°	—	1,13	8,0°	„	„	„
10	Spring *No. 4* & *5* („)	—	56,0°	—	0,77	9,7°	„	„ 2, „	„
11	Kidachiya-no-yu	carbonated	55,0°	130	0,38	10,2°	„	„ 3, „	„

YUGANO

Location.—Kami-kawazu-mura, Kamo-gun, Province Izu, Shizuoka-ken.

The springs issue from the Andesite.

Table 55.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water		Apparatus employed	Date when the water was taken	Examined by
					in Mache's units	at (temp. in C.)			
1	Yugano-Onsen (*Public bath*)	salt	52,0°	ca. 270	**0,21**	12,0°	K. & L.	March 4, 1913	Y. Kinugasa
2	Konabe-Onsen („)	„	42,0°	126	**0,17**	12,2°	„	„	„

YATSU

Location.—Shimo-kawazu-mura, Kamo-gun, Province Izu, Shizuoka-ken.

The springs issue from the Tertiary.

Table 56.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water		Apparatus employed	Date when the water was taken	Examined by
				in Mache's units	at (temp. in C.)			
1	Yatsu-Kyōdō-Onsen (*Public bath*)	salt	56,0°	**0,75**	15,0°	K. & L.	March 5, 1913	Y. Kinugasa
2	Ishida-Onsen	„	46,0°	**0,47**	15,8°	„	„	„
3	Ishida-shin-Onsen	„	52,0°	**0,80**	12,0°	„	„	„
4	Mageya-no-yu	„	50,0°	**0,35**	13,8°	„	„	„
5	Yamada-Onsen	„	70,0°	**0,36**	14,0°	„	„	„
6	Misawa-no-yu	„	65,0°	**0,42**	13,3°	„	„	„

RENDAIJI

Location.—Inōzawa-mura, Kamo-gun, Province Izu, Shizuoka-ken.

The springs issue from the Tertiary.

Table 57.

No.		Spring	Classification	Temp. of spring in C.	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Rendaiji	Kami-fujiwara-no-yu (*Public bath*)	salt	53,0°	**0,43**	15,0°	K. & L.	March 7, 1913	Y. Kinugasa
2		Shimo-fujiwara-no-yu („)	„	50,0°	**0,44**	14,7°	„	„	„
3		Bath of Zuyō middle school	„	47,0°	**0,27**	15,2°	„	„	„
4		Junji-kwan-no-yu	„	53,0°	**1,27**	14,6°	„	„	„
5		Kakezukaya-no-yu	„	45,0°	**0,36**	14,8°	„	„ 6, „	„
6		Aizu-kwan-no-yu	„	43,0°	**0,72**	16,1°	„	„	„
7		Shin-yoshirō-no-yu	„	42,0°	**0,44**	17,6°	„	„	„
8		Idoya-no-yu	„	48,0°	**1,97**	12,4°	„	„ 8, „	„
9		Private bath (*C. Murayama*)	„	53,0°	**0,50**	13,5°	„	„	„
10		„ (*I. Yoshimura*)	„	45,0°	**0,31**	17,0°	„	„ 6, „	„
11		„ (*R. Ogawa*)	„	46,0°	**0,34**	14,2°	„	„ 7, „	„
12		„ (*E. Ishibashi*)	„	47,0°	**0,43**	13,0°	„	„	„
13		„ (*K. Murayama*)	„	47,0°	**0,37**	13,0°	„	„	„
14	Kōchi	Kami-no-yu (*Public bath*)	„	39,0°	**0,42**	15,7°	„	„	„
15		Shimo-no-yu („)	„	48,0°	**0,52**	13,7°	„	„	„
16	Shimoda	Fuji-no-yu *	—	31,0°	**0,25**	10,8°	„	„ 8, „	„
17		Akama-Onsen *No. 1* *	—	29,0°	**0,35**	9,9°	„	„	„
18		„ *No. 2* *	—	22,0°	**0,33**	9,2°	„	„	„

* These springs, located in *Shimoda*, about 2,5 m. from Rendaiji, are grouped for convenience in this table.

SHIMOGAMO

Location.—Minami-naka-mura, Kamo-gun, Province Izu, Shizuoka-ken.

The springs issue from the Tertiary.

Table 58.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Kanō-Kyōdō-yu (*Public bath*)	salt	71,0°	**0,53**	13,6°	K. & L.	March 9, 1913	Y. Kinugasa
2	Hizume-Kyōdō-yu („)	„	79,0°	**0,89**	12,8°	„	„	„
3	Shimogamo-Kyōdō-yu („)	„	77,0°	**0,29**	11,5°	„	„	„
4	Seitō-Onsen (*M. Takahashi*)	„	63,0°	**2,62**	11,2°	„	„	„
5	Kinokuniya-no-yu	„	73,0°	**0,25**	11,5°	„	„	„

TOHI

Location.—Tohi-mura, Takata-gun, Province Izu, Shizuoka-ken.

The springs issue from the Tertiary.

The hot spring "Ō-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1904

Specific gravity: 1,001 at 17° C. Total residue: ca. 1,37.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0079	0,2018	0,2018
Sodium ion ($Na^{\cdot}$)	0,1360	5,9002	5,9002
Calcium ion ($Ca^{\cdot\cdot}$)	0,2624	6,5436	**13,0872**
			19,1892
Anions.			
Chlorine ion (Cl')	0,0685	1,9323	1,9323
Sulphate ion (SO_4'')	0,8290	8,6299	**17,2598**
	1,3038	23,2078	19,1921
Silicic acid (meta) (H_2SiO_3)	0,0506		
	1,3544		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0150
Sodium chloride ($NaCl$)	0,1013
Sodium sulphate (Na_2SO_4)	0,2967
Calcium sulphate ($CaSO_4$)	0,8908
Silicic acid (meta) (H_2SiO_3)	0,0506
	1,3544

Besides these trace of magnesium, ferrous, aluminium and hydrophosphate ion.

The spring thus may be classified as "**sulphated bitter spring**".

The hot spring "Ana-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1904.

Specific gravity: 1,001 at 17° C. Temperature: 48° C.

Flow of water: ca. 194 hectolitres in 24 hours. Total residue: ca. 1,62.

The spring, being in its composition nearly the same as that of "Ō-yu," may be classified as "**sulphated bitter spring**".

Radio-activity. **0,48** Mache's units in 1 litre of water at 19,5° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, March 18, 1913)

The hot spring "Tohi-kwan-no-yu" No. 1

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1910. Temperature: 53,5° C.
Specific gravity: 1,0018 at 12,5° C. Total residue: ca. 1,41.

The spring, being in its composition nearly the same as that of "Ō-yu", may be classified as "**sulphated bitter spring**".

Radio-activity. **0,40** Mache's units in 1 litre of water at 16,0° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, March 18, 1913).

The hot spring "Tohi-kwan-no-yu" No. 2

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1910. Temperature: 56° C.
Specific gravity: 1,0022 at 10° C. Total residue: ca. 1,69.

The spring, being in its composition nearly the same as that of "Ō-yu", may be classified as "**sulphated bitter spring**".

Radio-activity. **0,85** Mache's units in 1 litre of water at 15,3° C.
(Kohl.-Löw. fontact.; Y. Kinugasa, March 18, 1913).

Table 59.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Ō-yu (*Public bath*) *Vent No. 1*	sulphated bitter	46,0°	ca. —	**0,64**	16,7°	K.&L.	March 17, 1913	Y. Kinugasa
2	„ *Vent No. 2*	„	57,0°	—	**0,47**	15,3°	„	„	„
3	Kyōdō-yu (*Suzuki*)(*Public bath*)	„	55,0°	—	**0,29**	16,5°	„	„ 18, „	„
4	Hamano-Kyōdō-yu („)	„	55,0°	—	**0,73**	17,5°	„	„	„
5	Ana-yu („)	„	48,0°	194	**0,48**	19,5°	„	„	„
6	Tohi-kwan-no-yu *No. 1*	„	53,5°	—	**0,40**	16,0°	„	„	„
7	„ *No. 2*	„	56,0°	—	**0,85**	15,3°	„	„	„
8	Takasagoya-no-yu	„	36,0°	—	**0,28**	14,3°	„	„ 17, „	„
9	Asaka-no-yu *No. 1*	„	55,5°	—	**0,74**	17,4°	„	„	„
10	„ *No. 2*	„	52,0°	—	**0,20**	17,0°	„	„ 18, „	„
11	Private bath (*M. Ishiwara*)	„	43,0°	—	**0,25**	18,7°	„	„	„
12	„ (*S. Asaka*)	„	52,0°	—	**0,47**	17,0°	„	„	„
13	„ (*T. Yoshimura*)	„	55,0°	—	**0,23**	17,6°	„	„	„
14	„ (*T. Torizawa*)	„	66,0°	—	**0,69**	21,9°	„	„	„
15	„ (*Z. Yoda*)	„	57,0°	—	**0,27**	17,2°	„	„	„
16	„ (*K. Hasegawa*)	„	51,5°	—	**0,40**	18,0°	„	„	„

YUMURA

Location.—Ōmiya-mura, Nishi-yamanashi-gun, Province Kai, Yamanashi-ken.

Table 60.

No.	Spring	Geology	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water			Apparatus employed	Date when the water was taken	Examined by
						in 10^{-10} curies	in Mache's units	at (temp. in C.)			
1	Tani-Onsen (*Public bath*)	Alluvium	salt	35,5°	ca. —	5,17	1,42	33,0°	Schm.	March 19, 1914	Y. Kinugasa
2	Washi-Onsen („)	Augite Andesite and its Agglomerate	„	42,0°	313	—	1,80	16,0°	K.&L.	„ 18, „	„
3	Kōbōzue-Onsen	„	„	33,8°	—	—	1,86	14,8°	„	„	„
4	Meiji-Onsen	—	„	38,0°	—	—	2,41	12,9°	„	„ 19, „	„

KAMI-SEKISUIJI

Location.—Aikawa-mura, Nishi-yamanashi-gun, Province Kai, Yamanashi-ken.

Table 61.

No.	Spring	Geology	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water		Apparatus employed	Date when the water was taken	Examined by
						in Mache's units	at (temp. in C.)			
1	Yōsō-Onsen	Granite	—	10,5°	ca. —	2,95	14,4°	K.&L.	March 20, 1914	Y. Kinugasa
2	Yōgai-Onsen	Augite Andesite and its Agglomerate	simple	11,0°	36	1,55	15,2°	„	„ 21, „	„

SHIMOBE

Location.—Tomisato-mura, Nishi-yatsushiro-gun, Province Kai, Yamanashi-ken.

The springs issue from the Tertiary Shale.

The cold spring "Shimobe-Onsen"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 0,9998 at 19° C. Temperature: 35° C.

Total residue: ca. 0,46. Flow of water: ca. 6480 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,00024	0,00613	0,00613
Sodium ion ($Na^{\cdot}$)	0,08059	3,49631	3,49631
Ammonium ion ($NH_4^{\cdot}$)	0,00021	0,01162	0,01162
Calcium ion ($Ca^{\cdot\cdot}$)	0,05714	1,42850	2,85700
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00031	0,01273	0,02546
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00140	0,02500	0,05000
			6,44652
Anions.			
Chlorine ion (Cl')	0,06676	1,88322	1,88322
Sulphate ion (SO_4'')	0,20531	2,13731	4,27462
Hydrocarbonate ion (HCO_3')	0,01759	0,28831	0,28831
	0,42955	9,28913	6,44615
Boric acid (meta) (HBO_2)	0,01419		
Silicic acid (meta) (H_2SiO_3)	0,03052		
	0,47426		
Free carbon dioxide (CO_2)	0,00730	0,16591	
	0,48156		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,00046
Sodium chloride ($NaCl$)	0,10913
Ammonium chloride (NH_4Cl)	0,00062
Sodium sulphate (Na_2SO_4)	0,11591
Calcium sulphate ($CaSO_4$)	0,17987
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,01725
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,00155
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00445
Boric acid (meta) (HBO_2)	0,01419
Silicic acid (meta) (H_2SiO_3)	0,03052
	0,47395
Free carbon dioxide (CO_2)	0,00730
	0,48125

The spring thus may be classified as "**simple cold spring**".

Table 62.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water * in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Shimobe-Onsen *No. 1*	simple	35,0°	ca. 6480	**0,85**	**0,23**	21,5°	Schm.	May 25, 1914	H. Kakehi
2	„ *No. 2*	„	35,0°	6480	**0,48**	**0,13**	27,0°	„	Aug. 1, „	M. Komori
3	„ *No. 3*	„	36,0°	6480	**0,27**	**0,07**	28,0°	„	„	„

* Measurement was made with the sample brought to the laboratory by applicant, taking into account decay of radium emanation with the time.

MASUTOMI

Location.—Masutomi-mura, Kita-koma-gun, Province Kai, Yamanashi-ken.

The springs issue from the Granite.

The cold spring "Nibuzawa" No. 1

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0070 at 10° C. Temperature: 23.5° C. (air temp. 4,5° C.).

Total residue: ca. 7,41. Flow of water: ca. 77 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,13765	3,51596	3,51596
Sodium ion ($Na^{\cdot}$)	2,43382	105,58872	**105,58872**
Ammonium ion ($NH_4^{\cdot}$)	0,00106	0,05863	0,05863
Calcium ion ($Ca^{\cdot\cdot}$)	0,23677	5,91925	**11,83850**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,02085	0,85591	1,71182
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00140	0,02500	0,05000
			122,76363
Anions.			
Chlorine ion (Cl')	3,14674	88,76587	**88,76587**
Sulphate ion (SO_4'')	0,46988	4,89153	9,78306
Hydrocarbonate ion (HCO_3')	1,47765	24,21980	**24,21980**
	7,92582	233,84067	122,76873
Boric acid (meta) (HBO_2)	0,16910		
Silicic acid (meta) (H_2SiO_3)	0,16762		
	8,26254		
Free carbon dioxide (CO_2)	0,26432	6,00727	
	8,52686		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,2623
Sodium chloride ($NaCl$)	4,9835
Ammonium chloride (NH_4Cl)	0,0031
Sodium sulphate (Na_2SO_4)	0,6954
Sodium bicarbonate ($NaHCO_3$)	0,8927
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,9590
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,1253
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0045
Boric acid (meta) (HBO_2)	0,1691
Silicic acid (meta) (H_2SiO_3)	0,1676
	8,2625
Free carbon dioxide (CO_2)	0,2643
	8,5268

The spring thus may be classified as "**earthy common salt spring**".

Radio-activity. **1433,17** $\times 10^{-10}$ curies in 1 litre of water at 15,0° C.

(Schmidt's electrom.; Dr. R. Ishizu, Dec. 6, 1913).

394,12 Mache's units (recalculated).

The cold spring "Kamigawara" No. 1

Analysis.

Analysed by the Hygienic Laboratory of Yamanashi-ken 1914. Temperature: 21,5° C. (air temp. 23,5° C.).

Total residue: ca. 5,98. Flow of water: ca. 22 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Nibuzawa" No. 1, may be classified as "**earthy common salt spring**".

Radio-activity. **3012,14** $\times 10^{-10}$ curies in 1 litre of water at 21,5° C.

(Schmidt's electrom.; Y. Kinugasa, Sept. 9, 1914).

828,34 Mache's units (recalculated).

The cold spring "Yunokubo-gawara-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914. Specific gravity: 1,0066 at 23° C.

Temperature: 15,0° C. (air temp. 10,5° C.). Total residue: ca. 9,86.

The spring, being in its composition nearly the same as that of "Nibuzawa" No. 1, may be classified as "**earthy common salt spring**".

Radio-activity. **883,39** $\times 10^{-10}$ curies in 1 litre of water at 12,0° C.

(Schmidt's electrom.; Y. Kinugasa, March 23, 1914).

243,82 Mache's units (recalculated).

1871,31 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.

(Schmidt's electrom.; Y. Kinugasa, April 3, 1914).

514,61 Mache's units (recalculated).

The cold spring "Tsugane-yu" No. 1 (A)

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0070 at 11° C. Temperature: 17,5° C. (air temp. 7° C.).
Total residue: ca. 7,94. Flow of water: ca. 45 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Nibuzawa" No. 1, may be classified as "earthy common salt spring".

Radio-activity. **856,83** $\times 10^{-10}$ curies in 1 litre of water at 14,5° C.
(Schmidt's electrom; Y. Kinugasa, April 1, 1914).
235,63 Mache's units (recalculated).

The cold spring "Kuridaira" No. 1

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0028 at 10° C. Temperature: 16,0° C. (air temp. 7,0° C.).
Total residue: ca. 2,18. Flow of water: ca. 40 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Nibuzawa" No. 1, differing only in the smaller proportion of hydrocarbonates of alkaline-earth metals from the latter, may be classified as "common salt spring".

Radio-activity. **2147,05** $\times 10^{-10}$ curies in 1 litre of water at 5,0° C.
(Schmidt's electrom.; Dr. R. Ishizu, Dec. 7, 1913).
590,44 Mache's units (recalculated).
5506,30 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
(Schmidt's electrom.; Dr. R. Ishizu, Dec. 8, 1913).
1514,23 Mache's units (recalculated).

The cold spring "Tochikubo" No. 1

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0085 at 11° C. Temperature: 24,5° C. (air temp. 9,0° C.).
Total residue: ca. 9,20. Flow of water: ca. 66 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Nibuzawa" No. 1, may be classified as "earthy common salt spring".

Radio-activity. **25,87** $\times 10^{-10}$ curies in 1 litre of water at 14,0° C.
(Schmidt's electrom.; Dr. R. Ishizu, Dec. 9, 1913).
7,11 Mache's units (recalculated).
86,41 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
(Schmidt's electrom.; Dr. R. Ishizu, Dec. 13, 1913).
23,76 Mache's units (recalculated).

Composition of the gas (analysed in 1914).

1000 c.c. of gas* evolving from the spring consist of:

	Kuridaira No. 1	Tochikubo No. 1
Carbon dioxide (CO_2)	870 c.c.	960 c.c.
Oxygen (O_2).	10 „	10 „
The rest	not determined	not determined

* The analysis is not accurate, the numbers giving only the approximate value.

Discharge of Radium Emanation.

No.	Spring	Per minute: Flow of water in litres	Per minute: Emanation in 10^{-8} curies	Per minute: Emanation in Mache's units	Per hour: Flow of water in litres	Per hour: Emanation in 10^{-8} curies	Per hour: Emanation in 10^{3} Mache's units	Per day (24 hours): Flow of water in hectolitres	Per day (24 hours): Emanation in 10^{-6} curies (microcuries)	Per day (24 hours): Emanation in 10^{3} Mache's units
1	Kamigawara *No. 1*	1,5	46	*1266*	92	2761	*76*	22	663	*1822*
2	Kuridaira *No. 1*	2,8	60	*1640*	167	3578	*98*	40	859	*2362*
3	,, *No. 1 Vent A*	7,0	80	*2210*	417	4822	*133*	100	1157	*3183*
4	,, *No. 1 Vent B*	7,0	—	*2027*	417	—	*122*	100	—	*2919*
5	,, *No. 1 Vent C*	0,9	—	*370*	54	—	*22*	13	—	*532*
6	,, *No. 3*	0,9	9	*259*	54	565	*16*	13	136	*373*
7	Tsugane-yu *No. 1 (A)*	3,1	27	*736*	188	1607	*44*	45	386	*1060*
8	,, *No. 1 (B)*	0,9	—	*78*	54	—	*5*	13	—	*112*
9	Nibuzawa *No. 1*	5,4	77	*2108*	321	4598	*127*	77	1104	*3035*

Table 63.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Ōshiba *No. 1 (I. Ōshiba)*	—	air temp. 19,0° (14,5°)	ca. —	1008,76	277,41	8,5°	Schm.	March 26, 1914	Y. Kinugasa
2	,,	—	,,	—	—	298,33	17,4°	K. & L.	,, 24, ,,	,,
3	,, *No. 2 (T. Fujiwara)*	simple	14,5° (14°)	—	—	1,85	15,7°	,,	,,	,,
4	Ginsen-tō	—	29,5° (7°)	—	372,63	102,47	23,0°	Schm.	Dec. 10, 1913	Dr. R. Ishizu
5	,,	—	30,0° (14°)	—	—	109,96	15,4°	K. & L.	March 24, 1914	Y. Kinugasa
6	Kamigawara *No. 1 (K. Fujita)*	earthy common salt	21,5° (23,5°)	22	3012,14	828,34	21,5°	Schm.	Sept. 9, ,,	,,
7	,, *No. 2* (,,)	,,	14,0°	—	2390,02	657,26	8,5°	,,	March 28, ,,	,,
8	Kuridaira *No. 1 (S. Hakii)*	common salt	16,0° (7°)	40	2147,05	590,44	5,0°	,,	Dec. 7, 1913	Dr. R. Ishizu
9	,, *No. 1 Vent A* (,,)	,,	20,0° (4°)	100	1157,29	318,25	13,3°	,,	March 31, 1914	Y. Kinugasa
10	,,	,,	,,	,,	—	388,14	7,8°	K. & L.	,, 27, ,,	,,
11	,, *No. 1 Vent C* (,,)	,,	21,5° (4°)	13	—	409,31	7,6°	,,	,,	,,
12	,, *No. 1 Vent B* (,,)	,,	20,0°	100	—	291,93	8,7°	,,	,, 28, ,,	,,
13	,, *No. 2 (A)* (,,)	—	26,0° (17°)	15	7,42	2,04	14,5°	Schm.	,, 25, ,,	,,
14	,, *No. 2 (C)* (,,)	—	20,0° (17°)	11	—	1,92	14,0°	K. & L.	,,	,,
15	,, *No. 2 (D)* (,,)	—	20,0° (9,5°)	41	6,79	1,87	8,0°	Schm.	Dec. 11, 1913	Dr. R. Ishizu

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
			air temp.	ca.						
16	Kuridaira *No. 3* (*S. Hakii*)	—	20,0° (10,5°)	13	1042,17	286,60	12,0°	Schm.	March 30, 1914	Y. Kinugasa
17	Tsugane-yu *No. 1* (*A*)	earthy common salt	17,5° (7°)	45	856,83	235,63	14,5°	„	Apr. 1, „	„
18	„	„	„	„	—	240,20	9,6°	K. & L.	March 26, „	„
19	„ *No. 1* (*B*)	„	19,0° (7°)	13	—	86,27	9,1°	„	„	„
20	„ *No. 1* (*C*)	„	16,0° (7°)	—	—	83,35	9,2°	„	„	„
21	Yunokubo *No. 1* (*M. Shirakura*)	—	17,0°	—	900,12	247,53	7,0°	Schm.	„ 27, „	„
22	„	—	18,0°	—	—	298,22	14,1°	K. & L.	„ 25, „	„
23	Yunokubo-gawara-no-yu (*K. Arii*)	earthy common salt	15,0° (10,5°)	—	883,39	243,82	12,0°	Schm.	„ 23, „	„
24	„	„	„	—	—	239,22	16,0°	K. & L.	„	„
25	Tochikubo *No. 1* (*S. Hakii*)	„	24,5° (9°)	66	25,87	7,11	14,0°	Schm.	Dec. 9, 1913	Dr. R. Ishizu
26	Hatchō-jyaya-shita *No. 1*	—	18,5°	—	—	146,97	7,2°	K. & L.	March 27, 1914	Y. Kinugasa
27	Yunomukai *No. 1*	—	10,0°	—	—	75,62	11,8°	„	„ 31, „	„
28	Umamichi-zawa *No. 1*	—	12,0°	—	—	2,86	11,2°	„	„	„
29	Yunosawa *No. 1*	—	17,0° (6°)	—	5,76	1,58	8,0°	Schm.	Dec. 5, 1913	Dr. R. Ishizu
30	Kinsen-tō	—	31,5° (5,5°)	362	7,58	2,08	7,5°	„	„ 12, „	„
31	„	—	33,0°	„	—	2,29	17,0°	K. & L.	Apr. 2, 1914	Y. Kinugasa
32	Nibuzawa *No. 1* (*Z. Gotō*)	earthy common salt	23,5° (4,5°)	77	1433,17	394,12	15,0°	Schm.	Dec. 6, 1913	Dr. R. Ishizu
33	„	„	22,5° (1°)	„	—	312,54	9,6°	K. & L.	March 28, 1914	Y. Kinugasa
34	Taikarizawa *No. 1*	—	8,2°	—	—	6,54	7,0°	„	„ 29, „	„
35	„ *No. 2*	—	8,2°	—	—	8,77	7,2°	„	„	„
36	„ *No. 3*	—	4,5°	—	—	8,42	7,4°	„	„	„
37	Matsudaira *No. 1*	—	3,9°	—	—	2,12	8,2°	„	„	„
38	Toyanosawa *No. 1*	—	9,0°	—	—	4,03	8,9°	„	„	„
39	Akashibu *No. 1*	—	13,0°	—	—	2,61	14,9°	„	Apr. 1, „	„
40	„ *No. 2*	—	12,0°	—	—	2,97	15,6°	„	„	„
41	„ *No. 3*	—	10,5°	—	—	3,15	15,2°	„	„	„
42	Itaya *No. 1*	—	14,0°	—	—	2,92	14,9°	„	„	„
43	„ *No. 2*	—	12,0°	—	—	2,13	15,0°	„	„	„
	Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Kamigawara *No. 2* (*K. Fujita*)	—	—	—	2037,42	560,29	—	Schm.	Apr. 2, 1914	„
2	Yunokubo gawara-no-yu (*K. Arii*)	—	—	—	1871,31	514,61	—	„	„ 3, „	„
3	„	—	—	—	—	539,99	—	K. & L.	March 31, „	„
4	Tochikubo *No. 1* (*S. Hakii*)	—	—	—	86,41	23,76	—	Schm.	Dec 13, 1913	Dr. R. Ishizu
5	Kuridaira *No. 1* („)	—	—	—	5506,30	1514,23	—	„	„ 8, „	„

SHIBU

Location.—Kitayama-mura, Suwa-gun, Province Shinano, Nagano-ken.

The springs issue from the Andesite.

The cold spring "Shibu-no-yu"

Analysis.

Analysed by Dr. R. Ishizu. 1904.
Total residue: ca. 0,86.
Flow of water: abundant.
Specific gravity: 1,0003 at 15° C.
Temperature: 27° C.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,0275	Aluminium sulphate [$Al_2(SO_4)_3$]	0,0976
Sodium chloride (NaCl)	0,0923	Free sulphuric acid (H_2SO_4)	0,6692
Potassium sulphate (K_2SO_4)	0,1624	Silica (SiO_2)	0,0890
Calcium sulphate ($CaSO_4$)	0,0326		1,1854
Magnesium sulphate ($MgSO_4$)	0,0046	Free hydrogen sulphide (H_2S)	0,0167
Ferrous sulphate ($FeSO_4$)	0,0102		1,2021

The spring may be classified as "**acid hydrogen sulphide spring**".

Radio-activity. **1,22** $\times 10^{-10}$ curies in 1 litre of water* at 23° C.
(Schmidt's electrom.; M. Komori, Oct. 6, 1914).
0,34 Mache's units (recalculated).

Composition of the mineral salt "Hana-jio" (analysed in 1904).

100 parts of the brownish crystalline crust, weak acid and saline in taste, consist of:

Potassium chloride (KCl)	0,4167 parts	Ferrous sulphate ($FeSO_4$)	9,5390 parts
Sodium chloride (NaCl)	0,1053 ,,	Aluminium sulphate [$Al_2(SO_4)_3$]	16,1674 ,,
Sodium sulphate (Na_2SO_4)	15,4596 ,,	Sulphuric acid (H_2SO_4)	2.2395 ,,
Calcium sulphate ($CaSO_4$)	1,2250 ,,	Silica (SiO_2)	1,2504 ,,
Magnesium sulphate ($MgSO_4$)	0,7968 ,,	Water	47,7850 ,,

Composition of the sinter-deposit "Yu-no-hana" (analysed in 1904).

100 parts of the yellowish-white powder, acid in taste, consist of:

Sulphur (S)	77,9959 parts	Calcium sulphate ($CaSO_4$)	2,8422 parts
Potassium sulphate (K_2SO_4)	2,1258 ,,	Ferric oxide (Fe_2O_3)	2,7703 ,,

Besides these a small quantity of magnesia, alumina, chlorine, silica, etc.

SUWA

Location.—Suwa-gun, Province Shinano, Nagano-ken.

The springs issue from the Alluvium.

The hot spring "Suwa-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1890.
Specific gravity: 1,00195 at 15° C.
Temperature: 64.7° C.
Total residue: ca. 1,06.

* Measurement was made with the sample brought to the laboratory by applicant, taking into account decay of radium emanation with the time.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0163	0,4163	0,4163
Sodium ion ($Na^{\cdot}$)	0,2451	10,6334	**10,6334**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0738	1,8404	3,6808
			14,7305
Anions.			
Chlorine ion (Cl')	0,2443	6,8914	**6,8914**
Sulphate ion (SO_4'')	0,3765	3,9194	**7,8388**
	0,9560	23,7009	14,7302
Silicic acid (meta) (H_2SiO_3)	0,0681		
	1 0241		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,4031
Potassium sulphate (K_2SO_4)	0,0364
Sodium sulphate (Na_2SO_4)	0,2664
Calcium sulphate ($CaSO_4$)	0,2501
Silicic acid (meta) (H_2SiO_3)	0,0681
	1,0241

Besides these trace of hydrophosphate ion and boric acid.

The spring thus may be classified as "**weak muriated saline bitter spring**".

Table 64.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
	Public bath:								
1 Kami-suwa	Shōjin-yu	simple	67,5°	ca. 130	**1,29**	5,4°	K & L.	Apr. 6, 1914	Y. Kinugasa
2 Kami-suwa	Hira-no-yu	„	59,0°	130	**0,94**	6,4°	„	„	„
3 Kami-suwa	Tajiku-no-yu	„	83,0°	130	**1,13**	6,0°	„	„	„
4 Shimo-suwa	Wata-no-yu	„	47,5°	2700	**1,61**	6,0°	„	„ 7. „	„
5 Shimo-suwa	Ko-yu	„	52,0°	1800	**0,92**	7,0°	„	„	„
6 Shimo-suwa	Tankwa-no-yu	„	67,0°	3600	**1,32**	6,6°	„	„	„

ASAMA

Location.—Hongō-mura, Higashi-chikuma-gun, Province Shinano, Nagano-ken.

The springs issue from the Tertiary.

The hot spring "Asama-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1893.

Specific gravity: 1,00029 at 15° C. Total residue: ca. 0,44.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0094	0,2401	0,2401
Sodium ion ($Na^{\cdot}$)	0,0880	3,8178	3,8178
Calcium ion ($Ca^{\cdot\cdot}$)	0,0371	0,9252	1,8504
			5,9083

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,0475
Potassium sulphate (K_2SO_4)	0,0209
Sodium sulphate (Na_2SO_4)	0,2139
Calcium sulphate ($CaSO_4$)	0,1258

Anions.

Chlorine ion (Cl')	0,0288	0,8124	0,8124
Sulphate ion (SO_4'')	0,2448	2,5484	5,0968
	0,4081	8,3439	5,9092
Silicic acid (meta) (H_2SiO_3) . . .	0,0491		
	0,4572		

Silicic acid (meta) (H_2SiO_3)	0,0491
	0,4572

Besides these a small quantity of ferrous and aluminium ion, trace of magnesium and hydrophosphate ion.

The spring thus may be classified as "**simple thermal**".

Table 65.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water		Apparatus employed	Date when the water was taken	Examined by
				in Mache's units	at (temp. in C.)			
1	Me-no-yu	simple	36,5° (air temp. 29°)	**2,27**	27,6°	K. & L.	Aug. 4, 1914	Y. Kinugasa, T. Saitō
2	Matsu-no-yu	"	53,0° (30°)	**0,73**	27,0°	"	"	"
3	Taki-no-yu (*Public bath*)	"	50,0° (28°)	**0,93**	27,4°	"	"	"
4	Kizu-no-yu	"	44,0° (26°)	**1,24**	27,4°	"	"	"

YAMABE

Location.—Sato-yamabe-mura, Higashi-chikuma-gun, Province Shinano, Nagano-ken.

The springs issue from the Tertiary.

The hot spring "Shiraito-Onsen" No. 1

Analysis.

Analyst: Unknown. Specific gravity: 1,0003 at 15° C. Total residue: ca. 0,45.

Flow of water: ca. 130 hectolitres in 24 hours. Temperature: 42° C. (air temp. 30,2° C.).

In 1 kilogram of the mineral water are contained:

	Grams	Hypothetical form of combination.	Grams
Potassium (K)	0,0314	Potassium sulphate (K_2SO_4)	0,0542
Sodium (Na)	0,0208	Sodium sulphate (Na_2SO_4)	0,0556
Calcium (Ca)	0,0450	Potassium carbonate (K_2CO_3)	0,0454
Magnesium (Mg)	0,0250	Sodium carbonate (Na_2CO_3)	0,0725
Chlorine (Cl)	0,0406	Calcium sulphate ($CaSO_4$)	0,0474
Sulphuric anhydride (SO_3)	0,1745	Magnesium sulphate ($MgSO_4$)	0,0642
Silica (SiO_2)	0,0324	Silica (SiO_2)	0,0324
Carbon dioxide (CO_2)	0,1000		0,3717

Besides these a small quantity of phosphoric acid and trace of iron.

The spring may be classified as "**simple thermal**".

Radio-activity. **1,38** Mache's units in 1 litre of water at 27,8° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 4, 1914).

Table 66.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Shiraito-Onsen *No. 1*	simple	42,0° (air temp. 30,2°)	ca. 130	**1,38**	27,8°	K.&L.	Aug. 4. 1914	Y. Kinugasa, T. Saitō
2	„ *No. 2*	„	42,0° (30,2°)	356	**1,51**	27,8°	„	„	„
3	Mitarashi-no-yu	—	28,0° (30°)	—	**1,19**	27,3°	„	„	„
4	Oboke-no-yu	—	29,0° (30°)	—	**0,58**	27,6°	„	„	„

SHIRAHONE

Location.—Azumi-mura, Minami-azumi-gun, Province Shinano, Nagano-ken.

The hot spring "Ō-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1897.

Temperature: 52° C. (air temp. 24° C.). Flow of water: ca. 236 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0290	0,7407	0,7407
Sodium ion ($Na^{\cdot}$)	0,1284	5,5705	**5,5705**
Calcium ion ($Ca^{\cdot\cdot}$)	0,1403	3,4962	**6,9924**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0467	1,9174	3,8348
			17,1384
Anions.			
Chlorine ion (Cl')	0,1011	2,8519	2,8519
Sulphate ion (SO_4'')	0,0649	0,6756	1,3512
Hydrocarbonate ion (HCO_3')	0,7892	12,9353	**12,9353**
	1,2996	28,1876	17,1384
Silicic acid (meta) (H_2SiO_3)	0,0571		
	1,3567		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0552
Sodium chloride (NaCl)	0,1236
Sodium bicarbonate ($NaHCO_3$)	0,2905
Calcium sulphate ($CaSO_4$)	0,0920
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,4576
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,2807
Silicic acid (meta) (H_2SiO_3)	0,0571
	1,3567

Besides these trace of ferrous, aluminium and hydrophosphate ion.

The spring thus may be classified as "**earthy alkaline spring**".

Radio-activity. **0,37** Mache's units in 1 litre of water at 24,6° C.

1,05 Mache's units in 1 litre of gas at 0° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 6, 1914).

Table 67.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Ō-yu (*Public bath*)	earthy alkaline	air temp. 52,0° (24°)	ca. 236	**0,37**	24,6°	K.&L.	Aug. 6, 1914	Y. Kinugasa, T. Saitō
2	Chi-no-yu	,,	48,0° (26°)	—	**0,86**	26,3°	,,	,,	,,
3	Senki-no-yu	,,	52,0° (28°)	236	**0,57**	26,0°	,,	,,	,,
4	Wata-no-yu	,,	51,0° (28°)	126	**0,97**	25,8°	,,	,,	,,
					Emanation per litre of gas at 0° C.			Date when the gas was collected	
	Gas evolving from Ō-yu	—	—	—	**1,05**	—	,,	Aug. 6, 1914	,,

KAMIKŌCHI

Location.—Azumi-mura, Minami-azumi-gun, Province Shinano, Nagano-ken.

The spring issues from the Granite.

The hot spring "Kamikōchi-Onsen"

Temperature: 53,5° C. (air temp. 20° C.). Flow of water: ca. 778 hectolitres in 24 hours.

No accurate analysis has ever been made, but the spring seems to be "**simple thermal**".

Radio-activity. **1,28** Mache's units in 1 litre of water at 21,0° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 7, 1914).

NAKABUSA

Location.—Ariake-mura, Minami-azumi-gun, Province Shinano, Nagano-ken.

The springs issue from the Granite.

The hot spring "Shirataki-no-yu"

Analysis.

Analysed by the Imperial Geological Survey. Specific gravity: 1,00 at 15° C.

Temperature: 59,5° C. (air temp. 29° C.). Total residue: ca. 0,55.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium (K)	0,0362	Sulphate ion (SO_4'')	0,0930
Sodium (Na)	0,0955	Silica (SiO_2)	0,1758
Calcium (Ca)	0,0110	Organic substances	0,0284
Magnesium (Mg)	0,0002	Carbon dioxide (CO_2)	0,0790
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,0034	Hydrogen sulphide (H_2S)	0,0090
Chlorine (Cl)	0,0798		

The spring may be classified as "**sulphur spring**".

Radio-activity. **1,85** Mache's units in 1 litre of water at 27,7° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 11, 1914).

The hot spring "Danjō-no-yu"

Analysis.

Analysed by the Imperial Geological Survey. Specific gravity: 1,00 at 15° C.
Temperature: 96° C. (air temp. 28° C.). Total residue: ca. 0,71.

The spring, being in its composition nearly the same as that of "Shirataki-no-yu", may be classified as "**alkaline sulphur spring**".

Radio-activity. **0,79** Mache's units in 1 litre of water at 28,1° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 11, 1914).

The hot spring "Taki-no-yu"

Analysis.

Analysed by the Imperial Geological Survey. Specific gravity: 1,00 at 15° C.
Temperature: 95,5° C. (air temp. 28° C.). Total residue: ca. 1,14.

The spring, being in its composition nearly the same as that of "Shirataki-no-yu", may be classified as "**alkaline sulphur spring**".

Radio-activity. **0,77** Mache's units in 1 litre of water at 27° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 11. 1914).

The hot spring "Oyogi-no-yu"

Analysis.

Analysed by the Imperial Geological Survey. Specific gravity: 0,99 at 15° C.
Temperature: 74° C. (air temp. 30° C.). Total residue: ca. 0,46.

The spring, being in its composition nearly the same as that of "Shirataki-no-yu", may be classified as "**alkaline sulphur spring**".

Radio-activity. **1,28** Mache's units in 1 litre of water at 22,6° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 11. 1914).

Table 68.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Yakushi-no-yu *No. 1*	alkaline sulphur	92,0° (air temp. 27°)	**1,06**	26,8°	K.&L.	Aug. 11, 1914	Y. Kinugasa, T. Saitō
2	„ *No. 2*	„	93,0° (26,5°)	**0,98**	27,4°	„	„	„
3	Danjō-no-yu	„	96,0° (28°)	**0,79**	28,1°	„	„	„
4	Myōken-no-yu	„	96,0° (27,5°)	**1,14**	27,9°	„	„	„
5	Taki-no-yu	„	95,5° (28°)	**0,77**	27,0°	„	„	„
6	Shira-taki-no-yu	sulphur	59,5° (29°)	**1,85**	27,7°	„	„	„
7	Tamura-no-yu	alkaline sulphur	94,0° (30°)	**1,50**	23,2°	„	„	„
8	Oyogi-no-yu	„	74,0° (30°)	**1,28**	22,6°	„	„	„

KUZU

Location.—Taira-mura, Kita-azumi-gun, Province Shinano, Nagano-ken.

The springs issue from the Granite.

Table 69.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water in Mache's units	Emanation per litre of water at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Kanatsubo-no-yu	salt	62,0° (air temp. 27°)	1,98	26,2°	K. & L.	Aug. 9, 1914	Y. Kinugasa, T. Saitō
2	Gorin-no-yu	„	63,0° (28°)	2,01	27,0°	„	„	„
3	Shin-yu *No. 2*	„	57,0° (31°)	1,45	25,0°	„	„	„
4	Spring *A*	sulphur (?)	88,0° (29°)	1,42	26,2°	„	„	„

HIRAO

Location.—Hirao-mura, Shimo-takai-gun, Province Shinano, Nagano-ken.

YUDANAKA

The springs issue from the Misaka Series.

The hot spring "Ō-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1886. Total residue: ca. 1,53.

Temperature: 76° (air temp. 27,5° C.) Flow of water: ca. 1703 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,02735	0,69859	0,69859
Sodium ion ($Na^{\cdot}$)	0,27396	11,88546	**11,88546**
Calcium ion ($Ca^{\cdot\cdot}$)	0,19197	4,78728	**9,57456**
			22,15861
Anions.			
Chlorine ion (Cl')	0,42138	11,88660	**11,88660**
Sulphate ion (SO_4'')	0,49344	5,13679	**10,27358**
	1,40810	34,39472	22,16018
Silicic acid (meta) (H_2SiO_3)	0,15394		
	1,56204		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,69534
Potassium sulphate (K_2SO_4)	0,06091
Calcium sulphate ($CaSO_4$)	0,65185
Silicic acid (meta) (H_2SiO_3)	0,15394
	1,56204

Besides these trace of magnesium, ferrous and iodine ion.

The spring thus may be classified as "**muriated sulphated bitter spring**".

Radio-activity. **1,33** Mache's units in 1 litre of water (taken from Vent No. 1) at 27,4° C.

(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 6, 1914).

ANDAI

The springs issue from the Diluvium.

The hot spring "Ō-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1898. Temperature 56° C.

Flow of water: ca. 648 hectolitres in 24 hours. Total residue: ca. 0,95.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0188	0,4803	0,4803
Sodium ion ($Na^{\cdot}$)	0,2181	9,4577	9,4577
Calcium ion ($Ca^{\cdot\cdot}$)	0,0735	1,8329	3,6658
			13,6038
Anions.			
Chlorine ion (Cl')	0,2746	7,7461	7,7461
Sulphate ion (SO_4'')	0,2812	2,9273	5,8546
	0,8662	22,4443	13,6007
Silicic acid (meta) (H_2SiO_3)	0,1064		
	0,9726		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,4531
Potassium sulphate (K_2SO_4)	0,0418
Sodium sulphate (Na_2SO_4)	0,1221
Calcium sulphate ($CaSO_4$)	0,2492
Silicic acid (meta) (H_2SiO_3)	0,1064
	0,9726

Besides these trace of magnesium, ferrous, aluminium and hydrophosphate ion.

The spring thus may be classified as "**simple thermal**".

Radio-activity. **0,97** Mache's units in 1 litre of water at 27,6° C.

(Kohl.-Low. fontact.; Y. Kinugasa and T. Saitō, Sept. 6, 1914).

SHIBU

The springs issue from the Diluvium.

The hot spring "Ō-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1887.

Specific gravity: 1,00203 at 14° C. Total residue: ca. 1,21.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0058	0,1481	0,1481
Sodium ion ($Na^{\cdot}$)	0,2639	11,4490	**11,4490**
Calcium ion ($Ca^{\cdot\cdot}$)	0,1052	2,6190	**5,2380**
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0038	0,0680	0,1360
			16,9711
Anions.			
Chlorine ion (Cl')	0,3236	9,1283	**9,1283**
Sulphate ion (SO_4'')	0,3705	3,8519	**7,7138**
Hydrocarbonate ion (HCO_3')	0,0082	0,1310	0,1310
	1,0810	27,3953	16,9731
Silicic acid (meta) (H_2SiO_3)	0,1752		
	1,2562		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,5340
Potassium sulphate (K_2SO_4)	0,0130
Sodium sulphate (Na_2SO_4)	0,1650
Calcium sulphate ($CaSO_4$)	0,3570
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0120
Silicic acid (meta) (H_2SiO_3)	0,1752
	1,2562

Besides these trace of magnesium, aluminium, iodine and hydrophosphate ion, and boric acid.

The spring thus may be classified as "**sulphated common salt spring**".

Table 70.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
	Yudanaka								
1	Ō-yu * *Vent No. 1*	muriated sulphated bitter	76,0° air temp. (27,5°)	ca. } 1703	1,33	27,4°	K. & L.	Sept. 6, 1914	Y. Kinugasa, T. Saitō
2	„ *Vent No. 2*	„	74,0° (27°)		1,27	28,2°	„	„	„
3	Washi-no-yu	—	74,5° (27,5°)	364	1,22	27,7°	„	„	„
	Andai								
4	Ō-yu *	simple	56,0°	648	0,97	27,6°	„	„	„
5	Kaikwa-no-yu	„	55,0°	194	0,84	27,5°	„	„	„
	Shibu								
6	Ō-yu * *Vent No. 1*	sulphated common salt	74,0° (28°)	—	1,11	28,0°	„	„ 5, „	„
7	„ *Vent No. 4*	„	72,0° (27,7°)	—	1,46	27,0°	„	„	„
8	„ *Vent No. 5*	„	70,5° (27,5°)	—	0,81	26,2°	„	„	„
9	„ *Vent No. 8*	„	62,0° (29°)	—	1,51	27,0°	.	„	„
10	„ *Vent No. 12*	„	76,0° (27°)	—	1,40	26,7°	„	„	„
11	Hatsu-yu *	„	73.5° (26°)	519	1,46	27.1°	„	„	„
12	Wata-no-yu *	„	66,0° (26°)	—	1,20	27,6°	„	„ 6, „	„
13	Mearai-no-yu	„	58 0° (27°)	519	0,82	24,5°	„	„	„
14	Mujina-no-yu	„	45,0° (29°)	—	0,91	24.7°	„	„	„
15	Nanakuri-no-yu* *Vent A*	sulphur	60,0° (24,5°)	—	0,94	27,0°	„	„	„
	Kambayashi								
16	Tsuru-no-yu *	salt	55 0°	501	0,84	26,0°	„	„	„
	Kakuma								
17	Ō-yu *†	common salt	65,0°	735	0,82	26,0°	„	„	„
18	Taki-no-yu *†	„	54,0°	389	—	—	—	—	—
19	Shin-yu *†	„	52,0°	389	—	—	—	—	—

* These springs are for public use.
† These springs, located at *Honami-mura*, about 1.2 m. S. from Shibu, are grouped for convenience in this table.

TAKAYAMA

Location.—Fukuoka-mura, Ena-gun, Province Mino, Gifu-ken.

The springs issue from the Granite.

The cold spring "Ena-Kōsen" (Yunoshima)

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914. Specific gravity 1,0002 at 15° C.
Temperature: 10° C. (air temp. 13° C.). Total residue: ca. 0,12.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,00032	0,00817	0,00817
Sodium ion ($Na^{\cdot}$)	0,02773	1,20303	1,20303
Ammonium ion ($NH_4^{\cdot}$)	0,00016	0,00885	0,00885
Calcium ion ($Ca^{\cdot\cdot}$)	0,00714	0,17850	0,35700
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00022	0,00903	0,01806
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00140	0,02500	0,05000
			1,64511
Anions.			
Chlorine ion (Cl')	0,03538	0,99803	0,99803
Sulphate ion (SO_4'')	0,00123	0,01280	0,02560
Hydrocarbonate ion (HCO_3')	0,03801	0,62301	0,62301
	0,11159	3,06642	1,64664
Silicic acid (meta) (H_2SiO_3)	0,02597		
	0,13756		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,00061
Sodium chloride ($NaCl$)	0,05739
Ammonium chloride (NH_4Cl)	0,00047
Sodium sulphate (Na_2SO_4)	0,00182
Sodium bicarbonate ($NaHCO_3$)	0,01652
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,02897
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,00136
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00445
Silicic acid (meta) (H_2SiO_3)	0,02597
	0,13756

Besides these a small quantity of free carbon dioxide and trace of boric acid.

The spring thus may be classified as "**simple cold spring**".

Radio-activity. **1022,15** $\times 10^{-10}$ curies in 1 litre of water at 11,0° C.
(Schmidt's electrom.; Y. Kinugasa, April 13, 1914).
281,09 Mache's units (recalculated).

Table 71.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
			air temp.						
1	Ena-Kōsen (*Yunoshima*)	simple	10,0° (13°)	**1022,15**	**281,09**	11,0°	Schm.	Apr. 13, 1914	Y. Kinugasa
2	„ (*Dairi-yakushi*)*	„	12,0° (20°)	**220,64**	**60,68**	13.5°	„	„ 15, „	„
3	„ (*Shimizu-ido*)	„	13,0° (19°)	**213,21**	**58,63**	14,7°	„	„ 14, „	„
4	Ichi-no-sawa *No. 1*	„	10,0° (21,5°)	—	**23,70**	13.7°	K. & L.	„ 11, „	„
5	„ *No. 2*	„	12,5° (21°)	—	**2,95**	13,4°	„	„	„
6	„ *No. 3*	„	9,5° (21°)	—	**17,08**	13,1°	„	„	„
7	Okuhora	„	13,0° (21°)	—	**31,90**	12,7°	„	„	„
8	Shimo-isshiki (*Dairi*)*	„	12,0° (20°)	—	**25,77**	14,0°	„	„ 12, „	„
9	Shimoyama *No. 1*	„	12,0° (23°)	—	**19,42**	13.2°	„	„	„
10	Yamaki-no-yu	„	11,0° (20°)	—	**25,16**	12,9°	„	„	„
11	Inari-no-yu	„	13,0° (19°)	—	**30,36**	13,3°	„	„	„
12	Kami-no-ido	„	—	—	**18,48**	16,4°	„	„ 13, „	„
13	Shishi-no-neya	„	—	—	**14,20**	16.7°	„	„	„
14	Bunsaku-ido	„	—	—	**17,13**	16,6°	„	„	„

* These springs, located at *Hirukawa-mura*, about 2,5 m. S. W. from Takayama, are grouped for convenience in this table.

OGAWA

Location.—Yamazaki-mura, Shimo-niikawa-gun, Province Etchū, Toyama-ken.

The springs issue from the Liparite.

The hot spring "Ogawa-Onsen" * No. 5

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1913. Specific gravity: 1 00117 at 15° C.
Temperature: 60° C. (air temp. 26° C.). Total residue: ca. 1,14.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,01338	0,34176	0,34176
Sodium ion ($Na^{\cdot}$)	0,35482	15,39349	**15,39349**
Calcium ion ($Ca^{\cdot\cdot}$)	0,05147	1,28354	2 56708
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00365	0,14984	0,29968
			18 60201
Anions.			
Chlorine ion (Cl')	0,40055	11,29901	**11,29901**
Sulphate ion (SO_4'')	0,03580	0,37268	0,74536
Hydrocarbonate ion (HCO_3')	0,40007	6,55764	**6,55764**
	1,25974	35,39796	18,60201
Boric acid (meta) (HBO_2)	0,02870		
Silicic acid (meta) (H_2SiO_3)	0,08556		
	1,37400		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,02550
Sodium chloride ($NaCl$)	0,64100
Sodium sulphate (Na_2SO_4)	0,05298
Sodium bicarbonate ($NaHCO_3$)	0,31025
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,20808
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,02193
Boric acid (meta) (HBO_2)	0,02870
Silicic acid (meta) (H_2SiO_3)	0,08556
	1,37400

Besides these a small quantity of free carbon dioxide and trace of aluminium, ferrous and hydrophosphate ion. The spring thus may be classified as "**alkaline common salt spring**".

Radio-activity. **2,71** Mache's units in 1 litre of water at 23,5° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, July 24, 1913).

Table 72.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Ogawa-Onsen * *No. 1*	alkaline common salt	50,0° (air temp. 23,9°)	ca. 2340	**0,43**	22,5°	K. & L.	July 24, 1913	Dr. R. Ishizu
2	" *No. 2*	"	49,0° (26°)		**2,46**	24,6°	"	"	"
3	" *No. 3*	"	59,5° (26°)		**0,34**	23,3°	"	" 25, "	"
4	" *No. 4*	"	50,5° (26°)		**1,11**	22,8°	"	" 24, "	"
5	" *No. 5*	"	60,0° (26°)		**2,71**	23,5°	"	"	"
6	" *No. 6*	"	57,0° (26°)		**2,61**	23,4°	"	"	"

* The waters were taken at the source of the springs at *Yamazaki-mura*, about 7,5 m. distant from the present bath-place located in the town of *Tomari*.

FUTAMI

Location.—Aimoto-mura, Shimo-niikawa-gun, Province Etchū, Toyama-ken.

The springs issue from the Granite.

The hot spring "Dai-ichi-no-yu"

Analysis.

Analysed by the Toyama Red Cross Hospital. 1913. Specific gravity: 1,0004 at 15° C.
Temperature: 64,5° (air temp. 29° C.). Total residue: ca. 0,50.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,0314	Aluminium sulphate [$Al_2(SO_4)_3$]	0,0273
Sodium chloride (NaCl)	0,1514	Boric acid (meta) (HBO_2)	0,0204
Sodium bicarbonate ($NaHCO_3$)	0,2057	Silicic acid (meta) (H_2SiO_3)	0,1664
Calcium sulphate ($CaSO_4$)	0,0126		0,6232
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0038	Free carbon dioxide (CO_2)	0,0067
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0037	Free hydrogen sulphide (H_2S)	0,0004
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0005		0,6303

The spring may be classified as "**sulphur spring**".

Radio-activity. **2,60** Mache's units in 1 litre of water at 25,5° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 3, 1914).

The hot spring "Dai-ni-no-yu"

Analysis.

Analysed by the Toyama Red Cross Hospital. 1913. Specific gravity: 1,0006 at 15° C.
Temperature: 85° C. (air temp. 24° C.). Total residue: ca. 0,61.

The spring, being in its composition nearly the same as that of "Dai-ichi-no-yu", may be classified as "**sulphur spring**".

Radio-activity. **1,38** Mache's units in 1 litre of water at 24,2° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 3, 1913).

Table 73.

No.		Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Futami	Dai-ichi-no-yu	sulphur	64,5° (air temp. 29°)	**2,60**	25,5°	K. & L.	Sept. 3, 1914	Y. Kinugasa, T. Saitō
2		Dai-ni-no-yu	,,	85,0° (21°)	**1,38**	24.2°	,,	,,	,,
3		Dai-san-no-yu	,,	95,0°	**1,11**	24,1°	,,	,,	,,
4		Spring *A*	simple	12,5° (29°)	**0,61**	26,0°	,,	,,	,,
5	Kuronagi	Otoko-yu	sulphur	88,5° (27°)	**1,94**	25.0°	,,	,, 2, ,,	,,
6		Onna-yu	,,	83,0° (28°)	**2,21**	24,5°	,,	,,	,,

KANETSURI

Location.—Katakaidani-mura, Shimo-niikawa-gun, Province Etchū, Toyama-ken.

The spring issues from the Contact Zone of Granite and Limestone.

The hot spring "Kanetsuri-Onsen"

Temperature: 49° C. (air temp. 29,5° C.). Flow of water: ca. 180 hectolitres in 24 hours.

No accurate analysis has ever been made, but the spring seems to be "**simple thermal**".

Radio-activity. **2,20** Mache's units in 1 litre of water at 26,8° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Sept. 3, 1914).

ŌMAKI

Location.—Toga-mura, Higashi-tonami-gun, Province Etchū, Toyama-ken.

The spring issues from the Porphyrite Dyke.

The hot spring "Ōmaki-Onsen"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1911.

Specific gravity: 1,0127 at 23° C. Temperature: 49° C. (air temp. 25,5° C.).

Total residue: ca. 3,29. Flow of water: ca. 346 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,01895	0,48404	0,48404
Sodium ion ($Na^{\cdot}$)	0,73404	31,84555	**31,84555**
Ammonium ion ($NH_4^{\cdot}$)	0,00048	0,02655	0,02655
Calcium ion ($Ca^{\cdot\cdot}$)	0,39442	9,86050	**19,72100**
			52,07714
Anions.			
Chlorine ion (Cl')	1,41621	39,94951	**39,94951**
Sulphate ion (SO_4'')	0,57774	6,01437	**12,02874**
Hydrocarbonate ion (HCO_3')	0,00603	0,09883	0,09883
	3,14787	88,27935	52,07708
Boric acid (meta) (HBO_2)	0,08514		
Silicic acid (meta) (H_2SiO_3)	0,05539		
	3,28840		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,03611
Sodium chloride ($NaCl$)	1,86306
Ammonium chloride (NH_4Cl)	0,00142
Calcium chloride ($CaCl_2$)	0,42093
Calcium sulphate ($CaSO_4$)	0,81833
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,00810
Boric acid (meta) (HBO_2)	0,08514
Silicic acid (meta) (H_2SiO_3)	0,05539
	3,28848

Besides these a small quantity of free carbon dioxide.

The spring thus may be classified as "**sulphated common salt spring**".

Radio-activity. **2,11** Mache's units in 1 litre of water at 25,7° C.
(Kohl.-Löw. fontact.; Y. Kinugasa and T. Saitō, Aug. 16, 1914).

WAKURA

Location.—Hashi-mura, Kashima-gun, Province Noto, Ishikawa-ken.

The springs issue from the Tertiary Tufaceous Sandstone.

The hot spring "Wakura-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1897.

Specific gravity: 1,08 at 7,8° C.
Total residue: ca. 20,93.

Temperature: 82° C.
Flow of water: ca. 2160 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,2050	5,2366	5,2366
Sodium ion ($Na^{\cdot}$)	4,3456	188,5303	**188,5303**
Calcium ion ($Ca^{\cdot\cdot}$)	3,1918	79,5910	**159,1820**
			352,9489
Anions.			
Chlorine ion (Cl')	12,3680	348,8857	**348,8857**
Sulphate ion (SO_4'')	0,1943	2,0229	4,0458
	20,3047	624,2665	352,9315
Silicic acid (meta) (H_2SiO_3)	0,0922		
	20,3969		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,3905
Sodium chloride (NaCl)	11,0295
Calcium chloride ($CaCl_2$)	8,6091
Calcium sulphate ($CaSO_4$)	0,2756
Silicic acid (meta) (H_2SiO_3)	0,0922
	20,3969

Besides these trace of magnesium, ferrous, aluminium, bromine, iodine and hydrophosphate ion.

The spring thus may be classified as "**earth-muriated common salt spring**".

AWAZU

Location.—Awazu-mura, Nomi-gun, Province Kaga, Ishikawa-ken.

The springs issue from the Brecciated Liparite.

The hot spring "Awazu-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Ishikawa-ken. 1912.

Specific gravity: 1,0032 at 15° C.
Total residue: ca. 2,24.

Temperature: 47° C. (air temp. 4° C.).
Flow of water: ca. 2700 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium oxide (K_2O)	0,0354
Sodium oxide (Na_2O)	0,3840
Calcium oxide (CaO)	0,4595
Magnesia (MgO)	0,0098
Chlorine (Cl)	0,2359
Sulphuric anhydride (SO_3)	0,4727
Silica (SiO_2)	0,0121
Carbon dioxide (total) (CO_2)	0,6534
Free hydrogen sulphide (H_2S)	0,0173

Hypothetical form of combination.

	Grams
Potassium chloride (KCl)	0,0541
Sodium chloride (NaCl)	0,3471
Sodium bicarbonate ($NaHCO_3$)	0,5937
Calcium sulphate ($CaSO_4$)	0,8032
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,3725
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0360
Silica (SiO_2)	0,0121
	2,2187
Free carbon dioxide (CO_2)	0,1457
Free hydrogen sulphide (H_2S)	0,0173
	2,3817

Besides these trace of iron oxide and alumina.

The spring may be classified as "**sulphur spring**".

KATAYAMAZU

Location.—Sakumi-mura, Enuma-gun, Province Kaga, Ishikawa-ken.

The springs issue from the Tertiary.

The hot spring "Katayamazu-Onsen"

Analysis.

Analysed by the Kanazawa Garrison Hospital. 1909.

Specific gravity: 1,01024 at 15° C. Temperature: 74° C.

Total residue: ca. 15,79. Flow of water: ca. 630 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	5,1311
Sodium chloride (NaCl)	7,2840
Sodium carbonate (Na_2CO_3)	0,0029
Calcium chloride ($CaCl_2$)	1,3009
Calcium sulphate ($CaSO_4$)	1,1370
Magnesium sulphate ($MgSO_4$)	0,6513
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,1147
Silica (SiO_2)	0,1606
	15,7825

Besides these trace of phosphoric and boric acid.

The spring may be classified as "**common salt spring**".

YAMASHIRO

Location.—Yamashiro-machi, Enuma-gun, Province Kaga, Ishikawa-ken.

The springs issue from the Tertiary Shale.

The hot spring "Yamashiro-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1905.

Specific gravity: 1,0000 at 25° C. Temperature: 66° C.

Total residue: ca. 1,66. Flow of water: ca. 2142 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0125	0,3556	0,3556
Sodium ion ($Na^{\cdot}$)	0,3994	17,3275	**17,3275**
Calcium ion ($Ca^{\cdot\cdot}$)	0,1175	2,9302	5,8604
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0016	0,0657	0,1314
			23,6749
Anions.			
Chlorine ion (Cl')	0,2691	7,5910	7,5910
Sulphate ion (SO_4'')	0,7455	7,7608	**15,5216**
Hydrocarbonate ion (HCO_3')	0,0319	0,3286	0,3286
	1,5775	36,3594	23,4412
Silicic acid (meta) (H_2SiO_3)	0,0876		
	1,6651		
Free carbon dioxide (CO_2)	not determined		
Free hydrogen sulphide (H_2S)	**0,0016**		
	1,6667		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0238
Sodium chloride (NaCl)	0,4178
Sodium sulphate (Na_2SO_4)	0,6874
Sodium bicarbonate ($NaHCO_3$)	0,0439
Magnesium chloride ($MgCl_2$)	0,0063
Calcium sulphate ($CaSO_4$)	0,3983
Silicic acid (meta) (H_2SiO_3)	0,0876
	1,6651
Free hydrogen sulphide (H_2S)	0,0016
	1,6667

Besides these trace of ammonium, ferrous, aluminium and hydrophosphate ion and boric acid.

The spring thus may be classified as "**saline bitter sulphur spring**".

YAMANAKA

Location.—Yamanaka-machi, Enuma-gun, Province Kaga, Ishikawa-ken.

The spring issues from the Tertiary Tuff Breccia.

The hot spring ' Yamanaka-Onsen "

Analysi (calculated from the salt table).

Analysed by the Kanazawa Garrison Hospital.

Specific gravity: 1,0016 at 15° C. Temperature: 49° C.
Total residue: ca. 1,65. Flow of water: ca. 1800 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,1698	4,3372	4,3372
Sodium ion ($Na^{\cdot}$)	0,1416	6,1432	6,1432
Calcium ion ($Ca^{\cdot\cdot}$)	0,2747	6,8504	**13,7008**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0076	0,3120	0,6240
			24,8052
Anions.			
Chlorine ion (Cl')	0,0799	2,2539	2,2539
Sulphate ion (SO_4'')	1,0802	11,2451	**22,4902**
Hydrocarbonate ion (HCO_3')	0,0023	0,0377	0,0377
	1,7561	31,1795	24,7818
Silicic acid (meta) (H_2SiO_3)	0,0441		
	1,8002		
Free carbon dioxide (CO_2)	not determined		
Free hydrogen sulphide (H_2S)	**0,0010**		
	1,8012		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,1318
Potassium sulphate (K_2SO_4)	0,3781
Sodium sulphate (Na_2SO_4)	0,2741
Sodium bicarbonate ($NaHCO_3$)	0,0032
Calcium sulphate ($CaSO_4$)	0,9311
Magnesium sulphate ($MgSO_4$)	0,0378
Silicic acid (meta) (H_2SiO_3)	0,0441
	1,8002
Free hydrogen sulphide (H_2S)	0,0010
	1,8012

Besides these trace of ferrous, aluminium and hydrophosphate ion and boric acid.

The spring thus may be classified as "**sulphated bitter sulphur spring**".

YUWAKU

Location.—Yuwakudani-mura, Ishikawa-gun, Province Kaga, Ishikawa-ken.

The springs issue from the Tertiary.

The hot spring " Yuwaku-Onsen "

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1912.

Specific gravity: 1,0020 at 17° C. Temperature: 41° C.
Flow of water: ca. 1800 hectolitres in 24 hours. Total residue: ca. 3.31.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,01287	0,32874	0,32874
Sodium ion ($Na^{\cdot}$)	0,92424	40,09718	**40,09718**
Ammonium ion ($NH_4^{\cdot}$)	0,00317	0,17533	0,17533
Calcium ion ($Ca^{\cdot\cdot}$)	0,23096	5,77400	**11,54800**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00175	0,07184	0,14368
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00140	0,02500	0,05000
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,00317	0,11700	0,35100
			52,69393

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,02452
Sodium chloride (NaCl)	2,15305
Ammonium chloride (NH_4Cl)	0,00938
Sodium sulphate (Na_2SO_4)	0,23417
Calcium sulphate ($CaSO_4$)	0,70586
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,09494
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,01052
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00426

Anions.			
Chlorine ion (Cl′)	1,32261	37,30917	**37,30917**
Sulphate ion (SO_4'')	0,67343	7,01051	**14,02102**
Hydrocarbonate ion(HCO_3').	0,08319	1,36356	1,36356
	3,25679	92,27233	52,69375
Boric acid (meta) (HBO_2) . .	0,11329		
Silicic acid (meta) (H_2SiO_3).	0,04923		
	3,41931		

Aluminium sulphate [$Al_2(SO_4)_3$]	0,02003
Boric acid (meta) (HBO_2)	0,11329
Silicic acid (meta) (H_2SiO_3).	0,04923
	3,41925

Besides these a small quantity of free carbon dioxide.

The spring thus may be classified as "**sulphated common salt spring**".

AWARA

Location.—Awara-mura, Sakai-gun, Province Echizen, Fukui-ken.

The springs issue from the Alluvium.

The hot spring "Beniya-no-yu" (Funatsu No. 10)

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0085 at 12° C. Temperature: 76° C.

Flow of water: ca. 152 hectolitres in 24 hours. Total residue: ca. 10,03.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion (K˙).	0,11510	2,94000	2,94000
Sodium ion (Na˙).	2,32621	100,92025	**100,92025**
Ammonium ion (NH_4˙). .	0,00212	0,11726	0,11726
Calcium ion (Ca˙˙)	1,28974	32,24350	**64,48700**
Magnesium ion (Mg˙˙) . .	0,00438	0,17980	0,35960
Ferrous ion (Fe˙˙)	0,00070	0,01250	0,02500
			168,84911
Anions.			
Chlorine ion (Cl′)	5,70011	160,79295	**160,79295**
Sulphate ion (SO_4''). . . .	0,38556	4,01374	8,02748
Hydrocarbonate ion(HCO_3')	0,00175	0,02868	0,02868
	9,82567	301,24868	168,84911
Boric acid (meta) (HBO_2).	0,14069		
Silicic acid (meta) (H_2SiO_3)	0,08884		
	10,05520		
Free carbon dioxide (CO_2)	0,05374 . .	1,22136	
	10,10894		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,2193
Sodium chloride (NaCl)	5,9041
Ammonium chloride (NH_4Cl)	0,0063
Calcium chloride ($CaCl_2$).	3,1501
Calcium sulphate ($CaSO_4$)	0,5221
Magnesium sulphate ($MgSO_4$)	0,0213
Magnesium bicarbonate [$Mg(HCO_3)_2$] . . .	0,0005
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0022
Boric acid (meta) (HBO_2)	0,1407
Silicic acid (meta) (H_2SiO_3)	0,0888
	10,0554
Free carbon dioxide (CO_2).	0,0537
	10,1091

Besides these trace of bromine, nitrate and hydrophosphate ion.

The spring thus may be classified as "**earth-muriated common salt spring**".

Radio-activity. **3,21**‡ Mache's units in 1 litre of water at 17,1° C.
(Eng.-Siev. fontact.; Y. Kinugasa, Dec. 12, 1913).

39,43‡ Mache's units in 1 litre of gas at 0° C.
(Eng.-Siev. fontact.; Y. Kinugasa, Dec. 13, 1913).

‡ Correction for the absorption of the radiation by the wall of the ionisation chamber and also for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was made.

Table 74.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units I *	II †	III ‡	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Beniya-no-yu (*Funatsu—No. 10*)	earth-muriated common salt	76,0°	ca. 152	2,72	3,15	3,21	17,1°	E. & S.	Dec. 12, 1913	Y. Kinugasa
2	„ („ *No. 9*)	„	70,0°	„	1,83	2,12	2,16	16,5°	„	„	„
3	Kaikwatei-no-yu „ *No. 6*)	„	74,0°	„	1,08	1,25	1,28	8,2°	„	„ 10, „	„
4	Fukuirō-no-yu („ *No. 21*)	„	70,5°	„	2,36	2,73	2,79	13,0°	„	„ 13, „	„
5	Oda-no-yu (*Nimen—No. 21*)	„	53,0°	„	1,51	1,75	1,79	12,7°	„	„	„
6	Haiya-no-yu („ *No. 28*)	„	75,0°	„	2,26	2,61	2,66	8,0°	„	„ 10, „	„
7	Toichirō-no-yu (*Tanaka-naka—No. 22*)	„	63,0°	„	1,54	1,77	1,81	12,4°	„	„ 13, „	„
8	Ishizukaya-no-yu („ *No. 6*)	„	68,2°	„	1,85	2,14	2,18	7,8°	„	„ 16, „	„
	Gas evolving from:				Emanation per litre of gas at 0° C.					Date when the gas was collected	
1	Beniya-no-yu (*Funatsu—No. 10*)	—	—	—	33,55	38,69	39,43	—	—	Dec. 13 1913	„
2	„ („ *No. 9*)	—	—	—	22,45	25,88	26,37	—	—	„ 15, „	„

* Determined according to the authors' original direction.
† Correction for the absorption of the radiation by the wall of the ionisation chamber was made.
‡ Correction for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was also made.

KOMONO

Location.—Komono-mura, Mie-gun, Province Ise, Mie-ken.

The springs issue from the Granite.

The cold spring "Shika-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1907.

Specific gravity: 1,0006.

Total residue: ca. 0,14.

Temperature: 29° C. (air temp. 13° C.).

Flow of water: abundant.§

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0026	0,0664	0,0664
Sodium ion ($Na^{\cdot}$)	0,0392	1,7031	1,7031
Calcium ion ($Ca^{\cdot\cdot}$)	0,0025	0,0623	0,1246
			1,8941

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0050
Sodium chloride ($NaCl$)	0,0180
Sodium bicarbonate ($NaHCO_3$)	0,1173
Calcium sulphate ($CaSO_4$)	0,0030

§ The waters flow down constantly from iron pipe, 3 inches in diameter, at the height of about 6 ft. above the ground.

Anions.

Chlorine ion (Cl')	0,0133	0,3752	0,3752
Sulphate ion (SO_4'')	0,0021	0,0219	0,0438
Hydrocarbonate ion (HCO_3')	0,0901	1,4768	1,4768
	0,1498	3,7057	1,8958
Silicic acid (meta) (H_2SiO_3)	0,0221		
	0,1719		

Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0065
Silicic acid (meta) (H_2SiO_3)	0,0221
	0,1719

Besides these a small quantity of ferrous and aluminium ion and trace of magnesium ion, boric acid and organic substances.

The spring thus may be classified as "**simple cold spring**".

Radio-activity. 8,18 Mache's units in 1 litre of water at 13,4° C.

(Kohl.-Löw. fontact.; Y. Kinugasa, April 17, 1914).

Table 75.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Shika-no-yu	simple	29,0° (air temp. 13°)	8,18	13,4°	K. & L.	Apr. 17, 1914	Y. Kinugasa
2	Spring *A*	,,	10,0° (7°)	13,32	11,6°	,,	,,	,,

ROKUYŌ

Location.—Tōichi-mura, Soekami-gun, Province Yamato, Nara-ken.

The spring issues from the Alluvium.

The cold spring "Nanto-rokuyō-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1907.

Specific gravity: 1,005. Temperature: 20,5° C.

Total residue: ca. 3,79. Flow of water: ca. 45 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0492	1,2567	1,2567
Sodium ion ($Na^{\cdot}$)	0,0623	2,7028	2,7028
Calcium ion ($Ca^{\cdot\cdot}$)	0,0156	0,3890	0,7780
Ferrous ion ($Fe^{\cdot\cdot}$)	**1,0751**	19,2325	38,4650
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0190	0,7011	2,1033
			45,3058
Anions.			
Chlorine ion (Cl')	0,1308	3,6897	3,6897
Sulphate ion (SO_4'')	1,9990	20,8099	**41,6198**
	3,3510	48,7817	45,3095
Silicic acid (meta) (H_2SiO_3)	0,2739		
	3,6249		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0740
Sodium chloride ($NaCl$)	0,1580
Potassium sulphate (K_2SO_4)	0,0230
Calcium sulphate ($CaSO_4$)	0,0530
Ferrous sulphate ($FeSO_4$)	2,9230
Aluminium sulphate [$Al_2(SO_4)_3$]	0,1200
Silicic acid (meta) (H_2SiO_3)	0,2739
	3,6249

Besides these a small quantity of hydrogen and hydrosulphate ion, and trace of hydrophosphate ion.

The spring thus may be classified as "**vitriol spring**".

Radio-activity. **1,86**$\times 10^{-10}$ curies in 1 litre of water at 17° C.

(Schmidt's electrom.; H. Kibezaki, Sept. 12, 1913).

0,51 Mache's units (recalculated).

SHIRAYA

Location.—Kawakami-mura, Yoshino-gun, Province Yamato, Nara-ken.

The springs issue from the Chichibu Series.

The cold spring "Shiraya-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1904.

Specific gravity: 1,0026 at 15° C. Total residue: ca. 1,74.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0105	0,2682	0,2682
Sodium ion ($Na^{\cdot}$)	0,2577	11,1801	**11,1801**
Calcium ion ($Ca^{\cdot\cdot}$)	0,3553	8,8604	**17,7208**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0194	0,7964	1,5928
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0015	0,0268	0,0536
Manganous ion ($Mn^{\cdot\cdot}$)	0,0010	0,0182	0,0364
			30,8519
Anions.			
Chlorine ion (Cl')	0,0422	1,1904	1,1904
Hydrocarbonate ion (HCO_3')	1,8095	29,6597	**29,6597**
	2,4971	52,0002	30,8501
Silicic acid (meta) (H_2SiO_3)	0,0082		
	2,5053		
Free carbon dioxide (CO_2)	**1,4180**	32,2273	
	3,9233		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0200
Sodium chloride (NaCl)	0,0540
Sodium bicarbonate ($NaHCO_3$)	0,8622
Calcium bicarbonate [$Ca(HCO_3)_2$]	1,4369
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,1163
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0046
Manganous bicarbonate [$Mn(HCO_3)_2$]	0,0031
Silicic acid (meta) (H_2SiO_3)	0,0082
	2,5053
Free carbon dioxide (CO_2)	1,4180
	3,9233

Besides these trace of lithium, aluminium, iodine, nitrate, sulphate and hydrophosphate ion, boric acid and organic substances.

The spring thus may be classified as "**alkaline earthy carbondioxated spring**".

SEDO-NO-KANAYAMA

Location.—Sedo-no-kanayama-mura, Nishi-muro-gun, Province Kii, Wakayama-ken.

The springs issue from the Younger Tertiary.

The hot spring "Hama-no-yu"

Analysis.

Analysed by S. Hirohashi. 1901.

Specific gravity: 1,00465 at 22° C. Temperature: 52° C.

Total residue: ca. 4,82. Flow of water: ca. 156 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride ($NaCl$)	2,03794	Silica (SiO_2)	0,13605
Potassium sulphate (K_2SO_4)	0,00943		6,56536
Sodium bicarbonate ($NaHCO_3$)	4,16764	Total carbon dioxide (CO_2)	3,86100
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,12259	Carbon dioxide (free and in form of bicarbonates) (CO_2)	2,58900
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,08471		
Alumina and trace of iron oxide ($Al_2O_3+Fe_2O_3$)	0,00700		

Besides these a small quantity of potassium chloride.

The spring may be classified as "**muriated alkaline carbondioxated spring**".

Radio-activity. **0,43** $\times 10^{-10}$ curies in 1 litre of water at 52° C.

(Schmidt's electrom.; H. Kibezaki, March 28, 1913).

0,12 Mache's units (recalculated).

The hot spring "Moto-no-yu"

Analysis.

Analysed by S. Hirohashi. 1901.

Specific gravity: 1,00425 at 22° C. Temperature: 49° C.

Flow of water: ca. 87 hectolitres in 24 hours. Total residue: ca. 4,26.

The spring, being in its composition nearly the same as that of "Hama-no-yu", may be classified as "**muriated alkaline carbondioxated spring**".

Radio-activity. **0,53** $\times 10^{-10}$ curies in 1 litre of water at 49° C.

(Schmidt's electrom.; H. Kibezaki, March 29, 1913).

0,14 Mache's units (recalculated).

The hot spring "Saki-no-yu"

Analysis.

Analysed by S. Hirohashi. 1901.

Specific gravity: 1,00421 at 22° C. Temperature: 60° C.

Flow of water: ca. 260 hectolitres in 24 hours. Total residue: ca. 4,31.

The spring, being in its composition nearly the same as that of "Hama-no-yu", may be classified as "**muriated alkaline carbondioxated spring**".

Radio-activity. **0,36** $\times 10^{-10}$ curies in 1 litre of water at 60° C.

(Schmidt's electrom.; H. Kibezaki, March 30, 1913).

0,10 Mache's units (recalculated).

The hot spring "Yagata-yu"

Analysis.

Analysed by S. Hirohashi. 1901.

Specific gravity: 1,00413 at 22° C. Temperature: 42° C.

Flow of water: ca. 260 hectolitres in 24 hours. Total residue: ca. 4,09.

The spring, being in its composition nearly the same as that of "Hama-no-yu", may be classified as "**muriated alkaline carbondioxated spring**".

Radio-activity. **0,49** $\times 10^{-10}$ curies in 1 litre of water at 42° C.

(Schmidt's electrom.; H. Kibezaki, March 30, 1913).

0,14 Mache's units (recalculated).

Table 76.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Moto-no-yu (*Public bath*)	muriated alkaline carbondioxated	49,0°	ca. 87	**0,53**	**0,14**	49,0°	Schm.	March 29, 1913	H. Kibezaki
2	Saki-no-yu („)	„	60,0°	260	**0,36**	**0,10**	60,0°	„	„ 30, „	„
3	Yagata-yu („)	„	42,0°	260	**0,49**	**0,14**	42,0°	„	„	„
4	Hama-no-yu („)	„	52,0°	156	**0,43**	**0,12**	52,0°	„	„ 28, „	„
5	Senki-yu	„	48,0°	69	—	—	—	—	—	—
6	Mabu-yu	„	45,0°	225	—	—	—	—	—	—
7	Awa-yu	„	48,0°	78	—	—	—	—	—	—
8	Yorozuya-no-yu	„	43,0°	130	—	—	—	—	—	—

YUNOMINE

Location.—Shi-mura, Higashi-muro-gun, Province Kii, Wakayama-ken.

The springs issue from the Tertiary.

The hot spring "Yunomine-Onsen"

Analysis (calculated from the original numbers).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1914. Temperature: 90° C.

Specific gravity: 1,0012 at 15° C. Total residue: ca. 1,38.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0396	1,0102	1,0102
Sodium ion ($Na^{\cdot}$)	0,3236	14,0695	**14,0695**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0451	1,1255	2,2510
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0030	0,0537	0,1074
			17,4381
Anions.			
Chlorine ion (Cl')	0,1845	5,2030	5,2030
Sulphate ion (SO_4'')	0,5870	6,1101	**12,2202**
	1,1828	27,5720	17,4232
Silicic acid (meta) (H_2SiO_3)	0,1805		
	1,3633		
Free carbon dioxide (CO_2)	not determined		
Free hydrogen sulphide (H_2S)	**0,01014**		
	1,37344		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,07530
Sodium chloride (NaCl)	0,24520
Sodium sulphate (Na_2SO_4)	0,70070
Calcium sulphate ($CaSO_4$)	0,15350
Ferrous sulphate ($FeSO_4$)	0,00810
Silicic acid (meta) (H_2SiO_3)	0,18050
	1,36330
Free hydrogen sulphide (H_2S)	0,01014
	1,37344

The spring thus may be classified as "**saline bitter sulphur spring**".

KATSU-URA

Location.—Katsu-ura-machi, Higashi-muro-gun, Province Kii, Wakayama-ken.

The springs issue from the Tertiary.

The hot spring "Soto-no-yu"

Analysis.

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1900.

Specific gravity: 1,0008 at 15° C. Temperature: 38,5° C.

Flow of water: ca. 900 hectolitres in 24 hours. Total residue: ca. 0,93.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	0,0078
Sodium chloride ($NaCl$)	0,6567
Calcium chloride ($CaCl_2$)	0,1244
Magnesium chloride ($MgCl_2$)	0,0037
Calcium sulphate ($CaSO_4$)	0,0524
Calcium carbonate ($CaCO_3$)	0,0352
Ferric oxide (Fe_2O_3)	0,0002
Alumina (Al_2O_3)	0,0002
Silica (SiO_2)	0,0251
	0,9057
Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,0045
Free hydrogen sulphide (H_2S)	0,00798 (5,2 c.c. at 0° C. and 760 mm.)
	0,91818

Besides these trace of lithium, manganese, iodine and nitric, phosphoric and boric acid.

The spring thus may be classified as "**sulphur spring**".

Radio-activity. **3,69** $\times 10^{-10}$ curies in 1 litre of water at 38,5° C.

(Schmidt's electrom.; H. Kibezaki, April 8, 1914)

0,85 Mache's units (recalculated).

Table 77.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Soto-no-yu (*Public bath*)	sulphur	38,5°	ca. 900	**3,69**	**0,85**	38,5°	Schm	Apr. 8, 1914	H. Kibezaki
2	Nakanoshima-Onsen	—	27,0°	—	**10,36**	**2,85**	27,0°	,,	,, 9, ,,	,,
3	Akashima-Onsen	alkaline sulphur	45,0°	900	**6,55**	**1,80**	45,0°	,,	,, 10, ,,	,,
4	Benten-yu	—	17,0°	—	**2,26**	**0,62**	17,0°	,,	,, 11, ,,	,,

YUKAWA

Location.—Nachi-mura, Higashi-muro-gun, Province Kii, Wakayama-ken.

The springs issue from the Misaka Series.

Table 78.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Ōhata-no-yu (*Public bath*)	—	22,0°	ca. —	5,31	1,46	22,0°	Schm.	Apr. 12, 1914	H. Kikezaki
2	Koshi-Onsen	alkaline	28,5°	108	—	—	—	—	—	—
3	Kosse-Onsen	sulphur	24,5°	108	—	—	—	—	—	—
4	Naka-no-yu	simple	36,3°	360	—	—	—	—	—	—
5	Hamano-miya-yu	„	40,0°	360	—	—	—	—	—	—

KASAGI

Location.—Kasagi-mura, Sōraku-gun, Province Yamashiro, Kyōto-fu.

The springs issue from the Granite.

The cold spring "Kasagi-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1900.

Specific gravity: 1,0044 at 15° C.

Temperature: 13,6° C. (air temp. 13° C.).

Flow of water: ca. 27–36 hectolitres in 24 hours.

Total residue: ca. 5,08.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Sodium ion ($Na^{\cdot}$)	1,8077	78,4252	**78,4252**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0752	1,8753	3,7506
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0263	1,0796	2,1592
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0029	0,0518	0,1036
Manganous ion ($Mn^{\cdot\cdot}$)	0,0009	0,0164	0,0328
			84,4714
Anions.			
Chlorine ion (Cl')	0,9775	27,5740	**27,5740**
Hydrocarbonate ion (HCO_3')	3,4758	56,9710	**56,9710**
	6,3663	165,9933	84,5450
Silicic acid (meta) (H_2SiO_3)	0,1272		
	6,4935		
Free carbon dioxide (CO_2)	not determined		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	1,6130
Sodium bicarbonate ($NaHCO_3$)	4,2781
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,3046
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,1584
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0092
Manganous bicarbonate [$Mn(HCO_3)_2$]	0,0030
Silicic acid (meta) (H_2SiO_3)	0,1272
	6,4935

Besides these trace of lithium, aluminium, bromine and hydrophosphate ion and organic substances.

The spring thus may be classified as "**muriated alkaline spring**".

Table 79.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water		Apparatus employed	Date when the water was taken	Examined by
				in Mache's units	at (temp. in C.)			
1	Kasagi-Kōsen *No. 1*	muriated alkaline	13,6° air temp. (13°)	**1,01**	15,0°	K. & L.	Apr. 18, 1914	Y. Kinugasa
2	„ *No. 2*	„	13,6° (13°)	**0,84**	14,0°	„	„	„

DAITŌ

Location.—Mikkaichi-mura, Minami-kawachi-gun, Province Kawachi, Ōsaka-fu.

The spring issues from the Tertiary.

The cold spring "Daitō-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1890.

Specific gravity: 1,012. Total residue: ca. 15,64.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,1619	4,1354	4,1354
Sodium ion ($Na^{\cdot}$)	4,2157	182,8937	**182,8937**
Ammonium ion ($NH_4^{\cdot}$)	0,0060	0,3326	0,3326
Calcium ion ($Ca^{\cdot\cdot}$)	0,8282	20,6534	**41,3068**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,3844	15,7800	**31,5600**
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0154**	0,2755	0,5510
			260,7795
Anions.			
Chlorine ion (Cl')	7,1471	201,6107	**201,6107**
Hydrocarbonate ion (HCO'_3)	3,6100	59,1705	**59,1705**
	16,3687	484,8518	260,7812
Silicic acid (meta) (H_2SiO_3)	0,0909		
	16,4596		
Free carbon dioxide (CO_2)	not determined		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram

	Grams
Potassium chloride (KCl)	0,3083
Sodium chloride ($NaCl$)	10,6998
Ammonium chloride (NH_4Cl)	0,0178
Calcium chloride ($CaCl_2$)	0,7911
Calcium bicarbonate [$Ca(HCO_3)_2$]	2,1927
Magnesium bicarbonate [$Mg(HCO_3)_2$]	2,3100
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0490
Silicic acid (meta) (H_2SiO_3)	0,0909
	16,4596

Besides these trace of aluminium, bromine, sulphate and hydrophosphate ion, and boric acid.

The spring thus may be classified as "**earthy iron carbonate common salt spring**".

Radio-activity. **1.60** $\times 10^{-10}$ curies in 1 litre of water* at 28° C.

(Schmidt's electrom.; H. Kibezaki, July, 6, 1914).

0,44 Mache's units (recalculated).

* Measurement was made with the sample brought to the laboratory by applicant, taking into account decay of radium emanation with the time.

YOKOYAMA

Location.—Yokoyama-mura, Sempoku-gun, Province Izumi, Osaka-fu.

The springs issue from the Tertiary.

The cold spring "Yokoyama-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1903.

Specific gravity: 0,9983 at 15° C. Total residue: ca. 0,07.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mo's	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0019	0,0485	0,0485
Sodium ion ($Na^{\cdot}$)	0,0081	0,3514	0,3514
Calcium ion ($Ca^{\cdot\cdot}$)	0,0099	0,2469	0,4938
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0007	0,0287	0,0574
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0010	0,0179	0,0358
			0,9869
Anions.			
Chlorine ion (Cl')	0,0077	0,2172	0,2172
Hydrocarbonate ion (HCO_3')	0,0471	0,7720	0,7720
	0,0764	1,6826	0,9892
Silicic acid (meta) (H_2SiO_3)	0,0266		
	0,1030		
Free carbon dioxide (CO_2)	1,0250	23,2955	
	1,1280		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0037
Sodium chloride (NaCl)	0,0097
Sodium bicarbonate ($NaHCO_3$)	0,0159
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0399
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0040
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0032
Silicic acid (meta) (H_2SiO_3)	0,0266
	0,1030
Free carbon dioxide (CO_2)	1,0250
	1,1280

Besides these trace of aluminium, sulphate ion and organic substances.

The spring thus may be classified as "**simple carbondioxated spring**".

Radio-activity. **9,38** $\times 10^{-10}$ curies in 1 litre of gas.

(Schmidt's electrom.; H. Kibezaki, June 18, 1914).

2,58 Mache's units (recalculated).

KOSHIKI-IWA-SHINDEN

Location.—Taisha-mura, Muko-gun, Province Settsu, Hyōgo-ken.

The springs issue from the Granite.

Table 80.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Kurakuen-Kōsen *No. 1*	simple	19,0°	**34,51**	**9,49**	19,0°	Schm.	Sept. 10, 1913	H. Kibezaki
2	„ *No. 2*	„	18,0°	**22,01**	**6,06**	18,0°	„	Oct. 4, „	„
3	„ *No. 3*	„	18,0°	**26,22**	**7,21**	18,0°	„	„ 5, „	„
4	„ *No. 4*	„	18,5°	**12,84**	**3,53**	18,5°	„	„	„

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
5	Kurakuen-Kōsen *No. 5*	simple	—	14,73	4,05	—	Schm.	Oct. 25, 1913	H. Kibezaki
6	„ *No. 6*	„	—	31,02	8,53	—	„	„ 27, „	„
7	„ *No. 7*	„	—	18,80	5,17	—	„	Nov. 7, „	„
8	„ *No. 8*	„	17,0°	19,02	5,23	17,0°	„	„ 9, „	„
9	„ *No. 9*	„	15,0°	17,93	4,93	15,0°	„	Jan. 26, 1914	„
10	„ *No. 10*	„	15,0°	60,15	16,54	15,0°	„	„ 25, „	„
11	„ *No. 11*	„	11,0°	33,67	9,26	11,0°	„	„	„
12	„ *No. 12*	„	12,0°	20,80	5,72	12,0°	„	„ 28, „	„
13	„ *No. 13*	„	14,5°	16,15	4,44	14,5°	„	June 5, „	„
14	„ *No. 14*	„	18,0°	13,93	3,83	18,0°	„	„ 8, „	„
15	Sarumaru-ishi-yama *No. 1*	„	14,5°	56,80	15,62	14,5°	„	Dec. 20, 1913	„
16	„ *No. 2*	„	12,0°	51,46	14,15	12,0°	„	Jan. 22, 1914	„
17	„ *No. 3*	„	14,0°	58,33	16,04	14,0°	„	„ 23, „	„
18	„ *No. 4*	„	14,0°	22,22	6,11	14,0°	„	„ 24, „	„
19	„ *No. 5*	„	14,5°	44,29	12,18	14,5°	„	May 23, „	„
20	„ *No. 6*	„	14,0°	35,71	9,82	14,0°	„	„ 22, „	„
21	Myōbandani-ue *No. 1*	„	13,0°	1,53	0,42	13,0°	„	Jan. 31, „	„
22	„ *No. 2*	„	12,0°	9,42	2,59	12,0°	„	Feb. 1, „	„
23	Myōbandani *No. 1*	vitriol	—	7,35	2,02	—	„	Dec. 19, 1913	„
24	„ *No. 2*	„	—	4,36	1,20	—	„	„ 21, „	„
25	Fukae-Onsen *	—	14,5°	4,22	1,16	14,5°	„	„ 11, „	„

* The spring, located at *Honjō-mura*, is grouped for convenience in this table.

TAKARAZUKA

Location.—Ryōgen-mura, Muko-gun, Province Settsu, Hyōgo-ken.

The springs issue from the Granite.

The cold spring "Takarazuka-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1891.

Specific gravity: 1,011. Temperature: 18,5° C.

Total residue: ca. 13,76. Flow of water: ca. 360 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,4196	10,7178	10,7178
Sodium ion ($Na^{\cdot}$)	4,6092	199,9740	199,9740
Ammonium ion ($NH_4^{\cdot}$)	0,0013	0,0719	0,0719
Calcium ion ($Ca^{\cdot\cdot}$)	0,0004	0,0010	0,0020
Magnesium ion ($Mg^{\cdot\cdot}$)	0,1238	5,0821	10 1642
			220,9299
Anions.			
Chlorine ion (Cl')	7,1216	200,8914	200,8914
Hydrocarbonate ion (HCO_3')	1,2260	20,0951	20,0951
	13,5019	436,8333	220,9865
Silicic acid (meta) (H_2SiO_3)	0,0974		
	13,5993		
Free carbon dioxide (CO_2)	0,9338	21,2227	
	14,5331		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,7993
Sodium chloride (NaCl)	11,1252
Sodium bicarbonate ($NaHCO_3$)	0,8245
Ammonium bicarbonate (NH_4HCO_3)	0,0054
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0015
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,7460
Silicic acid (meta) (H_2SiO_3)	0,0974
	13,5993
Free carbon dioxide (CO_2)	0,9338
	14,5331

Besides these trace of ferrous, aluminium, bromine, iodine, sulphate and hydrophosphate ion and boric acid.

The spring thus may be classified as "**carbondioxated * common salt spring**".

Radio-activity. **2,66** × 10^{-10} curies in 1 litre of water at 18,5° C.
(Schmidt's electrom.; H. Kibezaki, Sept. 13, 1913).
0,73 Mache's units (recalculated).
7,16 × 10^{-10} curies in 1 litre of gas.
(Schmidt's electrom.; H. Kibezaki, Oct. 7, 1913).
1,97 Mache's units (recalculated).

The cold spring "Takarazuka-Tansan-sui"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1901. Temperature: 18,5° C.

Specific gravity: 1,0015. Total residue: ca. 0,58.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0184	0,5235	0,5235
Sodium ion ($Na^{\cdot}$)	0,1689	7,3193	7,3193
Calcium ion ($Ca^{\cdot\cdot}$)	0,0213	0,5312	1,0624
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0021	0,0821	0,1642
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0015	0,0268	0,0536
			9,1230
Anions.			
Chlorine ion (Cl')	0,2440	6,8829	6,8829
Sulphate ion (SO_4'')	0,0036	0,0375	0,0750
Hydrocarbonate ion (HCO_3')	0,1310	2,1472	2,1472
	0,5908	17,5505	9,1051
Silicic acid (meta) (H_2SiO_3)	0,0360		
	0,6268		
Free carbon dioxide (CO_2)	1,5360	34,9091	
	2,1628		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0351
Sodium chloride (NaCl)	0,3747
Sodium bicarbonate ($NaHCO_3$)	0,0783
Calcium sulphate ($CaSO_4$)	0,0051
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0800
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0128
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0048
Silicic acid (meta) (H_2SiO_3)	0,0360
	0,6268
Free carbon dioxide (CO_2)	1,5360
	2,1628

Besides these trace of manganous, aluminium and hydrophosphate ion.

The spring thus may be classified as "**simple carbondioxiated spring**".

Radio-activity. **12,03** × 10^{-10} curies in 1 litre of water at 18,5° C.
(Schmidt's electrom.; H. Kibezaki, June 17, 1913).
3,31 Mache's units (recalculated).

* As it is probable that the actual amount of free carbon dioxide will be, if determined at the source of the spring, more than 1 gram, the water may be classified more properly as "**carbondioxated common salt spring.**"

HIRANO

Location.—Tada-mura, Kawabe-gun, Province Settsu, Hyōgo-ken.

The springs issue from the Chichibu Series.

The cold spring "Hirano-Kōsen" (A)

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1893. Temperature: 27° C.

Specific gravity: 1,0048. Total residue: ca. 4,59.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0333	0,8506	0,8506
Sodium ion ($Na^{\cdot}$)	1,4227	61,7223	**61,7223**
Calcium ion ($Ca^{\cdot\cdot}$)	0,2201	5,4888	**10,9776**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0804	3,3005	6,6010
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0107**	0,1914	0,3828
			80,5343
Anions.			
Chlorine ion (Cl')	1,5867	44,7588	**44,7588**
Hydrocarbonate ion (HCO_3')	2,1865	35,8384	**35,8384**
	5,5404	152,1508	80,5972
Silicic acid (meta) (H_2SiO_3)	0,1704		
	5,7108		
Free carbon dioxide (CO_2)	**1,1924**	27,1000	
	6,9032		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0635
Sodium chloride ($NaCl$)	2,5685
Sodium bicarbonate ($NaHCO_3$)	1,4990
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,8910
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,4842
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0342
Silicic acid (meta) (H_2SiO_3)	0,1704
	5,7108
Free carbon dioxide (CO_2)	1,1924
	6,9032

Besides these trace of aluminium ion and boric acid.

The spring thus may be classified as "**earthy alkaline iron carbonate carbondioxated common salt spring**".

TAKEDAO

Location.—Shioze-mura, Arima-gun, Province Settsu, Hyōgo-ken.

The springs issue from the Quartz Porphyry.

The cold spring "Takedao-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1902. Specific gravity: 1,0005 at 15° C.

Total residue: ca. 1,13. Flow of water: ca. 90 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0040	0,1033	0,1033
Sodium ion ($Na^{\cdot}$)	0,2885	12,5163	**12,5163**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0952	2,3738	4,7476
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0037	0,1519	0,3038
			17,6710

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0077
Sodium chloride ($NaCl$)	0,7323
Calcium chloride ($CaCl_2$)	0,0907
Calcium sulphate ($CaSO_4$)	0,0064
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,2446

Anions.

Chlorine ion (Cl')	0,5054	14,2567	14,2567
Sulphate ion (SO_4'')	0,0045	0,0468	0,0936
Hydrocarbonate ion (HCO_3').	0,2026	3,3207	3,3207
	1,1039	32,7695	17,6710
Silicic acid (meta) (H_2SiO_3) .	0,0374		
	1,1413		
Free carbon dioxide (CO_2) . .	not determined		
Free hydrogen sulphide (H_2S)	0,0014		
	1,1427		

Magnesium bicarbonate [$Mg(HCO_3)_2$] . .	0,0222
Silicic acid (meta) (H_2SiO_3)	0,0374
	1,1413
Free hydrogen sulphide (H_2S).	0,0014
	1,1427

Besides these trace of lithium, ferrous, manganous, aluminium, bromine, iodine and hydrophosphate ion and boric acid.

The spring thus may be classified as "**muriated sulphur spring**".

Table 81.

No.		Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Takarazuka	Takarazuka-Kōsen	carbondioxated common salt	18,7°	ca. 360	2,09	0,58	18,7°	Schm.	June 19, 1913	H. Kibezaki
2		„	„	18,5°	„	2,66	0,73	18,5°	„	Sep. 13, „	„
3		Takarazuka-Tansan-sui	simple carbon-dioxated	18,5°	—	12,03	3,31	18,5°	„	June 17, „	„
4	Takedao	Yu-moto (*Public bath*)	muriated sulphur	19,5°	—	19,91	5,47	19,5°	„	May 29, „	„
5		Moto-no-yu	„	23,5°	—	11,34	3,12	23,5°	„	„ 30, „	„
		Gas evolving from				Emanation per litre of gas				Date when the gas was collected	
		Takarazuka-Kōsen	—	—	—	7,16	1,97	—	„	Oct. 7, 1913	„

ARIMA

Location.—Arima-machi, Arima-gun, Province Settsu, Hyōgo-ken.

The springs issue from the Quartz Porphyry.

The hot spring "Ichi-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Temperature: 53,4° C.

Specific gravity: 1,012 at 23° C.

Total residue: ca. 19,66.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,6725	17,1775	17,1775
Sodium ion ($Na^{\cdot}$)	5,7985	251,5617	**251,5617**
Calcium ion ($Ca^{\cdot\cdot}$)	1,0455	26,0723	**52,1446**
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,1912**	3,4707	6,9414
Manganous ion ($Mn^{\cdot\cdot}$)	0,0426	0,7745	1,5490
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0059	0,2177	0,6531
			330,0273
Anions.			
Chlorine ion (Cl')	11,4006	321,5966	**321,5966**
Hydrocarbonate ion (HCO_3')	0,5121	8,3937	8,3937
	19,6689	629,2647	329,9903
Silicic acid (meta) (H_2SiO_3)	0,0753		
	19,7442		
Free carbon dioxide (CO_2)	not determined		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	1,2810
Sodium chloride ($NaCl$)	14,7170
Calcium chloride ($CaCl_2$)	2,8960
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,6088
Manganous bicarbonate [$Mn(HCO_3)_2$]	0,1371
Aluminium chloride ($AlCl_3$)	0,0290
Silicic acid (meta) (H_2SiO_3)	0,0753
	19,7442

Besides these trace of lithium, magnesium ion and organic substances.

The spring thus may be classified as "**earth-muriated iron carbonate common salt spring**".

The hot spring "Ikenobō-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1901.

Temperature: 47° C. Total residue: ca. 64,01.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	3,9485	100,8341	**100,8341**
Sodium ion ($Na^{\cdot}$)	17,4712	757,9609	**757,9609**
Lithium ion ($Li^{\cdot}$)	0,0256	3,6714	3,6714
Ammonium ion ($NH_4^{\cdot}$)	0,0098	0,5432	0,5432
Calcium ion ($Ca^{\cdot\cdot}$)	3,7688	93,9850	**187,9200**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0435	1,7469	3,4938
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,2569**	4,5941	9,1882
Manganous ion ($Mn^{\cdot\cdot}$)	0,0632	1,1527	2,3054
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0053	0,1956	0,5868
			1066,5038
Anions.			
Chlorine ion (Cl')	36,7229	1035,9069	**1035,9069**
Bromine ion (Br')	0,0854	1,0768	1,0768
Hydrocarbonate ion (HCO_3')	1,8221	29,8656	29,8656
	64,2232	2031,5332	1066,8493
Silicic acid (meta) (H_2SiO_3)	0,0714		
	64,2946		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	7,5210
Sodium chloride ($NaCl$)	43,2070
Ammonium chloride (NH_4Cl)	0,0290
Lithium chloride ($LiCl$)	0,1550
Sodium bromide ($NaBr$)	0,1100
Sodium bicarbonate ($NaHCO_3$)	1,5438
Calcium chloride ($CaCl_2$)	10,4400
Magnesium chloride ($MgCl_2$)	0,1700
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,8182
Manganous bicarbonate [$Mn(HCO_3)_2$]	0,2032
Aluminium chloride ($AlCl_3$)	0,0260
Silicic acid (meta) (H_2SiO_3)	0,0714
	64,2946

Besides these trace of nitrate and hydrophosphate ion, boric acid and organic substances.

The spring thus may be classified as "**earth-muriated iron carbonate concentrated common salt spring**".

Table 82.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Arima-Onsen *	common salt	51,5°	0,92	0,25	51,5°	Schm.	May 26, 1913	H. Kibezaki
2	Maruyama-Kōsen	—	19,0°	30,07	8,27	19,0°	„	„ 27, „	„
3	Arima-tansan-sen (*Teppō-sui*)*	simple carbon-dioxated	17,0°	6,34	1,75	17,0°	„	„ 28, „	„
4	Zuihōji-Onsen	—	28,3°	107,67	29,61	28,3°	„	„	„
5	Ichi-no-yu *	earth-muriated iron carbonate common salt	53,4°	—	—	—	—	—	—
6	Ni-no-yu *	„ (?)	53,4°	—	—	—	—	—	—
7	Mearai-yu *	„ (?)	34,5°	—	—	—	—	—	—
8	Hana-no-yu	„ (?)	43,6°	—	—	—	—	—	—
9	Ikenobō-Kōsen	earth-muriated iron carbonate concentrated common salt	47,0°	—	—	—	—	—	—

* These springs are for public use.

KINOSAKI

Location.—Kinosaki-machi, Kinosaki-gun, Province Tajima, Hyōgo-ken.

The springs issue from the Tertiary.

The hot spring "Ichi-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Total residue: ca. 5,32.
Flow of water: ca. 259 hectolitres in 24 hours. Specific gravity: 1,00404 at 8,5° C.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0387	0,9885	0,9885
Sodium ion ($Na^{\cdot}$)	1,3108	56,8677	56,8677
Calcium ion ($Ca^{\cdot\cdot}$)	0,5994	14,9476	29,8952
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0018	0,0739	0,1478
			87,8992
Anions.			
Chlorine ion (Cl')	2,8446	80,2426	80,2426
Bromine ion (Br')	0,0005	0,0063	0,0063
Sulphate ion (SO_4'')	0,3026	3,1501	6,3002
Hydrocarbonate ion (HCO_3')	0,0850	1,3932	1,3932
	5,1834	157,6699	87,9423
Silicic acid (meta) (H_2SiO_3)	0,0898		
	5,2732		
Free carbon dioxide (CO_2)	not determined		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	3,0165
Potassium sulphate (K_2SO_4)	0,0862
Sodium sulphate (Na_2SO_4)	0,3774
Calcium chloride ($CaCl_2$)	1,5910
Magnesium bromide ($MgBr_2$)	0,0006
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,1013
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0104
Silicic acid (meta) (H_2SiO_3)	0,0898
	5,2732

Besides these trace of ferrous, aluminium and iodine ion and boric acid.

The spring thus may be classified as "**earth-muriated common salt spring**".

Table 83.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water			Apparatus employed	Date when the water was taken	Examined by
					in 10^{-10} curies	in Mache's units	at (temp. in C.)			
1	Ichi-no-yu *Vent No. 1*	earth-muriated common salt	50,5°	ca. 259	9,91	2,73	50,5°	Schm.	May 23, 1913	H. Kibezaki
2	„ *Vent No. 2*	„	59,5°		10,08	2,77	59,5°	„	„ 24, „	„
3	Kō-no-yu	„	57,0°	204	9,37	2,58	57,0°	„	„ 21, „	„
4	Mandara-no-yu *Vent No. 1*	„	58,0°	207	5,17	1,42	58,0°	„	„ 19, „	„
5	„ *Vent No. 2*	„	47,0°		11,08	3,05	47,0°	„	„ 20, „	„
6	Gosho-no-yu *Vent No. 1*	„	56,5°	220	12,77	3,51	56,5°	„	„ 22, „	„
7	„ *Vent No. 2*	„	60,3°		30,57	8,41	60,3°	„	„	„
8	Yanagi-no-yu	„	59.5°	216	13,58	3,74	59,5°	„	„ 18, „	„
9	Jizō-no-yu	„	48,5°	207	5,21	1,43	48,5°	„	„ 20, „	„

YUMURA

Location.—Onsen-mura, Mikata-gun, Province Tajima, Hyōgo-ken.

The springs issue from the Granite overlaid by Alluvium.

The hot spring "Kabu-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Specific gravity: 1,00092 at 7° C.
Total residue: ca. 0,99.

Temperature: 90,5° C.
Flow of water: ca. 900 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0358	0,9144	0,9144
Sodium ion ($Na^{\cdot}$)	0,2685	11,6486	**11,6486**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0179	0,4464	0,8928
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0008	0,0328	0,0656
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0034	0,0608	0,1216
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0023	0,0849	0,2547
			13,8977
Anions.			
Chlorine ion (Cl')	0,1408	3,9718	3,9718
Sulphate ion (SO_4'')	0,2134	2,2215	4,4430
Hydrocarbonate ion (HCO_3')	0,3346	5,4843	**5,4843**
	1,0175	24,8655	13,8991
Silicic acid (meta) (H_2SiO_3)	0,1869		
	1,2044		
Free carbon dioxide (CO_2)	**1,2354**	20,2491	
	2,4398		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,2323
Potassium sulphate (K_2SO_4)	0,0798
Sodium sulphate (Na_2SO_4)	0,2329
Sodium bicarbonate ($NaHCO_3$)	0,3702
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0723
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0046
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0111
Aluminium sulphate [$Al_2(SO_4)_3$]	0,0143
Silicic acid (meta) (H_2SiO_3)	0,1869
	1,2044
Free carbon dioxide (CO_2)	1,2354
	2,4398

Besides these a very small quantity of boric acid, and trace of hydrogen sulphide and organic substances.

The spring thus may be classified as "**alkaline carbondioxated spring**".

Radio-activity. **3,09** $\times 10^{-10}$ curies in 1 litre of water at 12,8° C.
(Schmidt's electrom.; Dr. R. Ishizu, March 14, 1914).
0,85 Mache's units (recalculated).

Table 84.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Kabu-yu (*Public bath*)	alkaline carbon-dioxated	90,5°	ca. 900	**3,09**	**0,85**	12,8°	Schm.	March 14, 1914	Dr. R. Ishizu
2	,,	,,	,,	,,	—	**0,95**	11,8°	K. & L.	,,	,,
3	Ara-yu	,,	95,0°	abundant	—	**1,76**	11,5°	,,	,,	,,
4	Drinking water at Chimizu	—	—	—	—	**3,09**	11,6°	,,	,,	,,
5	,, at Shin-machi	—	—	—	—	**2,02**	12,2°	,,	,,	,,
					Emanation per litre of gas at 0° C.				Date when the gas was collected	
	Gas evolving from Ara-yu	—	—	—	—	**25,98**	—	,,	March 14, 1914	,,

ŌDAKE

Location.—Yamada-mura, Muko-gun, Province Settsu, Hyōgo-ken.

The cold spring "Ōdake-Kōsen"

Analysis (calculated from the original numbers).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1913. Specific gravity: 1,0022 at 15° C.

Temperature: 17,5° C. Total residue: ca. 3,73.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0860	2,1994	2,1994
Sodium ion ($Na^{\cdot}$)	0,9442	41,0521	**41,0521**
Calcium ion ($Ca^{\cdot\cdot}$)	0,3015	7,5268	**15,0536**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0218	0,8964	1,7928
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0126**	0,2256	0,4512
			60,5491
Anions.			
Chlorine ion (Cl')	1,4468	40,0000	**40,0000**
Sulphate ion (SO_4'')	0,0644	0,6703	1,3406
Hydrocarbonate ion (HCO_3')	1,1662	19,1155	**19,1155**
	4,0435	111,6861	60,5491
Silicic acid (meta) (H_2SiO_3)	0,0780		
	4,1215		
Free carbon dioxide (CO_2)	**2,4000**	54,5454	
	6,5215		

The mineral water corresponds approximately in its composion to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,1640
Sodium chloride (NaCl)	2,2569
Sodium bicarbonate ($NaHCO_3$)	0,2490
Calcium sulphate ($CaSO_4$)	0,0913
Calcium bicarbonate [$Ca(HCO_3)_2$]	1,1111
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,1311
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0401
Silicic acid (meta) (H_2SiO_3)	0,0780
	4,1215
Free carbon dioxide (CO_2)	2,4000
	6,5215

Besides these a very small quantity of aluminium ion, and trace of hydrophosphate ion.

The spring thus may be classified as "**earthy iron carbonate carbondioxiated common salt spring**".

Radio-activity. **13,56** $\times 10^{-10}$ curies in 1 litre of water at 17,5° C.
(Schmidt's electrom.; H. Kibezaki, June 27, 1913).
3,73 Mache's units (recalculated).

IWAI

Location.—Iwai-mura, Iwami-gun, Province Inaba, Tottori-ken.

The springs issue from the Older Tertiary.

The hot spring "Moto-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888.

Specific gravity: 1,002 at 15° C.
Total residue: ca. 1,91.

Temperature: 58,5° C.
Flow of water: ca. 4066 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0303	0,7739	0,7739
Sodium ion ($Na^{\cdot}$)	0,2573	11,1626	**11,1626**
Calcium ion ($Ca^{\cdot\cdot}$)	0,2894	7,2170	**14,4340**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0078	0,3202	0,6404
			27,0109
Anions.			
Chlorine ion (Cl')	0,2070	5,8392	5,8392
Sulphate ion (SO_4'')	1,0170	10,5871	**21,1742**
	1,8088	35,9000	27,0134
Silicic acid (meta) (H_2SiO_3)	0,0623		
	1,8711		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,3416
Potassium sulphate (K_2SO_4)	0,0675
Sodium sulphate (Na_2SO_4)	0,3782
Calcium sulphate ($CaSO_4$)	0,9828
Magnesium sulphate ($MgSO_4$)	0,0387
Silicic acid (meta) (H_2SiO_3)	0,0623
	1,8711

Besides these trace of ferrous, aluminium and hydrophosphate ion, boric acid and organic substances.

The spring thus may be classified as "**saline sulphated bitter spring**".

Radio-activity. **2,29** Mache's units in 1 litre of water at 17,2° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, March 13, 1914).

Table 85.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Moto-yu (*Public bath*)	saline sulphated bitter	58,5°	ca. 4066	**2,29**	17,2°	K.&L.	March 13, 1914	Dr. R. Ishizu
2	Bizenya-no-yu	„	50,0°	448	**1,46**	18,8°	„	„	„
3	Hanaya-no-yu	„	50,0°	538	**1,77**	18,2°	„	„	„
4	Iwaiya-no-yu	„	60,0°	749	**1,15**	19,0°	„	„	„
5	Nakajimaya-no-yu	„	46,0°	—	**2,87**	16,7°	„	„	„
6	Iwami-kwan-no-yu	„	46,0°	—	**4,17**	17,8°	„	„	„
7	Shimo-nakagawara-no-yu *	—	37,0°	—	**2,93**	16,7°	„	„	„

* Measurement was made with the sample brought to the examiner by applicant, taking into account dacay of radium emanation with the time.

TOTTORI

Location.—Tottori-shi, Province Inaba, Tottori-ken.

The springs issue from the Alluvium.

YOSHIKATA

The hot spring "Tottori-Onsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1906.

Specific gravity: 1,0045 at 15,5° C. Temperature: 47,5° C. (air temp. 15° C.).

Flow of water: ca. 36 hectolitres in 24 hours. Total residue: ca. 4,62.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,1657	4,2324	4,2324
Sodium ion ($Na^{\cdot}$)	1,4670	63,6432	63,6432
Calcium ion ($Ca^{\cdot\cdot}$)	0,0971	2,4214	4,8428
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0158	0,6486	1,2972
			74,0156
Anions.			
Chlorine ion (Cl')	1,0217	28,8209	28,8209
Sulphate ion (SO_4'')	1,6354	17,0247	34,0494
Hydrocarbonate ion (HCO_3')	0,6801	11,1472	11,1472
	5,0828	127,9384	74,0175
Silicic acid (meta) (H_2SiO_3)	0,4413		
	5,5241		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	1,6860
Potassium sulphate (K_2SO_4)	0,3690
Sodium sulphate (Na_2SO_4)	1,7760
Sodium bicarbonate ($NaHCO_3$)	0,8274
Calcium sulphate ($CaSO_4$)	0,3290
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0954
Silicic acid (meta) (H_2SiO_3)	0,4413
	5,5241

Besides these trace of ferrous, manganous, aluminium, bromine, iodine and hydrophosphate ion and boric acid.

The spring thus may be classified as "**muriated saline bitter spring**".

Radio-activity. 11,91 $\times 10^{-10}$ curies in 1 litre of water at 18,5° C.

(Schmidt's electrom.; Dr. R. Ishizu, Feb. 17, 1914).

3,28 Mache's units (recalculated).

The hot spring "Takasago-Onsen"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1905.

Specific gravity: 1,0044 at 15° C. Temperature: 43° C. (air temp. 15° C.).

Flow of water: ca. 25 hectolitres in 24 hours. Total residue: ca. 4,03.

The spring, being in its composition nearly the same as that of "Tottori-Onsen", may be classified as "**muriated saline bitter spring**".

Radio-activity. 3,45 Mache's units in 1 litre of water at 16,3° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 17, 1914).

TERAMACHI

The cold spring "Kasuga-Onsen"

Analysis (calculated from the original numbers).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1912. Total residue: ca. 3,09.

Specific gravity: 1,0023 at 15° C. Temperature: 28,5° C. (air temp. 10° C.).

The spring, being in its composition nearly the same as that of "Tottori-Onsen", may be classified as "**muriated saline bitter spring**".

Radio-activity. **2,21** $\times 10^{-10}$ curies in 1 litre of water at 18,9° C.
(Schmidt's electrom.; Dr. R. Ishizu, Feb. 16, 1914).
0,61 Mache's units (recalculated).
8,76 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
(Schmidt's electrom.; Dr. R. Ishizu, Feb. 17, 1914).
2,41 Mache's units (recalculated).

Table 86.

No.	Area	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Tera-machi	Kasuga-Onsen	muriated saline bitter	28.5° (air temp. 10°)	ca. —	**2,21**	**0,61**	18,9°	Schm.	Feb. 16, 1914	Dr. R. Ishizu
2	Tera-machi	Ebisu-Onsen	—	26,0° (13°)	—	—	**0,98**	14,2°	K. & L.	„ 17, „	„
3	Baba-machi	Yōrō-no-yu	—	—	—	—	**0,25**	13,7°	„	„	„
4	Yoshikata	Tottori-Onsen (*Uchi-yu*)	muriated saline bitter	47,5° (15°)	36	**11,91**	**3,28**	18,5°	Schm.	„	„
5	Yoshikata	„	„	„	„	—	**3,12**	15,1°	K. & L.	„	„
6	Yoshikata	Takasago-Onsen	„	43,0° (15°)	25	—	**3,45**	16,3°	„	„	„
7	Yoshikata	Matsukawa-Onsen (*Soto-yu*)	—	47.0° (15°)	—	—	**4,86**	12,2°	„	„	„
8	Yoshikata	Shiratama-Onsen	—	35,6° (14°)	—	—	**3,87**	13,5°	„	„	„
9	Yoshikata	Kinka-Onsen	—	24,4° (15°)	25	—	**5,83**	16,5°	„	„	„
10	Yoshikata	Kinoe-Onsen *No. 1*	—	—	15	—	**3,33**	13,9°	„	„	„
11	Yoshikata	„ *No. 2*	—	—	—	—	**1,35**	13,3°	„	„ 16, „	„
12	Yoshikata	Iroha-no-yu	—	—	15	—	—	—	—	—	—
13	Yoshikata	Sangai-ryokwan-no-yu	—	—	—	—	—	—	—	—	—
14	Yoshikata	Marufuku-no-yu	—	—	15	—	—	—	—	—	—
						Emanation per litre of gas at 0° C.				Date when the gas was collected	
		Gas evolving from Kasuga-Onsen	—	—	—	**8,76**	**2,41**	—	Schm.	Feb. 17, 1914	Dr. R. Ishizu

YUDANI

Location.—Meiji-mura, Yazu-gun, Province Inaba, Tottori-ken.

The spring issues from the Tertiary.

The cold spring "Kabu-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888.

Specific gravity: 1,0029 at 15° C. Temperature: 32° C. (air temp. 11° C.).
Flow of water: ca. 90 hectolitres in 24 hours. Total residue: ca. 2,75.

In 1 kilogram of the mineral water are contained.

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0557	1,4227	1,4227
Sodium ion ($Na^{\cdot}$)	0,9494	41,1887	**41,1887**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0589	1,4688	2,9376
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0025	0,0447	0,0894
			45,6384
Anions.			
Chlorine ion (Cl')	0,9506	26,8152	**26,8152**
Sulphate ion (SO_4'')	0,1070	1,1139	2,2278
Hydrocarbonate ion (HCO_3')	1,0123	16,5924	**16,5924**
	3,1364	88,6464	45,6354
Silicic acid (meta) (H_2SiO_3)	0,0831		
	3,2195		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,1060
Sodium chloride ($NaCl$)	1,4857
Sodium bicarbonate ($NaHCO_3$)	1,3273
Calcium sulphate ($CaSO_4$)	0,1516
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0578
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0080
Silicic acid (meta) (H_2SiO_3)	0,0831
	3,2195

Besides these trace of ammonium, magnesium, bromine and iodine ion, boric acid and organic substances.

The spring thus may be classified as "**alkaline common salt spring**".

Radio-activity. **15,42** $\times 10^{-10}$ curies in 1 litre of water at 13,6° C.
4,24 Mache's units (recalculated).
86,54 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
23,80 Mache's units (recalculated).
(Schmidt's electrom.; Dr. R. Ishizu, Feb. 20, 1914).

YOSHIOKA

Location.—Yoshioka-mura, Kedaka-gun, Province Inaba, Tottori-ken.

The springs issue from the Tertiary.

The hot spring "Kamei-dono-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1889. Temperature: 50° C.
Specific gravity: 1,003 at 16,5° C. Total residue: ca. 0,56.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0136	0,3474	0,3474
Sodium ion ($Na^{\cdot}$)	0,1653	7,1714	7,1714
Calcium ion ($Ca^{\cdot\cdot}$)	0,0170	0,4239	0,8478
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0011	0,0457	0,0914
			8,4580
Anions.			
Chloline ion (Cl')	0,1119	3,1566	3,1566
Sulphate ion (SO_4'')	0,1462	1,5220	3,0440
Hydrocarbonate ion (HCO_3')	0,1377	2,2574	2,2574
	0,5928	14,9244	8,4580
Silicic acid (meta) (H_2SiO_3)	0,0727		
	0,6655		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,1847
Potassium sulphate (K_2SO_4)	0,0302
Sodium sulphate (Na_2SO_4)	0,1917
Sodium bicarbonate ($NaHCO_3$)	0,1108
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0688
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0067
Silicic acid (meta) (H_2SiO_3)	0,0727
	0,6656

Besides these trace of ferrous, hydrophosphate ion and boric acid.

The spring thus may be classified as "**simple thermal**".

Radio-activity. **4,36** Mache's units in 1 litre of water at 10,2° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 18, 1914).

The hot spring "Naka-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888. Specific gravity: 1,0010 at 15° C.

Temperature: 52,5° C. (air temp. 15,5° C.). Total residue: ca. 0,58.

The spring, being in its composition nearly the same as that of "Kamei-dono-no-yu", may be classified as "**simple thermal**".

Radio-activity. **3,19** Mache's units in 1 litre of water at 9,6° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 18, 1914).

The hot spring "Shimo-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888. Specific gravity: 1,0005 at 15° C.

Temperature: 42,5° C. (air temp. 8° C.). Total residue: ca. 0,68.

The spring, being in its composition nearly the same as that of "Kamei-dono-no-yu", differing only in containing hydrogen sulphide from the latter, may be classified as "**sulphur spring**".

Radio-activity. **3,07** Mache's units in 1 litre of water at 10,2° C.
9,63 Mache's units in 1 litre of gas at 0° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 18, 1914).

Table 87.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water			Apparatus employed	Date when the water was taken	Examined by
				in 10^{-10} curies	in Mache's units	at (temp. in C.)			
1	Kabu-yu *	simple	56,5° (air temp. 18°)	**10,33**	**2,84**	9,5°	Schm.	Feb. 18, 1614	Dr. R. Ishizu
2	Kamei-dono-no-yu *	"	50,0°	—	**4,36**	10,2°	K. & L.	"	"
3	Naka-no-yu *	"	52,5° (15,5°)	—	**3,19**	9,6°	"	"	"
4	Nakajimaya-no-yu	"	53,5°	—	**3,17**	10,2°	"	"	"
5	Shimo-no-yu *	sulphur	42,5° (8°)	—	**3,07**	10,2°	"	"	"
6	Tonosama-no-yu *	simple	—	—	—	—	—	—	—
7	Kadoya-no-yu	"	—	—	—	—	—	—	—
8	Kagi-no-yu	"	—	—	—	—	—	—	—
9	Hiiragiya-no-yu	"	—	—	—	—	—	—	—
	Gas evolving from:			Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Kabu-yu *	—	—	**99,13**	**27,26**	—	Schm.	Feb. 18, 1914	Dr. R. Ishizu
2	Shimo-no-yu *	—	—	—	**9,63**	—	K. & L.	"	"

* These springs are for public use.

HAMAMURA

Location.—Seijō-mura, Kedaka-gun, Province Inaba, Tottori-ken.

The springs issue from the Alluvium with Granite Base.

KACHIMI

The hot spring "Nakataya-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888. Temperature: 56° C.

Specific gravity: 1,0013 at 15° C. Total residue: ca. 1,36.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0304	0,7765	0,7765
Sodium ion ($Na^{\cdot}$)	0,3146	13,6486	**13,6486**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0608	1,5162	3,0324
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0037	0,1519	0,3038
			17,7613
Anions.			
Chlorine ion (Cl')	0,2894	8,1636	**8,1636**
Sulphate ion (SO_4'')	0,4612	4,8012	**9,6024**
	1,1601	29,0580	17,7660
Silicic acid (meta) (H_2SiO_3)	0,3300		
	1,4901		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,4775
Potassium sulphate (K_2SO_4)	0,0678
Sodium sulphate (Na_2SO_4)	0,3903
Calcium sulphate ($CaSO_4$)	0,2062
Magnesium sulphate ($MgSO_4$)	0,0183
Silicic acid (meta) (H_2SiO_3)	0,3300
	1,4901

Besides these a small quantity of free carbon dioxide and organic substances and trace of aluminium, bromine and hydrophosphate ion.

The spring thus may be classified as "**muriated saline bitter spring**".

Radio-activity. **31,18** $\times 10^{-10}$ curies in 1 litre of water at 16,3° C.
8,57 Mache's units (recalculated).
197,62 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
54,35 Mache's units (recalculated).

(Schmidt's electrom.; Dr. R. Ishizu, Feb. 19, 1914).

HAMAMURA

The hot spring "Suzukiya-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888. Temperature: 49° C.

Specific gravity: 1,0008. Total residue: ca. 1,07.

The spring, being in its composition nearly the same as that of "Nakataya-no-yu", may be classified as "**muriated saline bitter spring**".

Radio-activity. **5,35** Mache's units in 1 litre of water at 13,0° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 19, 1914).

Table 88.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1 (Kachimi)	Sagi-no-yu (*Public bath*)	—	51,5°	ca. 126	—	5,89	14,1°	K.&L.	Feb. 19, 1914	Dr. R. Ishizu
2 (Kachimi)	Nakataya-no-yu	muriated saline bitter	56,0°	—	31,18	8,57	16,3°	Schm.	"	"
3 (Kachimi)	Private bath (*Y. Kinoshita*)	—	56,0°	—	—	7,01	13,0°	K.&L.	"	"
4 (Kachimi)	" (*Kurozumi-Kōsha*) *Vent No. 1*	—	53,0°	—	—	7,15	13,0°	"	"	"
5 (Hamamura)	Kyōdō-yu *Vent No. 1* (*Public bath*)	—	48,0°	—	—	1,90	13,4°	"	"	"
6 (Hamamura)	Suzukiya-no-yu	muriated saline bitter	49,0°	—	—	5,35	13,0°	"	"	"
7 (Hamamura)	Kadoya-no-yu	—	45,0°	—	—	3,70	12,9°	"	"	"
8 (Hamamura)	Tabakoya-no-yu	—	45,0°	—	—	3,89	13,6°	"	"	"
	Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Nakataya-no-yu	—	—	—	197,62	54,35	—	Schm.	Feb. 19, 1914	"
2	Private bath (*Kurozumi-Kōsha*) *Vent No. 2*	—	51,0°	—	—	13,37	—	K.&L.	"	"

TŌGŌ

Location.—Tōgō-mura, Tōhaku-gun, Province Hōki, Tottori-ken.

The springs issue from the Andesite overlaid by Alluvium.

The hot spring "Yōjyō-kwan-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888.

Specific gravity: 1,0007. Total residue: ca. 0,93.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0204	0,5201	0,5201
Sodium ion ($Na^{\cdot}$)	0,2420	10,4945	10,4945
Calcium ion ($Ca^{\cdot\cdot}$)	0,0504	1,2569	2,5138
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0112	0,4598	0,9196
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0013	0,0233	0,0466
			14,4946
Anions.			
Chlorine ion (Cl')	0,3634	10,2511	10,2511
Sulphate ion (SO_4'')	0,1387	1,4439	2,8878
Hydrocarbonate ion (HCO_3')	0,0824	1,3503	1,3503
	0,9098	25,7999	14,4892
Silicic acid (meta) (H_2SiO_3)	0,0750		
	0,9848		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0389
Sodium chloride (NaCl)	0,5691
Sodium bicarbonate ($NaHCO_3$)	0,0650
Calcium sulphate ($CaSO_4$)	0,1707
Magnesium sulphate ($MgSO_4$)	0,0231
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0390
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0040
Silicic acid (meta) (H_2SiO_3)	0,0750
	0,9848

Besides these trace of ammonium, aluminium, bromine and hydrophosphate ion and organic substances.

The spring thus may be classified as "**simple thermal**".

Table 89.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1 Tōgō	Yōjyō-kwan-no-yu *Jet No. 1*	simple	50,0°	ca. 1730	**11,17**	**3,07**	10,6°	Schm	Feb. 23, 1914	Dr. R. Ishizu
2	,,	,,	,,	—	—	**4,06**	10,2°	K. & L.	,,	,,
3	,, *Jet No. 3*	,,	45,0°	—	—	**5,02**	10,2°	,,	,,	,,
4	,, *Jet No. 5*	,,	31,0°	—	—	**3,04**	10,0°	,,	,,	,,
5	,, *Jet No. 6*	,,	46,5°	—	—	**1,64**	9,6°	,,	,,	,,
6 Matsuzaki	Matsuzaki-kwan-no-yu	salt	36,0°	—	—	**5,87**	11,2°	,,	,,	,,
7	Spring (*in Matsuzaki station*)	,,	32,0°	—	—	**4,55**	11,7°	,,	,,	,,

ASŌZU

Location.—Asōzu-mura, Tōhaku-gun, Province Hōki, Tottori-ken.

The springs issue from the Andesite overlaid by Alluvium.

The hot spring "Moto-yu"

Analysis.

Analyst: Unknown. Specific gravity: 1,00017 at 15° C. Temperature: 56° C.

Total residue: ca. 1,64. Flow of water: ca. 360 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride ($NaCl$)	1,2056	Calcium sulphate ($CaSO_4$)	0,0648
Potassium sulphate (K_2SO_4)	0,0945	Silica (SiO_2)	0,0572
Sodium sulphate (Na_2SO_4)	0,0106		1,4327

Besides these trace of alumina, phosphoric and boric acid and organic substances.

The spring may be classified as "**common salt spring**".

Radio-activity. **4,33** Mache's units in 1 litre of water at 11,0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 21, 1914).

The hot spring "Asahi-kwan-no-yu"

Analysis.

Analyst: Unknown. Specific gravity: 1,00013 at 15° C. Temperature: 56° C.

Total residue: ca. 1,91. Flow of water: ca. 360 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Moto-yu", differing only in containing hydrogen sulphide from the latter, may be classified as "**muriated sulphur spring**".

Radio-activity. **3,56** Mache's units in 1 litre of water at 11,3° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 21, 1914).

Table 90.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water		Apparatus employed	Date when the water was taken	Examined by
					in Mache's units	at (temp. in C.)			
1	Moto-yu	common salt	56,0°	ca. 360	4,33	11,0°	K.&L.	Feb. 21, 1914	Dr. R. Ishizu
2	Asahi-kwan-no-yu	muriated sulphur	56,0°	360	3,56	11,3°	„	„	„
3	Sugimoto-no-yu	—	46,0°	—	2,73	12,2°	„	„	„
4	Nisshin-kwan-no-yu	—	48,0°	—	1,89	11,2°	„	„	„

SEKIGANE

Location.—Yaokuri-mura, Tōhaku-gun, Province Hōki, Tottori-ken.

The springs issue from the Granite.

The hot spring "Kabu-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888. Temperature: 42° C.

Specific gravity: 1,000 at 15° C. Total residue: ca. 0,52.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0192	0,4904	0,4904
Sodium ion ($Na^{\cdot}$)	0,1774	7,6963	7,6963
Calcium ion ($Ca^{\cdot\cdot}$)	0,0144	0,3591	0,7182
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0016	0,0286	0,0572
			8,9621
Anions.			
Chlorine ion (Cl')	0,1276	3,5994	3,5994
Sulphate ion (SO_4'')	0,1086	1,1306	2,2612
Hydrocarbonate ion (HCO_3')	0,1891	3,0995	3,0995
	0,6379	16,4039	8,9601
Silicic acid (meta) (H_2SiO_3)	0,0867		
	0,7246		
Free carbon dioxide (CO_2)	not determined		
Free hydrogen sulphide (H_2S)	**0,0002**		
	0,7248		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,2106
Potassium sulphate (K_2SO_4)	0,0427
Sodium sulphate (Na_2SO_4)	0,0751
Sodium bicarbonate ($NaHCO_3$)	0,2558
Calcium sulphate ($CaSO_4$)	0,0487
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0050
Silicic acid (meta) (H_2SiO_3)	0,0867
	0,7246
Free hydrogen sulphide (H_2S)	0,0002
	0,7248

Besides these trace of magnesium, aluminium and hydrophosphate ion, boric acid and a small quantity of organic substances.

The spring thus may be classified as "**sulphur spring**".

Radio-activity. **33,47** Mache's units in 1 litre of water at 9,4° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 23, 1914).

The hot spring "Kami-jyaya-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888.

Specific gravity: 1,0003. Temperature: 44,5° C.

Flow of water: ca. 270 hectolitres in 24 hours. Total residue: ca. 0,54.

The spring, being in its composition nearly the same as that of "Kubu-yu", may be classified as **"sulphur spring"**.

Radio-activity. **32,41** Mache's units in 1 litre of water at 10,4° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 23, 1914).

Table 91.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Kabu-yu (*Public bath*)	sulphur	42,0°	ca. —	—	**33,47**	9,4°	K & L.	Feb. 23, 1914	Dr. R. Ishizu
2	Shimo-jyaya-no-yu	"	44,0°	126	**109,51**	**30.12**	10,2°	Schm.	"	"
3	Kami-jyaya-no-yu	"	44,5°	270	—	**32,41**	10,4°	K. & L.	"	"
4	Inkyo-jyaya-no-yu	"	42,0°	90	—	**22,07**	10 9°	"	"	"
5	Kon-ya-no-yu	"	46,0°	108	—	**10,65**	9,9°	"	"	"
6	Shin-yu	"	—	171	—	—	—	—	—	—

MISASA

Location.—Misasa-mura, Tōhaku-gun, Province Hōki, Tottori-ken.

The springs issue from the Granite.

The hot spring "Naka-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1888. Temperature: 56,5° C.

Specific gravity: 1,0005. Total residue: ca. 1,24.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0375	0,9553	0,9553
Sodium ion ($Na^{\cdot}$)	0,4118	17,8655	**17,8655**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0317	0,7905	1,5810
			20,4018
Anions.			
Chlorine ion (Cl')	0,4500	12,6939	**12,6939**
Sulphate ion (SO_4'')	0,0957	0,9963	1,9926
Hydrocarbonate ion (HCO_3')	0,3487	5,7153	5,7153
	1 3754	39,0168	20,4018
Silicic acid (meta) (H_2SiO_3)	0,1019		
	1,4773		
Free carbon dioxide (CO_2)	not determined		
Free hydrogen sulphide (H_2S)	**0,0023**		
	1,4796		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0401
Sodium chloride (NaCl)	0,7112
Potassium sulphate (K_2SO_4)	0,0365
Sodium bicarbonate ($NaHCO_3$)	0,4803
Calcium sulphate ($CaSO_4$)	0,1073
Silicic acid (meta) (H_2SiO_3)	0,1019
	1,4773
Free hydrogen sulphide (H_2S)	0,0023
	1,4796

Besides these trace of ferrous, aluminium, bromine, iodine and hydrophosphate ion, boric acid and organic substances.

The spring thus may be classified as "**muriated sulphur spring**".

Radio-activity. **11,04** Mache's units in 1 litre of water at 12,0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 22, 1914).

The hot spring "Sakaya-no-yu" No. 2

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1889. Specific gravity: 1,0003 at 16,5° C.
Temperature: 67° C. Total residue: ca. 0,87.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0178	0,4547	0,4547
Sodium ion ($Na^{\cdot}$)	0,2649	11,4924	11,4924
Calcium ion ($Ca^{\cdot\cdot}$)	0,0194	0,4838	0,9676
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0003	0,0123	0,0246
			12,9393
Anions.			
Chlorine ion (Cl')	0,2991	8,4372	8,4372
Sulphate ion (SO_4'')	0,0812	0,8453	1,6906
Hydrocarbonate ion (HCO_3')	0,1715	2,8115	2,8115
	0,8542	24,5372	12,9393
Silicic acid (meta) (H_2SiO_3)	0,0922		
	0,9464		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,4936
Potassium sulphate (K_2SO_4)	0,0396
Sodium sulphate (Na_2SO_4)	0,0879
Sodium bicarbonate ($NaHCO_3$)	0,1529
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0787
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0015
Silicic acid (meta) (H_2SiO_3)	0,0922
	0,9464

Besides these trace of ferrous, aluminium and hydrophosphate ion and boric acid.

The spring thus may be classified as "**simple thermal**".

Radio-activity. **60,35** Mache's units in 1 litre of water at 15,5° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, March 12, 1914).

The hot spring "Kyōyūchi-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1889. Specific gravity: 1,0005 at 16,5° C.
Temperature: 71,5° C. Total residue: ca. 0,86.

The spring, being in its composition nearly the same as that of "Sakaya-no-yu" No. 2, may be classified as "**simple thermal**".

Radic-activity. **13,81** Mache's units in 1 litre of water at 12,5° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Feb. 22, 1914).

The hot spring "Tōkyōya-no-yu"

Analysis.

Analyst: Unknown. Specific gravity: 1,0009 at 15° C.
Temperature: 72° C. Total residue: ca. 1,16.

In 1 kilogram of the mineral water are contained:

	Grams
Sodium chloride ($NaCl$)	0,7112
Potassium sulphate (K_2SO_4)	0,0785
Sodium sulphate (Na_2SO_4)	0,0325
Sodium carbonate (Na_2CO_3)	0,2075
Calcium sulphate ($CaSO_4$)	0,0505
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0060
Silica (SiO_2)	0,0780
	1,1642

Besides these trace of magnesia, alumina, bromine, iodine, phosphoric and boric acid and organic substances.

The spring may be classified as "**common salt spring**".

Radio-activity. **20,23** Mache's units in 1 litre of water at 13,1° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, March 11, 1914).

Table 92.

Group	No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
Kabu-yu	1	Kabu-yu (*Public bath*)	—	air temp. 45,0°	37,19	10,23	12,0°	Schm.	Feb. 22, 1914	Dr. R. Ishizu
	2	Drinking water (*N. Okazaki*)	—	—	—	4,19	15,1°	K. & L.	March 12, „	„
	3	Ochaya-no-yu	—	63,5°	—	27,88	12,1°	„	Feb. 22, „	„
	4	Shin-ya-no-yu	—	44,5°	—	27,87	15,9°	„	March 12, „	„
	5	Mae-jyaya-no-yu	—	61,0°	—	6,69	16,0°	„	„	„
	6	Naka-no-yu (*Public bath*)	muriated sulphur	56,5°	—	11,04	12,0°	„	Feb. 22, „	„
	7	Hashizuya-no-yu	—	63,0°	—	15,52	15,9°	„	March 12, „	„
Muradōri	8	Private bath (*S. Mifune*)	—	63,0°	—	18,55	15,3°	„	„	„
	9	Bun-aburaya-no-yu	—	67,0°	—	24,46	13,3°	„	„ 11, „	„
	10	Tōfuya-no-yu	—	57,0°	—	24,46	11,5°	„	„	„
	11	Hanaya-no-yu	—	60,0°	—	72,65	12,6°	„	„	„
	12	Sakaya-no-yu *No. 1*	—	64,0°	—	63,47	15,7°	„	„ 12, „	„
	13	„ *No. 2*	simple	67,0°	—	60,35	15,5°	„	„	„
Morigasaki	14	Private bath * (*K. Tsugawa*)	carbonated (?)	52,0°	—	12,85	12,5°	„	Feb. 22, „	„
	15	Spring *A* („)	simple	11,5° (14°)	—	3,02	15,3°	„	March 12, „	„
	16	Aburaya-no-yu	—	48,5°	—	19,20	12,6°	„	„ 11, „	„
Tsukada	17	Uenoya-no-yu	—	46,0°	—	24,75	12,4°	„	„	„
	18	Private bath (*K. Kishida*)	—	49,0°	—	58,48	12,6°	„	„	„
	19	Iwa-yu (*Otoko-yu*)	—	54,5°	—	36,02	13,3°	„	„	„
	20	„ (*Onna-yu*)	—	56,0°	—	39,70	13,3°	„	„	„
	21	Private bath (*T. Matsubara*)	—	71,0°	516,87	142,14	16,3°	Schm.	„ 12 „	„
	22	„	—	„	—	121,99	14,0°	K. & L.	„	„
	23	Akazakiya-no-yu	—	75,0°	—	58,18	13,5°	„	„ 11, „	„
Hambata	24	Kyōyūchi-no-yu	simple	71,5°	—	13,81	12,5°	„	Feb. 22, „	„
	25	Tōkyōya-no-yu	common salt	72,0°	—	20,23	13,1°	„	March 11, „	„
	26	Kiya-no-yu	—	58,5°	—	28,37	12,3°	„	„	„
	27	Seitō-kwan-no-yu	—	51,0° (8°)	371,83	102,25	11,7°	Schm.	„	„
	28	„	—	„	—	107,82	12,2°	K. & L.	„	„
	29	Spring *B* (*River bed*)	—	69,5°	—	28,57	15,7°	„	„ 12, „	„
Yudani	30	Spring *C*	—	33,5° (9°)	—	15,18	12,9°	„	Feb. 22, „	„
					Emanation per litre of gas at 0° C.				Date when the gas was collected	
		Gas evolving from Kabu-yu (*Public bath*)	—	—	228,19	62,75	—	Schm.	Feb. 22, 1914	„

* The water originates in an artesian well, about 52 ft. in depth.

TAMATSUKURI

Location.—Tamayu-mura, Yatsuka-gun, Province Izumo, Shimane-ken.

The springs issue from the Tertiary.

The hot spring "Kami-no-yu"

Analysis.

Analysed by the Matsue Garrison Hospital. 1909.

Specific gravity: 1,0023 at 15° C. Temperature: 64° C.

Flow of water: ca. 1953 hectolitres in 24 hours. Total residue: ca. 1,58.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	0,0415
Sodium chloride (NaCl)	0,9125
Sodium sulphate (Na_2SO_4)	0,0375
Sodium bicarbonate ($NaHCO_3$)	0,0481
Calcium sulphate ($CaSO_4$)	0,1740
Magnesium sulphate ($MgSO_4$)	0,0254
	1,2390

Besides these a small quantity of iron and trace of bromine, phosphoric and boric acid, silica and organic substances.

The spring may be classified as "**common salt spring**".

Radio-activity. **10,79** × 10^{-10} curies in 1 litre of water at 15,1° C.
2,97 Mache's units (recalculated).
101,79 × 10^{-10} curies in 1 litre of gas at 0° C.
27,99 Mache's units (recalculated).
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, Feb. 25. 1914).

Table 93.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Kami-no-yu (*Public bath*)	common salt	64,0°	ca. 1953	**10,79**	**2,97**	15,1°	Schm.	Feb. 25, 1914	Dr. R. Ishizu, T. Saitō
2	Tonosama-yu („)	—	61,5°	—	—	**2,37**	13,6°	K. & L.	„	„
3	Private bath (*S. Hasegawa*)	—	54,0°	—	—	**5,14**	14,5°	„	„	„
	Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Kami-no-yu	—	—	—	**101,79**	**27,99**	—	Schm.	Feb. 25, 1914	„
2	River-bed *Vent A*	—	—	—	**128,04**	**35,21**	—	„	„	„
3	„ *Vent B*	—	—	—	—	**24,44**	—	K. & L.	„	„
4	„ *Vent C*	—	—	—	—	**28,44**	—	„	„	„

HIROSE

Location.—Iinashi-mura, Nogi-gun, Province Izumo, Shimane-ken.

The springs issue from the Tertiary.

Table 94.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Sagi-no-yu	—	43,0°	**9,91**	**2,73**	13,2°	Schm.	Feb. 27, 1914	Dr. R. Ishizu, T. Saitō
2	Private bath (*Asylum*)	—	37,0°	—	**2,06**	10,2°	K. & L.	"	"

GAKUTŌ

Location.—Shōbara-mura, Hinokawa-gun, Province Izumo, Shimane-ken.

The springs issue from the Tertiary.

Table 95.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Yunokawa-Kōsen	salt	27,0°	ca. 864	**0,42**	10,1°	K. & L.	Feb. 26, 1914	Dr. R. Ishizu, T. Saitō
2	Sudani-yakutō	"	—	—	**0,72**	10,1°	"	"	"

USHIO

Location.—Ushio-mura, Ōhara-gun, Province Izumo, Shimane-ken.

The springs issue from the Andesite.

The hot spring "Ushio-no-yu"

Temperature: 41,5° C. (air temp. 14,8° C.). Total residue: ca. 1,22.
Flow of water: ca. 441 hectolitres in 24 hours.

From the result of an old analysis made in 1881, the spring seems to be "**bitter spring**".

Radio-activity. **1,19** $\times 10^{-10}$ curies in 1 litre of water at 18,3° C.
0,33 Mache's units (recalculated).
9,03 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
2,48 Mache's units (recalculated).
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, March 1, 1914).

YUMURA

Location.—Yu-mura, Nita-gun, Province Izumo, Shimane-ken.

The springs issue from the Granite.

The hot spring "Shitsuui-no-yu"

Temperature: 43° C. (air temp. 8° C.). Total residue: ca. 0,32.
Flow of water: ca. 3888 hectolitres in 24 hours.

From the result of an old analysis made in 1881, the spring seems to be "**simple thermal**".

Radio-activity. **13,60** $\times 10^{-10}$ curies in 1 litre of water at 16,1° C.
3,74 Mache's units (recalculated).
84,30 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
23,18 Mache's units (recalculated).
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, Feb. 28, 1914).

KAWAI

Location.—Kawai-mura, Anno-gun, Province Iwami, Shimane-ken.

The springs issue from the Granite.

The cold spring "Tōkōji-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Shimane-ken. 1911.
Specific gravity: 1,0079 at 16° C. Temperature: 14° C. (air temp. 12° C.).
Total residue: ca. 9,77. Flow of water: ca. 29 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,2196	Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0440
Sodium chloride ($NaCl$)	5,6670	Alumina (Al_2O_3)	0,0188
Calcium chloride ($CaCl_2$)	2,3210	Silica (SiO_2)	0,0580
Calcium sulphate ($CaSO_4$)	0,9313		10,5755
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,6607	Free carbon dioxide (CO_2)	2,2815
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,6551		12,8570

Besides these a small quantity of boric acid.

The spring may be classified as "**earth-muriated iron carbonate carbondioxated common salt spring**".

Radio-activity. **1,01** Mache's units in 1 litre of water at 14,9° C.
2,03 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu and T. Saitō, March 3, 1914).

The cold spring "Urisaka-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Shimane-ken. 1911.
Specific gravity: 1,0103 at 18° C. Temperature: 13° C. (air temp. 12° C.).
Total residue: ca. 10,20. Flow of water: ca. 29 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,3029	Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0114
Sodium chloride ($NaCl$)	7,2197	Alumina (Al_2O_3)	0,0044
Potassium sulphate (K_2SO_4)	0,2174	Silica (SiO_2)	0,0700
Magnesium chloride ($MgCl_2$)	0,4062		10,3574
Calcium sulphate ($CaSO_4$)	1,0545	Free carbon dioxide (CO_2)	2,0736
Magnesium bicarbonate [$Mg(HCO_3)_2$]	1,0709		12,4310

Beside these a very small quantity of boric acid.

The spring may be classified as "**carbondioxated common salt spring**".

Radio-activity. **1,18** Mache's units in 1 litre of water at 13,2° C.
2,21 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu and T. Saitō, March 3, 1914).

SAHIME

Location.—Sahime-mura, Anno-gun, Province Iwami, Shimane-ken.

The springs issue from the Enstatite Andesite.

KOYABARA

The hot spring "Koyabara-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Shimane-ken. 1911.

Specific gravity: 1,0032 at 17° C. Temperature: 38,2° C. (air temp. 8° C).
Total residue: ca. 5,28. Flow of water: ca. 540 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride ($NaCl$)	3,9120	Alumina (Al_2O_3)	0,0180
Calcium chloride ($CaCl_2$)	0,2837	Silica (SiO_2)	0,1560
Calcium sulphate ($CaSO_4$)	0,3313		5,8395
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,6889	Free carbon dioxide (CO_2)	0,9053
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,4172		6,7448
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0324		

Beside these a small quantity of boric acid.

The spring may be classified as "**iron carbonate common salt spring**".

Radio-activity. **13,65** $\times 10^{-10}$ curies in 1 litre of water at 18,7° C.
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, March 4, 1914).
3,75 Mache's units (recalculated).
29,53 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, March 3, 1914).
8,12 Mache's units (recalculated).

SHIGAKU

The springs issue from the Enstatite Andesite.

The hot spring "Shigaku-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Shimane-ken. 1911.

Specific gravity: 1,0028 at 17° C. Temperature: 46,5° C. (air temp. 18° C.).
Total residue: ca. 2,39. Flow of water: ca. 31100 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride ($NaCl$)	1,5212	Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0211
Sodium bicarbonate ($NaHCO_3$)	0,0463	Silica (SiO_2)	0,1590
Calcium chloride ($CaCl_2$)	0,4151		2,5469
Calcium sulphate ($CaSO_4$)	0,0302	Free carbon dioxide (CO_2)	0,5932
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,3540		3,1401

Besides these trace of alumina and boric acid.

The spring may be classified as "**common salt spring**".

Radio-activity. **1,06** Mache's units in 1 litre of water at 15,6° C.
1,56 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu and T. Saitō, March 5, 1914).

Table 96.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1 (Koya-bara)	Koyabara-Onsen	iron carbonate common salt	air temp. 38,2° (8°)	ca. 540	**13,65**	**3,75**	18,7°	Schm	March 4, 1914	Dr. R. Ishizu, T. Saitō
2 (Ikeda-dōharame)	Nobata-no-yu *	carbonated(?)	24,0° (12°)	—	—	**3,14**	16,1°	K. & L.	"	"
3	Nobata-shin-yu *	"	17,0° (12°)	—	**682,67**	**187,74**	16,3°	Schm.	"	"
4 (Shigaku)	Shigaku-Onsen	common salt	46,5° (18°)	31100	—	**1,06**	15,6°	K. & L.	" 5, "	"
5	Private bath (*S. Nagira*)	—	46,5° (15°)	—	—	**0,29**	16.3°	"	"	"
6	Spring *A*	—	22,5° (15°)	—	—	**1,86**	16,4°	"	"	"
	Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Koyabara-Onsen	—	—	—	**29,53**	**8,12**	—	Schm.	March 3, 1914	"
2	Nobata-shin-yu *	—	—	—	**1307,21**	**359,48**	—	"	" 4 "	"
3	Nobata-no-yu *	—	—	—	—	**18,16**	—	K. & L.	"	"
4	Shigaku-Onsen	—	—	—	—	**1,56**	—	"	" 5, "	"

* These springs issue from the Granite.

YUNOTSU

Location.—Yunotsu-machi, Nima-gun, Province Iwami, Shimane-ken.

The springs issue from the Tertiary.

The hot spring "Yunotsu-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Shimane-ken. 1911.

Specific gravity: 1,0056 at 15° C. Total residue: ca. 7,06.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	0,1528
Sodium chloride ($NaCl$)	4,7941
Sodium bicarbonate ($NaHCO_3$)	0,4049
Calcium sulphate ($CaSO_4$)	1,0986
Magnesium sulphate ($MgSO_4$)	0,3185
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0923
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0174
Alumina (Al_2O_3)	0,0900
Silica (SiO_2)	0,0925
	7,0611
Free carbon dioxide (CO_2)	0,8813
	7,9424

Besides these trace of phosphoric and boric acid.

The spring may be classified as "**sulphated common salt spring**".

FUKUMITSU

Location.—Fukumitsu-mura, Nima-gun, Province Iwami, Shimane-ken.

The spring issues from the Tertiary.

The cold spring "Yunohara-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Shimane-ken. 1911.

Specific gravity: 1,0038 at 15° C. Temperature: 34,5° C. (air temp. 16° C.)
Total residue: ca. 4,48. Flow of water: ca. 77 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,2395	Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0174
Sodium chloride (NaCl)	2,6202	Alumina (Al_2O_3)	0,0375
Sodium bicarbonate ($NaHCO_3$)	0,6258	Silica (SiO_2)	0,1025
Calcium sulphate ($CaSO_4$)	0,4415		4,5521
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0616	Free carbon dioxide (CO_2)	1,0617
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,4061		5,6138

Besides these trace of phosphoric and boric acid.

The spring may be classified as "**carbondioxated common salt spring**".

Radio-activity. **0,12** Mache's units in 1 litre of water at 21,6° C.
0,03 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu and T. Saitō, March 7, 1914).

Table 97.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1 Yumotsu	Kyū-yu	sulphated common salt	air temp. 50,0°	ca. 700	—	**1,61**	20.1°	K.&L.	March 6, 1914	Dr. R. Ishizu, T. Saitō
2 Yumotsu	Shin-yu	"	46,0°	544	**18,00**	**4,95**	24,8°	Schm.	"	"
3 Fuku-mitsu	Yunohara-Onsen	carbondioxated common salt	34,5° (16°)	77	—	**0,12**	21,6°	K.&L.	" 7, "	"
	Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Shin-yu	—	—	—	**4,92**	**1,35**	—	Schm.	March 6, 1914	"
2	Kyū-yu	—	—	—	—	**3,31**	—	K.&L.	"	"
3	Yunohara-Onsen	—	—	—	—	**0,03**	—	"	" 7, "	"

ARIFUKU

Location.—Arifuku-mura, Naka-gun, Province Iwami, Shimane-ken.

The springs issue from the Diorite.

The hot spring "Arifuku-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Shimane-ken. 1912.

Specific gravity: 1,0013 at 14° C. Total residue: ca. 0,29.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Sodium chloride ($NaCl$)	0,1401	Calcium sulphate ($CaSO_4$)	0,0243
Potassium sulphate (K_2SO_4)	0,0141	Silica (SiO_2)	0,0560
Magnesium chloride ($MgCl_2$)	0,0098		0,2443

Besides these a small quantity of boric acid and organic substances.

The spring may be classified as "**simple thermal**".

Table 98.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in 10^{-10} curies	in Mache's units	at (temp in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Arifuku-Onsen *Vent No. 1*	simple	48,0°	ca. 3230	**0,80**	**0,22**	18,6°	Schm.	March 7, 1914	Dr. R. Ishizu / T. Saitō
2	" *Vent No. 2*	"	49,0°		—	**0,64**	19,2°	K. & L.	"	"
3	Arifuku-shin-yu	"	44,5°	—	—	**1,51**	18,9°	"	"	"

TOMBARA

Location.—Tombara-mura, Iishi-gun, Province Izumo, Shimane-ken.

The springs issue from the Granite.

The cold spring "Kamiyasumi-Kōsen"

Temperature: 15,7° C. Flow of water: ca. 108 hectolitres in 24 hours.

No accurate analysis has ever been made, but the spring seems to be "**carbonated spring**".

Radio-activity. **9,69** Mache's units in 1 litre of water* at 15,2° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu and T. Saitō, March 3, 1914).

KASUBUCHI

Location.—Kasubuchi-mura, Oochi-gun, Province Iwami, Shimane-ken.

The spring issues from the Liparite.

The cold spring "Kasubuchi-no-yu"

No accurate analysis has ever been made, but the spring seems to be "**carbonated spring**".

Radio-activity. **15,77** Mache's units in 1 litre of water* at 16,0° C.

(Kohl.-Löw. fontact.; Dr. R. Ishizu and T. Saitō, March 4, 1914).

* Measurement was made with the sample brought to the examiners by applicant, taking into account decay of radium emanation with the time.

YUNOGŌ

Location.—Yunogō-mura, Katsuda-gun, Province Mimasaka, Okayama-ken.

The springs issue from the Liparite.

The hot spring "Sagi-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1914.

Specific gravity: 1,0022 at 13° C. Temperature: 38° C. (air temp. 3° C.).
Total residue: ca. 2,27. Flow of water: ca. 1296 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,02091	0,53410	0,53410
Sodium ion ($Na^{\cdot}$)	0,46393	20,12711	**20,12711**
Calcium ion ($Ca^{\cdot\cdot}$)	0,35208	8,80200	**17,60400**
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00044	0,01806	0,03612
Ferrous ion ($Fe^{\cdot\cdot}$)	0,00084	0,01500	0,03000
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,00042	0,01550	0,04650
			38,37783
Anions.			
Chlorine ion (Cl')	1,34209	37,85867	**37,85867**
Sulphate ion (SO_4'')	0,01560	0,16240	0,32480
Hydrocarbonate ion (HCO_3')	0,01184	0,19407	0,19407
	2,20815	67,72691	38,37754
Boric acid (meta) (HBO_2)	0,01419		
Silicic acid (meta) (H_2SiO_3)	0,04598		
	2,26832		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram

	Grams
Potassium chloride (KCl)	0,03984
Sodium chloride (NaCl)	1,17748
Calcium chloride ($CaCl_2$)	0,95356
Calcium sulphate ($CaSO_4$)	0,01894
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,01037
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,00264
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,00267
Aluminium sulphate [$Al_2(SO_4)_3$]	0,00265
Boric acid (meta) (HBO_2)	0,01419
Silicic acid (meta) (H_2SiO_3)	0,04598
	2,26832

Besides these a small quantity of free carbon dioxide.

The spring thus may be classified as "**earth-muriated common salt spring**".

Radio-activity. **3,06** $\times 10^{-10}$ curies in 1 litre of water at 11.5° C.
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, March 17, 1914).
0,84 Mache's units (recalculated).

Gas evolving from the spring (collected at the vent, from which gas evolution is most abundant) consists almost of Nitrogen,

19,50 $\times 10^{-10}$ curies in 1 litre of gas at 0° C.
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, March 17, 1914).
5,36 Mache's units (recalculated).

The hot spring "Shin-sagi-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1912.

Specific gravity: 1,0018 at 17° C. Temperature: 37,7° C. (air temp. 27,2° C.).
Flow of water: ca. 540 hectolitres in 24 hours. Total residue: ca, 2,25.

The spring, being in its composition nearly the same as that of "Sagi-no-yu", may be classified as "**earth-muriated common salt spring**".

Radio-activity. **0,85** Mache's units in 1 litre of water at 27,7° C.
4,56 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, July 15, 1913).

Table 99.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Sagi-no-yu (*Public bath*)	earth-muriated common salt	air temp. 38,0° (3°)	ca. 1296	3,06	0,84	11 5°	Schm.	March 17, 1914	Dr. R. Ishizu, T. Saitō
2	”	”	”	”	—	1,00	10,0°	K. & L.	”	”
3	” (*Onna-yu*)	”	37,0° (3°)	—	—	0,90	7,4°	”	”	”
4	Shin-sagi-no-yu	”	37,7° (27,2°)	540	—	0,85	27,7°	”	July 15, 1913	”
5	Me-no-yu	sulphur (?)	25,0° (10°)	—	—	1,00	13,4°	”	March 17, 1914	”
	Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1	Sagi-no-yu	—	—	—	19,50	5,36	—	Schm.	March 17, 1914	”
2	” (*Onna-yu*)	—	—	—	—	4,11	—	K. & L.	”	”
3	Shin-sagi-no-yu	—	—	—	—	4,56	—	”	July 15, 1913	”
4	Me-no-yu	—	—	—	—	4,74	—	”	March 17, 1914	”

KAIDANI

Location.—Nodani-mura, Mitsu-gun, Province Bitchū, Okayama-ken.

The spring issues from the Granite.

The cold spring "Tomada-no-yu"

Temperature: 14,5° C. (air temp. 9,2° C.)

No accurate analysis has ever been made, but the spring seems to be "**simple cold spring**".

Radio-activity. 48,66 × 10^{-10} curies in 1 litre of water at 11,5° C.
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, Feb. 13, 1914).
13,38 Mache's units (recalculated).

TAKEBE

Location.—Kami-takebe-mura, Mitsu-gun, Province Bitchū, Okayama-ken.

The spring issues from the Granite.

The cold spring "Yawata-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Okayama-ken. 1900.

Specific gravity: 1,0011 at 12° C. Temperature: 28° C. (air temp. 16° C.).
Total residue: ca. 0,26. Flow of water: ca. 390 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained :

	Grams		Grams
Potassium chloride (KCl)	0,12410	Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,00708
Sodium chloride (NaCl)	0,13842	Silica (SiO_2)	0,02692
Sodium sulphate (Na_2SO_4)	0,01677		0,39845
Sodium bicarbonate ($NaHCO_3$)	0,04250	Free carbon dioxide (CO_2)	0,00900
Calcium sulphate ($CaSO_4$)	0,02499		0,40745
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,01767		

Besides these trace of iron, alumina, phosphoric and boric acid.

The spring may be classified as "**simple cold spring**".

Radio-activity. 17,66 × 10^{-10} curies in 1 litre of water at 13,0° C.
(Schmidt's electrom.; Dr. R. Ishizu and T. Saitō, Feb. 14, 1914)
4,86 Mache's units (recalculated).

YUDA

Location.—Shimo-unoryō-mura, Yoshiki-gun, Province Suō, Yamaguchi-ken.

The springs issue from the Alluvium.

Table 100.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Nagamune-no-yu	salt	45,0°	9,72	2,67	45,0°	Schm.	Aug. 4, 1914	H. Kibezaki S. Nishimura
2	Matsudaya-no-yu	,,	41,0°	9,60	2,64	41,0°	,,	,, 5, ,,	,,

KAWATANA

Location.— Kawatana-mura, Toyora-gun, Province Nagato, Yamaguchi-ken.

The springs issue from the Granite.

Table 101.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
	Public bath :								
1	Juei-sen	salt	41,0°	36,19	9,95	41,0°	Schm.	Aug. 9, 1914	H. Kibezaki S. Nishimura
2	Seiryū-sen	,,	40,0°	43,21	11,88	40,0°	,,	,,	,,

TAWARAYAMA

Location.—Tawarayama-mura, Ōtsu-gun, Province Nagato, Yamaguchi-ken.

The springs issue from the Mesozoic Conglomerate.

Table 102.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
	Public bath :								
1	Kagi-yu	alkaline	40,0°	3,59	0,99	40,0°	Schm.	Aug. 7, 1914	H. Kibezaki S. Nishimura
2	Kawa-yu	„	42,0°	6,21	1,71	42,0°	„	„ 8, „	„

FUKAWA

Location.—Fukawa-mura, Ōtsu-gun, Province Nagato, Yamaguchi-ken.

The springs issue from the Liparite.

Table 103.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
	Public bath :									
1	Yumoto-Onsen (*On-tō*)	alkaline	40,0°	ca. 2520	0,45	0,12	40,0°	Schm.	Aug. 6, 1914	H. Kibezaki S. Nishimura
2	„ (*Rei-tō*)	„	42,0°		0,40	0,11	42,0°	„	„ 7, „	„

DŌGO

Location.—Dōgo-yuno-machi, Onsen-gun, Province Iyo, Ehime-ken.

The springs issue from the Granite.

The hot spring "Kami-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Hiroshima-ken. 1896. Temperature: 47° C.
Specific gravity: 1,00106 at 15° C. Total residue: ca. 0,78.

In 1 kilogram of the mineral wat r are contained:

	Grams		Grams
Sodium chloride (NaCl)	0,15597	Calcium sulphate ($CaSO_4$)	0,11855
Potassium sulphate (K_2SO_4)	0,03775	Magnesium sulphate ($MgSO_4$)	0,08758
Sodium sulphate (Na_2SO_4)	0,19669		0,78828
Sodium bicarbonate ($NaHCO_3$)	0,03964	Carbon dioxide (free and in form of bicarbonates) (CO_2)	0,05887
Sodium phosphate (Na_2HPO_4)	0,01597		0,84715
Sodium silicate (Na_4SiO_4)	0,13613		

Besides these a very small quantity of ferrous oxide, boric acid and trace of nitric acid.

The spring may be classified as "**simple thermal**".

Radio-activity. **14,47** $\times 10^{-10}$ curies in 1 litre of water at 47,0° C.
(Schmidt's electrom.; H. Kibezaki, July 10, 1913).
3,98 Mache's units (recalculated).
85,02 $\times 10^{-10}$ curies in 1 litre of gas.
(Schmidt's electrom.; H. Kibezaki, July 15, 1913).
23,38 Mache's units (recalculated).

The hot spring "Yōjyō-yu"

Analysis.

Analysed by the Hygienic Laboratory of Hiroshima-ken. 1896. Temperature: 46° C.
Specific gravity: 1,01418 at 15° C. Total residue: ca. 0,83.

The spring, being in its composition nearly the same as that of "Kami-no-yu", may be classified as "**simple thermal**".

Radio-activity. **16,07** $\times 10^{-10}$ curies in 1 litre of water at 46,0° C.
(Schmidt's electrom.; H. Kibezaki, July 16, 1913).
4,42 Mache's units (recalculated).

Table 104.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Kami-no-yu (*Public bath*)	simple	46,5° (air temp.)	**16,33**	**4,49**	46,5°	Schm.	March 24, 1913	H. Kibezaki
2	,,	,,	47,0°	**14,47**	**3,98**	47,0°	,,	July 10, ,,	,,
3	Yōjyō-yu (,,)	,,	46,5°	**13,70**	**3,77**	46,5°	,,	March 25, ,,	,,
4	,,	,,	46,0°	**16,07**	**4,42**	46,0°	,,	July 16, ,,	,,
5	Shin-Onsen (*I. Iwasaki*)	—	29,0°	**23,05**	**6,34**	29,0°	,,	March 26, ,,	,,
6	,,	—	29,0°	**24,04**	**6,61**	29,0°	,,	July 13, ,,	,,
7	Tama-no-i	—	—	**3,90**	**1,07**	—	,,	March 23, ,,	,,
8	Well (Funaya)	—	23,0°	**8,85**	**2,43**	23,0°	,,	,,	,,
9	Tama-no-yu (*Public bath*)	simple	45,8° (19,9°)	—	—	—	—	—	—
10	Matsu-no-yu (,,)	,,	42,0° (19,5°)	—	—	—	—	—	—
	Gas evolving from Kami-no-yu	—	—	Emanation per litre of gas: **85,02**	**23,38**	—	Schm.	Date when the gas was collected: July 15, 1913	H. Kibezaki

MUSASHI

Location.—Futsukaichi-machi, Tsukushi-gun, Province Chikuzen, Fukuoka-ken.

The springs issue from the Granite.

The hot spring "Yakushi-no-yu"

Analysis.

Analysed by the Hygienic Laboratory of Fukuoka-ken. 1897. Specific gravity: 1,002 at 12° C.
Flow of water: ca. 377 hectolitres in 24 hours. Total residue: ca. 0,72.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium chloride (KCl)	0,02160
Sodium chloride (NaCl)	0,55285
Potassium sulphate (K_2SO_4)	0,00395
Sodium carbonate (Na_2CO_3)	0,08244
Calcium sulphate ($CaSO_4$)	0,02151
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,00785
Silica (SiO_2)	0,03366
	0,72386
Free hydrogen sulphide (H_2S)	0,00226
	0,72612

Besides these a small quantity of boric acid and trace of magnesia and phosphoric acid.

The spring may be classified as "**sulphur spring**".

Table 105.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Yakushi-no-yu *No. 1* (*Public bath*)	sulphur	41,0°	ca. 377	7,29	2,00	41,0°	Schm.	July 30, 1914	H. Kibezaki, S. Nishimura
2	„ *No. 2* („)	„	44,0°		14,78	4,07	44,0°	„	„ 29, „	„
3	Enju-no-yu („)	„	46,0°	315	13,46	3,70	46,0°	„	„ 31, „	„
4	Ōsakaya-no-yu	„	44,5°	207	11,67	3,21	44,5°	„	„ 30, „	„
5	Gozen-yu (*Public bath*)	„	42,2°	213	—	—	—	—	—	—
6	Kawa-yu („)	„	46,7°	890	—	—	—	—	—	—
					Emanation per litre of gas				Date when the gas was collected	
	Gas evolving from Ōsakaya-no-yu	—	—	—	118,33	32,54	—	Schm.	July 31, 1914	H. Kibezaki, S. Nishimura

FUNAGOYA

Location.—Mizuta-mura, Yame-gun, Province Chikugo, Fukuoka-ken.

The springs issue from the Diluvium.

The cold spring "Funagoya-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1900. Temperature: 21,0° C.
Flow of water: ca. 63 hectolitres in 24 hours. Total residue: ca. 0,17.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Sodium ion ($Na^{\cdot}$)	0,0185	0,8026	0,8026
Calcium ion ($Ca^{\cdot\cdot}$)	0,0168	0,4189	0,8378
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0058	0,2385	0,4770
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0021	0,0376	0,0752
			2,1926
Anions.			
Chlorine ion (Cl')	0,0285	0,8142	0,8142
Sulphate ion (SO_4'')	0,0183	0,1905	0,3810
Hydrocarbonate ion (HCO_3')	0,0609	0,9982	0,9982
	0,1509	3,5005	2,1934
Silicic acid (meta) (H_2SiO_3)	0,0430		
	0,1939		
Free carbon dioxide (CO_2)	**1,9391**	44,0705	
	2,1330		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,0470
Calcium sulphate ($CaSO_4$)	0,0260
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0364
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0349
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0066
Silicic acid (meta) (H_2SiO_3)	0,0430
	0,1939
Free carbon dioxide (CO_2)	0,8924
	1,0863

Besides these trace of hydrophosphate ion.

The spring thus may be classified as "**simple carbondioxated spring**".

Table 106.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Funagoya-Onsen (*Public bath*)	simple carbon-dioxated	17,5°	ca. 63	**3,43**	**0,94**	17,5°	Schm.	Aug. 2, 1914	H. Kibezaki S. Nishimura
2	Nomi-yu	„	21,0°	„	**1,45**	**0,40**	21,0°	„	„	„

BEPPU

Location.—Beppu-machi, Hayami-gun, Province Bungo, Ōita-ken.

The springs issue from the Andesite overlaid by Alluvium.

The hot spring "Furō-sen"

Analysis (calculated from the salt table).

Analysed by the Hygienic Laboratory of Fukuoka-ken. Temperature: 57,5° C.

Flow of water: ca. 648 hectolitres in 24 hours. Total residue: ca. 0,85.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0023	0,0587	0,0587
Sodium ion ($Na^{\cdot}$)	0,1059	4,5944	4,5944
Calcium ion ($Ca^{\cdot\cdot}$)	0,0168	0,4190	0,8380
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0354	1,4532	2,9064
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0120**	0,2147	0,4294
			8,8269

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,2263
Potassium sulphate (K_2SO_4)	0,0051
Sodium sulphate (Na_2SO_4)	0,0516
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0680
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,2210
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0383

Anions.

Chlorine ion (Cl')	0,1371	3,8646	3,8646
Sulphate ion (SO_4'')	0,0377	0,3925	0,7850
Hydrocarbonate ion (HCO_3') .	0,2631	4,3124	4,3124
	0,6103	15,3095	8,9620
Silicic acid (meta) (H_2SiO_3) .	0,2548		
	0,8651		
Free carbon dioxide (CO_2) . .	not determined		

Silicic acid (meta) (H_2SiO_3) 0,2548
0,8651

Besides these trace of aluminium and hydrophosphate ion.

The spring thus may be classified as "**iron carbonate spring**".

Radio-activity. **0,66** $\times 10^{-10}$ curies in 1 litre of water at 57,5° C.
(Schmidt's electrom.; H. Kibezaki, March 7, 1913)
0,18 Mache's units (recalculated).

KWANKAIJI

Location.—Ishikaki-mura, Hayami-gun, Province Bungo, Ōita-ken.

The spring issues from the Pyroxene Andesite and its Agglomerate.

The hot spring "Kwankaiji-Onsen"

Analysis.

Analysed by the Hygienic Laboratory of Ōita-ken. 1906.

Specific gravity: 1,0004 at 15° C. Temperature: 57° C.
Total residue: ca. 0,77. Flow of water: ca. 216 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium oxide (K_2O)	0,0062	Chlorine (Cl)	0,0732
Sodium oxide (Na_2O)	0,0536	Sulphuric anhydride (SO_3)	0,0346
Calcium oxide (CaO)	0,0818	Silica (SiO_2)	0,0936
Magnesia (MgO)	0,0357	Carbon dioxide (total) (CO_2)	0,5933
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,0590		

Besides these trace of phosphoric and boric acid.

The spring may be classified as "**iron carbonate spring**".

Radio-activity. **0,07** $\times 10^{-10}$ curies in 1 litre of water at 57,0° C.
(Schmidt's electrom.; H. Kibezaki, March 8, 1913).
0,02 Mache's units (recalculated).

KANNAWA

Location.—Asahi-mura, Hayami-gun, Province Bungo, Ōita-ken.

The springs issue from the Pyroxene Andesite and its Agglomerate.

The hot spring "Shibu-no-yu"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Specific gravity: 1,00109 at 4° C. Temperature: 89° C.
Flow of water: ca. 414 hectolitres in 24 hours. Total residue: ca. 2,67.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Hydrogen ion ($H^{\cdot}$)	0,0221	21,8812	**21,8812**
Potassium ion ($K^{\cdot}$)	0,1128	2,8812	2,8812
Sodium ion ($Na^{\cdot}$)	0,2957	12,8286	12,8286
Calcium ion ($Ca^{\cdot\cdot}$)	0,0657	1,6384	3,2768
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0162	0,6650	1,3300
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0157**	0,2809	0,8427
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0310	1,1439	3,4317
			46,4722
Anions.			
Chlorine ion (Cl')	1,1402	32,1636	**32,1636**
Sulphate ion (SO_4'')	0,6801	7,0800	**14,1600**
	2,3795	80,5628	46,3236
Silicic acid (meta) (H_2SiO_3)	0,3751		
	2,7546		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,0923
Potassium sulphate (K_2SO_4)	0,2514
Sodium sulphate (Na_2SO_4)	0,8009
Calcium chloride ($CaCl_2$)	0,1820
Magnesium chloride ($MgCl_2$)	0,0635
Ferric chloride ($FeCl_3$)	0,0456
Aluminium chloride ($AlCl_3$)	0,1528
Free hydrochloric acid (HCl)	0,7910
Silicic acid (meta) (H_2SiO_3)	0,3751
	2,7546

Besides these a small quantity of organic substances and a very small quantity of boric acid.

The spring thus may be classified as "**acid vitriol spring**".

Composition of the mineral salt "Yu-no-hana"

(analysed by the Hygienic Laboratory of Ōita-ken in 1900).

100 parts of the yellowish crystalline mass, almost totally soluble in water with an acid reaction and in an astringent taste, consist of:

	Parts
Potassium sulphate (K_2SO_4)	0,11
Sodium sulphate (Na_2SO_4)	0,93
Calcium sulphate ($CaSO_4$)	0,29
Magnesium sulphate ($MgSO_4$)	2,20
Ferric sulphate [$Fe_2(SO_4)_3$]	16,77
Aluminium sulphate [$Al_2(SO_4)_3$]	35,51
Calcium phosphate [$Ca_2(HPO_4)_2$]	0,15
Boric acid (H_3BO_3)	trace
Insoluble matters	1,77
Water	42,23

The salt is used for bathing purpose.

The hot spring "Umi-Jigoku"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1912. Total residue: ca. 3,51.

Specific gravity: 1,0029 at 15° C. Temperature: 90,5° C. (air temp. 26° C.).

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Hydrogen ion ($H^{\cdot}$)	0,00613	6,06930	**6,06930**
Potassium ion ($K^{\cdot}$)	0,17560	4,48531	4,48531
Sodium ion ($Na^{\cdot}$)	0,82521	35,80086	**35,80086**
Ammonium ion ($NH_4^{\cdot}$)	0,00154	0,08518	0,08518
Calcium ion ($Ca^{\cdot\cdot}$)	0,08456	2,11400	4,22800
Magnesium ion ($Mg^{\cdot\cdot}$)	0,03183	1,30660	2,61320
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,01293**	0,23100	0,46200
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,00788	0,29077	0,87210
			54,61595
Anions.			
Chlorine ion (Cl')	1,26300	35,62764	**35,62764**
Sulphate ion (SO_4'')	0,91216	9,49573	**18,99146**
	3,32084	95,50639	54,61910
Boric acid (meta) (HBO_2)	0,01414		
Silicic acid (meta) (H_2SiO_3)	0,48049		
	3,81547		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Gram
Sodium chloride ($NaCl$)	1,32380
Ammonium chloride (NH_4Cl)	0,00455
Potassium sulphate (K_2SO_4)	0,39102
Sodium sulphate (Na_2SO_4)	0,93622
Calcium chloride ($CaCl_2$)	0,23444
Magnesium chloride ($MgCl_2$)	0,12447
Ferrous sulphate ($FeSO_4$)	0,03513
Aluminium sulphate [$Al_2(SO_4)_3$]	0,04977
Free hydrochloric acid (HCl)	0,22140
Boric acid (meta) (HBO_2)	0,01414
Silicic acid (meta) (H_2SiO_3)	0,48049
	3,81543

The spring thus may be classified as "**acid vitriol spring**".

MYŌBAN

Location.—Asahi-mura, Hayami-gun, Province Bungo, Ōita-ken.

The springs issue from the Andesite.

The hot spring "Jizō-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1898.

Specific gravity: 1,003 at 20° C. Temperature: 91° C. (air temp. 22° C.).
Total residue: ca. 2,52. Flow of water: ca. 389 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Hydrogen ion ($H^{\cdot}$)	0,0205	20,2970	**20,2970**
Potassium ion ($K^{\cdot}$)	0,0373	0,9528	0,9528
Sodium ion ($Na^{\cdot}$)	0,0480	2,0824	2,0824
Calcium ion ($Ca^{\cdot\cdot}$)	0,0430	1,0723	2,1446
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,0585**	1,0465	2,0930
Ferric ion ($Fe^{\cdot\cdot\cdot}$)	**0,0880**	1,5742	4,7226
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,1366	5,0406	**15,1218**
			47,4142
Anions.			
Hydrosulphate ion (HSO_4')	1 9665	20,2586	20,2586
Sulphate ion (SO_4'')	1,3026	13,5603	**27,1206**
	3,7010	65,8847	47,3792
Silicic acid (meta) (H_2SiO_3)	0,4608		
	4,1618		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium sulphate (K_2SO_4)	0,0830
Sodium sulphate (Na_2SO_4)	0,1480
Calcium sulphate ($CaSO_4$)	0,1460
Ferrous sulphate ($FeSO_4$)	0,1590
Ferric sulphate [$Fe_2(SO_4)_3$]	0,3150
Aluminium sulphate [$Al_2(SO_4)_3$]	0,8630
Free sulphuric acid (H_2SO_4)	1,9870
Silicic acid (meta) (H_2SiO_3)	0,4608
	4,1618

Besides these trace of magnesium, nitrate and chlorine ion and boric acid.

The spring thus may be classified as "**acid alum vitriol spring**".

Radio-activity. **0,13** Mache's units in 1 litre of water at 25,0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Oct. 11, 1913).

KAMEGAWA

Location.—Okoshi-machi, Hayami-gun, Province Bungo, Ōita-ken.

The springs issue from the Pyroxene Andesite and its Agglomerate.

The hot spring "Shi-no-yu"

Analysis (calculated from the salt table).

Analysed by the Ōsaka Imperial Hygienic Laboratory. 1895. Temperature: 57,0° C. (air temp. 24° C.).
Flow of water: ca. 198 hectolitres in 24 hours. Total residue: ca. 1,22.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0377	0,9630	0,9630
Sodium ion ($Na^{\cdot}$)	0,2939	12,7505	**12,7505**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0363	0,9052	1,8104
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0085	0,3489	0,6978
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0022	0,0394	0,0788
			16,3005

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,6780
Potassium sulphate (K_2SO_4)	0,0840
Sodium sulphate (Na_2SO_4)	0,0040
Sodium bicarbonate ($NaHCO_3$)	0,0930
Calcium sulphate ($CaSO_4$)	0,1230
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0510

nions.

Chlorine ion (Cl')	0,4109	11,5910	11,5910
Sulphate ion (SO_4'')	0,1357	1,4127	2,8254
Hydrocarbonate ion (HCO_3')	0,1148	1,8817	1,8817
	1,0400	29,8924	16,2981
Silicic acid (meta) (H_2SiO_3)	0,2557		
	1,2957		
Free carbon dioxide (CO_2)	0,0310	0,7045	
	1,3267		

Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0070
Silicic acid (meta) (H_2SiO_3)	0,2557
	1,2957
Free carbon dioxide (CO_2)	0,0310
	1,3267

Besides these trace of aluminium ion.

The spring thus may be classified as "**common salt spring**".

Radio-activity. **0,22** Mache's units in 1 litre of water at 24,0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Oct. 14, 1913).

The hot spring "Kiyō-sen"

Analysis.

Analysed by the Hygienic Laboratory of Ōita-ken. 1913.

Specific gravity: 1,0027 at 15° C. Temperature: 54° C. (air temp. 24,5° C.).

Total residue: ca. 2,65. Flow of water: ca. 270 hectolitres in 24 hours.

The spring, being in its composition nearly the same as that of "Shi-no-yu", may be classified as "**common salt spring**".

Radio-activity. **0,32** Mache's units in 1 litre of water at 29,0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Oct. 14, 1913).

The hot spring "Chinoike-Jigoku"

Temperature: 76° C. (air temp. 26° C.). Flow of water: abundant.*

No accurate analysis has ever been made, but the spring seems to be "**acid vitriol spring**".

Composition of the gas (analysed by the Tōkyō Imperial Hygienic Laboratory in 1913).

1000 c.c. of gas evolving from the spring consist of:

Carbon dioxide (CO_2)	450 c.c.	Nitrogen (N_2)	477,5 c.c.
Oxygen (O_2)	70 „	Ethane (C_2H_6)	2,5 „

The analysis is not so accurate, the number being only the approximate value.

Radio-activity. **4,82** Mache's units in 1 litre of gas, evolving from Vent No. 1, at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Oct. 10, 1913).
4,99 Mache's units in 1 litre of gas, evolving from Vent No. 2, at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Oct. 13, 1913).

Composition of the sinter-deposit † (analysed by the Tōkyō Imperial Hygienic Laboratory in 1913).

100 parts of the ochreous mass, almost insoluble in water consist of:

	Parts		Parts
Ferric oxide (Fe_2O_3)	42,38	Calcium oxide (CaO)	0,40
Alumina (Al_2O_3)	22,20	Sulphuric acid (H_2SO_4)	trace
Silica (SiO_2)	16,84	Chlorine (Cl)	„
Magnesia (MgO)	0,58	Water	17,60

The ochreous clay is used for dyeing in the place near "Chi-no-ike".

* The outflow of the boiling pool forms a steaming brook rushing down to the sea.

† The ochreous sinter-deposit is found on the shore of the pool.

SHIBASEKI

Location.—Okoshi-machi, Hayami-gun, Province Bungo, Ōita-ken.

The springs issue from the Pyroxine Andesite and its Agglomerate.

The hot spring "Hijiri-yu"

Analysis.

Analysed by the Hygienic Laboratory of Ōita-ken. Temperature: 69° C. (air temp. 23° C.).
Flow of water: ca. 216 hectolitres in 24 hours. Total residue: ca. 1,59.

In 1 kilogram of the mineral water are contained:

	Grams
Sodium chloride ($NaCl$)	0,36317
Potassium sulphate (K_2SO_4)	0,00600
Sodium sulphate (Na_2SO_4)	0,43012
Sodium bicarbonate ($NaHCO_3$)	0,23108
Calcium chloride ($CaCl_2$)	0,20002
Magnesium chloride ($MgCl_2$)	0,06806
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,01084
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,22072
Alumina (Al_2O_3)	0,00142
Silica (SiO_2)	0,21802
	1,74945
Free carbon dioxide (CO_2)	0,01531
	1,76476

The spring may be classified as "**iron carbonate spring**".

Radio-activity. **0,31** Mache's units in 1 litre of water at 20,0° C.
1,91 Mache's units in 1 litre of gas at 0° C.
(Kohl.-Löw. fontact.; Dr. R. Ishizu, Oct. 13, 1913).

Table 107.

No.		Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Emanation per litre of water: at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Beppu	Furō-sen	iron carbonate	air temp. 57,5°	ca. 648	**0,66**	**0,18**	57,5°	Schm.	March 7, 1913	H. Kibezaki
2	Beppu	Kojimaya-no-yu *No. 1*	carbonated common salt	55,0°	—	**0,75**	**0,21**	55,0°	„	„ 5, „	„
3	Beppu	„ *No. 2*	„	54,0°	—	**0,52**	**0,14**	54,0°	„	„ 9, „	„
4	Beppu	Shiokyū-no-yu	„	57,0°	—	**0,39**	**0,11**	57,0°	„	„ 8, „	„
5	Beppu	Seisen-kaku-no-yu	carbonated	54,0°	—	**0,20**	**0,05**	54,0°	„	„ 9, „	„
6	Beppu	Reichō-sen (*Public bath*)	simple carbondioxated	67,0°	520	—	—	—	—	—	—
7	Beppu	Higashi-Onsen („)	common salt	60,0°	1167	—	—	—	—	—	—
8	Beppu	Nishi-Onsen („)	iron carbonate carbondioxated	57,0°	783	—	—	—	—	—	—
9	Beppu	Kusunoki-Onsen („)	iron carbonate	51,0°	1321	—	—	—	—	—	—
10	Beppu	Takegawara-Onsen („)	carbonated	56,0°	—	—	—	—	—	—	—
11	Beppu	Azenashi-Onsen („)	simple	51,0°	162	—	—	—	—	—	—
12	Beppu	Asami-Onsen („)	„ (?)	41,0°	—	—	—	—	—	—	—
13	Kwankaiji	Kwankaiji-Onsen („)	iron carbonate	57,0°	216	**0,07**	**0,02**	57,0°	Schm.	March 8, 1913	H. Kibezaki
14	Hotta	Hotta-no-yu („)	sulphur	36,0°	225	—	—	—	—	—	—

No.		Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
15	Kannawa	Netsu-no-yu (*Public bath*)	carbonated	air temp. 80,0°	865	—	—	—	—	—	—
16	Kannawa	Shin-yu („)	sulphur	96,0°	414	—	—	—	—	—	—
17	Kannawa	Shibu-yu („)	acid vitriol	89,0°	414	—	—	—	—	—	—
18	Kannawa	Mushi-buro (*Vapour bath*)	—	69,0°	—	—	—	—	—	—	—
19	Kannawa	Andō-mushi („)	—	45,0°	—	—	—	—	—	—	—
20	Kannawa	Umi-Jigoku	acid vitriol	90,5° (26°)	—	—	—	—	—	—	—
21	Myōban	Tsuru-no-yu (*Public bath*)	sulphur	98,0° (18°)	373	—	—	—	—	—	—
22	Myōban	Jizō-no-yu („)	acid alum vitriol	91,0° (22°)	389	—	0,13	25,0°	K.&L.	Oct. 11, 1913	Dr. R. Ishizu
23	Myōban	Yakushi-no-yu („)	„	97,0°	360	—	—	—	—	—	—
24	Myōban	Kamii-no-yu („)	„	63,0° (30°)	90	—	—	—	—	—	—
25	Kamegawa	Kiyō-sen („)	common salt	54,0° (24,5°)	270	—	0,32	29,0°	K.&L.	„ 14, „	Dr. R. Ishizu
26	Kamegawa	Shi-no-yu („)	„	57,0° (24°)	198	—	0,22	24,0°	„	„	„
27	Kamegawa	Kamado-no-yu	—	99,0° (26°)	—	—	0,22	22,0°	„	„ 10, „	„
28	Kamegawa	Noda-no-yu	—	89,0° (25°)	—	—	0,48	24,0°	„	„ 12, „	„
29	Kamegawa	Gomusō-no-yu	—	48,0° (24°)	—	—	0,45	25,0°	„	„	„
30	Kamegawa	Hamada-Onsen (*Public bath*)	carbonated	59 0° (25°)	180	—	0,11	25,0°	„	„ 13, „	„
31	Shibuseki	Hijiri-yu	iron carbonate	69,0° (23°)	216	—	0,31	20,0°	„	„	„
		Gas evolving from:				Emanation per litre of gas at 0° C.				Date when the gas was collected	
1		Chinoike-Jigoku *Vent No. 1*	—	—	—	—	4,82	—	„	Oct. 10, 1913	„
2		„ *Vent No. 2*	—	—	—	—	4,99	—	„	„ 13, „	„
3		Hijiri-yu	—	—	—	—	1,91	—	„	„	„

OBAMA

Location.—Obama-mura, Minami-takagi-gun, Province Hizen, Nagasaki-ken.

The springs issue from the Augite Andesite.

The hot spring "Fukiage-yu" *

Analysis.

Analysed by the Hygienic Laboratory of Nagasaki-ken. 1909. Specific gravity: 1,0065 at 15° C.
Temperature: 65° C. Total residue: ca. 8,84.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium chloride (KCl)	0,3985	Calcium sulphate ($CaSO_4$)	0,4699
Sodium chloride (NaCl)	5,4326	Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,0055
Calcium chloride ($CaCl_2$)	1,2578	Silica (SiO_2)	0,2200
Magnesium chloride ($MgCl_2$)	0,9097		8,6940

Besides these trace of ammonia and phosphoric acid.

* The spring is of intermittent nature and sinter cone is being formed around its jet (vide Plate IV, fig. 1).

The spring may be classified as "**earth-muriated common salt spring**".

Radio-activity. **0,36** × 10^{-10} curies in 1 litre of water at 65,0° C.
(Schmidt's electrom.; H. Kibezaki and S. Nishimura, July 22, 1914).
0,10 Mache's units (recalculated).

Table 108.

No.	Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Fukiage-yu (*Public bath*)	earth muriated common salt	65,0°	**0,36**	**0,10**	65,0°	Schm.	July 22, 1914	H. Kibezaki S. Nishimura
2	Gorin-yu („)	—	94,0°	**2,31**	**0,64**	94,0°	„	„ 21, „	„
3	Meiji-yu	—	54,0°	**0,83**	**0,23**	54,0°	„	„	„
4	Karimizu-Kōsen	carbonated	24,0°	**3,29**	**0,90**	24,0°	„	„ 22, „	„

UNZEN

Location.—Obama-mura, Minami-takagi-gun, Province Hizen, Nagasaki-ken.

The springs issue from the Hornblende Andesite.

The hot spring "Enryaku-yu"

Analysis.

Analysed by the Hygienic Laboratory of Nagasaki-ken. 1909.

Specific gravity: 1,0017 at 15° C. Temperature: 65° C.
Total residue: ca. 1,20. Flow of water: ca. 180 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams
Potassium sulphate (K_2SO_4)	0,0172
Sodium sulphate (Na_2SO_4)	0,0613
Calcium sulphate ($CaSO_4$)	0,0656
Magnesium sulphate ($MgSO_4$)	0,0516
Ferrous sulphate ($FeSO_4$)	0,2539
Aluminium sulphate [$Al_2(SO_4)_3$]	0,3986
Free sulphuric acid (H_2SO_4)	1,2887
Silica (SiO_2)	0,2450
	2,3819
Free hydrogen sulphide (H_2S)	0,0035
	2,3854
Free carbon dioxide (CO_2)	not determined

Besides these a very small quantity of free hydrochloric acid and phosphoric acid and trace of ammonia.

The spring may be classified as "**acid hydrogen sulphide vitriol spring**".

Radio-activity. **4,34** × 10^{-10} curies in 1 litre of water at 65,0° C.
(Schmidt's electrom.; H. Kibezaki and S. Nishimura, July 24, 1914).
1,19 Mache's units (recalculated).

The hot spring "Ko-Jigoku"

Analysis.

Analysed by the Hygienic Laboratory of Nagasaki-ken. 1910.

Specific gravity: 1,0007 at 15° C. Temperature: 74° C.
Flow of water: ca. 260 hectolitres in 24 hours. Total residue: 0,37.

In 1 kilogram of the mineral water are contained:

	Grams		Grams
Potassium sulphate (K_2SO_4)	0,0183	Free sulphuric acid (H_2SO_4)	0,0735
Sodium sulphate (Na_2SO_4)	0,0917	Silica (SiO_2)	0,0920
Calcium sulphate ($CaSO_4$)	0,0729		0,3634
Ferric oxide and alumina ($Fe_2O_3+Al_2O_3$)	0,0150		

Besides these a very small quantity of free hydrochloric acid and phosphoric acid, trace of ammonia and magnesium sulphate.

The spring may be classified as "**acid spring**".

Radio-activity. **1,46** $\times 10^{-10}$ curies in 1 litre of water at 74,0° C.
(Schmidt's electrom.; H. Kibezaki and S. Nishimura, July 24, 1914).
0,40 Mache's units (recalculated).

Table 109.

No.	Spring	Classification	Temp. of spring in C.	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Enryaku-yu (*Public bath*)	acid hydrogen sulphide vitriol	65,0°	ca. 180	**4,34**	**1,19**	65,0°	Schm.	July 24, 1914	H. Kibezaki S. Nishimura
2	Shin-yu	acid hydrogen sulphide	38,0°	—	**8,51**	**2,34**	38,0°	"	" 23. "	"
3	Ko-Jigoku	acid	74,0°	260	**1,46**	**0,40**	74,0°	"	" 24, "	"
4	Hiki-yu (*Yūmei-Hotel*)	—	63,0°	—	**2,69**	**0,74**	63,0°	"	" 25, "	"
5	Shin-yu (*Jami-Jigoku*)	acid	56,0°	180	—	—	—	—	—	—
6	" (*Nomi-yu*)	acid hydrogen sulphide	61,0°	180	—	—	—	—	—	—

MICHINO-O

Location.—Nagayo-mura, Nishi-sonogi-gun, Province Hizen, Nagasaki-ken.

The springs issue from the Tertiary Tuff.

The cold spring "Michino-o-Kōsen"

Temperature: 24,0° Flow of water: ca. 108 hectolitres in 24 hours.

No accurate analysis has ever been made, but the spring seems to be "**vitriol spring**."

Radio-activity. **5,50** $\times 10^{-10}$ curies in 1 litre of water at 24,0° C.
(Schmidt's electrom.; H. Kibezaki and S. Nishimura, July 27, 1914).
1,51 Mache's units (recalculated).

TAKEO

Location.—Takeo-machi, Kinoshima-gun, Province Hizen, Saga-ken.

The spring issues from the Mica Andesite.

The hot spring "Takeo-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Temperature: 49° C.
Flow of water: ca. 1512 hectolitres in 24 hours. Total residue: ca. 0,77.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0046	0,1252	0,1252
Sodium ion ($Na^{\cdot}$)	0,2154	9,3466	9,3466
Calcium ion ($Ca^{\cdot\cdot}$)	0,0036	0,0898	0,1796
			9,6514
Anions.			
Chlorine ion (Cl')	0,1040	2,9337	2,9337
Hydrocarbonate ion (HCO_3')	0,4094	6,7104	6,7104
	0,7370	19,2057	9,6441
Silicic acid (meta) (H_2SiO_3)	0,0480		
	0,7850		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0088
Sodium chloride (NaCl)	0,1648
Sodium bicarbonate ($NaHCO_3$)	0,5489
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0145
Silicic acid (meta) (H_2SiO_3)	0,0480
	0,7850

Besides these trace of magnesium and hydrosulphide ion.

The spring thus may be classified as "**simple thermal**".

TOCHINOKI

Location.—Nagakita-mura, Aso-gun, Province Higo, Kumamoto-ken.

The springs issue from the Augite Andesite.

Table 110.

No.		Spring	Classification	Temp. of spring in C.	Emanation per litre of water: in 10^{-10} curies	in Mache's units	at (temp. in C.)	Apparatus employed	Date when the water was taken	Examined by
1	Tochinoki	Tochinoki-Onsen (*Public bath*) *No. 1*	sulphated bitter	45,0°	0,66	0,18	45,0°	Schm.	March 12, 1913	H. Kibezaki
2	Tochinoki	„ *No. 2*	„	39,0°	0,39	0,11	39,0°	„	„	„
3	Yunotani	Yunotani-Onsen (*Public bath*)	carbonated	75,0°	2,39	0,66	75,0°	„	„ 13, „	„
4	Yunotani	Yunotani-Jigoku (*Suzume-Jigoku*)	—	76,0°	1,08	0,30	76,0°	„	„	„
5	Tarutama	Kami-no-yu (*Public bath*)	sulphur	57,0°	3,80	1,05	57,0°	„	„ 14, „	„
6	Tarutama	Shimo-no-yu („)	„	64,0°	0,59	0,16	64,0°	„	„	„
7	Tarutama	Tarutama-Jigoku	—	75,0°	0,36	0,10	75,0°	„	„	„

IWŌDANI

Location.—Makizono-mura, Aira-gun, Province Ōsumi, Kagoshima-ken.

The springs issue from the Volcanic Ash and Mud Lava.

The hot spring "Iwōdani-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881. Temperature: 60,6° C.

Specific gravity: 1,0003 at 27° C. Total residue: ca. 0,47.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0213	0,5441	0,5441
Sodium ion ($Na^{\cdot}$)	0,0483	2,0955	2,0955
Calcium ion ($Ca^{\cdot\cdot}$)	0,0188	0,4688	0,9376
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0050	0,2053	0,4106
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0029	0,0519	0,1038
			4,0916
Anions.			
Chlorine ion (Cl')	0,0223	0,6291	0,6291
Sulphate ion (SO_4'')	0,0499	0,5195	1,0390
Hydrocarbonate ion (HCO_3')	0,1171	1,9195	1,9195
Hydrosulphide ion (HS')	0,0167	0,5040	0,5040
	0,3023	6,9377	4,0916
Silicic acid (meta) (H_2SiO_3)	0,2151		
	0,5174		
Free carbon dioxide (CO_2)	0,0766	1,7418	
Free hydrogen sulphide (H_2S)	0,0522		
	0,6462		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0328
Sodium chloride (NaCl)	0,0110
Potassium sulphate (K_2SO_4)	0,0092
Sodium bicarbonate ($NaHCO_3$)	0,1183
Sodium hydrosulphide (NaHS)	0,0283
Calcium sulphate ($CaSO_4$)	0,0636
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0298
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0094
Silicic acid (meta) (H_2SiO_3)	0,2151
	0,5175
Free carbon dioxide (CO_2)	0,0766
Free hydrogen sulphide (H_2S)	0,0522
	0,6463

The spring thus may be classified as "**hydrogen sulphide spring**".

EINO-O

Location.—Makizono-mura, Aira-gun, Province Ōsumi, Kagoshima-ken.

The springs issue from the Volcanic Ash and Mud Lava.

The hot spring "Eino-o-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1881.

Specific gravity: 1,00048. Temperature: 76,7° C.

Total residue: ca. 1,02. Flow of water: ca. 5400 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0128	0,3270	0,3270
Sodium ion ($Na^{\cdot}$)	0,0871	3,7787	3,7787
Calcium ion ($Ca^{\cdot\cdot}$)	0,0196	0,4888	0,9776
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0070	0,2874	0,5748
Ferrous ion ($Fe^{\cdot\cdot}$)	0,0019	0,0340	0,0680
			5,7261
Anions.			
Chlorine ion (Cl')	0,0290	0,8181	0,8181
Sulphate ion (SO_4'')	0,1178	1,2263	2,4526
Hydrocarbonate ion (HCO_3')	0,0803	1,3164	1,3164
Hydrosulphide ion (HS')	0,0377	1,1390	1,1390
	0,3932	9,4157	5,7261
Silicic acid (meta) (H_2SiO_3)	0,2129		
	0,6061		
Free carbon dioxide (CO_2)	0,1063	2,4152	
Free hydrogen sulphide (H_2S)	0,2374		
	0,9498		

The mineral water corresponds approximately in its composion to a solution containing in 1 kilogram:

	Grams
Sodium chloride (NaCl)	0,0478
Potassium sulphate (K_2SO_4)	0,0285
Sodium sulphate (Na_2SO_4)	0,0816
Sodium bicarbonate ($NaHCO_3$)	0,0573
Sodium hydrosulphide (NaHS)	0,0640
Calcium sulphate ($CaSO_4$)	0,0665
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0417
Ferrous bicarbonate [$Fe(HCO_3)_2$]	0,0060
Silicic acid (meta) (H_2SiO_3)	0,2129
	0,6063
Free carbon dioxide (CO_2)	0,1063
Free hydrogen sulphide (H_2S)	0,2374
	0,9500

The spring thus may be classified as "**hydrogen sulphide spring**".

ON-YŌ

Location.—Jinshū-men, Gazan-gun, Chūsei-nandō, Chōsen.

The springs issue from the Granite.

The hot spring "On-yō-Onsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1906.

Specific gravity: 1,0004 at 15° C. Temperature: 38–42° C.

Total residue: ca. 0,21. Flow of water: ca. 233 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,0051	0,1303	0,1303
Sodium ion ($Na^{\cdot}$)	0,0570	2,4729	2,4729
			2,6032
Anions.			
Chlorine ion (Cl')	0,0182	0,5134	0,5134
Hydrocarbonate ion (HCO_3')	0,1275	2,0898	2,0898
	0,2078	5,2064	2,6032
Silicic acid (meta) (H_2SiO_3)	0,0779		
	0,2857		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Sodium chloride ($NaCl$)	0,0300
Potassium bicarbonate ($KHCO_3$)	0,0130
Sodium bicarbonate ($NaHCO_3$)	0,1648
Silicic acid (meta) (H_2SiO_3)	0,0779
	0,2857

Besides these trace of ferrous and aluminium ion.

The spring thus may be classified as "**simple thermal**".

TŌRAI

Location.—Tōrai-men, Tōrai-gun, Keishō-nandō, Chōsen.

The springs issue from the Granite.

The hot spring "Tōrai-Onsen"

Analysis.

Analysed by the Government Hygienic Laboratory of Chōsen. 1908.

Specific gravity: 1,0012 at 15° C. Temperature: 52° C.

Total residue: ca. 5,50. Flow of water: ca. 907 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

	Grams
Sodium chloride ($NaCl$)	2,961
Potassium carbonate (K_2CO_3)	0,068
Sodium carbonate (Na_2CO_3)	0,186
Calcium sulphate ($CaSO_4$)	0,700
Calcium carbonate ($CaCO_3$)	0,520
Magnesium carbonate ($MgCO_3$)	0,450
Ferrous oxyde and Alumina ($FeO+Al_2O_3$)	0,028
Silica (SiO_2)	0,540
	5,453
Free carbon dioxide (CO_2)	0,066
	5,519

The spring may be classified as "**common salt spring**".

HOKUTŌ

Location.—Hokutō-shō, Shiran-nihō, Daihoku-chō, Taiwan (Formosa).

The springs issue from the Volcanic Rock.

The hot spring "Kaikōsha-Onsen".

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1911.

Specific gravity: 1,0094 at 26° C. Temperature: 51° C.

Flow of water: ca. 1080 hectolitres in 24 hours. Total residue: ca. 0,30.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Potassium ion ($K^{\cdot}$)	0,00355	0,09068	0,09068
Sodium ion ($Na^{\cdot}$)	0,01034	0,44859	0,44859
Ammonium ion ($NH_4^{\cdot}$)	0,01572	0,86891	0,86891
Calcium ion ($Ca^{\cdot\cdot}$)	0,00679	0,16975	0,33950
Magnesium ion ($Mg^{\cdot\cdot}$)	0,00306	0,12562	0,25124
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,01458	0,53801	1,61403
			3,61295
Anions.			
Chlorine ion (Cl')	0,00964	0,27193	0,27193
Sulphate ion (SO_4'')	0,16049	1,67073	3,34146
	0,22417	4,18422	3,61339
Silicic acid (meta) (H_2SiO_3)	0,07582		
	0,29999		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Ammonium chloride (NH_4Cl)	0,01456
Potassium sulphate (K_2SO_4)	0,00790
Sodium sulphate (Na_2SO_4)	0,03188
Ammonium sulphate [$(NH_4)_2SO_4$]	0,03945
Calcium sulphate ($CaSO_4$)	0,02310
Magnesium sulphate ($MgSO_4$)	0,01513
Aluminium sulphate [$Al_2(SO_4)_3$]	0,09210
Silicic acid (meta) (H_2SiO_3)	0,07582
	0,29994

Besides these trace of ferrous and ferric ion and boric acid.

The spring thus may be classified as "**simple thermal**".

The hot spring "Taki-no-yu"

Analysis (calculated from the original numbers).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1911. Specific gravity: 1,0152 at 27° C.

Flow of water: ca. 59530 hectolitres in 24 hours. Temperature: 48,5° C.

In 1 kilogram of the mineral water are contained:

	Grams	Milli-mols	Milligram-equivalents
Cations.			
Hydrogen ion ($H^{\cdot}$)	0,06575	65,09901	**65,09901**
Potassium ion ($K^{\cdot}$)	0,41636	10,63499	10,63499
Sodium ion ($Na^{\cdot}$)	1,12728	48,90586	48,90586
Ammonium ion ($NH_4^{\cdot}$)	0,20867	11,54148	11,54148
Calcium ion ($Ca^{\cdot\cdot}$)	0,12665	3,16375	6,32750
Magnesium ion ($Mg^{\cdot\cdot}$)	0,02686	1,10263	2,20526
Ferrous ion ($Fe^{\cdot\cdot}$)	**0,13791**	2,46268	4,92536
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,15670	5,78229	**17,34687**
			166,98633
Anions.			
Chlorine ion (Cl')	3,76525	106,21298	**106,21298**
Sulphate ion (SO_4'')	2,91844	30,38143	**60,76286**
Hydrophosphate ion (HPO_4'')	0,00102	0,01062	0,02124
	8,95089	285,29772	166,99708
Boric acid (meta) (HBO_2)	0,07805		
Silicic acid (meta) (H_2SiO_3)	0,17904		
	9,20798		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,79337
Sodium chloride ($NaCl$)	1,10772
Ammonium chloride (NH_4Cl)	0,61773
Sodium sulphate (Na_2SO_4)	2,13025
Calcium sulphate ($CaSO_4$)	0,43078
Magnesium sulphate ($MgSO_4$)	0,13277
Ferrous sulphate ($FeSO_4$)	0,37445
Aluminium sulphate [$Al_2(SO_4)_3$]	0,98870
Aluminium phosphate [$Al_2(HPO_4)_3$]	0,00121
Free hydrochloric acid (HCl)	2,37365
Boric acid (meta) (HBO_2)	0,07805
Silicic acid (meta) (H_2SiO_3)	0,17904
	9,20772

Besides these trace of barium, lead and ferric ion.

The spring thus may be classified as "**acid alum vitriol spring**".

SU-Ō

Location.—Su-ō-shō, Ritakukan-hō, Giran-chō, Taiwan (Formosa).

The spring issues from the Clay Slate.

The cold spring "Su-ō-Kōsen"

Analysis (calculated from the salt table).

Analysed by the Tōkyō Imperial Hygienic Laboratory. 1901.

Temperature: 23° C. Total residue: ca. 0,14.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,0006	0,0154	0,0154
Sodium ion ($Na^{\cdot}$)	0,0222	0,9631	0,9631
Calcium ion ($Ca^{\cdot\cdot}$)	0,0148	0,3691	0,7382
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0048	0,1970	0,3940
Aluminium ion ($Al^{\cdot\cdot\cdot}$)	0,0021	0,0775	0,2325
			2,3432
Anions.			
Chlorine ion (Cl')	0,0111	0,3131	0,3131
Hydrocarbonate ion (HCO_3')	0,1242	2,0357	2,0357
	0,1798	3,9709	2,3488
Silicic acid (meta) (H_2SiO_3)	0,0356		
	0,2154		
Free carbon dioxide (CO_2)	**1,5682**	35,6409	
	1,7836		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,0012
Sodium chloride (NaCl)	0,0039
Sodium bicarbonate ($NaHCO_3$)	0,0756
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0599
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0290
Aluminium chloride ($AlCl_3$)	0,0102
Silicic acid (meta) (H_2SiO_3)	0,0356
	0,2154
Free carbon dioxide (CO_2)	1,5682
	1,7836

Besides these trace of ferrous and hydrophosphate ion.

The spring thus may be classified as "**simple carbondioxated spring**".

KWANSHIREI

Location.—Kwanshirei-shō, Tarakaku-tōkahō, Kagi-chō, Taiwan (Formosa).

The springs issue from the Tertiary.

The hot spring "Kwanshirei-Onsen" No. 1

Analysis (calculated from the salt table).

Analysed by the Central Government Laboratory of Taiwan. 1912.

Specific gravity: 1,0090 at 22 C. Temperature: 80° C.

Flow of water: ca. 260 hectolitres in 24 hours.

In 1 kilogram of the mineral water are contained:

Cations.	Grams	Milli-mols	Milligram-equivalents
Potassium ion ($K^{\cdot}$)	0,1865	4,7637	4,7637
Sodium ion ($Na^{\cdot}$)	2,6982	117,0586	**117,0586**
Calcium ion ($Ca^{\cdot\cdot}$)	0,0080	0,1995	0,3990
Magnesium ion ($Mg^{\cdot\cdot}$)	0,0071	0,2915	0,5830
			122,8043
Anions.			
Chlorine ion (Cl')	2,7000	76,1636	**76,1636**
Bromine ion (Br')	0,0171	0,2139	0,2139
Iodine ion (I')	0,0123	0,0969	0,0969
Sulphate ion (SO_4'')	0,0210	0,2186	0,4372
Hydrocarbonate ion (HCO_3')	2,8028	45,9400	**45,9400**
	8,4530	244,9463	122,8516
Silicic acid (meta) (H_2SiO_3)	0,0130		
Organic substances	0,0506		
	8,5166		

The mineral water corresponds approximately in its composition to a solution containing in 1 kilogram:

	Grams
Potassium chloride (KCl)	0,3553
Sodium chloride (NaCl)	4,1769
Sodium bromide (NaBr)	0,0220
Sodium iodide (NaI)	0,0145
Sodium sulphate (Na_2SO_4)	0,0311
Sodium bicarbonate ($NaHCO_3$)	3,7783
Calcium bicarbonate [$Ca(HCO_3)_2$]	0,0324
Magnesium bicarbonate [$Mg(HCO_3)_2$]	0,0425
Silicic acid (meta) (H_2SiO_3)	0,0130
Organic substances	0,0506
	8,5166

Besides these trace of ferrous and hydrophosphate ion.

The spring thus may be classified as "**alkaline common salt spring**".

PART II (B)

(II) The Tables of Mineral Springs arranged according to:

I. Radio-activity.
II. Temperature.
III. Flow of Water.
IV. The Quantity of Solid Ingredients.

(III) A. The Tables of Hot Spring Spas arranged according to:

I. Altitude.
II. The Number of Visitors.

B. The Tables of Summer Resorts and Watering Places arranged geographically.

I. Radio-activity.

The sample of water for examination was generally taken directly from the source of each spring.

Radio-activity of the water marked with Asterisk (*) was determined with the sample brought to the laboratory by applicant, taking into account decay of radium emanation with the time.

Table 1.

The quantity of radium emanation was determined from the diminution in the charge after the maximum current had been reached, by employing Schmidt's electrometer standardized with a normal solution of radium.

For recalculation of Mache's unit from the international unit following factor was used:

1×10^{-10} curie=0,275 Mache's units.

(A) Hot Springs.

No.	Emanation per litre of water		Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
	in 10^{-10} curies	in Mache's units (recalculated)	ca.						
1	516,87	*142,14*	—	71,0°	—	Misasa	三　朝(鳥取)	Granite	Private bath (*T. Matsubara*)
2	371,83	*102,25*	—	51,0°	—	„	„	„	Seitō-kwan-no-yu
3	109,51	*30,12*	126	44,0°	sulphur	Sekigane	關　金(„)	„	Shimo-jyaya-no-yu
4	94,03	*25,85*	1800	39,0°	simple	Tochiomata	栃尾又(新潟)	„	Tochiomata-no-yu *No. 1*
5	43,21	*11,88*	—	40,0°	salt	Kawatana	川　棚(山口)	„	Seiryū-sen
6	37,19	*10,23*	—	45,0°	—	Misasa	三　朝(鳥取)	„	Kabu-yu
7	36,19	*9,95*	—	41,0°	salt	Kawatana	川　棚(山口)	„	Juei-sen
8	31,18	*8,57*	—	56,0°	muriated saline bitter	Kachimi	勝　見(鳥取)	„	Nakataya-no-yu
9	30,57	*8,41*	—	60,3°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	Tertiary	Gosho-no-yu *Vent No. 2*
10	25,21	*6,93*	—	93,0°	„	Wakura	和　倉(石川)	„	Wakazaki-no-yu *No. 1*
11	18,00	*4,95*	544	46,0°	sulphated common salt	Yunotsu	溫泉津(島根)	„	Shin-yu
12	16,07	*4,42*	—	46,0°	simple	Dōgo	道　後(愛媛)	Granite	Yōjō-yu
13	15,13	*4,16*	504	·72,0°	salt	Takase	高　瀬(新潟)	Alluvium	Takase-no-yu
14	14,78	*4,07*	—	44,0°	sulphur	Musashi	武　藏(福岡)	Granite	Yakushi-no-yu *No. 2*
15	14,47	*3,98*	—	47,0°	simple	Dōgo	道　後(愛媛)	„	Kami-no-yu
16	13,65	*3,75*	540	38,2°	iron carbonate common salt	Koyabara	小屋原(島根)	Andesite	Koyabara-Onsen
17	13,60	*3,74*	3888	43,0°	simple	Yumura (Shimane-ken)	湯　村(„)	Granite	Shitsuni-no-yu
18	13,58	*3,74*	216	59,5°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	Tertiary	Yanagi-no-yu
19	13,46	*3,70*	315	46,0°	sulphur	Musashi	武　藏(福岡)	Granite	Enju-no-yu
20	12,77	*3,51*	—	56,5°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	Tertiary	Gosho-no-yu *Vent No. 1*
21	12,09	*3,33*	830	39,5°	carbonated	Deyu	出　湯(新潟)	Granite	Chōsenkutsu-no-yu
22	11,91	*3,28*	36	47,5°	muriated saline bitter	Yoshikata	吉　方(鳥取)	Alluvium	Tottori-Onsen
23	11,67	*3,21*	207	44,5°	sulphur	Musashi	武　藏(福岡)	Granite	Osakaya-no-yu
24	11,27	*3,10*	65	50,0°	salt	Yuzawa [Onnagawa]	湯澤[女川](新潟)	Alluvium	Moto-yu
25	11,25	*3,09*	—	57,0°	simple	O-yu (Niigata-ken)	大　湯(„)	Granite	Ō-yu (*Otoko-yu*)
26	11,17	*3,07*	1730	50,0°	„	Tōgō	東　郷(鳥取)	Andesite	Yōjo-kwan-no-yu *No. 1*
27	11,08	*3,05*	—	47,0°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	Tertiary	Mandara-no-yu *Vent No. 2*
28	10,79	*2,97*	1953	64,0°	common salt	Tamatsukuri (shimane-ken)	玉　造(島根)	„	Kami-no-yu
29	10,33	*2,81*	2592	56,5°	simple	Yoshioka	吉　岡(鳥取)	„	Kabu-yu
30	10,08	*2,77*	—	59,5°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	„	Ichi-no-yu *Vent No. 2*
31	9,91	*2,73*	—	43,0°	—	Hirose (Shimane-ken)	廣　瀬(島根)	„	Sagi-no-yu
32	9,91	*2,73*	—	50,5°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	„	Ichi-no-yu *Vent No. 1*
33	9,72	*2,67*	—	45,0°	salt	Yuda	湯　田(山口)	Alluvium	Nagamune-no-yu
34	9,60	*2,61*	—	41,0°	„	„	„	„	Matsudaya-no-yu
35	9,37	*2,58*	204	57,0°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	Tertiary	Kō-no-yu
36	8,51	*2,31*	—	38,0°	acid hydrogen sulphide	Unzen	溫　泉(長崎)	Andesite	Shin-yu

No.	Emanation per litre of water in 10^{-10} curies	Emanation per litre of water in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres ca.	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
37	7,64	2,10	—	73.5°	earth-muriated common salt	Wakura	和　倉(石川)	Tertiary	Sō-yu
38	* 7,48	2,06	—	—	simple	Kashi	甲　子(福島)	Granite	Kashi-Onsen
39	7,29	2,00	—	41,0°	sulphur	Musashi	武　藏(福岡)	"	Yakushi-no-yu *No. 1*
40	6,55	1,81	900	45,0°	alkaline sulphur	Katsu-ura	勝　浦(和歌山)	Tertiary	Akashima-Onsen
41	6,21	1,71	—	42,0°	alkaline	Tawarayama	俵　山(山口)	Mesoz. Conglom.	Kawa-no-yu
42	* 6,15	1,69	270	40,0°	simple	Kizu	木　津(京都)	Tertiary	Iwatsubo-no-yu
43	6,15	1,69	1800	45,2°	sulphated bitter sulphur	Yamanaka	山　中(石川)	"	Yamanaka-Onsen (*Sō-yu*)
44	* 5,93	1,63	—	59.5°	sulphur	Nakabusa	中　房(長野)	Granite	Shirataki-no-yu
45	5,21	1,43	207	48,5°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	Tertiary	Jizō-no-yu
46	5,17	1,42	—	58,0°	"	"	"	"	Mandara-no-yu *Vent No. 1*
47	* 4,82	1,33	346	49,0°	sulphated common salt	Ōmaki	大　牧(富山)	Porphyr. Dyke	Omaki-Onsen
48	4,65	1,28	—	79,0°	common salt	Katayamazu	片山津(石川)	Tertiary	Shiotsu-no-Tsubo
49	4,34	1,99	185	65,0°	acid hydrogen sulphide vitriol	Unzen	溫　泉(長崎)	Andesite	Enryaku yu
50	* 4,04	1,11	—	—	sulphated common salt	Atsumi	溫　海(山形)	Tertiary	Yuatsumi-no-yu
51	3,89	1,05	—	57,0°	sulphur	Tarutama	垂　玉(熊本)	Andesite	Kami-no-yu
52	3,59	0,99	—	40,0°	alkaline	Tawarayama	俵　山(山口)	Mesoz. Conglom.	Kagi-yu
53	3,54	0,97	2700	54,3°	sulphur	Awazu	粟　津(石川)	Liparite	Awazu-Onsen (*Sō-yu*)
54	3,11	0,86	360	50,0°	saline bitter	Yujiku	湯　宿(群馬)	Tertiary	O-daki
55	3,09	0,85	900	38,5°	sulphur	Katsu-ura	勝　浦(和歌山)	"	Soto-no-yu
56	3,09	0,85	900	90,5°	alkaline carbondioxated	Yumura (Hyōgo-ken)	湯　村(兵庫)	Granite	Kabu-yu
57	3,06	0,84	1296	38,0°	earth-muriated common salt	Yunogō	湯　鄕(岡山)	Liparite	Sagi-no-yu
58	3,03	0,83	—	45,0°	salt	Yuzawa [Uo-numa]	湯　澤[魚沼](新潟)	Misaka Series	Moto-yu
59	2,90	0,89	90	47,0°	saline bitter	Yujiku	湯　宿(群馬)	Tertiary	Ko-daki
60	2,69	0,74	—	63,0°	—	Unzen	溫　泉(長崎)	Andesite	Hiki-yu (*Yumei-Hotel*)
61	2,56	0,70	648	79,0°	saline bitter	Yujiku	湯　宿(群馬)	Tertiary	Kubo-yu
62	2,51	0,69	—	71,0°	saline bitter sulphur	Yamashiro	山　代(石川)	"	Araya-no-yu
63	2,39	0,66	—	75,0°	carbonated	Yunotani	湯ノ谷(熊本)	Andesite	Yunotani-Onsen
64	2,31	0,64	—	94,0°	—	Obama	小　濱(長崎)	"	Gorin-yu
65	2,30	0,63	—	67,0°	saline bitter	Yujiku	湯　宿(群馬)	Tertiary	Sen-tō
66	1,50	0,41	—	37,2°	"	"	"	"	Kawaburi-yu
67	1,48	0,41	2142	69,0°	saline bitter sulphur	Yamashiro	山　代(石川)	"	Yamashiro-Onsen (*Sō-yu*)
68	1,46	0,40	260	74,0°	acid	Unzen	溫　泉(長崎)	Andesite	Ko-Jigoku
69	1,19	0,33	441	41.5°	bitter	Ushio	海　潮(島根)	"	Ushio-no-yu
70	1,08	0,30	—	76,0°	—	Yunotani	湯ノ谷(熊本)	"	Yunotani-Jigoku
71	0,92	0,25	—	51.5°	common salt	Arima	有　馬(兵庫)	Quartz Porph.	Arima-Onsen
72	0,83	0,23	—	54,0°	—	Obama	小　濱(長崎)	Andesite	Meiji-yu
73	0,80	0,22	—	48,0°	simple	Arifuku	有　福(島根)	Diorite	Arifuku-Onsen *Vent No. 1*
74	0.75	0,21	—	55,0°	carbonated common salt	Beppu	別　府(大分)	Andesite	Kojimaya-no-yu *No. 1*
75	0,66	0,18	—	45,0°	sulphated bitter	Tochinoki	栃　木(熊本)	"	Tochinoki-Onsen *No. 1*
76	0,66	0,18	648	57,5°	iron carbonate	Beppu	別　府(大分)	"	Furō-sen
77	0,59	0,16	—	64,0°	sulphur	Tarutama	垂　玉(熊本)	"	Shimo-no-yu
78	0,53	0,11	87	49.0°	muriated alkaline carbondioxated	Sedo-no-kanayama	瀬戸鉛山(和歌山)	Tertiary	Moto-no-yu
79	0,52	0,14	—	54,0°	carbonated common salt	Beppu	別　府(大分)	Andesite	Kojimaya-no-yu *No. 2*
80	0,49	0,14	260	42,0°	muriated alkaline carbondioxated	Sedo-no-kanayama	瀬戸鉛山(和歌山)	Tertiary	Yagata-yu
81	* 0,49	0,14	—	—	—	Yugano	湯ケ野(靜岡)	Andesite	Spring *B*
82	* 0,48	0,13	—	—	—	"	"	"	" *A*
83	0,45	0,12	—	40,0°	alkaline	Fukawa	深　川(山口)	Liparite	Yumoto-Onsen (*On-tō*)
84	0,43	0,12	156	52,0°	muriated alkaline carbondioxated	Sedo-no-kanayama	瀬戸鉛山(和歌山)	Tertiary	Hama-no-yu
85	0,40	0,11	—	42,0°	alkaline	Fukawa	深　川(山口)	Liparite	Yumoto-Onsen (*Kei-tō*)
86	0,40	0,11	236	52,0°	earthy alkaline	Shirahone	白　骨(長野)	Chichibu Series	Ō-yu
87	0,39	0,11	—	57,0°	carbonated common salt	Beppu	別　府(大分)	Andesite	Shiokyū-no-yu
88	0,39	0,11	—	39,0°	sulphated bitter	Tochinoki	栃　木(熊本)	"	Tochinoki-Onsen *No. 2*
89	0,36	0,10	—	65,0°	earth-muriated common salt	Obama	小　濱(長崎)	"	Fukiage-yu
90	0,36	0,10	—	75,0°	—	Tarutama	垂　玉(熊本)	"	Tarutama-Jigoku

No.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地 名(府縣名)	Geology	Spring
91	0,36	*0,10*	ca. 260	60,0°	muriated alkaline carbondioxated	Sedo-no-kanayama	瀬戸鉛山(和歌山)	Tertiary	Saki-no-yu
92	0,22	*0,06*	9000	102,0°	common salt	Senami	瀬 波(新潟)	—	Senami-Funtō
93	0,20	*0,05*	—	51,0°	carbonated	Beppu	別 府(大分)	Andesite	Seisenkaku-no-yu
94	* 0,13	*0,04*	—	—	—	Yugano	湯ヶ野(靜岡)	,,	Spring *C*
95	0,07	*0,02*	216	57,0°	iron carbonate	Kwankaiji	観海寺(大分)	,,	Kwankaiji-Onsen
	Emanation per litre of gas at 0° C.								Gas evolving from:
1	339,32	*93,31*	—	93,0°	earth-muriated common salt	Wakura	和 倉(石川)	Tertiary	Wakazaki-no-yu *No. 1*
2	228,19	*62,75*	—	45,0°	—	Misasa	三 朝(鳥取)	Granite	Kabu-yu
3	197,62	*54,35*	—	56,0°	muriated saline bitter	Kachimi	勝 見(,,)	,,	Nakataya-no-yu
4	128,04	*35,21*	—	—	—	Tamatsukuri (Shimane-ken)	玉 造(島根)	Tertiary	River bed *A*
5	† 118,33	*32,54*	—	44,5°	sulphur	Musashi	武 藏(福岡)	Granite	Ōsakaya-no-yu
6	101,79	*27,99*	—	64,0°	common salt	Tamatsukuri (Shimane-ken)	玉 造(島根)	Tertiary	Kami-no-yu
7	99,13	*27,26*	—	56,5°	simple	Yoshioka	吉 岡(鳥取)	,,	Kabu-yu
8	87,91	*24,18*	—	79,0°	common salt	Katayamazu	片山津(石川)	,,	Shiotsu no-Tsubo
9	† 85,02	*23,38*	—	47,0°	simple	Dōgo	道 後(愛媛)	Granite	Kami-no-yu
10	84,30	*23,18*	—	43,0°	,,	Yumura (Shimane-ken)	湯 村(島根)	,,	Shitsuni-no-yu
11	33,36	*9,18*	—	67,0°	saline bitter	Yujiku	湯 宿(群馬)	Tertiary	Sen-tō
12	30,69	*8,44*	—	71,0°	saline bitter sulphur	Yamashiro	山 代(石川)	,,	Araya-no-yu
13	29,53	*8,12*	—	38,2°	iron carbonate common salt	Koyabara	小屋原(島根)	Andesite	Koyabara-Onsen
14	19,50	*5,35*	—	38,0°	earth-muriated common salt	Yunogō	湯 郷(岡山)	Liparite	Sagi-no-yu
15	9,03	*2,48*	—	41,5°	bitter	Ushio	海 潮(島根)	Andesite	Ushio-no-yu
16	4,92	*1,35*	—	46,0°	sulphated common salt	Yunotsu	溫泉津(,,)	Tertiary	Shin-yu

† Radio-activity of the gas was determined at a temperature lower than 30° C., but the correction of the volume due to temperature was not made.

(B) Cold Springs.

No.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C. (air temp.)	Classification	Location	地 名(府縣名)	Geology	Spring
1	3012,14	*828,31*	ca 22	21,5° (23,5°)	earthy common salt	Masutomi	増 富(山梨)	Granite	Kamigawara *No. 1*
2	2390,02	*657,26*	—	14,0°	,,	,,	,,	,,	,, *No. 2*
3	2147,05	*590,44*	40	16,0° (7°)	common salt	,,	,,	,,	Kuridaira *No. 1*
4	1433,17	*394,12*	77	23,5° (4,5°)	earthy common salt	,,	,,	,,	Nibuzawa *No. 1*
5	1157,29	*318,25*	100	20,0° (4°)	common salt	,,	,,	,,	Kuridaira *No. 1 Vent A*
6	1042,17	*286,60*	13	20,0° (10,5°)	—	,,	,,	,,	,, *No. 3*
7	1022,15	*281,09*	—	10,0° (13°)	simple	Takayama	高 山(岐阜)	,,	Ena-Kōsen (*Yunoshima*)
8	1008,76	*277,41*	—	19,0° (14,5°)	—	Masutomi	増 富(山梨)	,,	Oshiba *No. 1*
9	900,12	*247,53*	—	17,0°	—	,,	,,	,,	Yunokubo *No. 1*
10	883,39	*243,82*	—	15,0° (10,5°)	earthy common salt	,,	,,	,,	Yunokubogawara-no-yu
11	856,83	*235,63*	45	17,5° (7°)	,,	,,	,,	,,	Tsugane-yu *No. 1* (*A*)
12	682,67	*187,74*	—	17,0° (12°)	carbonated (?)	Ikeda	池 田(島根)	,,	Nobata shin-yu
13	372,63	*102,47*	—	29,5° (7°)	—	Masutomi	増 富(山梨)	,,	Ginsen-tō
14	220,64	*60,68*	—	12,0° (20°)	simple	Hirukawa	蛭 川(岐阜)	,,	Ena-Kōsen *Dairi-Yakushi*
15	213,21	*58,63*	—	13,0° (19°)	,,	Takayama	高 山(,,)	,,	,, (*Shimizu-ido*)
16	180,41	*49,61*	530	25,6° (30°)	,,	Murasugi	村 杉(新潟)	,,	Murasugi-Kōsen *No. 1*

No.	Emanation per litre of water in 10^{-10} curies	Emanation per litre of water in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名（府縣名）	Geology	Spring
			ca.	air temp.					
17	176,61	*48,57*	—	26,0° (31,5°)	simple	Murasugi	村　杉(新潟)	Granite	Murasugi-Kōsen *No. 2*
18	161,74	*44.48*	236	36,0° (27,5°)	„	Tochiomata	栃尾又(　„　)	„	Jizai-kwan-uchiyu *No. 1*
19	107,67	*29,61*	—	28,3°	—	Arima	有　馬(兵庫)	Quartz Porph.	Zuihōji-Onsen
20	60,15	*16,54*	—	15,0°	simple	Koshiki-iwa-shinden	越木岩新田(„)	Granite	Kuraku-en-Kōsen *No. 10*
21	58,33	*16,04*	—	14,0°	„	„	„	„	Sarumaru-ishiyama *No. 3*
22	56,80	*15,62*	—	14,5°	„	„	„	„	„ *No. 1*
23	51,46	*14,15*	—	12,0°	„	„	„	„	„ *No. 2*
24	48,66	*13,38*	—	14,5° (9,2°)	„	Kaidani	栢　谷(岡山)	„	Tomada-no-yu
25	44,29	*12,18*	—	14,5°	„	Koshiki-iwa-shinden	越木岩新田(兵庫)	„	Sarumaru-ishiyama *No. 5*
26	43,48	*11.96*	130	14,0° (17°)	sulphur	Bobata	母　畑(福島)	Gneiss	Kami-no-moto-yu
27	35,71	*9,82*	—	14,0°	simple	Koshiki-iwa-shinden	越木岩新田(兵庫)	Granite	Sarumaru-ishiyama *No. 6*
28	34,51	*9,49*	—	19,0°	„	„	„	„	Kuraku-en-Kōsen *No. 1*
29	33,67	*9,26*	—	11,0°	„	„	„	„	„ *No. 11*
30	31,02	*8,53*	—	16,8° (13,5°)	„	„	„	„	„ *No. 6*
31	30,07	*8,27*	—	19,0°	—	Arima	有　馬(„)	Quartz Porph.	Maruyama-Kōsen
32	26,22	*7,21*	—	18,0°	simple	Koshiki-iwa-shinden	越木岩新田(„)	Granite	Kuraku-en-Kōsen *No. 3*
33	25,87	*7,11*	66	24,5° (9°)	earthy common salt	Masutomi	増　富(山梨)	„	Tochikubo *No. 1*
34	24,04	*6,61*	—	29,0°	—	Dōgo	道　後(愛媛)	„	Shin-Onsen
35	22,22	*6,11*	—	14,0°	simple	Koshiki-iwa-shinden	越木岩新田(兵庫)	„	Sarumaru-ishiyama *No. 4*
36	22,04	*6.06*	—	18,0°	„	„	„	„	Kuraku-en-Kōsen *No. 2*
37	21,47	*5,91*	22	—	„	Nekonaki	猫　啼(福島)	Gneiss	Nekonaki-no-yu
38	21,31	*5,86*	—	24,0°	„	Okoto	雄　琴(滋賀)	Alluvium	Spring *B* (*S. Imai*)
39	* 20,84	*5,73*	—	—	„	Ōno	大　野(„)	Diluvium	Spring *A* (*I. Kishimoto*)
40	20,80	*5,72*	—	12,0°	„	Koshiki-iwa-shinden	越木岩新田(兵庫)	Granite	Kuraku-en-Kōsen *No. 12*
41	19,91	*5.47*	—	19,5°	muriated sulphur	Takedao	武田尾(„)	Quartz Porph.	Yu-moto
42	19,02	*5,23*	—	17,0°	simple	Koshiki-iwa-shinden	越木岩新田(„)	Granite	Kuraku-en-Kōsen *No. 8*
43	* 18,85	*5,18*	—	—	carbonated	Ōkuwa	大　桑(長野)	„	Shika-no-yu
44	18,80	*5,17*	—	18,0° (13,5°)	simple	Koshiki-iwa-shinden	越木岩新田(兵庫)	„	Kuraku-en-Kōsen *No. 7*
45	* 18,73	*5,15*	—	—	„	Nishino	西　野(„)	Tertiary	Spring *B* (*K. Miyazaki*)
46	17,93	*4.93*	—	15,0°	„	Koshiki-iwa-shinden	越木岩新田(„)	Granite	Kuraku-en-Kōsen *No. 9*
47	17,66	*4,85*	390	28,0° (16°)	„	Takebe	建　部(岡山)	„	Yawata-Onsen
48	16,15	*4,44*	—	14,5°	„	Koshiki-iwa-shinden	越木岩新田(兵庫)	„	Kuraku-en-Kōsen *No. 13*
49	15,42	*4,24*	90	32,0° (11°)	alkaline common salt	Yudani	湯　谷(鳥取)	Tertiary	Kabu-yu
50	14,73	*4.05*	—	15,0° (13,5°)	simple	Koshiki-iwa-shinden	越木岩新田(兵庫)	Granite	Kuraku-en-Kōsen *No. 5*
51	13,93	*3,83*	—	18 0°	„	„	„	„	„ *No. 14*
52	13,56	*3,73*	—	17,5°	earthy iron carbondioxated common salt	Ōdake	大　岳(„)	Quartz Porph.	Ōdake-Kōsen
53	12,84	*3,53*	—	18,5°	simple	Koshiki-iwa-shinden	越木岩新田(„)	Granite	Kuraku-en Kōsen *No. 4*
54	12,05	*3,31*	285	27,0°	„	Bobata	母　畑(福島)	Gneiss	Shimo-no-yu *No. 1*
55	12,03	*3,31*	—	18,5°	simple carbondioxated	Takarazuka	寶　塚(兵庫)	Granite	Takarazuka-Tansan-sui
56	* 11,45	*3,14*	—	—	simple	Koto-ura	琴　浦(岡山)	„	Spring *C* (*K. Miki*)
57	11,41	*3,14*	—	—	—	Bobata	母　畑(福島)	Gneiss	Kami-no-shin-yu
58	* 11,38	*3,13*	—	—	simple	Nishinomiya	西ノ宮(兵庫)	Granite	Kōro-en-Kōsen
59	11,34	*3,12*	—	23,5°	muriated sulphur	Takedao	武田尾(„)	Quartz Porph.	Moto-no-yu
60	* 10,75	*2,96*	—	18,3°	—	Hōkaizawa	法界澤(青森)	Tertiary	Natsumazawa-Kōsen
61	10,36	*2,85*	—	27,0°	—	Katsu-ura	勝　浦(和歌山)	„	Nakanoshima-Onsen
62	* 9,64	*2,65*	—	—	simple	Nishino	西　野(兵庫)	„	Spring *A* (*K. Miyazaki*)
63	9,42	*2,59*	—	12,0°	„	Koshiki-iwa-shinden	越木岩新田(„)	Granite	Myōbandani-ue *No. 2*
64	8,85	*2,43*	—	23,0°	—	Dōgo	道　後(愛媛)	„	Well (*Funaya*)
65	8,58	*2,36*	—	—	simple	Bobata	母　畑(福島)	Gneiss	Naka-no-yu *No. 1*
66	* 8,39	*2,31*	—	—	carbonated	Sawaguchi	澤　口(秋田)	Diluvium	Ojigasawa-Kōsen *No. 3*
67	* 8,26	*2,27*	—	—	—	Koto-ura	琴　浦(岡山)	Granite	Spring *D* (*K. Miki*)
68	7,58	*2,08*	362	31,5° (5,5°)	—	Masutomi	増　富(山梨)	„	Kinsen-tō
69	7,42	*2,04*	15	26,0° (17°)	—	„	„	„	Kuridaira *No. 2* (*A*)

No.		Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地 名(府縣名)	Geology	Spring
				ca.	air temp.					
70		7,35	2,02	—	—	vitriol	Koshiki-iwa-shinden	越木岩新田(兵庫)	Granite	Myōbandani *No. 1*
71		6,79	1,87	41	20,0° (9,5°)	—	Masutomi	増 富(山梨)	,,	Kuridaira *No. 2 (D)*
72	*	6,78	1,87	—	—	—	Koto-ura	琴 浦(岡山)	,,	Spring *B (M. Miki)*
73	*	6,73	1,85	—	—	earthy common salt	Hoshio	星 尾(群馬)	Chichibu Series	Shiomizu-Kōsen
74		6,34	1,75	—	17,0°	simple carbon-dioxated	Arima	有 馬(兵庫)	Quartz Porph.	Arima-Tansan-sen *(Teppōsui)*
75	*	5,81	1,60	—	13,9°	simple	Toyohira	豐 平(長野)	Andesite	Karasawa-Kōsen *A*
76		5,76	1,58	—	17,0° (6°)	—	Masutomi	増 富(山梨)	Granite	Yunosawa *No. 1*
77		5,50	1,51	108	24,0°	vitriol	Michi-no-o	道之尾(長崎)	Tertiary	Michi-no-o-Kōsen
78		5,31	1,46	—	22,0°	—	Yukawa	湯 川(和歌山)	Misaka Series	Ōhata-no-yu
79		5,17	1,42	—	35,5°	salt	Yumura (Yamanashi-ken)	湯 村(山梨)	Alluvium	Tani-Onsen
80		5,10	1,40	—	—	—	Tōkyō—Shitaya-ku	下 谷(東京)	Diluvium	Well *(G. Suzuki)*
81		4,81	1,32	—	17,0°	common salt	Tomoe	巴 (茨城)	,,	Tomoe-Kōsen *No. 2*
82		4,75	1,31	—	18,5°	—	Daishi-gawara	大師河原(神奈川)	Alluvium	Well *(T. Mizuno)*
83		4,72	1,30	270	16,9°	common salt	Tomoe	巴 (茨城)	Diluvium	Tomoe-Kōsen *No. 1*
84		4,36	1,20	—	—	vitriol	Koshiki-iwa-shinden	越木岩新田(兵庫)	Granite	Myōbandani *No. 2*
85		4,22	1,16	—	14,5°	—	Honjō	本 庄(〃)	Alluvium	Fukae-Kōsen
86	*	4,12	1,13	—	—	earthy common salt	Atsushio	熱 鹽(福島)	,,	Atsushio-Kōsen *No. 1*
87		3,90	1,07	—	—	—	Dōgo	道 後(愛媛)	Granite	Tama-no-i
88		3,78	1,04	—	9,0°	—	Isobe (Gumma-ken)	磯 部(群馬)	Tertiary	Ji-no-yu
89	*	3,73	1,03	—	—	—	Shirakawa	白 河(福島)	Alluvium	Emmyōji Kōsen
90		3,43	0,94	63	17,5°	simple carbon-dioxated	Funagoya	船小屋(福岡)	Diluvium	Funagoya-Onsen
91		3,29	0,90	—	24,0°	carbonated	Obama	小 濱(長崎)	Andesite	Karimizu-Kōsen
92		3,23	0,89	—	—	—	Ōi	大 井(東京)	Diluvium	Well *(G. Aoshi)*
93		3,21	0,88	—	13,0°	simple	Nekonaki	猫 啼(福島)	Gneiss	Tomaki-no-yu
94	*	3,20	0,88	—	—	earthy sulphated common salt	Natsu-abura	夏 油(岩手)	Liparite	Natsu-abura-Kōsen *A*
95	*	3,14	0,86	—	—	alkaline carbon-dioxated concentrated common salt	Onishi	鬼 石(群馬)	Chrystal.Schist	Yashio-Kōsen *A (T. Urabe)*
96	*	2,91	0,80	—	—	—	Koto-ura	琴 浦(岡山)	Granite	Spring *A (M. Saegi)*
97	*	2,82	0,78	—	—	earthy common salt	Atsushio	熱 鹽(福島)	Alluvium	Atsushio-Kōsen *No. 3*
98	*	2,70	0,74	—	—	—	Ōmi	青 海(新潟)	,,	Taumi-Kōsen
99		2,66	0,73	360	18,5°	carbondioxated common salt	Takarazuka	寶 塚(兵庫)	Granite	Takarazuka-Kōsen
100		2,64	0,73	270	17,5° (15°)	common salt	Shingū	新 宮(石川)	,,	Shingū-Kōsen *No. 1*
101	*	2,51	0,69	—	—	—	Tomoe	巴 (茨城)	Diluvium	Momiji-Kōsen
102	*	2,40	0,66	58	18,0°	carbonated	Notsubaru	野津原(大分)	Volc. Ejectam.	Tsukano-no-yu
103		2,26	0,62	—	17,0°	—	Katsu-ura	勝 浦(和歌山)	Tertiary	Benten-yu
104		2,21	0,61	—	28,5° (10°)	muriated saline bitter	Tera-machi [Tottori]	寺 町(鳥取)	Alluvium	Kasuga-Onsen
105	*	2,10	0,58	—	—	—	Shinagawa	品 川(東京)	Diluvium	Well *(in Ebara Jinja)*
106		2,00	0,55	—	—	—	Tōkyō—Ushigome-ku	牛 込(〃)	,,	,, *(K. Shibata)*
107	*	1,98	0,54	—	—	earthy common salt	Atsushio	熱 鹽(福島)	Alluvium	Atsushio-Kōsen *No. 2*
108	*	1,94	0,53	—	—	—	Hirotsu	廣 津(長野)	Tufec. shale	Hirotsu-Kōsen
109		1,86	0,51	—	17,0°	—	Iriarai	入新井(東京)	Alluvium	Well *(C. Hirabayashi)*
110		1,86	0,51	45	20,5°	vitriol	Rokuyō	鹿野園(奈良)	,,	Nanto-rokuyō-Kōsen
111		1,81	0,50	—	16,0°	—	Tōkyō—Shiba-ku	芝 (東京)	Diluvium	Well *(H. Ebizawa)*
112	*	1,76	0,48	—	—	—	Haneda	羽 田(〃)	Alluvium	Well *(S. Motohashi)*
113		1,70	0,47	—	—	alkaline	Oami (Kanagawa-ken)	大 網(神奈川)	,,	Spring *A (C. Homma)*
114		1,68	0,46	—	—	—	Enoshima	江ノ島(〃)	Tertiary	Well *(Ebisuya)*
115		1,62	0,45	—	17,0°	iron carbonate common salt	Haneda	羽 田(東京)	Alluvium	Anamori-Kōsen *(Izumi-kwan)*
116	*	1,60	0,44	—	—	earthy iron carbonate common salt	Daitō	大 塔(大阪)	Tertiary	Daitō-Kōsen
117		1,56	0,43	—	24,0°	simple	Okoto	雄 琴(滋賀)	Alluvium	Spring *A (S. Imai)*
118		1,55	0,43	—	—	—	Ōsaki	大 崎(東京)	Diluvium	Well *(H. Kamada)*
119	*	1,55	0,43	—	—	earthy sulphated common salt	Natsu-abura	夏 油(岩手)	Liparite	Natsu-abura-Kōsen *B*
120		1,53	0,42	—	—	—	Yokohama—Koyasu	横 濱(神奈川)	Alluvium	Well *(F. Fukamachi)*
121		1,53	0,42	—	13,0°	simple	Koshiki-iwa-shinden	越木岩新田(兵庫)	Granite	Myōbandani-ue *No. 1*

No.	Emanation per litre of water		Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名 府縣名	Geology	Spring
	in 10^{-10} curies	in Mache's units (recalculated)							
			ca.	air temp					
122	* 1,52	0,42	—	—	—	Chōshi	銚　子(千葉)	—	Well (*K. Watanabe*)
123	1,51	0,42	—	—	—	Shinagawa	品　川(東京)	Alluvium	„ (*Y. Sakurai*)
124	* 1,45	0,49	—	—	—	Haneda	羽　田(„)	„	„ (*A. Furutani*)
125	1,45	0,49	63	21,0°	simple carbondioxated	Funagoya	船小屋(福岡)	Diluvium	Nomi-yu
126	* 1,40	0,39	—	—	—	Futagawa	二　川(愛知)	„	Well (*K. Matsushima*)
127	* 1,40	0,39	—	—	earthy carbondioxated	Sawaguchi	澤　口(秋田)	„	Yunotai-Kōsen
128	* 1,39	0,38	—	—	—	Shinagawa	品　川(東京)	„	Well (*S. Ōkubo*)
129	* 1,35	0,37	—	—	—	Tōshimo	東　下(茨城)	Alluvium	„ (*U. Nenaka*)
130	* 1,33	0,37	—	—	carbonated	Sawaguchi	澤　口(秋田)	Diluvium	Ojigasawa-Kōsen *No. 2*
131	* 1,29	0,36	—	—	—	Naguri	名　栗(埼玉)	—	Spring *A*
132	1,27	0,35	—	—	—	Shibuya	澁　谷(東京)	Diluvium	Well (*R. Hata*)
133	* 1,22	0,34	abundant	27,0°	acid hydrogen sulphide	Shibu [Suwa]	澁[諏訪](長野)	Andesite	Shibu-no-yu
134	1,15	0,32	—	16,0°	—	Ikegami	池　上(東京)	Diluvium	Well (*S. Shimizu*)
135	1,10	0,30	—	—	—	Tōkyō—Honjō-ku	本　所(„)	Alluvium	„ (*K. Fujii*)
136	* 1,08	0,30	—	—	—	Nakano	中　野(茨城)	„	„ (*K. Yasu*)
137	* 1,04	0,29	—	—	—	Unakami	海　上(千葉)	—	Kakine-Kōsen
138	* 1,04	0,29	—	14,5°	—	Goka	伍　賀(長野)	Volc. Detr.	Toai-Kōsen *A*
139	* 0,98	0,27	—	12,8°	—	„	„	„	„ *B*
140	* 0,95	0,26	—	10,0°	common salt (?)	Narutō	成　東(千葉)	—	Narutō-Kōsen
141	* 0,94	0,26	—	—	—	Sawaguchi	澤　口(秋田)	Diluvium	Ojigasawa-Kōsen *No. 4*
142	* 0,93	0,26	—	14,0°	—	Uraga	浦　賀(神奈川)	—	Aramaki-Kōsen
143	* 0,89	0,25	—	11,7°	—	Matsu-ida	松井田(群馬)	Tertiary	Spring *A* (*T. Ezaka*)
144	* 0,85	0,23	6480	35,0°	simple	Shimobe	下　部(山梨)	Tert. Shale	Shimobe-Onsen *No. 1*
145	* 0,81	0,22	—	—	—	Tōkyō—Azabu-ku	麻　布(東京)	Diluvium	Well (*T. Yagi*)
146	* 0,79	0,22	—	—	—	Shinagawa	品　川(„)	„	„ (*S. Isoki*)
147	* 0,78	0,22	—	13,0°	—	Hitomi	人　見(群馬)	Volc. Detr.	Spring *A* (*S. Hidaka*)
148	0,77	0,21	864	27,0°	salt	Gakutō	學　頭(島根)	Tertiary	Yunokawa-Kōsen
149	* 0,48	0,13	6480	34,0°	simple	Shimobe	下　部(山梨)	Tert. Shale	Shimobe-Onsen *No. 2*
150	0,47	0,13	720	15,5° (3°)	alkaline carbondioxated concentrated common salt	Isobe (Gumma-ken)	磯　部(群馬)	Tertiary	Isobe-Kōsen
151	* 0,47	0,13	—	20,0° (27°)	—	Taura	田　浦(神奈川)	„	Ura-no-gō-Kōsen
152	* 0,41	0,11	—	—	alkaline common salt	Hirose (Miyagi-ken)	廣　瀬(宮城)	—	Nanatsu-ishi-Kōsen
153	* 0,30	0,08	6480	36,0°	simple	Shimobe	下　部(山梨)	Tert. Shale	Shimobe-Onsen *No. 3*
154	* 0,28	0,08	—	—	—	Mobara	茂　原(千葉)	Diluvium	Well (*K. Inoue*)
155	* 0,27	0,07	—	—	—	Ta-ura	田　浦(神奈川)	Tertiary	Yaochi-Kōsen
156	* 0,25	0,07	—	—	—	Tōkyō—Asakusa-ku	淺　草(東京)	Alluvium	Well (*K. Izumigawa*)
157	* 0,22	0,06	—	32,0°	alkaline	Higashi-nagakura	東長倉(長野)	Volc. Detr.	Aka-iwa-Kōsen
	Emanation per litre of gas at 0° C.								Gas evolving from :
1	5506,30	1514,23	—	16,0° (7°)	common salt	Masutomi	増　富(山梨)	Granite	Kuridaira *No. 1*
2	2037,42	560,29	—	14,0°	earthy common salt	„	„	„	Kamigawara *No. 2*
3	1871,31	514,61	—	15,0° (10,5°)	„	„	„	„	Yunokubo-gawara-no-yu
4	1307,21	359,48	—	17,0° (12°)	carbonated (?)	Ikeda	池　田(島根)	„	Nobata-shin-yu
5	86,54	23,80	—	32,0° (11°)	alkaline common salt	Yudani	湯　谷(鳥取)	Tertiary	Kabu-yu
6	86,41	23,76	—	24,5° (9°)	earthy common salt	Masutomi	増　富(山梨)	Granite	Tochikubo *No. 1*
7	† 35,02	9,63	—	—	carbonated (?)	Kawakami	川　上(大阪)	„	Spring *A* (*K. Fujiki*)
8	† 9,38	2,58	—	—	simple carbondioxated	Yokoyama	横　山(„)	Tertiary	Yokoyama-Kōsen
9	8,76	2,41	—	28,5° (16°)	muriated saline bitter	Tera-machi [Tottori]	寺　町(鳥取)	Alluvium	Kasuga-Onsen
10	7,42	2,04	—	9,0°	—	Isobe (Gumma-ken)	磯　部(群馬)	Tertiary	Ji-no-yu
11	† 7,16	1,97	—	—	carbondioxated common salt	Takarazuka	寶　塚(兵庫)	Granite	Takarazuka-Kōsen
12	1,41	0,39	—	15,5° (3°)	alkaline carbondioxated concentrated common salt	Isobe (Gumma-ken)	磯　部(群馬)	Tertiary	Isobe-Kōsen

† Radio-activity of the gas was determined at a temperature lower than 30° C., but the correction of the volume due to temperature was not made.

Table 2.

The determination of radium emanation was carried on with the fontactoscope of C. Engler and H. Sieveking modified by Kohlrausch and Löwenthal exactly according to the authors' original instructions.

(A) Hot Springs.

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地名(府縣名)	Geology	Spring
1	**121,99**	ca. —	71,0°	—	Misasa	三朝(鳥取)	Granite	Private bath (*T. Matsubara*)
2	**107,82**	—	51,0°	—	,,	,,	,,	Seitō-kwan-no-yu
3	**72,65**	—	60,0°	—	,,	,,	,,	Hanaya-no-yu
4	**63,47**	—	64,0°	—	,,	,,	,,	Sakaya-no-yu *No. 1*
5	**60,35**	—	67,0°	simple	,,	,,	,,	,, *No. 2*
6	**58,48**	—	49,0°	—	,,	,,	,,	Private bath (*K. Kishida*)
7	**58,18**	—	75,0°	—	,,	,,	,,	Akazakiya-no-yu
8	**39,70**	—	56,0°	—	,,	,,	,,	Iwa-no-yu (*Onna-yu*)
9	**36,02**	—	54,5°	—	,,	,,	,,	,, (*Otoko-yu*)
10	**33,47**	—	42,0°	sulphur	Sekigane	關金(,,)	,,	Kabu-yu
11	**32,41**	270	44,5°	,,	,,	,,	,,	Kamijyaya-no-yu
12	**28,57**	—	69,5°	—	Misasa	三朝(,,)	,,	Spring *B* (*River bed*)
13	**28,37**	—	58,5°	—	,,	,,	,,	Kiya-no-yu
14	**27,88**	—	63,5°	—	,,	,,	,,	Ochaya-no-yu
15	**27,87**	—	44,5°	—	,,	,,	,,	Shin-ya-no-yu
16	**25,15**	1800	39,0°	simple	Tochiomata	栃尾又(新潟)	,,	Tochiomata-no-yu *No. 1*
17	**24,75**	—	46,0°	—	Misasa	三朝(鳥取)	,,	Uenoya-no-yu
18	**24,46**	—	57,0°	—	,,	,,	,,	Tōfuya-no-yu
19	**24,46**	—	67,0°	—	,,	,,	,,	Bun-aburaya-no-yu
20	**24,05**	236	38,0°	simple	Tochiomata	栃尾又(新潟)	,,	Jizai-kwan-uchi-yu *No. 2*
21	**23,33**	—	39,0°	,,	,,	,,	,,	Tochiomata-no-yu *No. 2*
22	**22,07**	90	42,0°	sulphur	Sekigane	關金(鳥取)	,,	Inkyojyaya-no-yu
23	**20,23**	—	72,0°	common salt	Misasa	三朝(,,)	,,	Tōkyōya-no-yu
24	**19,20**	—	48,5°	—	,,	,,	,,	Aburaya-no-yu
25	**18,55**	—	63,0°	—	,,	,,	,,	Private bath (*S. Mifune*)
26	**15,52**	—	63,0°	—	,,	,,	,,	Hashizuya-no-yu
27	**13,81**	—	71,5°	simple	,,	,,	,,	Kyōyūchi-no-yu
28	**13,21**	—	48,0°	earthy common salt	Yunokawa	湯川(北海道)	Liparite	Senshin-kwan-no-yu *No. 2*
29	**12,85**	—	52,0°	carbonated (?)	Misasa	三朝(鳥取)	Granite	Private bath (*K. Tsugawa*)
30	**11,32**	216	46,0°	earthy common salt	Yunokawa	湯川(北海道)	Liparite	Hōmei-kwan-no-yu
31	**11,24**	—	40,5°	,,	,,	,,	,,	Senshin-kwan-no-yu *No. 1*
32	**11,04**	—	56,5°	muriated sulphur	Misasa	三朝(鳥取)	Granite	Naka-no-yu
33	**10,65**	108	46,0°	sulphur	Sekigane	關金(,,)	,,	Kon-ya-no-yu
34	**10,28**	126	62,0°	common salt	Ōwani	大鰐(青森)	Liparite	Umeka-no-yu
35	**9,69**	144	63,0°	salt	,,	,,	,,	Hie-no-yu
36	**9,27**	126	69,0°	,,	,,	,,	,,	Kagasuke-no-yu
37	**8,77**	144	62,5°	,,	,,	,,	,,	Netsu-no-yu
38	**8,48**	—	48,0°	earthy common salt	Yunokawa	湯川(北海道)	,,	Shin-yu *No. 1* (*Rinchō-kwan*)
39	**8,21**	—	49,0°	,,	,,	,,	,,	Chōju-yu (,,)
40	**7,96**	216	42,5°	,,	,,	,,	,,	Toyokawa-no-yu
41	**7,50**	108	67,0°	common salt	Ōwani	大鰐(青森)	,,	Yamabuki-no-yu
42	**7,47**	216	50,0°	earthy common salt	Yunokawa	湯川(北海道)	,,	Mura-yu
43	**7,35**	216	50,0°	,,	,,	,,	,,	Taki-no-yu (*Rinchō-kwan*)
44	**7,15**	—	53,0°	—	Kachimi	勝見(鳥取)	Granite	Private bath *Vent No. 1* (*Kurozumi-kyō*)
45	**7,01**	—	56,0°	—	,,	,,	,,	,, (*Y. Kinoshita*)
46	**6,69**	—	61,0°	—	Misasa	三朝(,,)	,,	Maejyaya-no-yu

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
47	6,51	ca. —	50,0°	earthy common salt	Yunokawa	湯川(北海道)	Liparite	Shin-yu *No. 2* (*Rinchō-kwan*)
48	5,80	126	51,5°	—	Kachimi	勝見(鳥取)	Granite	Sagi-no-yu
49	5,78	—	70,0°	earth-muriated common salt	Onogawa	小野川(山形)	Tertiary	Taki-no-yu
50	5,76	—	50,0°	common salt	Shiobara—Fukuwata	鹽原—福渡戸(栃木)	„	Hadaka-no-yu
51	5,54	—	66,0°	earthy common salt	Nezaki	根崎(北海道)	Liparite	Rikuzō-no-yu
52	5,35	—	49,0°	muriated saline bitter	Hamamura	濱村(鳥取)	Granite	Suzukiya-no-yu
53	5,14	—	54,0°	—	Tamatsukuri (Shimane-ken)	玉造(島根)	Tertiary	Private bath (*S. Hasegawa*)
54	5,02	—	45,0°	simple	Tōgō	東郷(鳥取)	Andesite	Yōjō-kwan-no-yu *No. 3*
55	4,86	—	47,0°	—	Yoshikata	吉方(〃)	Alluvium	Matsukawa-Onsen
56	4,77	—	42,0°	simple	Yumura (Shimane-ken)	湯村(島根)	Granite	Spring *A*
57	4,77	504	72,0°	salt	Takase	高瀬(新潟)	Alluvium	Takase-no-yu
58	4,59	—	51,0°	simple	Kashi	甲子(福島)	Granite	Moto-yu
59	4,59	—	42,0°	saline bitter	Higashiyama	東山(〃)	Andesite or Tertiary	Fudō-no-yu
60	4,38	—	69,0°	common salt	Kuradate	藏館(青森)	Alluvium	Kami-no-yu
61	4,37	544	46,0°	sulphated common salt	Yunotsu	溫泉津(島根)	Tertiary	Shin-yu
62	4,36	—	50,0°	simple	Yoshioka	吉岡(鳥取)	„	Kamei-dono-no-yu
63	4,33	360	56,0°	common salt	Asōzu	淺津(〃)	Andesite	Moto-yu
64	4,17	—	46,0°	saline sulphated bitter	Iwai	岩井(〃)	Tertiary	Iwami-kwan-no-yu
65	* 4,17	—	37,0°	—	Mimata	美又(島根)	Granite	Mimata-Onsen
66	4,15	—	57,5°	saline bitter	Shiobara—Ōami	鹽原—大網(栃木)	Tertiary	Ishi-ai-no-yu
67	4,14	—	56,0°	simple	Ōyu (Niigata-ken)	大湯(新潟)	Granite	Kawagishi-no-yu *No. 1*
68	4,11	—	55,0°	saline bitter	Shiobara—Ōami	鹽原—大網(栃木)	Tertiary	Kawara-no-yu
69	4,10	65	50,0°	salt	Yuzawa [Onnagawa] (Niigata-ken)	湯澤[女川](新潟)	Alluvium	Moto-yu
70	4,06	1730	50,0°	simple	Tōgō	東郷(鳥取)	Andesite	Yōjō-kwan-no-yu *No. 1*
71	4,00	979	63,0°	common salt	Takanosu	鷹之巣(新潟)	Tertiary	Takanosu-Onsen
72	3,89	—	45,0°	—	Hamamura	濱村(鳥取)	Granite	Tabakoya-no-yu
73	3,83	—	56,0°	simple	Ōyu (Niigata-ken)	大湯(新潟)	„	Kawagishi-no-yu *No. 2*
74	3,70	—	45,0°	—	Hamamura	濱村(鳥取)	„	Kadoya-no-yu
75	3,62	—	56,0°	simple	Ōyu (Niigata-ken)	大湯(新潟)	„	Sakashita-no-yu
76	3,60	—	48,0°	salt	Yuzawa [Onnagawa] (Niigata-ken)	湯澤[女川](〃)	Alluvium	Sugai-no-yu
77	3,59	—	57,0°	simple	Ōyu (Niigata-ken)	大湯(〃)	Granite	Ō-yu (*Otoko-yu*)
78	3,56	360	56,0°	muriated sulphur	Asōzu	淺津(鳥取)	Andesite	Asahi-kwan-no-yu
79	3,55	—	43,5°	earthy common salt	Nezaki	根崎(北海道)	Liparite	Taishō-kwan-no-yu
80	3,52	—	56,0°	simple	Ōyu (Niigata-ken)	大湯(新潟)	Granite	Ō-yu (*Onna-yu*)
81	3,45	—	68,0°	earth-muriated common salt	Onogawa	小野川(山形)	Tertiary	Suzuki-no-yu
82	3,45	25	43,0°	muriated saline bitter	Yoshikata	吉方(鳥取)	Alluvium	Takasago-Onsen
83	3,43	—	53,0°	simple	Ōyu (Niigata-ken)	大湯(新潟)	Granite	Yakushi-no-yu
84	3,43	830	39,5°	carbonated	Deyu	出湯(〃)	„	Chōsenkutsu-no-yu
85	3,39	—	43,0°	simple	Yumura (Shimane-ken)	湯村(島根)	„	Spring *B*
86	3,38	—	50,0°	„	Kashi	甲子(福島)	„	Yujin-no-yu
87	3,24	—	70,5°	earth-muriated common salt	Wakura	和倉(石川)	Tertiary	Wakazaki-no-yu *No. 3*
88	3,23	180	56,5°	saline bitter	Higashiyama	東山(福島)	Andesite or Tertiary	Sō-yu
89	3,20	—	43,0°	—	Hirose (Shimane-ken)	廣瀬(島根)	Tertiary	Sagi-no-yu
90	3,20	180	43,0°	saline bitter	Higashiyama	東山(福島)	Andesite or Tertiary	Saru-no-yu
91	3,20	3888	43,0°	simple	Yumura (Shimane-ken)	湯村(島根)	Granite	Shitsuni-no-yu
92	3,20	—	52,0°	salt	Yuzawa [Onnagawa] (Niigata-ken)	湯澤[女川](新潟)	Alluvium	Takahashi-kwan-no-yu
93	3,19	—	52,5°	simple	Yoshioka	吉岡(鳥取)	Tertiary	Naka-no-yu
94	3,17	—	53,5°	„	„	„	„	Nakajimaya-no-yu
95	3,14	—	59,0°	saline bitter	Higashiyama	東山(福島)	Andesite or Tertiary	Sugi-no-yu
96	3,12	36	47,5°	earthy common salt	Yoshikata	吉方(鳥取)	Alluvium	Tottori-Onsen
97	3,07	—	42,5°	sulphur	Yoshioka	吉岡(〃)	Tertiary	Shimo-no-yu
98	3,02	216	45,0°	earth-muriated common salt	Yunokawa	湯川(北海道)	Liparite	Tōyō-kwan-no-yu
99	3,02	180	58,0°	saline bitter	Higashiyama	東山(福島)	Andesite or Tertiary	Saza-nami-no-yu

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
100	*2,93	ca. —	37,0°	—	Iwai	岩　井(鳥取)	Tertiary	Shimo-nakagawara-no-yu
101	2,87	—	46,0°	saline sulphated bitter	„	„	„	Nakajimaya-no-yu
102	2,86	450	72,5°	common salt	Kuradate	藏　館(青森)	Alluvium	Shimo-no-yu
103	2,86	—	48,5°	simple	Kashi	甲　子(福島)	Granite	Tengu-no-yu
104	2,77	—	48,0°	common salt	Shiobara—Fukuwata	鹽原—福渡戸(栃木)	Tertiary	Iwa-no-yu
105	2,73	—	37,0°	salt	Yuzawa [Uonuma] (Niigata-ken)	湯　澤[魚沼](新潟)	Misaka Series	Kiridōshi-no-yu
106	2,73	—	46,0°	—	Asōzu	淺　津(鳥取)	Andesite	Sugimoto-no-yu
107	2,71	—	60,0°	alkaline common salt	Ogawa	小　川(富山)	Liparite	Ogawa-Onsen *No. 5*
108	2,62	—	63,0°	salt	Shimogamo	下賀茂(靜岡)	Tertiary	Seitō-Onsen
109	2,61	—	57,0°	alkaline common salt	Ogawa	小　川(富山)	Liparite	Ogawa-Onsen *No. 6*
110	2,60	540	38,2°	iron carbonate common salt	Koyabara	小屋原(島根)	Andesite	Koyabara-Onsen
111	2,60	540	72,0°	common salt	Kuradate	藏　館(青森)	Alluvium	Ō-yu
112	2,60	—	64,5°	sulphur	Futami	二　見(富山)	Granite	Dai-ichi-no-yu
113	2,46	—	49,0°	alkaline common salt	Ogawa	小　川(„)	Liparite	Ogawa-Onsen *No. 2*
114	2,41	—	38,0°	salt	Yumura (Yamanashi-ken)	湯　村(山梨)	—	Meiji-Onsen
115	2,37	—	61,5°	—	Tamatsukuri (Shimane-ken)	玉　造(島根)	Tertiary	Tonosama-yu
116	2,36	—	44,5°	common salt	Shiobara—Fukuwata	鹽原—福渡戸(栃木)	„	Awa-no-yu
117	2,29	4066	58,5°	saline sulphated bitter	Iwai	岩　井(鳥取)	„	Moto-yu
118	2,28	—	45,2°	sulphated bitter sulphur	Yamanaka	山　中(石川)	„	Kiku-no-yu (*Onna-yu*)
119	2,23	—	66,5°	earth-muriated common salt	Onogawa	小野川(山形)	„	Ōgiya-no-yu *No. 2*
120	2,21	—	83,0°	sulphur	Kuronagi	黒　薙(富山)	Granite	Onna-yu
121	2,20	180	49,0°	simple	Kanetsuri	鐘　釣(„)	Contact Zone of Granite & Limestone	Kanetsuri-Onsen
122	*2,19	4500	48,0°	„	Yubara (Okayama-ken)	湯　原(岡山)	Granite	Yakuō-tō
123	*2,18	2700	37,5°	„	Maga	眞　賀(„)	„	Kin-yu
124	2,17	152	76,0°	earth-muriated common salt	Awara	蘆　原(福井)	Alluvium	Funatsu *No. 10*
125	2,17	488	61,5°	bitter	Kaminoyama	上ノ山(山形)	Liparite	Kawashimaya-no-yu *No. 2*
126	2,11	346	49,0°	sulphated common salt	Omaki	大　牧(富山)	Porphyr. Dyke	Ōmaki-Onsen
127	2,09	1953	64,0°	common salt	Tamatsukuri (Shimane-ken)	玉　造(島根)	Tertiary	Kami-no-yu
128	2,08	—	62,0°	hydrogen solphide	Nikkō-Yumoto	日光湯本(栃木)	Quartz Porph.	Tsuru-no-yu
129	2,07	—	54,0°	simple	Nasu—Benten	那須—辨天(„)	Andesite	Kawa-no-yu
130	2,06	—	37,0°	—	Hirose (Shimane-ken)	廣　瀬(島根)	Tertiary	Private bath (*Asylum*)
131	2,01	—	63,0°	salt	Kuzu	葛　(長野)	Granite	Gorin-no-yu
132	1,98	—	62,0°	„	„	„	„	Kanatsubo-no-yu
133	1,97	—	48,0°	„	Rendaiji	蓮臺寺(靜岡)	Tertiary	Idoya-no-yu
134	1,97	—	88,0°	simple	Yubiso	湯檜曾(群馬)	Granite	Yubiso-no-yu *No. 2*
135	*1,95	—	—	—	Ginzan-daira	銀山平(新潟)	—	Koyu-no-mata-Onsen
136	1,95	—	73,5°	earth-muriated common salt	Onogawa	小野川(山形)	Tertiary	Ama-no-yu
137	1,95	—	38,5°	alkaline	Goshiki	五　色(„)	„	Goshiki-Onsen *No. 2*
138	1,94	—	88,5°	sulphur	Kuronagi	黒　薙(富山)	Granite	Otoko-yu
139	1,93	216	55,0°	salt	Yugashima	湯ケ島(靜岡)	Andes. and Tuff	Seko-no-Ō-yu
140	1,93	—	42,0°	earthy common salt	Aoyama	青　山(北海道)	Andesite	Furōkaku-no-yu *No. 2*
141	1,90	—	48,0°	—	Hamamura	濱　村(鳥取)	Granite	Kyōdō-yu *Vent No. 1*
142	1,89	152	70,5°	earth-muriated common salt	Awara	蘆　原(福井)	Alluvium	Funatsu *No. 21*
143	1,89	—	48,0°	—	Asōzu	淺　津(鳥取)	Andesite	Nisshin-kwan-no-yu
144	1,87	—	78,0°	common salt	Kuradate	藏　館(青森)	Alluvium	Hoyōen-no-yu
145	*1,86	—	—	—	Ginzan-daira	銀山平(新潟)	—	Rōhai-no-yu
146	1,85	—	59,5°	sulphur	Nakabusa	中　房(長野)	Granite	Shirataki-no-yu
147	1,83	—	38,5°	saline common salt	Kamasaki	鎌　先(宮城)	Andesite	Mogamiya-no-yu
148	1,83	3944	62,0°	bitter	Kaminoyama	上ノ山(山形)	Liparite	Hie-no-yu
149	1,81	—	45,8°	sulphated bitter sulphur	Yamanaka	山　中(石川)	Tertiary	Kiku-no-yu (*Otoko yu*)
150	1,80	313	42,0°	salt	Yumura (Yamanashi-ken)	湯　村(山梨)	Andesite	Washi-Onsen
151	1,78	—	56,0°	sulphur	Awazu	粟　津(石川)	Liparite	Zengorō-no-yu

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地名(府縣名)	Geology	Spring
152	1,77	ca. 538	50,0°	saline sulphated bitter	Iwai	岩井(鳥取)	Tertiary	Hanaya-no-yu
153	1,76	abundant	95,0°	alkaline carbon-dioxated	Yumura (Hyōgo-ken)	湯村(兵庫)	Granite	Ara-yu
154	1,75	152	75,0°	earth-muriated common salt	Awara	蘆原(福井)	Alluvium	Nimen *No. 28*
155	1,73	270	66,0°	bitter	Asamushi	淺虫(青森)	Andesite	Ō-yu
156	1,73	—	64,0°	hydrogen sulphide	Nikkō-Yumoto	日光湯本(栃木)	Quartz Porph.	Kawara-no-yu
157	1,70	3944	61,0°	bitter	Kaminoyama	上ノ山(山形)	Liparite	Atatamari-no-yu
158	1,69	152	68,2°	earth-muriated common salt	Awara	蘆原(福井)	Alluvium	Tanaka-naka *No. 6*
159	1,64	—	46,5°	simple	Tōgō	東郷(鳥取)	Andesite	Yōjō-kwan-no-yu *No. 6*
160	1,62	—	45 0°	salt	Yuzawa [Uonuma] (Niigata-ken)	湯澤[魚沼](新潟)	Misaka Series	Moto-yu
161	1,62	—	75,5°	earth-muriated common salt	Wakura	和倉(石川)	Tertiary	Sō-yu
162	1,61	700	50,0°	sulphated common salt	Yunotsu	溫泉津(島根)	Tertiary	Kyū-yu
163	1,61	2700	47,5°	simple	Shimo-Suwa	下諏訪(長野)	Alluvium	Wata-no-yu
164	1,59	152	70,0°	earth-muriated common salt	Awara	蘆原(福井)	„	Funatsu *No. 9*
165	1,58	—	66,0°	hydrogen sulphide	Nikkō-Yumoto	日光湯本(栃木)	Quartz Porph.	Gosho-no-yu
166	1,52	—	57,0°	muriated alkaline	Shiobara—Hataori	鹽原—畑下(„)	Tertiary	Hato-no-yu
167	1,51	—	62,0°	sulphated common salt	Shibu [Hirao]	澁[平穩](長野)	Diluvium	Ō-yu *Vent No. 8*
168	1,51	356	42,0°	simple	Yamabe	山邊(„)	Tertiary	Shiraito-Onsen *No. 2*
169	1,51	—	44,5°	„	Arifuku	有福(島根)	Diorite	Shin-yu
170	1,50	—	63,5°	muriated alkaline	Shiobara—Hataori	鹽原—畑下(栃木)	Tertiary	Mujina-no-yu
171	1,50	—	94,0°	alkaline sulphur	Nakabusa	中房(長野)	Granite	Tamura-no-yu
172	1,46	448	50,0°	saline sulphated bitter	Iwai	岩井(鳥取)	Tertiary	Bizenya-no-yu
173	1,46	—	72,0°	sulphated common salt	Shibu [Hirao]	澁[平穩](長野)	Diluvium	Ō-yu *Vent No. 4*
174	1,46	519	73,5°	„	„	„	„	Hatsu-yu
175	1,45	908	58,0°	earth-muriated common salt	Akayu (Yamagata-ken)	赤湯(山形)	Tertiary	Ō-yu
176	1,45	—	45,0°	salt	Yuzawa [Uonuma] (Niigata-ken)	湯澤[魚沼](新潟)	Misaka Series	Kami-no-yu
177	1,45	—	57,0°	„	Kuzu	葛(長野)	Granite	Shin-yu *No. 2*
178	1,42	—	50,0°	common salt	Shiobara—Fukuwata	鹽原—福渡戸(栃木)	Tertiary	Hie-no-yu
179	1,42	—	88,0°	sulphur (?)	Kuzu	葛(長野)	Granite	Spring *A*
180	1,40	—	76,0°	sulphated common salt	Shibu [Hirao]	澁[平穩](„)	Diluvium	Ō-yu *Vent No. 12*
181	1,39	2772	44,0°	earthy common salt	Aoyama	青山(北海道)	Andesite	Furōkaku-no-yu *No. 1*
182	1,39	—	62,0°	common salt	Ikariga-seki	碇ヶ關(青森)	Volc. Ash	Bun-kwan-no-yu
183	1,38	130	42,0°	simple	Yamabe	山邊(長野)	Tertiary	Shiraito-Onsen *No. 1*
184	1,38	—	85,8°	sulphur	Futami	二見(富山)	Granite	Dai-ni-no-yu
185	1,38	—	43,0°	sulphated bitter sulphur	Yamanaka	山中(石川)	Tertiary	Mitaniya-no-yu
186	1,38	179	49,0°	earth-muriated common salt	Akayu (Yamagata-ken)	赤湯(山形)	„	Ama-yu
187	1,35	—	59.5°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Ishi-yu
188	1,33	207	50.0°	earth-muriated common salt	Akayu (Yamagata-ken)	赤湯(山形)	Tertiary	Tamba-yu
189	1,33	—	76,0°	muriated sulphated bitter	Yudanaka	湯田中(長野)	Misaka Series	Ō-yu *Vent No. 1*
190	1,32	3600	67,0°	simple	Shimo-Suwa	下諏訪(„)	Alluvium	Tankwa-no-yu
191	1,32	972	81,0°	„	Yubiso	湯檜曾(群馬)	Granite	Yubiso-no-yu *No. 1*
192	1,32	—	57,0°	„	Yubara	湯原(„)	„	Fujiya-no-yu
193	1,31	173	64,0°	salt	Yagashima	湯ヶ島(靜岡)	Andes. and Tuff	Ochiai-rō-no-yu
194	1,30	—	42,0°	„	Yuzawa [Uonuma] (Niigata-ken)	湯澤[魚沼](新潟)	Misaka Series	Chūbu-no-yu
195	1,29	130	67,5°	simple	Kami-Suwa	上諏訪(長野)	Alluvium	Shōjin-yu
196	1,28	—	74,0°	alkaline sulphur	Nakabusa	中房(„)	Granite	Oyogi-no-yu
197	1,28	—	57,0°	sulphur	Awazu	粟津(石川)	Liparite	Kametani-no-yu
198	1,28	778	53,5°	simple	Kamikōchi	上高地(長野)	Granite	Kamikōchi-Onsen
199	1,27	130	56,0°	carbonated	Yugashima	湯ヶ島(靜岡)	Andes. and Tuff	Yumoto-kwan-no-yu
200	1,27	526	83,5°	common salt	Shima	四萬(群馬)	Misaka Series	Iwane-no-yu
201	1,27	630	61,0°	„	Ikariga-seki	碇ヶ關(青森)	Volc. Ash	Taki-no-yu
202	1,27	—	74 0°	muriated sulphated bitter	Yudanaka	湯田中(長野)	Misaka Series	Ō-yu *Vent No. 2*
203	1,27	—	53,0°	salt	Rendaiji	蓮臺寺(靜岡)	Tertiary	Junji-kwan-no-yu

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地名(府縣名)	Geology	Spring
204	1,26	ca. —	79,0°	common salt	Katayamazu	片山津(石川)	Tertiary	Niiho-no-Tsubo
205	1,25	778	44,5°	alkaline	Goshiki	五色(山形)	„	Goshiki-Onsen *No. 1*
206	1,24	—	44,0°	simple	Asama	淺間(長野)	„	Kizu-no-yu
207	1,23	—	41,5°	salt	Yuzawa [Uonuma] (Niigata-ken)	湯澤[魚沼](新潟)	Misaka Series	Tamago-no-yu
208	1,23	—	43,0°	„	„	„	„	Shin-yu
209	1,22	364	74,5°	—	Yudanaka	湯田中(長野)	„	Washi-no-yu
210	1,21	—	41,0°	simple	Innai-Yunosawa	院内湯澤(秋田)	Tertiary	Taki-no-yu
211	1,20	—	66,0°	sulphated common salt	Shibu [Hirao]	澁[平穩](長野)	Diluvium	Wata-no-yu
212	1,20	558	61,0°	common salt	Ikariga-seki	碇ヶ關(青森)	Volc. Ash	Netsu-no-yu
213	1,15	749	60,0°	saline sulphated bitter	Iwai	岩井(鳥取)	Tertiary	Iwaiya-no-yu
214	1,15	108	67,5°	simple	Dai	臺(岩手)	Diluvium	Tsuru-no-yu
215	1,15	—	54,0°	„	Nasu—Kita	那須—北(栃木)	Andesite	Ai-no-yu
216	1,15	—	68,0°	sulphated bitter	Asamushi	淺虫(青森)	„	Nambuya-shin-yu
217	1,14	—	96,0°	alkaline sulphur	Nakabusa	中房(長野)	Granite	Myōken-no-yu
218	1,13	—	56,0°	—	Yugashima	湯ヶ島(靜岡)	Andes. and Tuff	Spring *No. 9* (*K. Adachi*)
219	1,13	—	79,0°	sulphated bitter	Asamushi	淺虫(青森)	Andesite	Tsubaki-no-yu *No. 1*
220	1,13	130	83,0°	simple	Kami-Suwa	上諏訪(長野)	Alluvium	Tajiku-no-yu
221	1,11	—	74,0°	sulphated common salt	Shibu [Hirao]	澁[平穩](„)	Diluvium	O-yu *Vent No. 1*
222	1,11	—	50,5°	alkaline common salt	Ogawa	小川(富山)	Liparite	Ogawa-Onsen *No. 4*
223	1,11	—	69,0°	common salt	Shiobara—Fukuwata	鹽原—福渡戸(栃木)	Tertiary	Iwa-no-yu
224	1,11	—	79,0°	„	Katayamazu	片山津(石川)	„	Shibayama-no-Tsubo
225	1,11	—	95,0°	sulphur	Futami	二見(富山)	Granite	Dai-san-no-yu
226	1,09	—	55,0°	—	Yugashima	湯ヶ島(靜岡)	Andes. and Tuff	Yumoto-kwan-Taki-no-yu
227	1,08	519	55,0°	saline common salt	Shuzenji	修善寺(„)	„	Chigo-no-yu
228	1,07	—	48,3°	—	Shiobara-Furumachi	鹽原—古町(栃木)	Tertiary	Asahi-no-yu
229	1,06	31100	46,5°	common salt	Shigaku	志學(島根)	Andesite	Shigaku-Onsen
230	1,06	—	92,0°	alkaline sulphur	Nakabusa	中房(長野)	Granite	Yakushi-no-yu *No. 1*
231	1,06	24624	40,5°	simple	Innai-Yunosawa	院内湯澤(秋田)	Tertiary	Yunosawa-Onsen
232	1,06	—	58,0°	sulphur	Awazu	粟津(石川)	Liparite	Kamiya-no-yu
233	*1,04	864	62,0°	salt	Kaigake	貝掛(新潟)	—	Kaigake-Onsen
234	1,04	—	62,0°	earthy alkaline sulphur	Akakura	赤倉(„)	Andesite	Akakura-Onsen *Jet No. 2*
235	1,03	—	50,0°	common salt	Shiobara—Monzen	鹽原—門前(栃木)	Tertiary	Jirakubō-no-yu
236	1,01	abundant	40,5°	sulphur	Naruko	鳴子(宮城)	Andesite	Taki-no-yu *No. 1*
237	1,01	—	80,0°	earth-muriated common salt	Wakura	和倉(石川)	Tertiary	Wakazaki-no-yu *No. 2*
238	1,00	—	72,0°	sulphated bitter	Asamushi	淺虫(青森)	Andesite	Udō-no-yu
239	1,00	1296	38,0°	earth-muriated common salt	Yunogō	湯郷(岡山)	Liparite	Sagi-no-yu
240	1,00	—	65,0°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Taki-no-yu
241	1,00	—	49,0°	—	Yugashima	湯ヶ島(„)	„	Spring *No. 3* (*S. Adachi*)
242	0,98	630	58,0°	common salt	Oyu (Akita-ken)	大湯(秋田)	Alluv. Pum. Layer	Kami-no-yu
243	0,98	—	93,0°	alkaline sulphur	Nakabusa	中房(長野)	Granite	Yakushi-no-yu *No. 2*
244	0,97	126	51,0°	earthy alkaline	Shirahone	白骨(„)	Chichibu Series	Wata-no-yu
245	0,97	648	56,0°	simple	Andai	安代(„)	Diluvium	O-yu
246	0,96	—	79,0°	common salt	Katayamazu	片山津(石川)	Tertiary	Shiotsu-no-Tsubo
247	0,95	162	78,0°	acid	Dai	臺(岩手)	Diluvium	Matsu-no-yu
248	0,95	900	90,5°	alkaline carbon-dioxated	Yumura (Hyōgo-ken)	湯村(兵庫)	Granite	Kabu-yu
249	0,94	152	74,0°	earth-muriated common salt	Awara	蘆原(福井)	Alluvium	Funatsu *No. 6*
250	0,94	—	60,0°	sulphur	Shibu [Hirao]	澁[平穩](長野)	Diluvium	Nanakuri-no-yu *Vent A*
251	0,94	130	59,0°	simple	Kami-Suwa	上諏訪(„)	Alluvium	Hira-no-yu
252	0,93	6012	61,0°	sulphur	Ōdaki	大瀧(秋田)	Alluv. Tal. Dep.	Tsuru-no-yu
253	0,93	—	50,0°	simple	Asama	淺間(長野)	Tertiary	Taki-no-yu
254	0,92	1800	52,0°	„	Shimo-Suwa	下諏訪(„)	Alluvium	Ko-yu
255	0,92	—	65,5°	earth-muriated common salt	Onogawa	小野川(山形)	Tertiary	Ogiya-no-yu *No. 1*
256	0,92	432	58,5°	simple	Yuno	湯野(福島)	„	Anabara-no-yu

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　　名(府縣名)	Geology	Spring
257	0,92	378	91,0°	common salt	Jōzankei	定山溪(北海道)	Liparite	Moto-no-yu
258	0,92	—	55,0°	„	Ikariga-seki	碇ヶ關(青森)	Volc. Ash	Fuji-no-yu
259	0,91	—	45,0°	sulphated common salt	Shibu [Hirao]	澁[平穩](長野)	Diluvium	Mujina-no-yu
260	0,91	—	62,5°	simple	Shiobara—Sumaki	鹽原—須卷(栃木)	Tertiary	Taki-no-yu
261	0,90	—	37,0°	earth-muriated common salt	Yunogō	湯鄉(岡山)	Liparite	Sagi-no-yu (*Onna-yu*)
262	0,89	—	51,5°	simple	Yubara (Gumma-ken)	湯原(群馬)	Granite	Ubukata-no-yu
263	0,89	414	69,5°	common salt	Ōyu (Akita-ken)	大湯(秋田)	Alluv. Pum. Layer	Shimo-no-yu
264	0,89	—	79,0°	salt	Shimogamo	下賀茂(靜岡)	Tertiary	Hizume-Kyōdō-Onsen
265	0,88	—	69,0°	hydrogen sulphide	Nikkō-Yumoto	日光湯本(栃木)	Quartz Proph.	Ara-yu
266	0,87	311	55,0°	salt	Shima	四萬(群馬)	Misaka Series	Shinkoku-tō
267	0,87	3150	48,0°	saline common salt	Kamasaki	鎌先(宮城)	Andesite	Ichijō-no-yu
268	0,87	—	71,5°	common salt	Shiobara–Shio-no-yu	鹽原—鹽之湯(栃木)	Tertiary	Naka-no-yu
269	0,86	—	48,0°	earthy alkaline	Shirahone	白骨(長野)	Chichibu Series	Chi-no-yu
270	0,86	270	45,5°	hydrogen sulphide common salt	Ōyuzawa	大湯澤(秋田)	Diluvium	*No. 38* (*Ō-yu*)
271	0,85	540	37,7°	earth-muriated common salt	Yunogō	湯鄉(岡山)	Liparite	Shin-Sagi-no-yu
272	0,85	—	56,0°	sulphated bitter	Tohi	土肥(靜岡)	Tertiary	Tohi-kwan-no-yu *No. 2*
273	0,84	194	55,0°	simple	Andai	安代(長野)	Diluvium	Kaikwa-no-yu
274	0,84	501	55,0°	salt	Kambayashi	上林(〃)	Misaka Series	Tsuru-no-yu
275	0,82	346	40,5°	simple	Shin-Goshiki	新五色(山形)	Tertiary	Shin-goshiki-Onsen
276	0,82	735	65,0°	common salt	Kakuma	角間(長野)	Diluvium	Ō-yu
277	0,82	524	74,0°	salt	Shima	四萬(群馬)	Misaka Series	Shio-no-yu (*Sekizen-kwan*)
278	0,82	519	58,0°	sulphated common salt	Shibu [Hirao]	澁[平穩](長野)	Diluvium	Mearai-no-yu
279	0,82	635	62,0°	„	Shima	四萬(群馬)	Misaka Series	Tokiwa-no-yu
280	0,81	619	46,0°	common salt	Ōyu (Akita-ken)	大湯(秋田)	Alluv. Pum. Layer	Arase-no-yu
281	0,81	130	49,0°	salt	Yugashima	湯ヶ島(靜岡)	Andes. and Tuff	Seko-no-Moto-yu
282	0,81	—	70,5°	sulphated common salt	Shibu [Hirao]	澁[平穩](長野)	Diluvium	Ō-yu *Vent No. 5*
283	0,80	—	43,0°	saline common salt	Kamasaki	鎌先(宮城)	Andesite	Kimuraya-no-yu
284	0,80	—	52,0°	salt	Yatsu	谷津(靜岡)	Tertiary	Ishida-Shin-Onsen
285	0,79	—	54,0°	common salt	Shiobara—Monzen	鹽原—門前(栃木)	„	Kawara-no-yu
286	0,79	—	96,0°	alkaline sulphur	Nakabusa	中房(長野)	Granite	Danjō-no-yu
287	0,78	195	42,0°	earth-muriated common salt	Akayu (Yamagata-ken)	赤湯(山形)	Tertiary	Mori-no-yu
288	0,77	810	80,0°	simple	Jōzankei	定山溪(北海道)	Liparite	Naka-no-yu
289	0,77	360	61,5°	sulphated bitter	Asamushi	淺虫(青森)	Andesite	Hadaka-no-yu
290	0,77	—	56,0°	—	Yugashima	湯ヶ島(靜岡)	Andes. and Tuff	Spring *No. 4* & *5* (*K. Adachi*)
291	0,77	—	95,5°	alkaline sulphur	Nakabusa	中房(長野)	Granite	Taki-no-yu *No. 1*
292	0,77	—	42,0°	—	Shiobara-Furumachi	鹽原—古町(栃木)	Tertiary	Takara-no-yu
293	0,76	—	63,0°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Asabarō-no-yu
294	0,75	—	67,0°	saline bitter	Yujiku	湯宿(群馬)	Tertiary	Sen-tō
295	0,75	—	56,0°	salt	Yatsu	谷津(靜岡)	„	Yatsu-Kyōdō-Onsen
296	0,74	—	76,0°	„	Ōwani	大鰐(青森)	Liparite	Kawara-no-yu
297	0,74	—	55,5°	sulphated bitter	Tohi	土肥(靜岡)	Tertiary	Asaka-no-yu
298	0,74	—	42,0°	sulphur	Tsubame	燕(新潟)	Andesite	Tsubame-Onsen *Jet No. 3*
299	0,73	—	55,0°	sulphated bitter	Tohi	土肥(靜岡)	Tertiary	Hama-no-Kyōdō-yu
300	0,73	—	53,0°	simple	Asama	淺間(長野)	„	Matsu-no-yu
301	0,73	—	74,0°	hydrogen sulphide (?)	Nasu—Yumoto	那須—湯本(栃木)	Andesite	Taki-no-yu
302	0,72	—	51,0°	simple	Osawa	大澤(岩手)	Tertiary	Ō-yu *Vent No. 1*
303	0,72	—	42,5°	hydrogen sulphide	Nikkō-Yumoto	日光湯本(栃木)	Quartz Porph.	Donsu-no-yu
304	0,72	—	51,5°	alkaline	Shiobara-Furumachi	鹽原—古町(〃)	Tertiary	Gosho-no-yu
305	0,72	—	43,0°	salt	Rendaiji	蓮臺寺(靜岡)	„	Aizu-kwan-no-yu
306	0,71	—	62,0°	bitter	Ōdaki	大瀧(秋田)	Alluv. Tal. Dep.	Susuki-no-yu
307	0,71	144	50,0°	simple	Iizaka	飯坂(福島)	Tertiary	Tennōji-yu
308	0,70	—	49,0°	—	Yugashima	湯ヶ島(靜岡)	Andes. and Tuff	Spring *No. 2*
309	0,69	—	66,0°	sulphated bitter	Tohi	土肥(〃)	Tertiary	Private bath (*T. Torizawa*)

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地名(府縣名	Geology	Spring
310	0,68	180	94 0°	common salt	Noboribetsu	登別(北海道)	Tertiary	Kami-no-yu
311	0,68	180	59,0°	simple	Iizaka	飯坂(福島)	„	Taki-no-yu
312	0,67	—	46,0°	sulphated bitter	Ikao	伊香保(群馬)	Andesite	Nomi-yu
313	0,67	—	56.5°	simple	Iizaka	飯坂(福島)	Tertiary	Spring (*Sanat. II Div., Army*)
314	0,66	156	60,0°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Ume-no-yu
315	0,66	634	70.5°	common salt	Ōyu (Akita-ken)	大湯(秋田)	Alluv. Pum. Layer	Kawara-no-yu
316	0,65	—	71,0°	saline bitter sulphur	Yamashiro	山代(石川)	Tertiary	Araya-no-yu
317	0,64	—	40,0°	simple	Arifuku	有福(島根)	Diorite	Arifuku-Onsen *Vent No. 2*
318	0,64	389	76,0°	bitter	Shido-daira	志戸平(岩手)	Tertiary	Warabi-no-yu
319	0,64	635	84,0°	salt	Shima	四萬(群馬)	Misaka Series	Ryūgū-no-yu
320	0,64	432	69,0°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Dokko-no-yu
321	0,64	327	64,0°	„	„	„	„	Hako-yu
322	0,64	—	46,0°	sulphated bitter	Tohi	土肥(„)	Tertiary	Ō-yu *Vent No. 1*
323	0,63	—	61,0°	common salt	Katayamazu	片山津(石川)	„	Higashi-no-Tsubo
324	0,63	360	54,0°	„	Ikariga-seki	碇ヶ關(青森)	Volc. Ash	Hie-no-yu (*Onna-yu*)
325	0,57	360	50,0°	saline bitter	Yujiku	湯宿(群馬)	Tertiary	Ō-daki
326	0,57	216	58,0°	simple	Karurusu	カルヽス(北海道)	„	Tsuru-no-yu *Vent No. 2*
327	0,57	236	52,0°	earthy alkaline	Shirahone	白骨(長野)	Chichibu Series	Senki-no-yu
328	0,56	—	67.5°	salt	Shin-kuruma	新車(宮城)	Andesite	Moto-yu
329	0,56	—	43,0°	acid hydrogen sulphide	Nasu—Yumoto	那須—湯本(栃木)	„	Komatsu-no-yu
330	0,55	648	79,0°	saline bitter	Yujiku	湯宿(群馬)	Tertiary	Kubo-yu
331	0,54	—	62,0°	earthy alkaline sulphur	Akakura	赤倉(新潟)	Andesite	Akakura-Onsen *Jet No. 3*
332	0,54	1530	42,0°	earthy common salt	Miyagawa	宮川(北海道)	„	Miyagawa-no-yu
333	0,54	—	54 0°	salt	Shin-kuruma	新車(宮城)	„	Takashige-no-yu
334	0,53	—	71,0°	„	Shimogamo	下賀茂(靜岡)	Tertiary	Kanō-Kyōdō-yu
335	0,53	72	54,0°	simple	Dai	臺(岩手)	Diluvium	Suzume-no-yu
336	0,53	—	42 5°	carbonated	Kawatabi	川渡(宮城)	Tertiary	Suzukino-yu
337	0,52	—	48,0°	salt	Kōchi	河内(靜岡)	Andesite	Shimo-no-yu
338	0,52	—	70,0°	simple	Iizaka	飯坂(福島)	Tertiary	Shin-Sabako-no-yu
339	0,51	—	44,0°	„	Nagaoka	長岡(靜岡)	„	Tamon-yu *No. 4*
340	0,51	—	45,0°	sulphated bitter	Ikao	伊香保(群馬)	Andesite	Fukiage-no-yu
341	0,50	108	56.5°	simple	Iizaka	飯坂(福島)	Tertiary	Hako-yu
342	0,50	—	53,0°	salt	Rendaiji	蓮臺寺(靜岡)	„	Private bath (*C. Murayama*)
343	0,50	156	60,0°	saline common salt	Shuzenji	修善寺(„)	Andes. and Tuff	Sugi-no-yu
344	0,50	—	70,0°	„	„	„	„	Kikuya-no-yu *No. 2*
345	0,49	270	53,0°	simple	Onikōbe	鬼首(宮城)	Tertiary	Todoroki-no-yu
346	0,48	194	48,0°	sulphated bitter	Tohi	土肥(靜岡)	„	Ana-yu
347	0.48	—	89,0°	—	Kamegawa	龜川(大分)	Andesite	Noda-no-yu
348	0,48	—	39,0°	simple	Hatage	畑毛(靜岡)	Volc. Detr.	Hatage-Onsen *No. 5*
349	0,48	—	50,0°	—	Itō	伊東(„)	Quaternary	Private bath (*S. Kumagi*)
350	0,47	360	63,0°	sulphated bitter	Asamushi	淺虫(青森)	Andesite	Yanagi-no-yu
351	0,47	—	48,5°	—	Itō	伊東(靜岡)	Quaternary	Private bath (*W. Hirose*)
352	0,47	—	46.0°	salt	Yatsu	谷津(„)	Tertiary	Ishida-Onsen
353	0,47	—	59,0°	simple	Karurusu	カルヽス(北海道)	„	Matsu-no yu
354	0,47	—	52.0°	sulphated bitter	Tohi	土肥(靜岡)	„	Private bath (*S. Asaka*)
355	0,47	—	57,0°	„	„	„	„	O-yu *Vent No. 2*
356	0,47	—	47,0°	„	Ikao	伊香保(群馬)	Andesite	Ohaguro-no-yu
357	0,46	—	50,0°	salt	Itō	伊東(靜岡)	Quaternary	Kusumi-sō-yu (*Onna-yu*)
358	0,46	149	66,0°	saline common salt	Shuzenji	修善寺(„)	Andes. and Tuff	Meiji-no-yu
359	0,46	630	76.0°	common salt	Noboribetsu	登別(北海道)	Tertiary	Shimo-no-yu
360	0,45	—	47,0°	simple	Itō	伊東(靜岡)	Quaternary	Shishido-Onsen
361	0,45	—	48,0°	—	Kamegawa	龜川(大分)	Andesite	Gomusō-no-yu
392	0,44	—	50,0°	salt	Rendaiji	蓮臺寺(靜岡)	Tertiary	Shimo-fujiwara-no-yu
363	0,44	—	40,0°	simple	Hatage	畑毛(„)	Volc. Detr.	Hatage-Onsen *No. 2*

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　　名(府縣名)	Geology	Spring
364	0,44	—	41,0°	simple	Hatage	畑　毛(靜岡)	Volc. Detr.	Hatage-Onsen *No. 3*
365	0,44	—	42,0°	salt	Rendaiji	蓮臺寺(„)	Tertiary	Shin-yoshirō-no-yu
366	0,43	—	51,0°	simple	Ōsawa	大　澤(岩手)	„	Ō-yu *Vent No. 2*
367	0,43	2473	59,0°	salt	Shima	四　萬(群馬)	Misaka Series	Hinatami-no-yu
368	0,43	—	53,0°	„	Rendaiji	蓮臺寺(靜岡)	Tertiary	Kami-fujiwara-no-yu
369	0,43	—	47,0°	„	„	„	„	Private bath (*E. Ishibashi*)
370	0,43	—	50,0°	alkaline common salt	Ogawa	小　川(富山)	Liparite	Ogawa-Onsen *No. 1*
371	0,43	126	58,0°	Acid	Dai	臺　(岩手)	Diluvium	Ō-yu
372	0,42	—	39,0°	salt	Kōchi	河　內(靜岡)	Andesite	Kami-no-yu
373	0,42	—	65,0°	„	Yatsu	谷　津(„)	Tertiary	Misawa-no-yu
374	0,42	—	71,0°	simple	Nasu—Daimaru	那須—大丸(栃木)	Andesite	Sakura-no-yu
375	0,41	—	74,5°	acid hydrogen sulphide vitriol	„ —Yumoto	„ —湯本(„)	„	Shika-no-yu
376	0,41	—	40,0°	simple	Hatage	畑　毛(靜岡)	Volc. Detr.	Hatage-Onsen *No. 7*
377	0,40	—	51,5°	sulphated bitter	Tohi	土　肥(„)	Tertiary	Private bath (*K. Hasegawa*)
378	0,40	—	37,5°	salt	Itō	伊　東(„)	Quaternary	Wada-Onsen
379	0,40	—	53,5°	sulphated bitter	Tohi	土　肥(„)	Tertiary	Tohi-kwan-no-yu *No. 1*
380	0,39	—	39,0°	simple	Hatage	畑　毛(„)	Volc. Detr.	Hatage-Onsen *No. 8*
381	0,39	432	57,0°	„	Yuno	湯　野(福島)	Tertiary	Kiri-no-yu
382	0,39	540	50,0°	„	Noboribetsu	登　別(北海道)	„	Manju-no-yu *No. 1*
383	0,38	130	55,0°	carbonated	Yugashima	湯ヶ島(靜岡)	Andes. and Tuff	Kidachiya-no-yu
384	0,38	2160	56,0°	simple	Yuno	湯　野(福島)	Tertiary	Hashimoto-no-yu
385	0,38	216	60,0°	„	Karurusu	カルヽス(北海道)	„	Tsuru-no-yu *Vent No. 1*
386	0,38	—	41,0°	„	Nagaoka	長　岡(靜岡)	„	Private bath (*S. Matsumoto*)
387	0,37	108	52,0°	„	Karurusu	カルヽス(北海道)	„	Kame-no-yu
388	0,37	—	47,0°	salt	Rendaiji	蓮臺寺(靜岡)	„	Private bath (*K. Murayama*)
389	0,37	—	40,0°	simple	Hatage	畑　毛(„)	Volc. Detr.	Hatage-Onsen *No. 1*
390	0,37	236	52,0°	earthy alkaline	Shirahone	白　骨(長野)	Chichibu Series	Ō-yu
391	0,37	25400	44,5°	sulphated bitter	Ikao	伊香保(群馬)	Andesite	Ōseki-no-yu
392	0,36	—	41,0°	saline bitter	Yoshina	吉　奈(靜岡)	„	Tōfuya-shin-yu
393	0,36	—	45,0°	salt	Rendaiji	蓮臺寺(„)	Tertiary	Kakezukaya-no-yu
394	0,36	—	70,0°	„	Yatsu	谷　津(„)	„	Yamada-Onsen
395	0,36	540	49,0°	simple	Yuno	湯　野(福島)	„	Kitsune-yu
396	0,36	1400	77,0°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Ayame-no-yu
397	0,36	—	49,5°	salt	Itō	伊　東(„)	Quaternary	Kusumi-Onsen
398	0,35	—	39,0°	simple	Hatage	畑　毛(„)	Volc. Detr.	Hatage-Onsen *No. 6*
399	0,35	—	38,0°	„	„	„	„	„ *No. 4 A*
400	0,35	—	38,0°	„	„	„	„	„ *No. 4 B*
401	0,35	—	50,0°	salt	Yatsu	谷　津(„)	Tertiary	Mageya-no-yu
402	0,34	—	50,5°	—	Itō	伊　東(„)	Quaternary	Yumoto-kwan-no-yu
403	0,34	—	86,5°	salt	Moto-kuruma	元　車(宮城)	Andesite	Ubuchi-no-yu
404	0,34	—	64,0°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Katsura-no-yu
405	0,34	—	59,5°	alkaline common salt	Ogawa	小　川(富山)	Liparite	Ogawa-Onsen *No. 3*
406	0,34	—	46,0°	salt	Rendaiji	蓮臺寺(靜岡)	Tertiary	Private bath (*K. Ogawa*)
407	0,33	—	49,0°	simple	Nagaoka	長　岡(„)	„	Tamon-yu *No. 2*
408	0,33	—	55,5°	earthy alkaline sulphur	Akakura	赤　倉(新潟)	Andesite	Akakura-Onsen *Jet No. 1*
409	0,33	—	37,5°	salt	Itō	伊　東(靜岡)	Quaternary	Me-no-yu
410	0,32	270	51,0°	sulphur	Naruko	鳴　子(宮城)	Andesite	Genzō-no-yu
411	0,32	270	54,0°	common salt	Kamegawa	龜　川(大分)	„	Kiyō-sen
412	0,31	—	72,0°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Kikuya-no-yu *No. 1*
413	0,31	441	41,5°	bitter	Ushio	海　潮(島根)	Andesite	Ushio-no-yu
414	0,31	216	69,0°	iron carbonate	Shibaseki	芝　石(大分)	„	Hijiri-yu
415	0,31	—	45,0°	salt	Rendaiji	蓮臺寺(靜岡)	Tertiary	Private bath (*I. Yoshimura*)
416	0,31	—	48,5°	—	Itō	伊　東(„)	Quaternary	Private bath (*Yoshida*)
417	0,31	529	60,0°	saline common salt	Shuzenji	修善寺(„)	Andes. and Tuff	Iwa-no-yu

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地名(府縣名)	Geology	Spring
418	0,30	ca. 450	61,0°	simple	Noboribetsu	登別(北海道)	Tertiary	Ōkawa-no-yu
419	0,30	54	48.0°	salt	Naruko	鳴子(宮城)	Andesite	Kawara-no-yu
420	0,30	—	49.5°	acid alum vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Sai-no-kawara-no-yu (*Kami-no-yu*)
421	0,30	1530	46,0°	salt	Funabara	船原(靜岡)	Andesite	Kumano-no-yu
422	0,30	265	50,0°	saline bitter	Yoshina	吉奈(〃)	„	O-yu
423	0,29	—	46,5°	—	Shigaku	志學(島根)	„	Private bath (*S. Nagira*)
424	0,29	—	47,8°	simple	Itō	伊東(靜岡)	Quaternary	Matsubara-Moto-yu
425	0,29	—	77,0°	salt	Shimogamo	下賀茂(〃)	Tertiary	Shimogamo-Kyōdō-yu
426	0,29	—	55.0°	sulphated bitter	Tohi	土肥(〃)	„	Kyōdō-yu (*Suzuki*)
427	0,29	—	49,0°	simple	Nagaoka	長岡(〃)	„	Nagaoka-Onsen *No. 3*
428	0,28	—	58,0°	carbonated	Akayu (Miyagi-ken)	赤湯(宮城)	Andesite	Goten-no-yu
429	0,27	—	100,0°	common salt	Shimogamo	下賀茂(靜岡)	Tertiary	Spring near *Ji-un-ji temple*
430	0,27	—	47.0°	—	Itō	伊東(〃)	Quaternary	Private bath (*M. Suzuki*)
431	0,27	—	57,0°	sulphated bitter	Tohi	土肥(〃)	Tertiary	„ (*Z. Yoda*)
432	0,27	—	47,0°	salt	Rendaiji	蓮臺寺(〃)	„	Bath of Zuyō middle school
433	0,27	—	48,0°	simple	Nagaoka	長岡(〃)	„	Tamon-yu *No. 1*
434	0,27	—	48,0°	„	„	〃	„	„ *No. 3*
435	0,26	—	49,0°	„	„	〃	„	Private bath (*S. Sugiyama*)
436	0,26	—	91,0°	earth-muriated common salt	Atami	熱海(〃)	Andesite	Takasagoya-no-yu
437	0,25	—	73,0°	salt	Shimogamo	下賀茂(〃)	Tertiary	Kinokuniya-no-yu
438	0,25	—	43,0°	sulphated bitter	Tohi	土肥(〃)	„	Private bath (*M. Ishiwara*)
439	0,24	abundant	92,0°	acid vitriol	Naruko	鳴子(宮城)	Andesite	Taki-no-yu *No. 2*
440	0,23	—	55,0°	sulphated bitter	Tohi	土肥(靜岡)	Tertiary	Private bath (*T. Yoshimura*)
441	0,23	—	71.5°	saline bitter sulphur	Yamashiro	山代(石川)	„	Kuraya-no-yu
442	0,23	—	44.0°	sulphur	Tsubame	燕(新潟)	Andesite	Tsubame-Onsen *Jet No. 2*
443	0,22	—	82,5°	common salt	Yugawara	湯河原(神奈川)	„	Nakanishiya-no-yu
444	0,22	—	58,0°	—	Kusatsu	草津(群馬)	Volc. Detr.	Shirahata-no-yu
445	0,22	198	57.0°	common salt	Kamegawa	龜川(大分)	Andesite	Shi-no-yu
446	0,22	—	99,0°	—	„	〃	„	Kamado-no-yu
447	0,21	—	48,0°	sulphur	Noboribetsu	登別(北海道)	Tertiary	Manju-no-yu *No. 2*
448	0,21	—	43.5°	—	Itō	伊東(靜岡)	Quaternary	Private bath (*Kobayashi*)
449	0,21	270	52,0°	salt	Yugano	湯ケ野(〃)	Andesite	Yugano-Onsen
450	0,20	684	47,0°	saline bitter	Funabara	船原(〃)	„	Kōgyoku-no-yu *No. 1*
451	0,20	—	52,0°	sulphated bitter	Tohi	土肥(〃)	Tertiary	Asaka-no-yu *No. 2*
452	0,19	—	50,0°	simple	Nagaoka	長岡(〃)	„	Nagaoka-Onsen *No. 2*
453	0,18	—	43,0°	acid alum vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Sai-no-kawara-no-yu (*Shimo-no-yu*)
454	0,18	108	53,0°	acid	Dai	臺(岩手)	Diluvium	Yakushi-no-yu
455	0,18	—	88,5°	common salt	Yugawara	湯河原(神奈川)	Andesite	Uenoya-no-yu
456	0,18	—	53,0°	simple	Nagaoka	長岡(靜岡)	Tertiary	Nagaoka-Onsen *No. 4*
457	0,18	54000	71,5°	acid vitriol	Noboribetsu	登別(北海道)	„	Taki-no-yu
458	0,18	86	80,0°	earth-muriated common salt	Atami	熱海(靜岡)	Andesite	Furuya-no-yu
459	0,17	—	52,0°	simple	Kona	古奈(〃)	Tertiary	Kona-Onsen
460	0,17	—	56,0°	—	Kusatsu	草津(群馬)	Volc. Detr.	Chiyo-no-yu
461	0,17	—	93,0°	alkaline	Naruko	鳴子(宮城)	Andesite	Shin-unagi-no-yu
462	0,17	126	42,0°	salt	Konabe	小鍋(靜岡)	„	Konabe-Onsen
463	0,16	—	56,0°	acid alum vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Netsu-no-yu
464	0,16	—	46,0°	simple	Itō	伊東(靜岡)	Quaternary	Matsubara-Shin-yu
465	0,15	—	54.5°	common salt	Yugawara	湯河原(神奈川)	Andesite	Yuya-no-yu
466	0,15	126	49,0°	saline bitter	Yoshina	吉奈(靜岡)	„	Tōfuya-no-yu
467	0.15	86	41,0°	carbonated	Yugashima	湯ケ島(〃)	Andes. and Tuff	Kidachi-yu
468	0.15	—	40,0°	saline bitter	Funabara	船原(〃)	Andesite	Kōgyoku-no-yu *No. 3*
469	0,15	86	67,0°	saline common salt	Shuzenji	修善寺(〃)	Andes. and Tuff	Hana-no-yu
470	0,14	—	80,0°	common salt	Yugawara	湯河原(神奈川)	Andesite	Izuya-no-yu
471	0,14	466	97,0°	earth-muriated common salt	Atami	熱海(靜岡)	„	Ozawa-no-yu *No. 2*

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地名(府縣名)	Geology	Spring
472	0,14	ca. —	56,5°	acid alum vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Jizō-no-yu
473	0,14	—	77,0°	eatrh-muriated common salt	Atami	熱海(靜岡)	Andesite	Ishi-yu
474	0,13	—	58,0°	acid hydrogen sulphide alum vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Yubatake-no-yu
475	0,13	389	91,0°	acid alum vitriol	Myōban	明礬(大分)	Andesite	Jizō-no-yu
476	0,13	—	64,0°	aline common salt	Shuzenji	修善寺(靜岡)	Andes. aud Tuff	Ma-yu
477	0,13	abundant	103,0°	alkaliue sulphur	Naruko	鳴子(宮城)	Andesite	Unagi-no-yu
478	0,13	—	60,0°	acid vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Washi-no-yu
479	0,11	180	59,0°	carbonated	Kamegawa	龜川(大分)	Andesite	Hamada-Onsen
480	0,10	abundant	60,0°	sulphated bitter	Izusan	伊豆山(靜岡)	,,	Hashiri-yu
481	0,10	—	45,0°	simple	Nagaoka	長岡(,,)	Tertiary	Nagaoka-Onsen *No. 1*
482	0,09	—	48,0°	sulphur	Tsubame	燕(新潟)	Andesite	Tsubame-Onsen *Jet No. 1*
483	0,08	140	48,0°	earth-muriated common salt	Atami	熱海(靜岡)	,,	Me-no-yu
484	0,08	241	93,0°	,,	,,	,,	,,	Komatsu-no-yu
485	0,07	—	43,0°	common salt	Yugawara	湯河原(神奈川)	,,	Ōkura-no-yu
486	0,04	1296	108,0°	earth-muriated common salt	Atami	熱海(靜岡)	,,	Ō-yu
487	0,02	—	81,0°	,,	,,	,,	,,	Kawara-no-yu
	Emanation per litre of gas at 0° C.							Gas evolving from:
1	28,44	—	—	—	Tamatsukuri (Shimane-ken)	玉造(島根)	Tertiary	River bed *C*
2	25,98	—	95,0°	alkaline carbon-dioxated	Yumura (Hyōgo-ken)	湯村(兵庫)	Granite	Ara-yu
3	24,44	—	—	—	Tamatsukuri (Shimane-ken)	玉造(島根)	Tertiary	River bed *B*
4	14,60	—	39,5°	carbonated	Deyu	出湯(新潟)	Granite	Chōsen-kutsu-no-yu
5	13,37	—	51,0°	—	Kachimi	勝見(鳥取)	,,	Private bath *Vent No. 2* (*Kurozumi-kyō*)
6	9,63	—	42,5°	sulphur	Yoshioka	吉岡(,,)	Tertiary	Shimo-no-yu
7	8,73	—	59,5°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Ishi-yu
8	7,07	—	70,0°	,,	,,	,,	,,	Kikuya-no-yu *No. 2*
9	4,99	—	76,0°	acid vitriol	Kamegawa	龜川(大分)	Andesite	Chinoike-Jigoku *Vent No. 2*
10	4,82	—	76,0°	,,	,,	,,	,,	,, *Vent No. 1*
11	4,56	—	37,7°	earth-muriated common salt	Yunogō	湯郷(岡山)	Liparite	Shin-Sagi-no-yu
12	4,11	—	37,0°	,,	,,	,,	,,	Sagi-no-yu (*Onna-yu*)
13	4,11	—	69,0°	saline common salt	Shuzenji	修善寺(靜岡)	Andes. and Tuff	Dokko-no-yu
14	3,34	—	48,0°	simple	Nagaoka	長岡(,,)	Tertiary	Tamon-yu *No. 3*
15	3,31	—	50,0°	sulphated common salt	Yunotsu	溫泉津(島根)	,,	Kyū-yu
16	1,91	—	69,0°	iron carbonate	Shibaseki	芝石(大分)	Andesite	Hijiri-yu
17	1,77	—	47,0°	saline bitter	Funabana	船原(靜岡)	,,	Kōgyoku-no-yu *No. 1*
18	1,56	—	46,5°	common salt	Shigaku	志學(島根)	,,	Shigaku-Onsen
19	1,37	—	60,0°	acid vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Washi-no-yu
20	1,29	—	53,0°	simple	Nagaoka	長岡(靜岡)	Tertiary	Nagaoka-Onsen *No. 4*
21	1,19	—	47,8°	,,	Itō	伊東(,,)	Quaternary	Matsubara-Moto-yu
22	1,05	—	52,0°	earthy alkaline	Shirahone	白骨(長野)	Chichibu Series	Ō-yu
23	0,83	—	58,0°	acid hydrogen sulphide alum vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Yubatake-no-yu
24	0,71	—	56,0°	—	,,	,,	,,	Chiyo-no-yu
25	0,70	—	56,0°	acid alum vitriol	,,	,,	,,	Netsu-no-yu
26	0,66	—	58,0°	—	,,	,,	,,	Shirahata-no-yu
27	0,65	—	56,5°	acid alum vitriol	,,	,,	,,	Jizō-no-yu

(B) Cold Springs.

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地 名(府縣名)	Geology	Spring
		ca.	air temp.					
1	617,59	22	21.5° (23,5°)	earthy common salt	Masutomi	増 富(山梨)	Granite	Kamigawara *No. 1*
2	575,02	—	14,0°	,,	,,	,,	,,	,, *No. 2*
3	409,31	13	21.5° (4°)	common salt	,,	,,	,,	Kuridaira *No. 1 Vent C*
4	388,14	100	20,0° (4°)	,,	,,	,,	,,	,, *No. 1 Vent A*
5	312,54	77	22,5° (4°)	earthy common salt	,,	,,	,,	Nibuzawa *No. 1*
6	298,33	—	19,0° (14,5°)	—	,,	,,	,,	Ōshiba *No. 1*
7	298,22	—	18,0°	—	,,	,,	,,	Yunokubo *No. 1*
8	291,93	100	20,0°	common salt	,,	,,	,,	Kuridaira *No. 1 Vent B*
9	258,50	13	20,0° (10,5°)	—	,,	,,	,,	,, *No. 3*
10	257,42	—	10,0° (13°)	simple	Takayama	高 山(岐阜)	,,	Ena-Kōsen (*Yunoshima*)
11	240,20	45	17,5° (7°)	earthy common salt	Masutomi	増 富(山梨)	,,	Tsugane-yu *No. 1* (*A*)
12	239,22	—	15,0° (10,5°)	,,	,,	,,	,,	Yunokubo-gawara-no-yu
13	160,34	—	17,0° (12°)	carbonated (?)	Ikeda	池 田(島根)	,,	Nobata-shin-yu
14	146,97	—	18,5°	—	Masutomi	増 富(山梨)	,,	Hatchō-jyaya-shita *No. 1*
15	109,96	—	30,0° (11°)	—	,,	,,	,,	Ginsen-tō
16	86,27	13	19,0° (7°)	earthy common salt	,,	,,	,,	Tsugane-yu *No. 1* (*B*)
17	83,35	—	16,0° (7°)	,,	,,	,,	,,	,, *No. 1* (*C*)
18	75,62	—	10,0°	—	,,	,,	,,	Yunomukai *No. 1*
19	72,26	—	12,0° (20°)	simple	Hirukawa	蛭 川(岐阜)	,,	Ena-Kōsen (*Dairi-Yakushi*)
20	63,92	—	13,0° (19°)	,,	Takayama	高 山(,,)	,,	,, (*Shimizu-ido*)
21	56,41	—	28,5° (24,5°)	,,	Tochiomata	栃 尾 又(新潟)	,,	Tochiomata-no-yu *No. 4*
22	46,04	530	25,6° (30°)	,,	Murasugi	村 杉(,,)	,,	Murasugi-Kōsen *No. 1*
23	42,59	—	26,0° (31,5°)	,,	,,	,,	,,	,, *No. 2*
24	40,28	—	13.5° (30°)	,,	,,	,,	,,	,, *No. 3*
25	39,51	236	36,0° (27,5)	,,	Tochiomata	栃 尾 又(,,)	,,	Jizai-kwan-uchi-yu *No. 1*
26	31,90	—	13,0° (21°)	,,	Takayama	高 山(岐阜)	,,	Okuhora
27	30,36	—	13,0° (19°)	,,	,,	,,	,,	Inari-no-yu
28	27,18	—	35,5° (26°)	,,	Tochiomata	栃 尾 又(新潟)	,,	Tochiomata-no-yu *No. 3*
29	25,77	—	12,0° (20°)	,,	Hirukawa	蛭 川(岐阜)	,,	Shimo-isshiki
30	25,16	—	11,0° (20°)	,,	Takayama	高 山(,,)	,,	Yamaki-no-yu
31	23,70	—	10,0° (21,5°)	,,	,,	,,	,,	Ichi-no-sawa *No. 1*
32	19,42	—	12,0° (23°)	,,	,,	,,	,,	Shimoyama *No. 1*
33	18,48	—	—	,,	,,	,,	,,	Kami-no-ido
34	17,13	—	—	,,	,,	,,	,,	Bunsaku-ido
35	17,08	—	9,5° (21°)	,,	,,	,,	,,	Ichi-no-sawa *No. 3*
36	*15,77	—	—	carbonated	Kasubuchi	粕 淵(島根)	Liparite	Kasubuchi-no-yu
37	*15,38	—	—	simple	Takayama	高 山(岐阜)	Granite	Spring *A*
38	15,18	—	33,5° (9°)	—	Misasa	三 朝(鳥取)	,,	Spring *C*
39	14,20	—	—	simple	Takayama	高 山(岐阜)	,,	Shishi-no-neya
40	13,74	—	22,5° (30°)	,,	Murasugi	村 杉(新潟)	,,	Shiroyama-Kōsen
41	13,32	—	10,0° (7°)	,,	Komono	菰 野(三重)	,,	Spring *A*
42	13,00	—	14.5° (9,2°)	,,	Kaidani	栢 谷(岡山)	,,	Tomada-no-yu
43	11,57	—	33,0° (27°)	carbonated	Deyu	出 湯(新潟)	,,	Tōshundai-no-yu *No. 1*
44	11,31	—	31,0° (28°)	,,	,,	,,	,,	,, *No. 2*
45	* 9,69	108	15,7°	,,	Tombara	頓 原(島根)	,,	Kamiyasumi-Kōsen
46	9,69	—	—	simple	Bobata	母 畑(福島)	Gneiss	Spring *B* (*K. Watanabe*)
47	8,77	—	8,2°	—	Masutomi	増 富(山梨)	Granite	Taikarizawa *No. 2*
48	8,42	—	4,5°	—	,,	,,	,,	,, *No. 3*
49	8,18	abundant	29,0° (13°)	simple	Komono	菰 野(三重)	,,	Shika-no-yu
50	7,45	—	18,7° (32°)	,,	Imaita	今 板(新潟)	—	Imaita-Kōsen *No. 1*
51	6,99	—	33,5° (29,5°)	carbonated	Deyu	出 湯(,,)	Granite	Shiraneya-no-yu
52	6,54	—	8,2°	—	Masutomi	増 富(山梨)	,,	Taikarizawa *No. 1*

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地 名(府縣名)	Geology	Spring
		ca.	air temp.					
53	5,87	—	36,0°	salt	Matsuzaki	松　崎(鳥取)	Andesite	Matsuzaki-kwan-no-yu
54	5,83	25	24,4° (15°)	—	Yoshikata	吉　方(〃)	Alluvium	Kinka-Onsen
55	5,46	—	9,0° (3,5°)	simple	Shinji	宍　道(島根)	Granite	Ippai-shimizu
56	5,30	—	34,0°	saline bitter	Higashiyama	東　山(福島)	Andesite or Tertiary	Nuru-yu
57	4,93	—	19,0° (1°)	simple	Yumura (Shimane-ken)	湯　村(島根)	Granite	Spring *C*
58	4,55	—	32,0°	salt	Matsuzaki	松　崎(鳥取)	Andesite	Spring (in *Matsuzaki Station*)
59	4,32	390	28,0° (16°)	simple	Takebe	建　部(岡山)	Granite	Yawata-Onsen
60	4,19	—	16,0° (32°)	,,	Imaita	今　板(新潟)	—	Imaita-Kōsen *No. 2*
61	4,19	—	—	—	Misasa	三　朝(鳥取)	Granite	Drinking water (*N. Okazaki*)
62	4,08	—	—	simple	Nekonaki	猫　啼(福島)	Gneiss	Spring *A* (*Chōraku-en*)
63	4,03	—	9,0°	—	Masutomi	增　富(山梨)	Granite	Toyanosawa *No. 1*
64	3,87	—	35,6° (14°)	—	Yoshikata	吉　方(鳥取)	Alluvium	Shiratama-Onsen
65	3,59	—	14,0° (16,5°)	—	Shimo-sase	下佐世(島根)	Granite	Drinking water
66	3,49	90	32,0° (11°)	alkaline common salt	Yudani	湯　谷(鳥取)	Tertiary	Kabu-yu
67	3,33	15	—	—	Yoshikata	吉　方(〃)	Alluvium	Kinoe-Onsen *No. 1*
68	3,26	—	14,0° (28°)	simple	Haguro	羽　黑(新潟)	—	Uba-yu
69	3,18	—	—	,,	Nekonaki	猫　啼(福島)	Gneiss	Spring *C* (*Yakōji temple*)
70	3,15	—	10,5°	—	Masutomi	增　富(山梨)	Chichibu Series ?	Akashibu *No. 3*
71	3,14	—	24,0° (12°)	carbonated (?)	Ikeda	池　田(島根)	Granite	Nobata-no-yu
72	* 3,09	—	—	—	Yumura (Hyōgo-ken)	湯　村(兵庫)	,,	Drinking water at Chimizu
73	3,07	—	—	simple	Nekonaki	猫　啼(福島)	Gneiss	Spring *E*
74	3,04	—	31,0°	,,	Tōgō	東　鄉(鳥取)	Andesite	Yōjyō-kwan-no-yu *No. 5*
75	3,02	—	11,5° (14°)	,,	Misasa	三　朝(〃)	Granite	Spring *A* (*K. Tsugawa*)
76	2,97	—	12,0°	—	Masutomi	增　富(山梨)	Chichibu Series ?	Akashibu *No. 2*
77	2,95	—	12,5° (21°)	simple	Takayama	高　山(岐阜)	Granite	Ichinosawa *No. 2*
78	2,95	—	10,5°	—	Kami-sekisuiji	上積翠寺(山梨)	,,	Yōsō-Onsen
79	2,94	—	—	simple	Bobata	母　畑(福島)	Gneiss	Naka-no-yu *No. 2*
80	2,92	—	14,0°	—	Masutomi	增　富(山梨)	Chichibu Series ?	Itaya *No. 1*
81	2,86	—	12,0°	—	,,	,,	Granite	Umamichizawa *No. 1*
82	2,64	—	28,0°	simple	Sekine-Yunosawa	關根湯澤(山形)	Gneiss	Yunosawa-Onsen
83	2,61	—	13,0°	—	Masutomi	增　富(山梨)	Chichibu Series ?	Akashibu *No. 1*
84	2,36	—	—	simple	Bobata	母　畑(福島)	Gneiss	Shimo-no-yu *No. 2*
85	2,29	362	33,0°	—	Masutomi	增　富(山梨)	Granite	Kinsen-tō
86	2,27	—	36,5° (29°)	simple	Asama	淺　間(長野)	Tertiary	Me-no-yu
87	2,24	15	26,0° (17°)	—	Masutomi	增　富(山梨)	Granite	Kuridaira *No. 2* (*A*)
88	2,18	—	—	simple	Nekonaki	猫　啼(福島)	Gneiss	Tomaki-furu-yu
89	2,13	—	12,0°	—	Masutomi	增　富(山梨)	Chichibu Series ?	Itaya *No. 2*
90	2,12	—	3,9°	—	,,	,,	Granite	Matsudaira *No. 1*
91	* 2,02	—	—	—	Yumura (Hyōgo-ken)	湯　村(兵庫)	,,	Drinking water at Shin-machi
92	2,02	—	35,5°	salt	,, (Yamanashi-ken)	〃 (山梨)	Alluvium	Tani-Onsen
93	1,95	—	—	simple	Nekonaki	猫　啼(福島)	Gneiss	Spring *D*
94	* 1,95	—	—	—	Shimo-oritate	下折立(新潟)	Granite	Ibo-no-yu
95	1,92	11	20,0° (17°)	—	Masutomi	增　富(山梨)	,,	Kuridaira *No. 2* (*C*)
96	1,91	—	—	—	Kami-sase	上佐世(島根)	,,	Drinking water
97	1,89	—	—	simple	Bobata	母　畑(福島)	Gneiss	Toi-no-kuchi
98	* 1,88	—	—	—	Sugatani	菅　谷(新潟)	Alluvium	Sugatani-Kōsen
99	1,86	—	22 5° (15°)	—	Shigaku	志　學(島根)	Andesite	Spring *A*
100	1,86	—	33,8°	salt	Yumura (Yamanashi-ken)	湯　村(山梨)	,,	Kōbōzue-Onsen
101	1,85	—	14,5° (14°)	simple	Masutomi	增　富(〃)	Granite	Ōshiba *No. 2*
102	1,82	—	—	,,	Nekonaki	猫　啼(福島)	Gneiss	Spring *B* (*Chaya*)
103	1,55	36	11,0°	,,	Kami-sekisuiji	上積翠寺(山梨)	Andesite	Yōgai-Onsen
104	1,52	—	—	,,	Bobata	母　畑(福島)	Gneiss	Spring *A* (*C. Yabe*)
105	1,35	—	—	—	Yoshikata	吉　方(鳥取)	Alluvium	Kinoe-Onsen *No. 2*

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地名(府縣名)	Geology	Spring
		ca.	air temp.					
106	1,33	—	12,5°	—	Isobe (Gumma-ken)	磯部(群馬)	Tertiary	Ji-no-yu
107	1,24	—	34,0°	simple	Ōyuzawa	大湯澤(秋田)	Diluvium	Shimo-naizawa-no-yu
108	* 1,22	—	—	—	Hōgijiku	寶木宿(鳥取)	Granite	Drinking water (*U. Miyaishi*)
109	1,19	—	28,0° (30°)	—	Yamabe	山邊(長野)	Tertiary	Mitarashi-no-yu
110	1,18	29	13,0° (12°)	carbondioxated common salt	Kawai	川合(島根)	Granite	Urisaka-no-yu
111	1,14	—	9,0° (2°)	simple	Yumura (Shimane-ken)	湯村(„)	„	Spring *E*
112	1,10	—	16,0° (13°)	—	Ishioka	石岡(茨城)	Diluvium	Well (*K. Hasegawa*)
113	* 1,10	—	—	—	Komatsu	小松(石川)	Alluvium	Komatsu-Kōsen *A* (*K. Araki*)
114	* 1,09	—	—	—	Hōgijiku	寶木宿(鳥取)	Granite	Well (*Koizumi-ryokwan*)
115	1,08	—	28,0°	hydrogen sulphide	Nasu—Yumoto	那須—湯本(栃木)	Andesite	Kiraku-no-yu
116	1,06	—	—	—	Ushio	海潮(島根)	„	Drinking water
117	* 1,02	—	—	—	Utsuno	宇津野(新潟)	—	Sakamoto-no-yu
118	1,01	29	14,0° (12°)	earth-muriated iron carbon-dioxated common salt	Kawai	川合(島根)	Granite	Tokōji-no-yu
119	1,01	—	13,6° (13°)	muriated alkaline	Kasagi	笠置(京都)	„	Kasagi-Kōsen *No. 1*
120	1,00	—	25,0° (10°)	sulphur (?)	Yunogō	湯郷(岡山)	Liparite	Me-no-yu
121	0,98	180	33,5°	hydrogen sulphide common salt	Ōyuzawa	大湯澤(秋田)	Diluvium	*No. 39*
122	0,98	—	26,0° (13°)	—	Tera-machi [Tottori]	寺町(鳥取)	Alluvium	Ebisu-Onsen
123	0,97	—	17,5° (15°)	common salt	Shingū	新宮(石川)	Granite	Shingū-Kōsen *No. 1*
124	0,96	—	—	—	Yunogō	湯郷(岡山)	Liparite	Well (*M. Suminami*)
125	0,95	—	16,0° (14°)	—	Tadate	田館(茨城)	Tertiary	Shibu-ido (*Ō-sen*)
126	0,94	—	16,0° (15°)	common salt	Shingū	新宮(石川)	Granite	Shingū-Kōsen *No. 2*
127	* 0,92	—	21,1°	—	Komatsu	小松(„)	Alluvium	Komatsu-Kōsen *B* (*Y. Sakai*)
128	0,90	650	32,0°	iron carbonate	Akayu (Akita-ken)	赤湯(秋田)	Diluvium	Akayu-Onsen
129	0,89	—	12,0° (4°)	simple	Hinobori	日登(島根)	Granite	Spring *A*
130	0,84	—	13,6° (13°)	muriated alkaline	Kasagi	笠置(京都)	„	Kasagi-Kōsen *No. 2*
131	0,78	—	—	—	Tōkyō—Azabu-ku	麻布(東京)	Diluvium	Well (*S. Okabayashi*)
132	0,77	—	—	—	Yunogō	湯郷(岡山)	Liparite	„ (*T. Odaka*)
133	0,75	—	—	—	Tōkyō—Azabu-ku	麻布(東京)	Diluvium	„ (*K. Kobayashi*)
134	0,72	—	—	salt	Gakutō	學頭(島根)	Tertiary	Sudani-yakutō
135	0,67	—	—	—	Yunogō	湯郷(岡山)	Liparite	Well (*G. Maruyama*)
136	* 0,66	—	22,0°	—	Kōbu	構武(島根)	Alluvium	Myōbun-Kōsen
137	* 0,64	—	—	—	Hōgijiku	寶木宿(鳥取)	Granite	Well (*S. Hori*)
138	0,64	—	6,0° (1°)	simple	Yumura (Shimane-ken)	湯村(島根)	„	Spring *D*
139	* 0,63	—	—	„	Koyabara	小屋原(„)	Andesite	Spring *B*
140	0,61	—	12,5° (29°)	„	Futami	二見(富山)	Granite	Spring *A*
141	0,58	—	29,0° (30°)	—	Yamabe	山邊(長野)	Tertiary	Oboke-no-yu
142	0,55	—	14,0° (13,5°)	—	Ishioka	石岡(茨城)	Diluvium	Well (*O. Nakazawa*)
143	* 0,51	—	—	—	Tōkyō—Azabu-ku	麻布(東京)	„	„ (*T. Mamoru*)
144	0,49	—	17,0° (14°)	—	Ishioka	石岡(茨城)	„	„ (*T. Hasegawa*)
145	0,49	—	—	simple	Bobata	母畑(福島)	Gneiss	Shimo-no-kyū-yu
146	0,44	—	18,5° (15°)	—	Ōmori	大森(東京)	Alluvium	Well (*Seikwa-en*)
147	0,42	864	27,0°	salt	Gakutō	學頭(島根)	Tertiary	Yunokawa-Kōsen
148	* 0,42	—	—	—	Tōkyō—Azabu-ku	麻布(東京)	Diluvium	Well (*H. Miyanohara*)
149	0,42	—	34,0°	—	Itō	伊東(靜岡)	Quaternary	Private bath (*S. Kitazato*)
150	0,41	—	16,0° (16,5°)	—	Kawasaki (Kanagawa-ken)	川崎(神奈川)	Alluvium	Dokumizu
151	0,40	3370	17,0° (18°)	earth-muriated common salt	Ōmori	大森(東京)	„	Morigasaki-Kōsen
152	0,35	—	29,0°	—	Shimoda	下田(靜岡)	—	Akama-Kōsen *No. 1*
153	0,33	—	22,0°	—	„	„	—	„ *No. 2*
154	0,28	—	14,0° (14°)	simple	Ishioka	石岡(茨城)	Granite	Spring *A* (*Kankyo-zan*)
155	0,28	—	36,0°	sulphated bitter	Tohi	土肥(靜岡)	Tertiary	Takasagoya-no-yu
156	* 0,27	—	—	—	Saizu	西豆(„)	„ (?)	Yagizawa-Kōsen *A*
157	* 0,26	—	—	—	Atami	熱海(„)	Andesite	Drinking water (*G. Miura*)
158	0,25	—	31,0°	—	Shimoda	下田(„)	—	Fuji-no-yu

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地 名(府縣名)	Geology	Spring
159	0,25	ca. —	air temp. —	—	Baba-machi [Tottori]	馬 場 町(鳥取)	Alluvium	Yōrō-no-yu
160	0.23	—	35,0°	saline bitter	Funabara	船 原(靜岡)	Andesite	Kōgyoku-no-yu *No. 2*
161	* 0,19	—	15,0°	acid vitriol	Noroshi	狼 煙(石川)	Alluvium	Noroshi-Kōsen
162	0,19	—	—	—	Ōsaki	大 崎(東京)	Diluvium	Well (*T. Kakehi*)
163	0,18	—	—	simple	Bobata	母 畑(福島)	Gneiss	Spring *C*
164	0,14	—	15,0°	sulphur	Nakaishida	中 石 田(靜岡)	Volc. Detr.	Kametsuru-Onsen
165	0,12	77	34.5° (16°)	carbondioxated common salt	Fukumitsu	福 光(島根)	Tertiary	Yunohara-Onsen
166	0,11	—	33.5°	salt	Itō	伊 東(靜岡)	Quaternary	Yuda Onsen
167	0,03	—	—	—	Kusatsu	草 津(群馬)	Volc. Detr.	Drinking water
Emanation per litre of gas at 0° C.								Gas evolving from:
1	539,99	—	15 0° (10,5°)	earthy common salt	Masutomi	増 富(山梨)	Granite	Yunokubogawara-no-yu
2	169,98	—	26,0° (31,5°)	simple	Murasugi	村 杉(新潟)	„	Murasugi-Kōsen *No. 2*
3	18,16	—	24,0° (12°)	carbonated (?)	Ikeda	池 田(島根)	„	Nobata-no-yu
4	4,74	—	25.0° (10°)	sulphur (?)	Yunogō	湯 郷(岡山)	Liparite	Me-no-yu
5	2,21	—	13,0° (12)	carbondioxated common salt	Kawai	川 合(島根)	Granite	Urisaka-no-yu
6	2,03	—	14,0° (12°)	earth-muriated iron carbon-dioxated common salt	„	„	„	Tōkōji-no-yu
7	0,84	—	16,0° (16,5°)	—	Kawasaki	川 崎(神奈川)	Alluvium	Doku-mizu
8	0,03	—	34.5° (16°)	carbondioxated common salt	Fukumitsu	福 光(島根)	Tertiary	Yunohara-Onsen

Table 3.

The determination of radium emanation was carried on with the fontactoscope of C. Engler and H. Sieveking.

†I. Determined according to the authors' original direction.

‡II. Correction for the absorption of the radiation by the wall of the ionisation chamber was made.

§III. Correction for the loss of emanation by inserting dissipation cylinder in the ionisation chamber was also made.

No.	Emanation per litre of water in Mache's units			Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地 名(府縣名)	Geology	Spring
	I†	II‡	III§							
1	9,67	11,65	11,88	ca. —	50,0°	earthy common salt	Yunokawa	湯 川(北海道)	Liparite	Shin-yu *No. 2* (*Kinchō-kwan*)
2	9,42	10,87	11,09	216	50,0°	earth-muriated common salt	„	„	„	Taki-no-yu („)
3	7,05	8,13	8,29	—	66,0°	earthy common salt	Nezaki	根 崎(„)	„	Rikuzō-no-yu
4	2,72	3,15	3,21	152	76,0°	earth-muriated common salt	Awara	蘆 原(福井)	Alluvium	Funatsu *No. 10*
5	2,36	2,73	2,79	152	70,5°	„	„	„	„	„ *No. 21*
6	2,26	2,61	2,66	152	75,0°	„	„	„	„	Nimen *No. 28*
7	2,06	2,38	2,43	3944	62,0°	bitter	Kaminoyama	上 ノ 山(山形)	Liparite	Hie-no-yu
8	1,85	2,14	2,18	152	68,2°	earth-muriated common salt	Awara	蘆 原(福井)	Alluvium	Tanaka-naka *No. 6*
9	1,83	2,12	2,16	152	70,0°	„	„	„	„	Funatsu *No. 9*
10	1,54	1,77	1,81	152	63,0°	„	„	„	„	Tanaka-naka *No. 22*
11	1,51	1,75	1,79	152	53,0°	„	„	„	„	Nimen *No. 21*
12	1,08	1,25	1,28	152	74,0°	„	„	„	„	Funatsu *No. 6*
13	1,04	1,20	1,22	1530	42,0°	earthy common salt	Miyagawa	宮 川(北海道)	Andesite	Miyagawa-no-yu
14	0,91	1,09	1,11	270	45,5°	hydrogen sulphide common salt	Ōyuzawa	大 湯 澤(秋田)	Diluvium	*No. 38* (*Ō-yu*)
15	0,91	1,05	1,07	—	8,0°	—	Matsuida	松 井 田(群馬)	Tertiary	Ushio-Kōsen
16	0,82	0,95	0,97	—	7,5°	—	„	„	„	Yunosawa-Kōsen (*Kongō-ji*)

No.	Emanation per litre of water in Mache's units			Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
	I†	II‡	III§							
				ca.						
17	0,65	0,75	0,77	—	37,0°	common salt	Irinoyu	入之湯(群馬)	Andesite	Iri-no-yu
18	0,64	0,74	0,75	7	9,5°	alkaline	Matsuida	松井田(„)	Tertiary	Rokutanda-Kōsen
19	0,63	0,73	0,74	—	31,5°	common salt	Irinoyu	入之湯(„)	Andesite	Kaede-no-yu
20	0,61	0,71	0,72	—	33,5°	„	„	„	„	Me-no-yu
	Emanation per litre of gas at 0° C.									Gas evolving from:
1	85,97	99,14	101,03	—	66,0°	earthy common salt	Nezaki	根　崎(北海道)	Liparite	Rikuzō-no-yu
2	70,04	80,76	82,31	—	50,0°	earth-muriated common salt	Yunokawa	湯　川(„)	„	Taki-no-yu (*Kinchō-kwan*)
3	63,14	72,78	74,17	—	50,0°	earthy common salt	„	„	„	Shin-yu *No. 2* („)
4	33,55	38,69	39,43	—	76,0°	earth-muriated common salt	Awara	盧　原(福井)	Alluvium	Funatsu *No. 10*
5	22,45	25,88	26,37	—	70,0°	„	„	„	„	„ *No. 9*
6	13,45	15,51	15,80	—	62,0°	bitter	Kaminoyama	上ノ山(山形)	Liparite	Hie-no-yu
7	4,55	5,25	5,35	—	45,5°	hydrogen sulphide common salt	Oyuzawa	大湯澤(秋田)	Diluvium	*No. 38 (Ō-yu)*
8	3,54	4,08	4,16	—	42,0°	earthy common salt	Miyagawa	宮　川(北海道)	Andesite	Miyagawa-no-yu

Table 4.

The quantity of radium emanation and the temperature of springs in the following table were determind by Den'itirô Ishitani, Prof. of Physics, Imperial Peers' College, co-operated partly with Kaichirō Manabe, partly with Ichirō Yamakawa (both being assistants of Medical Faculty of Tōkyō Imperial University). As for particulars refer to Proceeding of the Tôkyô Mathematico-Physical Society (Tôkyô Sûgaku-Buturigakkwai Kizi), 2nd Ser.:

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For recalculation of Mache's units from the international unit following factor was used:

$$1 \times 10^{-10} \text{ curie} = 0{,}275 \text{ Mache's units.}$$

No.	Emanation per litre of water		Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
	in 10^{-10} curies	in Mache's units (recalculated)							
			ca.	air temp.					
1	138,00	*37,95*	—	>31,0°	—	Arima	有　馬(兵庫)	Quartz Porph.	Zuihōji-Onsen
2	42,00	*11,55*	—	>52,6°	salt	Tōgatta	遠刈田(宮城)	Liparite	Taki-no-yu
3	38,90	*10,70*	335	55,9°	carbonated	„	„	„	Kami-no-yu
4	31,40	*8,64*	—	19,0°	earth-muriated iron carbonate common salt (?)	Arima	有　馬(兵庫)	Quartz Porph	Maruyama-Kōsen
5	26,70	*7,34*	—	63,1°	earth-muriated common salt	Kinosaki	城　崎(„)	Tertiary	Gosho-no-yu *Vent A*
6	18,35	*5,05*	204	63,0°	„	„	„	„	Kō-no-yu
7	14,70	*4,04*	—	20,6° (3,5°)	muriated sulphur	Takedao	武田尾(„)	Quartz Porph.	Yumoto
8	13,60	*3,74*	—	46,0°	simple	Dōgo	道　後(愛媛)	Granite	Yōjō-yu
9	13,10	*3,60*	—	17,5° (24°)	—	Shioyu	鹽　湯(宮城)	—	Shio-yu
10	12,95	*3,56*	—	46,0°	simple	Dōgo	道　後(愛媛)	Granite	Kami-no-yu
11	12,90	*3,55*	—	91,0°	earth-muriated common salt	Wakura	和　倉(石川)	Tertiary	Artes. Well of Wakazaki
12	12,50	*3,41*	270	51,0°	salt	Sakunami	作　並(宮城)	„	Tsuru-no-yu
13	12,00	*3,30*	216	59,3°	earth-muriated common salt	Kinosaki	城　崎(兵庫)	„	Yanagi-yu
14	11,00	*3,03*	—	51,3°	salt	Tōgatta	遠刈田(宮城)	Liparite	Common bath in Naka-no-yu
15	10,40	*2,86*	—	24,6° (5,5°)	muriated sulphur	Takedao	武田尾(兵庫)	Quartz Porph.	Moto-yu
16	9,98	*2,75*	—	60,0°	earth-muriated common salt	Kinosaki	城　崎(„)	Tertiary	Ichi-no-yu *Vent B*

No.	Emanation per litre of water: in 10^{-10} curies	in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
			ca.	air temp.					
17	9,68	*2,66*	—	57,0°	saline bitter	Shiobara—Ōami	鹽原—大網(栃木)	Tertiary	Onna-yu
18	9,49	*2.59*	—	61,5°	earth-muriated common salt	Kinosaki	城崎(兵庫)	,,	Gosho-no-yu *Vent B*
19	8,92	*2,45*	—	44.5°	,,	,,	,,	,,	Mandara-no-yu *Vent E*
20	8,86	*2,44*	—	48,8°	salt	Sakunami	作並(宮城)	,,	Iwamatsu-Shin-yu
21	8,72	*2,40*	—	46,6°	,,	,,	,,	,,	Me-no-yu
22	8,58	*2,36*	270	50 6°	,,	,,	,,	,,	Kame-no-yu
23	8,24	*2.27*	—	8,8° (5°)	carbonated	Namaze	生瀨(兵庫)	Granite	Namaze-Kōsen
24	8,16	*2,24*	—	55,8°	earth-muriated common salt	Kinosaki	城崎(,,)	Tertiary	Mandara-no-yu *Vent B*
25	8,04	*2,21*	—	15,6° (9,4°)	simple carbon-dioxated	Takarazuka	寳塚(,,)	Granite	Tansan-sen *C*
26	7,97	*2,19*	—	45.0°	common salt	Shiobara—Fukuwata	鹽原—福渡戸(栃木)	Tertiary	Hadaka-yu
27	7,91	*2,18*	—	21,5°	simple carbon-dioxated	Kōbe	神戸(兵庫)	Granite	Jyareyama Tansan-sen *A*
28	7,85	*2,16*	—	14,7° (9,2°)	,,	Takarazuka	寳塚(,,)	,,	Tansan-sen *B*
29	7,83	*2,15*	—	21.5°	,,	Kōbe	神戸(,,)	,,	Jyareyama Tansan-sen *B*
30	7,78	*2,14*	—	18,8°	—	Arima	有馬(,,)	Quartz Porph.	Shōtō-en Tansan-sen
31	7,32	*2,01*	—	44.2°	earth-muriated common salt	Kinosaki	城崎(,,)	Tertiary	Ichi-no-yu *Vent D* (*Kase-yu*)
32	7,04	*1,94*	—	15,4° (8,6°)	simple carbon-dioxated	Takarazuka	寳塚(,,)	Granite	Tansan-sen *A*
33	6,70	*1,84*	—	59,2°	earth-muriated common salt	Kinosaki	城崎(,,)	Tertiary	Ichi-no-yu *Vent C* (*San-no-yu*)
34	6,45	*1,77*	—	51,1°	salt	Sakunami	作並(宮城)	,,	Taka-no-yu
35	6,02?	*1,66*	1400	56,0°	simple	Ao-ne	青根(,,)	,,	Shin-yu
36	5,91	*1,63*	—	49,0°	sulphated bitter sulphur	Yamanaka	山中(石川)	,,	Kiku-no-yu
37	5,60	*1,54*	432	24.5°	carbonated	Kōbe	神戸(兵庫)	Granite	Tennō-Kōsen
38	5,51	*1,52*	—	56.5°	earth-muriated common salt	Kinosaki	城崎(,,)	Tertiary	Ichi-no-yu *Vent A*
39	5,47	*1,50*	—	76,0°	,,	Wakura	和倉(石川)	,,	Sō-yu
40	4,92	*1,45*	—	54,2°	salt	Tōgatta	遠刈田(宮城)	Liparite	Kamasaki-no-yu
41	4,85	*1,33*	720	19,0°	carbonated	Kōbe	神戸(兵庫)	Granite	Suwayama Tansan-sen
42	4,47	*1,23*	—	17,4°	,,	Arima	有馬(,,)	Quartz Porph	Sugigatani Tansan-sen
43	4,44	*1,22*	—	46.0°	salt	Tōgatta	遠刈田(宮城)	Liparite	Special bath in Naka-no-yu
44	4,34	*1,19*	900	18,5°	carbonated	Kōbe	神戸(兵庫)	Granite	Nunobiki Tansan-sen
45	4,28	*1,18*	207	48,6°	earth-muriated common salt	Kinosaki	城崎(,,)	Tertiary	Jizō-no-yu
46	4,17	*1,15*	450	69,1°	salt	Sakunami	作並(宮城)	,,	Taki-no-yu
47	4,11	*1,13*	152	76,0°	earth-muriated common salt	Awara	蘆原(福井)	Alluvium	Artes. Well of Haiya-no-yu
48	4,03	*1,11*	—	50,6°	,,	Kinosaki	城崎(兵庫)	Tertiary	Mandara-no-yu *Vent A*
49	3,99	*1,10*	—	40,5°	saline common salt	Kamasaki	鎌先(宮城)	Andesite	Mogamiya-no-yu
50	3,97	*1,09*	—	47,0°	sulphated bitter sulphur	Yamanaka	山中(石川)	Tertiary	Ashi-no-yu
51	3,84	*1,06*	—	48,0°	salt	Tōgatta	遠刈田(宮城)	Liparite	Me-no-yu
52	3,69	*1,02*	—	—	—	Takarazuka	寳塚(兵庫)	Granite	Drinking water
53	3,60	*0,99*	504	25,0°	salt	Tatsunokuchi	辰之口(石川)	Tertiary	Tatsunokuchi Min. Spr.
54	3,41	*0,94*	—	13.0°	,,	Fukatani	深谷(,,)	,,	Moto-yu
55	3,31	*0,91*	—	50,5°	earth-muriated common salt	Kinosaki	城崎(兵庫)	,,	Mandara-no-yu *Vent D*
56	> 3,02	*0,83*	—	> 32.0° (25°)	salt	Yugawa	湯川(宮城)	—	Yugawa-Onsen
57	2,77	*0,76*	450	53.2°	,,	Sakunami	作並(,,)	Tertiary	Kawara-no-yu
58	2,75	*0,76*	—	41,2°	common salt	Akyu	秋保(,,)	,,	,,
59	2,74	*0,75*	—	13,0°	salt	Fukatani	深谷(石川)	,,	Oku-no-yu
60	2,71	*0.75*	389	74,2°	acid alum vitriol	Myōban	明礬(大分)	Andesite	Jizō-no-yu (*Ue-no-yu*)
61	2,66	*0,73*	—	39.0°	sulphated common salt	Yuwaku	湯涌(石川)	Tertiary	Shin-yu
62	2,61	*0.72*	—	55,0°	sulphur	Awazu	粟津(,,)	Liparite	Artes. Well of Kamiya
63	2,58	*0,71*	1433	57,1°	salt	Gaga	峨々(宮城)	Gneiss	Gaga-Onsen
64	2,48	*0,68*	—	15.0° (29°)	—	Kawasaki (Miyagi-ken)	川崎(,,)	—	Kawasaki-Onsen
65	2,38	*0,66*	—	16,5° (9,5°)	simple carbon-dioxated	Arima	有馬(兵庫)	Quartz Porph.	Jigokudani Tansan-sen
66	2,37	*0,65*	—	62,1°	simple	Hokutō	北投(臺北)	Tertiary	Tetsu-no-yu
67	2,03	*0,56*	—	54.5°	earth-muriated common salt	Kinosaki	城崎(兵庫)	,,	Mandara-no-yu *Vent C*
68	2,02	*0,56*	360	17,1° (9,9	carbondioxated common salt	Takarazuka	寳塚(,,)	Granite	Takarazuka-Kōsen
69	1,98	*0,55*	1400	51,4°	simple	Ao-ne	青根(宮城)	Tertiary	Myōgō-no-yu

No.	Emanation per litre of water		Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
	in 10^{-10} curies	in Mache's units (recalculated)		air temp.					
70	1,98	0.55	ca. 1584	52,8°	common salt	Akyu	秋　保(宮城)	Tertiary	Mi yu
71	1,91	0,53	—	51,2°	—	Beppu	別　府(大分)	Andesite	Suna-yu at sea coast
72	1,79	0,49	—	43,0°	saline common salt	Kamasaki	鎌　先(宮城)	„	Kimuraya-no-yu
73	1,73	0,48	—	11,5° (0,6°)	—	Arima	有　馬(兵庫)	Quartz Porph.	Valley water, Yubuna
74	1,72	0,47	—	—	—	Nishinomiya	西　宮(„)	Granite	Well water for sake "Shirayuki"
75	1,70	0,47	—	71,0°	saline bitter sulphur	Yamashiro	山　代(石川)	Tertiary	Source in Araya
76	1,54	0,42	—	43,6°	earth-muriated iron carbonate common salt (?)	Arima	有　馬(兵庫)	Quartz Porph.	Hana-no-yu
77	1,54	0,42	162	47,5°	simple	Beppu	別　府(大分)	Andesite	Azenashi-no yu (*Noda-no-yu*)
78	1,54	0,42	—	48,5°	„	Hokutō	北　投(臺北)	Tertiary	Kaikōsha Yudaki-no-yu
79	1,52	0,42	520	57,0°	simple carbon-dioxated	Beppu	別　府(大分)	Andesite	Reichō-sen
80	1,52	0,42	3150	48,0°	saline common salt	Kamasaki	鎌　先(宮城)	„	Ichijō-no-yu
81	1,50	0,41	—	15,5°	carbondioxated sulphur	Arima	有　馬(兵庫)	Quartz Porph.	Hana no-bō cold Min. W.
82	1,47	0,40	648	53,0°	iron carbonate	Beppu	別　府(大分)	Andesite	Furō-sen, Artes. Well
83	1,43	0,39	—	22,0°	common salt	Daigamori	臺ヶ森(宮城)	—	Daigamori-Kōsen
84	1,41	0,39	—	57,1°	sulphur	Naruko	鳴　子(„)	Andesite	Taga-no-yu
85	1,39	0,38	—	76,5°	„	Hokutō	北　投(臺北)	Volc. Detr.	Spring *G*
86	1,36	0,37	—	55,0°	simple carbon-dioxated	Myōban	明　礬(大分)	Andesite	Tobi-yu
87	1,34	0,37	—	40,0°	simple	Kimpōri	金包里(臺北)	Tertiary	Satsumaya Uchi-yu
88	1,34	0,37	7258	>42,0°	„	Ao-ne	青　根(宮城)	„	Ō-yu
89	1,30	0,36	—	45,0°	„ (?)	Kannawa	鐵　輪(大分)	Andesite	Kumi-yu ?
90	1,28	0,35	—	56,0°	„	Hokutō	北　投(臺北)	Tertiary	Kaikōsha-waki-no-yu
91	1,26	0,35	—	35,7°	alkaline common salt	Kwanshirei	關仔嶺(嘉義)	„	Saka-no-yu
62	1,25	0,34	—	32,5°	—	Arima	有　馬(兵庫)	Quartz Porph.	Hana-no-bō Uchi-yu
93	1,21	0,33	180	63,0°	simple	Iizaka	飯　坂(福島)	Tertiary	Taki-no-yu
94	1,19	0.33	—	34,5°	earth-muriated iron carbonate common salt (?)	Arima	有　馬(兵庫)	Quartz Porph.	Mearai-yu
95	1,19	0,33	225	33,0° ?	sulphur	Hotta	堀　田(大分)	Andesite	Hotta-no-yu
96	1,19	0,33	—	64,1°	salt	Shinkuruma	新　車(宮城)	„	A spring in Takashige Hotel
97	1,15	0,32	—	41,0°	simple (?)	Beppu	別　府(大分)	„	Asami-Onsen
98	1,11	0,31	108	46,0°	„	Iizaka	飯　坂(福島)	Tertiary	Kintaki-no-yu
99	1,03	0,28	—	80,3°	salt	Urai	ウライ(臺北)	„	Spring *B* (on the left bank)
100	1,01	0,28	—	23,0°	simple carbon-dioxated	Su-ō	蘇　澳(宜蘭)	Clay Slate	Tansan-sen
101	1,01	0,28	270	49,1°	simple	Onikōbe	鬼　首(宮城)	Tertiary	Todoroki-Onsen
102	1,00	0,28	216	50,0°	iron carbonate	Kwankaiji	觀海寺(大分)	Andesite	O-yu (*Kwankaiji-Onsen*)
103	1,00	0,27	abundant	—	simple carbon-dioxated	Iizunayama	飯綱山(長野)	Volc. Detr.	Carb. Spr. *No. 1*
104	0,99	0,27	—	28,0°	—	Komatsugura	小松倉(宮城)	—	Kinzan-Onsen
105	0,97	0,27	—	47,0°	simple	Beppu	別　府(大分)	Andesite	Waki-yu in Hinago
106	0,95	0,26	abundant	41,0°	sulphur	Naruko	鳴　子(宮城)	„	Taki-no-yu
107	0,95	0,26	—	—	—	Arima	有　馬(兵庫)	Quartz Porph.	Drinking W., Zuihōji
108	0,94	0,26	—	53,4°	earth-muriated iron carbonate common salt (?)	„	„	„	Ni-no-yu
109	0,94	0,26	198	57,0°	common salt	Kamegawa	龜　川(大分)	Andesite	Shi-no-yu
110	0,93	0,26	—	14,0°	—	Miyatoko	宮　床(宮城)	—	Yamada-Onsen
111	0,90	0,25	270	53,1°	simple	Obara	小　原(„)	—	Shin-yu
112	0,90	0,25	648	47,0°	carbonated	Kawatabi	川　渡(„)	Tertiary	Mayu-no-yu
113	0,87	0,24	54	38,0°	simple	Jōgi	定　義(„)	Andesite	Jogi-Onsen
114	0,84	0,23	—	32,5° (26°)	—	Ko-no-su	鴻　巣(„)	—	Konosu-Onsen
115	0,82	0,23	—	95,0°	sulphur	Hokutō	北　投(臺北)	Tertiary	Spring *E*
116	0,81	0,22	—	53,4°	earth-muriated iron carbonate common salt	Arima	有　馬(兵庫)	Quartz Porph.	Ichi-no-yu
117	0,81	0,22	—	27,2° (25°)	—	Kangane	神ヶ峯(宮城)	—	Kangane-Onsen
118	0,80	0,22	—	49,2°	carbonated	Beppu	別　府(大分)	Andesite	Takegawara-no yu (*Ken-eki-sen*)
119	0,76	0,21	—	13,0°	salt	Fukatani	深　谷(石川)	Tertiary	Shin-yu
120	0,76	0,21	—	61,5°	carbonated	Akayu (Miyagi-ken)	赤　湯(宮城)	Andesite	Shita-no-yu

No.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地名(府縣名)	Geology	Spring
121	0,76	*0,21*	ca. 126	air temp. 48,5°	saline bitter	Yoshina	吉奈(靜岡)	Andesite	Tōfuya-no-yu
122	0,75?	*0,21*	—	13,5°	—	Iizaka	飯坂(福島)	Tertiary	Mitarase-Well
123	0,73	*0,20*	270	54,0°	common salt	Kamegawa	龜川(大分)	Andesite	Source in Kiyō-sen
124	0,71?	*0,19*	1320	46,0°	iron carbonate	Beppu	別府(„)	„	Kusunoki-Onsen
125	0,70	*0,19*	—	56,2°	salt	Onikōbe	鬼首(宮城)	—	Shin-Mitaki-yu
126	0,70	*0,19*	265	45,0°	saline bitter	Yoshina	吉奈(靜岡)	Andesite	Ō-yu
127	0,70	*0,19*	—	26,0° (11°)	earthy alkaline iron carbon-dioxated common salt	Hirano	平野(兵庫)	Granite	Hirano Tansan-sen
128	0,70	*0,19*	216	75,0°	iron carbonate	Shibaseki	芝石(大分)	Andesite	Hijiri-yu
129	0,70	*0,19*	270	58,0°	sulphur	Naruko	鳴子(宮城)	„	Genzō-yu
130	0,69	*0,19*	—	30,0° (26°)	—	Yunoheda	湯邊田(„)	—	Yunoheda-Onsen
131	0,68	*0,19*	—	48,3°	—	Kawatabi	川渡(„)	Tertiary	Kagaya-Shin-yu
132	0,66	*0,18*	—	93,5°	sulphur	Hokutō	北投(臺北)	„	Spring *D*
133	0,64	*0,18*	—	79,3°	simple	Tōi	頭圍(宜蘭)	Alluvium	Spring in field
134	0,64	*0,18*	—	48,0°	—	Kawatabi	川渡(宮城)	Tertiary	Fujishimaya-Shin-yu
135	0,62	*0,17*	—	49,7°	—	Hokutō	北投(臺北)	—	Spring *B*
136	0,58	*0,16*	144	58,0°	simple	Iizaka	飯坂(福島)	Tertiary	Akagawa-no-yu
137	0,55	*0,15*	abundant	—	simple carbon-dioxated	Iizunayama	飯綱山(長野)	Volc. Detr.	Carb. Spr. *No.* 7
138	0,54	*0,15*	—	>57,0°	carbonated	Akayu (Miyagi-ken)	赤湯(宮城)	Andesite	Goten-no-yu (*Ue-no-yu*)
139	0,49?	*0,14*	108	59,0°	simple	Iizaka	飯坂(福島)	Tertiary	Hako-yu
140	0,48	*0,13*	1167	57,0°	common salt	Beppu	別府(大分)	Andesite	Higashi-Onsen, Artes. Well
141	0,48	*0,13*	—	44,0°	simple	Iizaka	飯坂(福島)	Tertiary	Kotaki-no-yu
142	0,48	*0,13*	—	16,0° (27°)	common salt	Daigamori	臺ケ森(宮城)	—	Daigamori-Shin-yu
143	0,47	*0,13*	54	55,0°	simple	Iizaka	飯坂(福島)	Tertiary	Tōza-yu
144	0,47	*0,13*	—	42,4°	—	Kawatabi	川渡(宮城)	„	Me-no-yu (*Masaka-no-yu*)
145	0,46	*0,13*	—	91,5°	sulphur	Hokutō	北投(臺北)	„	Spring *C*
146	0,44	*0,12*	51	54,0°	simple	Iizaka	飯坂(福島)	„	Akagawabata-no-yu
147	0,42	*0,12*	54	56,4°	salt	Naruko	鳴子(宮城)	Andesite	Kawara-no-yu
148	0,40	*0,11*	50	54,0°	simple	Iizaka	飯坂(福島)	Tertiary	Sabako-no-yu
149	0,40	*0,11*	—	90,0°	sulphur	Hokutō	北投(臺北)	„ (?)	Spring *A*
150	0,38?	*0,11*	—	53,0°	simple	Tōi	頭圍(宜蘭)	Alluvium	Nishiyama's Artes. Well
151	0,35	*0,10*	—	52,5°	—	Niizeki	新關(宮城)	—	Niizeki-Onsen
152	0,34	*0,09*	—	73,5°	salt	Urai	ウライ(臺北)	Tertiary	Spring (on the right bank)
153	0,26	*0,07*	—	64,5°	alkaline common salt	Kwanshirei	關仔嶺(嘉義)	„	Ue-no-yu
154	>0,21	*0,06*	—	53,2°	salt	Onikōbe	鬼首(宮城)	—	Kyū-Mitaki-yu
155	0,19	*0,05*	—	40-36,5°	„	Kimpōri	金包里(臺北)	Tertiary	Honkura
156	0,16	*0,05*	abundant	46,8°	sulphated bitter	Izusan	伊豆山(靜岡)	Andesite	Hashiri-yu
157	0,14	*0,04*	—	ca. 100,0°	salt	Onikōbe	鬼首(宮城)	Tertiary	Miyazawa Shita-no-yu
158	>0,14	*0,04*	—	63,5°	simple	Obara	小原(„)	—	Shita-no-yu of Furu-yu
159	0,13	*0,04*	—	74,0°	common salt	Yugawara	湯河原(靜岡)	Andesite	Hakoneya-Uchi-yu
160	0,11	*0,03*	—	57,8°	—	Atami	熱海(„)	„	Muen-no-yu
161	0,11	*0,03*	—	84,5°	simple	Shinkuruma	新車(宮城)	„	Chiyo-no-yu
162	0,10	*0,03*	—	84,0°	earth-muriated common salt	Atami	熱海(靜岡)	„	Kawara-no-yu
163	0,08?	*0,02*	—	93,0°	acid vitriol	Kannawa	鐵輪(大分)	„	Umi-Jigoku
164	0,08	*0,02*	—	79,5°	sulphur	Hokutō	北投(臺北)	Tertiary	Spring *F*
165	0,08	*0,02*	—	ca. 100,0°	salt	Onikōbe	鬼首(宮城)	„	Water from Fukiage Geyser
166	0,05	*0,01*	—	65,0°	—	Hokutō	北投(臺北)	Volc. Detr.	Sekimon, Yukawa
167	0,03	*0,01*	—	29,0°	—	„	„	„	Valley water
168	0,02	*0,01*	—	52,0°	—	„	„	„	Third Fall, Yukawa
169	Immeasurable small		—	27,0°	carbonated	Ayashi	愛子(宮城)	—	Ayashi Tansan-sen
170	0	*0*	—	100,0°	sulphur	Nakayama	中山(„)	Andesite	Hoshi-no-yu (*Hebi-yu*)
171	0	*0*	—	ca. 100,0°	salt	Onikōbe	鬼首(„)	Tertiary	Miyazawa Taki-no-yu
172	0	*0*	—	100,0°	alkaline sulphur	Naruko	鳴子(„)	Andesite	Unagi-no-yu
173	0	*0*	1296	ca. 108,0°	earth-muriated common salt	Atami	熱海(靜岡)	„	Water from Ō-yu Geyser

No.	Emanation per litre of gas at 0° C. in 10^{-10} curies	in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Gas evolving from :
			ca.	air temp.					
1	24,30	6.68	—	71,0°	saline bitter sulphur	Yama-hiro	山　代(石川)	Tertiary	Source in Araya
2	26,90	7.40	—	95,0°	sulphur	Hokutō	北　投(臺北)	"	Spring *E*
3	17,70	4,87	—	17.4°	carbondioxated sulphur	Arima	有　馬(兵庫)	Quartz Porph.	Sugigatani Tansan-sen
4	17,25	4,74	—	52,8°	common salt	Akyū	秋　保(宮城)	Tertiary	Mi-yu
5	15,70	4,32	—	53.4°	earth-muriated iron carbonate common salt	Arima	有　馬(兵庫)	Quartz Porph.	Ichi-no-yu
6	13,50	3,71	—	16.5° (9,5°)	simple carbon-dioxated	"	"	"	Jigokudani Tansan-sen
7	12,50	3,44	—	93.5°	sulphur	Hokutō	北　投(臺北)	Tertiary	Spring *D*
8	6,65	1,83	—	17,1° (9,5°)	carbondioxated common salt	Takarazuka	寶　塚(兵庫)	Granite	Takarazuka-Kōsen
9	6,46	1,78	—	33.0° (?)	sulphur	Hotta	堀　田(大分)	Andesite	Hotta-no-yu
10	6,33	1,74	—	48.5°	saline bitter	Yoshina	吉　奈(靜岡)	"	Tōfuya-no-yu
11	2,63	0,72	—	23.0°	simple carbon-dioxated	Suō	蘇　澳(宜蘭)	Clay Slate	Tansan-sen
12	2,31	0,64	—	40°–36,5°	—	Kimpōri	金　包　里(臺北)	Tertiary	Honkura
13	2,12	0,58	—	26,0° (11°)	earthy alkaline iron carbon-dioxated common salt	Hirano	平　野(兵庫)	Granite	Hirano Tansan-sen
14	1,96	0,54	—	64.5°	alkaline common salt	Kwanshirei	關　仔　嶺(嘉義)	Tertiary	Ue-no-yu
15	0,53	0,15	—	—	—	Hokutō	北　投(臺北)	Volc. Rock	A Spring in Solfatara
16	† small quantity		—	ca. 100°	earth-muriated common salt	Atami	熱　海(靜岡)	Andesite	Ō-yu Geyser
17	† small quantity		—	ca. 100°	salt	Onikōbe	鬼　首(宮城)	Tertiary	Fukiage Geyser

† The determination was made with steam ejected from springs.

Table 5.

The quantity of radium emanation, the temperature of springs, the flow of water, and the amount of gas‡ produced from springs in the following table were determined by Hazime Ikeuti (Physical Faculty of Tôkyô Imperial University). As for particulars refer to Proceeding of the Tôkyô Mathematico-Physical Society (Tôkyô Sûgaku-Buturigakkai Kizi), 2nd Ser., Vol. VII, No. 10, p. 177–180; No. 21, p. 423–426.

For recalculation of Mache's unit from the international unit following factor was used:

$$1 \times 10^{-10} \text{ curie} = 0{,}275 \text{ Mache's units.}$$

No.	Emanation per litre of water in 10^{-10} curies	in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
			ca.						
1	173,00	47,58	—	25.5°	simple	Murasugi	村　杉(新潟)	Granite	Murasugi-Kōsen
2	2,57	0,71	—	72,0°	earth-muriated common salt	Matsunoyama	松　之　山(")	Tertiary	Netsu-no-yu
3	2,56	0,70	—	65,0°	"	"	"	"	Hii-no-yu
4	2,47	0,68	—	73.0°	"	"	"	"	Washi-no-yu
5	1,76	0,48	—	44,0°	"	"	"	"	Fukushimaya-no-yu
6	1,59	0,44	111	42,0°	saline bitter	Yoshina	吉　奈(靜岡)	Andesite	Tōfuya-no-yu *No. 2*
7	1,58	0,44	—	65,0°	sulphated common salt	Shibu [Hirao]	澁 [平穩] (長野)	Diluvium	Ō-yu *No. 2*
8	1,37	0,38	—	13,0°	—	Matsunoyama	松　之　山(新潟)	Tertiary	Ushiyashiki-no-yu
9	1,26	0,35	—	49,0°	saline bitter	Yoshina	吉　奈(靜岡)	Andesite	Ō-yu
10	1,22	0,34	288	54,0°	earthy alkaline sulphur	Akakura	赤　倉(新潟)	"	Shin-yu
11	1,12	0,31	—	48,0°	sulphated common salt	Shibu [Hirao]	澁 [平穩] (長野)	Diluvium	Tsubataya-uchi-yu
12	1,12	0,31	—	25,0°	—	Matsunoyama	松　之　山(新潟)	Tertiary	Yuziri-no-yu
13	1,03	0,28	—	36,0°	sulphur	Tsubame	燕　(")	Andesite	Chi-no-ike-no-yu

No.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
14	0,85	*0,23*	ca. 63	46,5°	saline bitter	Yoshina	吉　奈(靜岡)	Andesite	Kikusuitei-no-yu
15	0,78	*0,22*	—	74.0°	sulphated common salt	Shibu [Hirao]	澁 [平穩] (長野)	Diluvium	Ō-yu *No. 1*
16	0,68	*0,19*	169	52,5°	saline bitter	Yoshina	吉　奈(靜岡)	Andesite	Tōfuya-no-yu *No. 1*
17	0,43	*0,12*	—	—	sulphated common salt	Shibu [Hirao]	澁 [平穩] (長野)	Diluvium	Wata-no-yu
18	0,24	*0,07*	—	45,0°	sulphur	Tsubame	燕　(新潟)	Andesite	Iwa-no-yu
	Emanation per litre of gas at 0° C.								Gas evolving from :
1	11,25	*3,09*	‡ 14.4	51,0°	earthy alkaline sulphur	Akakura	赤　倉(新潟)	Andesite	Shin-yu
2	2,29	*0,63*	—	—	sulphur	Tsubame	燕　(„)	„	Kawara-yu

Table 6.

The quantity of radium emanation, the temperature of springs, the flow of water, and the amount of gas§ produced from springs in the following table were determined by Suminosuke Ono, Prof. of Physics, Tôkyô Higher Normal School. As for particulars refer to Proceeding of the Tôkyô Mathematico-Physical Society (Tôkyô Sûgaku-Buturigakkwai Kizi), 2nd Ser., Vol. VII, No. 21, p. 421–422.

For recalculation of Mache's unit from the international unit following factor was used:

$$1 \times 10^{-10} \text{ curie} = 0{,}275 \text{ Mache's units.}$$

No.	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
1	37,1	*10,20*	ca. 916	40,0°	—	Agune	阿 久 根(鹿兒島)	Alluvium	Agune-Onsen *No. 1*
2	34,5	*9,49*	—	40,2°	—	„	„	„	„ *No. 2*
3	34,3	*9,43*	1166	41,0°	—	„	„	„	„ *No. 3*
4	33,4	*9,19*	—	40,0°	—	„	„	„	„ *No. 4*
5	14,2	*3,91*	233	47.5°	carbonated	Hinagu	日 奈 久(熊本)	Cretaceous	Gozen-yu
6	13,8	*3,80*	389	48,5°	„	„	„	„	Otsugi-yu (*Otoko-yu*)
7	10,5	*2,89*	147	47.0°	„	„	„	„	„ (*Onna-yu*)
8	4,6	*1,27*	864	50,0°	salt	Hayashi	林　(„)	Alluvium	Moto-yu
9	4,2	*1,16*	188	48,4°	„	„	„	„	Suiranrō-no-yu 1st Well
10	3,2	*0,88*	156	45,2°	carbonated	Hinagu	日 奈 久(„)	Cretaceous	Gata-yu (*Onna-yu*)
11	3,2	*0,88*	475	48,8°	salt	Hayashi	林　(„)	Alluvium	Suiranrō-no-yu 2nd Well
12	3,1	*0,85*	205	45,2°	carbonated	Hinagu	日 奈 久(„)	Cretaceous	Gata-yu (*Otoko-yu*)
13	2,8	*0,77*	340	48,5°	„	„	„	„	Izumiya-no-yu
14	2,1	*0,58*	97	46,5°	„	„	„	„	Kimparō-no-yu 1st Well
15	1,4	*0,39*	180	45,0°	„	„	„	„	„ mixture of 2nd and 3rd Well
16	0,4	*0,11*	?	39,0°	—	Yoshio	吉　尾(„)	Chichibu Series	Yoshio-Onsen
	Emanation per litre of gas at 0° C.								Gas evolving from :
1	27,8	*7,65*	§ 1,03	48,4°	salt	Hayashi	林　(熊本)	Alluvium	Suiranrō-no-yu 1st Well
2	21,2	*5,83*	§ 15,6	50,0°	„	„	„	„	Moto-yu
3	20,5	*5,64*	§ 3.33	48,8°	„	„	„	„	Suiranrō-no-yu 2nd Well

Table 7.

The quantity of radium emanation and the temperature of springs in the following table were determined by Dr. H. Kondō, [vide Official Report of Kagoshima Prefecture (" Kagoshima-ken Kōhō "), Aug., 1913].

No	Emanation per litre of water: in 10^{-10} curies	Emanation per litre of water: in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
1	7,05	*1,91*	ca. —	51,0°	hydrogen sulphide	Iwōdani	硫黄谷(鹿兒島)	Volc. Ash and Mud Lava	Iwōdani-Onsen *No. 1*
2	3,69	*1,00*	—	65,0°	salt	Suri-no-hama	摺之濱(〃)	〃	Surinohama-Onsen (*Kyū-yu*)
3	3,35	*0,90*	—	66,5°	hydrogen sulphide	Eino-o	榮之尾(〃)	〃	Eino-ō-Onsen *No. 1*
4	3,33	*0,90*	—	46,0°	salt	Myōban-yama	明礬山(〃)	〃	Myōban-yama-Onsen *No. 5*
5	3,21	*0,87*	—	59.5°	〃	Iwōdani	硫黄谷(〃)	〃	Iwōdani-Onsen *No. 5*
6	2,72	*0,74*	—	39,8°	iron carbonate	Anraku	安樂(〃)	〃	Spring *A*
7	2,63	*0,71*	—	64,2°	salt	Myōban-yama	明礬山(〃)	〃	Myōban-yama-Onsen *No. 3*
8	2,24	*0,60*	—	30,0°	carbonated	Shiose	鹽浸(〃)	〃	Shimo-no-yu *No. 3*
9	2,01	*0,54*	—	54,0°	salt	Yaji	彌次(〃)	〃	Yaji-ga-Onsen *No. 1*
10	1,69	*0,53*	—	68,0°	hydrogen sulphide	Myōban-yama	明礬山(〃)	〃	Myōban-yama-Onsen *No. 2*
11	1,54	*0,42*	—	48,7°	〃	Iwōdani	硫黄谷(〃)	〃	Iwōdani-Onsen *No. 4*
12	1,50	*0,41*	900	47,0°	carbonated	Myōken	妙見(〃)	〃	Myōken-yu
13	1,25	*0,34*	—	53.5°	iron carbonate	Anraku	安樂(〃)	〃	Shin-yu
14	1,22	*0,33*	—	48,0°	〃	〃	〃	〃	Kyū-yu *No. 1*
15	1,14	*0,31*	6480	42,0°	common salt	Shibadate	芝立(〃)	〃	Shibadate-Onsen
	Emanation per litre of gas								Gas evolving from :
1	7,33	*1,98*	—	47,0°	carbonated	Myōken	妙見(鹿兒島)	〃	Myōken-yu

Table 8.

Radium Emanation in Petroleum from Nishiyama Oil Field in the Province of Etigo.

(Tôkyô Sûgaku-Buturigakkai Kizi, 2nd Ser., Vol. VIII, No. 1, p. 14)

Date of exp.	Well	Radium emanation per litre: of petroleum	Radium emanation per litre: of gas	Observer
27–29 Nov., 1914	R. No. 22, Takiya	1,66 × 10^{-10} curies	0,35 × 10^{-10} curies	Kyōtoku Fuji
30 Nov., 1914	R. No. 7, Nagamine	1,44 〃	—	〃

Radio-activity of Notable Spring Waters in Europe and in the United States of America.

The following tables give the results of measurements of the radio-activity of several well-known European mineral waters and of a few American waters. Many of these waters also contain radio-active gases. Reports of different observations on the same spring indicate that the waters and the gases in them vary greatly in radio-activity. Because of differences in the methods of measurement and in allowance for disintegration products and also because of the uncertain or arbitrary nature of some of the units of expression the figures have not been reduced to a common unit for direct comparison.

We have therefore recorded in these tables only the numbers from authentic origins which enable direct comparison.

In Remarks are given geology, flow of water in 24 hours, and literature.

Abbreviations used in the tables:

Sommer..................... Über die Radioaktivitätsverhältnisse der natürlichen Heilquellen des deutschen Sprachgebietes. Von Prof. Dr. Ernst Sommer.
Lazarus .... Handbuch der Radium-Biologie und Therapie von Prof. Dr. Paul Lazarus, 1913.
Curie .... Die Radioaktivität von M[me] P. Curie, 1912. Band II.
Weidig .... Radioaktive Wässer in Sachsen von Dr.-Ing. M. Weidig, 1912. IV. Teil.
Ch. Z......................... Chemiker Zeitung.
Ph. Z......................... Physikalische Zeitschrift.
Bot. Gaz. .... National Bottler's Gazette.

Table 9.

(A) Results of measurements expressed in Mache's units.

No.	Emanation per litre of water in Mache's units	Temp. of spring in C.	Classification	Location		Altitude in ft.	Spring	Observer	Remarks
1	2400–1200	air temp. —	—	Joachimsthal	Austria	2100	Mine water (Depth: 990 ft.)	J. Stěp	Ch. Z. 1912, p. 1470
2	2050,00	—	—	„	„	„	Mine water	Schmidt	Ph. Z. 1907, p. 4
3	1964,40	7,0° (18°)	iron carbon-dioxated	Brambach	Germany	—	Neue Quelle	Weidig 1911	216 hl.; Contact Zone of Granite and Slate; Weidig, p. 302
4	600,00	—	—	Joachimsthal	Austria	2100	Wernerlaufquelle	J. Stěp 1905	Sommer, p. 25
5	486,90	7,4° (20°)	alkaline	Brambach	Germany	—	Schillerquelle	Weidig 1912	58 hl.; Contact Zone of Granite and Slate; Weidig, p. 301
6	372,00	57,0°	muriated alkaline	Lacco Ameno in Ischia	Italy	—	Altrömische Quelle	Engler	Ch. Z. 1907, p. 813
7	366,90	8,5°	iron carbonate	Brambach	Germany	—	Grenzquelle	Weidig 1911	Several litres per min.; Contact Zone of Granite and Slate; Weidig, p. 301
8	206,00	29,0°	sulphur	Landeck	„	1500	Georgenquelle	Schäfer 1909	Gneiss; Sommer, p. 29
9	155,00	36,3°	simple	Gastein	Austria	3400	Grabenbäckerquelle	Mache	Ch. Z. 1907, p. 813
10	149,00	36,3°	„	„	„	„	„	Engler & Sieveking	„
11	140,20	46,0°	„	„	„	„	Elisabethquelle (S)†	Sieveking	Ph. Z. 1905, p. 702
12	133,00	46,8°	„	„	„	„	„ (H)‡	Mache	Ch. Z. 1907, p. 813
13	126,00	23,5°	common salt	Baden-Baden	Germany	650	Büttquelle	Engler & Sieveking	643 hl.; Lower Rotliegende; Ch. Z. 1907, p. 813
14	122,40	46,8°	simple	Gastein	Austria	3400	Elisabethstollen (H)‡	„	Ch. Z. 1907 p. 813
15	121,90	41,9°	„	„	„	„	Chorinskyquelle (H)‡	„	„
16	119,80	—	sulphur	Landeck	Germany	1500	Friedrichsquelle	Schäfer 1909	Gneiss; Sommer, p. 29
17	106,00	—	simple	Gastein	Austria	3400	Wasserfallquelle	Mache & Meyer	Sommer, p. 21
18	73,70	—	„	„	„	„	Elisabethstollen (S)†	„	„
19	54,50	8,4°	alkaline sulphated	Karlsbad	„	1230	Eisenquelle	Sieveking	Ph. Z. 1905, p. 702
20	52,00	—	—	Tannbach	„	—	Schlossteichquelle	Bamberger 1908	Sommer, p. 43
21	51,00		iron	Froy in Villnösstal	Tyrol	3[illegible]80	Magenquelle, ober. Auslauf	„ 1907	„ p. 19
22	47,70	—	iron carbon-dioxated	Disentis	Switzerland	3770	Placidusquelle (untere)	Schweitzer 1908–9	„ p. 17
23	47,00	8,4°	alkaline sulphated	Karlsbad	Austria	1230	Eisenquelle	Engler & Sieveking	Ch. Z. 1907, p. 813
24	46,70	—	iron carbon-dioxated	Disentis	Switzerland	3770	Placidusquelle (obere)	Schweitzer 1908–9	Sommer, p. 17
25	38,40	8,4°	alkaline sulphated	Karlsbad	Austria	1230	Eisenquelle	Mache	Ch. Z. 1907, p. 813
26	32,80	12,6°	earth-muriated common salt	Kreuznach	Germany	340	Inselquelle	Aschoff 1905	Quartz Porph.; Sommer, p. 27

† Südliche Quelle. ‡ Hauptquelle.

No.	Emanation per litre of water in Mache's units	Temp. of spring in C.	Classification	Location		Altitude in ft.	Spring	Observer	Remarks
27	31,50	air temp 39,2° (?)	alkaline sulphated	Karlsbad	Austria	1230	Mühlbrunnen, vord. Quelle	Mache & Meyer 1905	Sommer, p. 27
28	28,60	15,0°	carbondioxated common salt	Nauheim	Germany	470	Karlsbrunnen	Schmidt & Kurz	Tertiary; Ch. Z. 1907, p. 813
29	27,90	—	earth-muriated common salt	Kreuznach	,,	310	Quelle am Gradienhaus I	Aschoff 1905	Quartz Porph.; Sommer, p. 29
30	27,60	24,0°	,,	,,	,,	,,	Quelle am Haus Nr. 5	Schmidt & Kurz 1905	Quartz Porph.; Ph. Z. 1906, p. 210
31	26,00	8,3° (?)	earthy saline iron carbondioxated	Griesbach	,,	1970	Badquelle	Engler & Sieveking	Gran. Dyke in Gneiss; Ch. Z. 1907, p. 813
32	24,00	59,0°	common salt	Baden-Baden	,,	650	Murquelle	,,	31 hl.; Lower Rotliegende; Ch. Z. 1907, p. 813
33	23,49	—	sulphur	Pistyan	Hungary	530	Brunnenschacht	Alexander & Weiss 1909	Sommer, p. 37
34	23,40	31,2°	earth-muriated common salt	Münster a. Stein	Germany	380	Hauptbrunnen	Schmidt & Kurz 1905	180 hl.; Quartz Porph.; Sommer, p. 35
35	22,60	13,3°	muriated alkaline	Castellamare	Italy	—	Acidola	Engler	Ch. Z. 1907, p. 813
36	22,50	—	iron	Kudowa	Germany	1310	—	—	Gravel bed; Lazarus, p. 200
37	22,10	—	acid	Yellowstone National Park	U. S. A.	7000	Apollinaris Spring	Schlundt & Moore	Bot. Gaz. 1914, p. 82
38	21,90	11,3°	earthy carbondioxated common salt	Soden in Taunus	Germany	460	Champagnerbrunnen	Schmidt & Kurz	Taunus Phyllite; Ch. Z. 1907, p. 813
39	20,40	12,6°	earth-muriated common salt	Kreuznach	,,	340	Inselquelle	,, 1905	Quartz Porph.; Ch. Z. 1907, p. 813
40	20,00	11,1°	sulphated hydrogen sulphide	Nenndorf	,,	230	Gewölbequelle	—	Bitum. Limestone with Serpulites, Lazarus, p. 200
41	19,80	cold	—	Fiuggi near Rome	Italy	—	Badquelle	Engler	Ch. Z. 1907, p. 813
42	17,50	—	—	Bründl	Austria	—	Quelle in der Kapelle	Bamberger 1908	Sommer, p. 15
43	16,30	—	sulphur	Talheim	Germany	—	—	—	Lazarus, p. 200
44	16,20	10,6°	—	Wetterau	,,	—	Sauerbrunnen	Schmidt & Kurz	501 hl.; Tert. Quartz Sand; Ph. Z. 1906, p. 210
45	16,00	9,2°	earthy alkaline saline iron carbondioxated	Antogast	,,	1640	Antoniusquelle	Frommel	14,4 hl.; Gneiss; Ch. Z. 1907, p. 813
46	16,00	cold	alkaline sulphated carbondioxated (?)	Marienbad	Austria	2090	Säuerling Markusgrün	Zörkendörfer & Dietel 1908	Sommer, p. 31
47	14,50	,,	,,	,,	,,	,,	Ortssäuerling	,,	,, ,,
48	14,20	—	—	Kefermarkt	,,	—	Dorfbrunnen	Bamberger 1908	,, p. 27
49	14,00	—	—	Hundsdorf	,,	—	Danedergrabenquelle	,,	,, p. 25
50	12,50	10,3°	—	Odenwald	Germany	—	Hirtenbrunnen	Schmidt & Kurz	Granite; Ph. Z. 1906, p. 210
51	11,95	42,0°	common salt	Wiesbaden	,,	380	Dr. Kurzs Quelle	Henrich	Ch. Z. 1907, p. 813
52	11,44–1,00	—	—	Shelesnowodsk in Caucasus	Russia	—	—	—	Ch. Z. 1910, p. 231
53	11,00	33°–48°	sulphur common salt	Lavey	Switzerland	1350	—	Sarasin, Guye & Micheli	Sommer, p. 29
54	10,10	22,5°	simple	Badenweiler	Germany	1450	Siegelsche Quelle	Engler & Sieveking	Ch. Z. 1907, p. 813
55	9,90	—	—	Westerwald	,,	—	—	Schmidt & Kurz	Basalt Tuff; Ph. Z. 1906, p. 210
56	8,73	—	alkaline saline	Teplitz	Austria	730	Riesenquelle bei Dux	Mache & Meyer 1905	Sommer, p. 45
57	8,16	cold	iron carbondioxated (?)	Franzensbad	,,	1500	Franzensquelle	Saubermann 1908	,, p. 17
58	8,00	10,6°	earthy carbondioxated common salt	Homburg	Germany	630	Elisabethbrunnen	Schmidt & Kurz	Pre-Devon. Slate & Quartz Vein, Ch. Z. 1907, p. 813
59	7,88	22°–35°	sulphur	Baden near Vienna	Austria	700	Franzensbad	Mache	Sommer, p. 13
60	7,80	cold	iron carbondioxated (?)	Petersthal	Germany	1330	Karl Boschert	Frommel	Gran. Dyke in Gneiss; Ch. Z. 1907, p. 813
61	7,40	,,	earthy saline iron carbondioxated	Freyersbach	,,	1475	Gasquelle	,,	Ch. Z. 1907, p. 813
62	7,10	9,8°	muriated bitter	Mergentheim	,,	690	Karlsquelle	—	3000 hl.; Lower Muschelkalk; Sommer, p. 23
63	7,10	13,0°	earth-muriated common salt	Spessart	,,	470	Albertquelle	Schmidt & Kurz	Zechstein; Ph. Z. 1906, p. 210
64	7,00	27,5°	simple	Badenweiler	,,	1450	Hauptbadquelle	Engler & Sieveking	Ch. Z. 1907, p. 813
65	6,56	32,5°	alkaline saline	Teplitz	Austria	730	Steinbadquelle	Mache	,,
66	5,70	—	alkaline muriated carbondioxated	Gleichenberg	,,	980	Constantinquelle	Bendorf 1907	Sommer, p. 21
67	5,70	74,0°	weak salt	Battaglia near Padua	Italy	1900	Surgone Grotta	Engler	Ch. Z. 1907, p. 813
68	5,15	—	concentrated common salt	Sulza	Germany	485	Konstantinquelle	Wieprecht	Sommer, p. 43
69	5,00	87,0°	weak salt (?)	Abano near Padua	Italy	100	Sorgente Montirone centrale	Engler	Ch. Z. 1907, p. 813
70	4,70	65,0°	muriated alkaline	Ischia	,,	—	Porto d'Ischia (Stabil. communale)	,,	,,
71	4,50	cold	alkaline sulphated	Rohitsch	Austria	750	Tempelquelle	Mache 1905	Sommer, p. 37
72	4,50	—	—	Giessen	Germany	—	Schwache Quelle	Schmidt & Kurz	Tert. Clay; Ph. Z. 1906, p. 210
73	4,33	—	—	Kislowdsk in Caucasus	Russia	—	—	—	Ch. Z. 1910, p. 231
74	4,33	10,4°	common salt	Kissingen	Germany	650	Maxquelle	F. Jentzsch	Upper Bunter; Ph. Z. 1907 p. 887
75	4,08	cold	iron carbonate	Spa	Belgium	1000	Tonnelet Spring	Girard & Chauvin	Bot. Gaz. 1914, p. 82
76	3,78	21,2°	alkaline carbondioxated	Apollinarisbrunnen	Germany	—	—	T. Kyll 1906	Sommer, p. 13
77	3,77	—	sulphur	Alvaneu	Switzerland	3150	Untere Quelle	Schweitzer	,,

No.	Emanation per litre of water in Mache's units	Temp. of spring in C.	Classification	Location		Altitude in ft.	Spring	Observer	Remarks
78	3,40	air temp. 12,5°	alkaline muriated hydrogen sulphide	Weilbach in Taunus	Germany	440	Natron-Lithiumquelle	Schmidt & Kurz	46,7 hl.: Tertiary Limestone; Sommer, p. 47
79	3,2–1,6	36°–38°	simple	Wildbad	,,	1410	Bohrlöcher im Badehaus	Engler & Sieveking	Granite; Ch. Z. 1907, p. 813
80	3,10	—	—	Württemberg	,,	—	Göppinger Sauerbrunnen	K. R. Koch	Ph. Z. 1907, p. 806
81	ca. 3,00	—	earthy sulphated common salt	Salzschlirf	,,	820	—	—	Lazarus, p. 199
82	2,60	—	salt alkaline	Bagnoli near Naples	Italy	—	Manganello	Engler	Ch. Z. 1907, p. 813
83	ca. 2,50	11,5°	earthy muriated carbondioxated	Wildungen	Germany	980	Helenenquelle	—	76 hl.; Clayslate; Lazarus, p. 200
84	2,48	—	earthy carbondioxated (?)	Altheide	,,	1310	Charlottensprudel	Fresenius 1909	Alluvium; Sommer, p. 13
85	2,20	72,0°	muriated alkaline	Casamicciola in Ischia	Italy	—	Manzi II	Engler	Ch. Z. 1907, p. 813
86	2,10	9,8°	earthy saline iron carbondioxated	Rippoldsau	Germany	1870	Wenzelsquelle	Engler & Sieveking	Gneiss; Ch. Z. 1907, p. 813
87	1,90	90,0°	muriated alkaline	Agnano near Naples	Italy	—	Purgativo	Engler	Ch. Z. 1907, p. 813
88	1,80	cold	,,	Pozzuoli near Naples	,,	—	Aqua media	,,	,,
89	1,52	,,	iron carbondioxated	St. Moritz	Switzerland	5820	Surpunt	Schweitzer	Sommer, p. 43
90	1,50	,,	iron	Roncegno	Austria	1750	Trinkquelle	Bamberger 1907	,, p. 37
91	1,40	—	alkaline muriated saline	Salzig	Germany	—	Quelle II	Schmidt	Low. Devon. Quartzite & Clayslate; Somer, p. 39
92	1,4–0,55	—	—	Piatigorsk in Caucasus	Russia	—	—	—	Ch. Z. 1910, p. 231
93	1,35	—	—	French Lick, Indiana	U. S. A.	—	Pluto Spring	Schlundt	Bot. Gaz. 1914, p. 82
94	1,31	—	carbondioxated	Passug	Switzerland	2925	Churwald. Quelle	Schweitzer	Sommer, p. 35
95	1,13	cold	alkaline carbondioxated (?)	Tarasp	,,	3900	Carolaquelle	,, 1909	,, p. 43
96	1,13–0,41	—	—	Essentuki in Caucasus	Russia	—	—	—	Ch. Z. 1910, p. 231
97	1,02	47°–52°	sulphur	Trenczin-Teplitz	Hungary	850	Quelle I	—	Lazarus, p. 200
98	0,84	—	iron	Levico	Austria	1640	Starkquelle	Bamberger 1907	Sommer, p. 29
99	0,76	31,7°–34°	simple	Ragaz-Pfäfers	Switzerland	2000	Alte Quelle	Schweitzer	,, p. 37
100	0,71	23,3°	,,	Vöslau	Austria	810	Hauptquelle	Mache & Meyer 1905	,, p. 47
101	0,58	36,7°–52°	muriated sulphur	Baden	Switzerland	1230	Kesselquelle	Sury	,, p. 13
102	0,31	14.0°	common salt	Reichenhall	Germany	1540	Kais. Karlquelle	Bender & Hobein 1909	Muschelkalk; Sommer, p. 37
103	0,26	33,9°–51,1°	sulphated iron	Leukerbad	Switzerland	4600	Lorenzquelle	Bamberger 1907	Sommer, p. 29
104	0,02	—	concentrated common salt	Rheinfelden	,,	866	—	Sommer 1908	,, p. 37
	Emanation per litre of gas						Gas evolving from:		
1	94,20	39,2° (?)	alkaline sulphated	Karlsbad	Austria	1230	Mühlbrunnen vord. Quelle	Mache & Meyer 1905	Sommer, p. 27
2	50,20	—	,,	,,	,,	,,	Schlossbrunnen	,, ,,	,, ,,
3	21,90	—	alkaline saline	Teplitz	,,	730	Urquelle	,, ,,	,, p. 45
4	15,00	—	alkaline muriated carbondioxated	Gleichenberg	,,	980	Constantinquelle	Bendorf 1907	,, p. 21
5	10,90	cold	alkaline sulphated carbondioxated (?)	Marienbad	,,	2090	Waldquelle	Mache, Maier and Zörkendörfer 1905	,, p. 33
6	2,60	23,3°	simple	Vöslau	,,	810	Hauptquelle	Mache & Meyer 1905	,, p. 47

(B) Results of measurements expressed in curies.

The quantity of radium emanation expressed in milligramme radium per minute in 10 litres of gas or water quoted from Curie's "Radioaktivität" and that expressed in milligramme radium bromide ($RaBr_2$) per minnte in 1 litre of gas or water quoted from Lazarus' "Handbuch der Radium-Biologie und Therapie" are recalculated into curies and Mache's units by using the following factors:

1 millig. min. emanation of radium $= 1250 \times 10^{-10}$ curies.

1 millig. min. emanation of radium bromide ($RaBr_2$) $= 734 \times 10^{-10}$ curies.

1×10^{-10} curie $= 0{,}275$ Mache's units.

The numbers in brackets denote the quantity of radium emanation calculated for reference under the supposition that the original numbers given in Curie's work refer to milligramme radium bromide ($RaBr_2$) per minute, and not to milligramme radium per minute.

No.	Emanation per litre of water: in 10^{-10} curies	in Mache's units (recalculated)	Temp. of spring in C.	Classification	Location		Altitude in ft.	Spring	Observer	Remarks
1	649,59	178,64	—	—	Agnas Lerez	Spain	—	Aceñas	Munoz del Castillo	Lazarus, p. 44
2	229,01	62,98	60,0°	muriated alkaline	La Bourboule	France	2780	Puits Choussy	Laborde	„
3	162,50 (95,42)	44,69 (26,24)	13,0°	iron carbondioxated	Bussang	„	2200	Grande Salmade	„	Curie, p. 504
4	161,48	44,41	43,0°	sulphur	Luchon	„	2600	Grande source Bordeu	Moureu	Lazarus, p. 44
5	59,45	16,35	46,0°	simple (?)	Plombières	„	1300	Capucins	Curie & Laborde	„
6	52,50 (30,83)	14,44 (8,48)	12,0°	iron carbondioxated	Dirza (Corsica)	„	1960?	Source Dirza	Laborde	Curie, p. 504
7	47,50 (27,89)	13,06 (7,67)	69,0°	simple (?)	Plombières	„	1300	Vauquelin	Curie & Laborde	„
8	40,37	11,10	47,0°	salt sulphur	Aix-les-Bains	„	860	Source d'Alun	„	Lazarus, p. 44
9	33,47	9,20	—	—	St. Lucasbad	Hungary	—	—	—	„
10	21,25 (12,48)	5,84 (3,43)	58,0°	saline	Bourbon-Lancy	France	1780	Le Lymbe	Curie & Laborde	Curie, p. 504
11	1,10	0,30	27,2°	saline sulphur	Uriage	„	1350	Source principale	Besson	Lazarus, p. 44
	Emanation per litre of gas							Gas evolving from:		
1	2936,00	807,40	36,3°	simple	Gastein	Austria	3400	Grabenbäckerquelle	Mache & Meyer	Lazarus, p. 44
2	1416,62	389,57	60,0°	muriated alkaline	La Bourboule	France	2780	Puits Choussy	Laborde	„
3	1347,62	370,60	43,0°	sulphur	Luchon	„	2600	Grande source Bordeu	Moureu	„
4	736,94	202,66	69,0°	simple (?)	Plombières	„	1300	Vauquelin	Curie & Laborde	„
5	507,50 (298,00)	139,56 (81,95)	46,0°	„	„	„	„	Capucins	„	Curie, p. 504
6	226,07	62,17	47,0°	salt sulphur	Aix-les-Bains	„	860	Source d'Alun	„	Lazarus, p. 44
7	222,50 (130,65)	61,19 (35,93)	58,0°	saline	Bourbon-Lancy	„	1780	Le Lymbe	Curie & Laborde	Curie, p. 504
8	90,28	24,83	—	—	St. Lucasbad	Hungary	—	—	—	Lazarus, p. 44

Radio-activity of Mineral Springs in Miyagi and Nagano Prefectures.

(Supplement to Tables 1 and 2)

Table 10.

(A) Determined with Schmidt's electrometer.

No.	Emanation per litre of water in 10^{-10} curies	Emanation per litre of water in Mache's units (recalculated)	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
1	237,31	*65,26*	ca. —	9,0°	carbonated	Ōkuwa	大　桑(長野)	Granite	Shika-no-yu *No. 2*
2	224,25	*61,67*	—	9,5°	”	”	”	”	” *No. 1*
3	53,01	*14,58*	335	56,0°	”	Tōgatta	遠 刈 田(宮城)	Liparite	Kami-no-yu
4	21,20	*5,83*	—	9,2°	”	Ōkuwa	大　桑(長野)	Granite	Shika-no-yu *No. 3*
5	13,41	*3,69*	—	49,5°	salt	Sakunami	作　並(宮城)	Tertiary	Shin-yu
6	11,42	*3,14*	—	51,0°	”	Tōgatta	遠 刈 田(”)	Liparite	Naka-no-yu
7	10,64	*2,93*	—	46,0°	”	Sakunami	作　並(”)	Tertiary	Me-no-yu
8	1,55	*0,43*	—	83,5°	”	Shin-kuruma	新　車(”)	Andesite	Moto-yu
	Emanation per litre of gas at 0° C.								Gas evolving from:
1	287,54	*79,07*	—	9 0°	carbonated	Ōkuwa	大　桑(長野)	Granite	Shika-no-yu *No. 2*
2	62,49	*17,18*	—	9,2°	”	”	”	”	” *No. 3*

(B) Determined with the fontactoscope of Kohlrausch and Löwenthal.

No.	Emanation per litre of water in Mache's units	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Classification	Location	地　名 (府縣名)	Geology	Spring
1	5,04	—	51,5°	salt	Tōgatta	遠 刈 田 (宮城)	Liparite	Miuraya-no-yu (*Otoko-yu*)
2	3,69	—	51,0°	”	”	” (”)	”	Naka-no-yu
3	3,50	270	51,0°	”	Sakunami	作　並 (”)	Tertiary	Tsuru-no-yu (*D. Koike*)
4	3,20	—	51,0°	”	”	”	”	Taka-no-yu
5	2,62	—	52,0°	”	”	”	”	Tsuru-no-yu (*Moritani*)
6	2,20	450	63,0°	”	”	”	”	Kawara-yu
7	2,13	—	52,0°	”	Tōgatta	遠 刈 田 (”)	Liparite	Kamasaki-no-yu
8	2,05	1400	57,0°	simple	Ao-ne	青　根 (”)	Tertiary	Shin-yu
9	2,01	—	51,5°	salt	Tōgatta	遠 刈 田 (”)	Liparite	Miuraya-no-yu (*Onna-yu*)
10	1,86	450	69,5°	”	Sakunami	作　並 (”)	Tertiary	Taki-no-yu
11	1,64	—	55,0°	”	Tōgatta	遠 刈 田 (”)	Liparite	Ōkomuro-uchi-yu
12	1,63	1400	52,0°	simple	Ao-ne	青　根 (”)	Tertiary	Myōgō-no-yu
13	1,43	—	50,0°	salt	Tōgatta	遠 刈 田 (”)	Liparite	Jōtō-yu
14	1,42	1584	43,0°	”	Akyū	秋　保 (”)	Tertiary	Sawa-no-yu
15	1,42	—	74,0°	—	Moto-kuruma	元　車 (”)	Andesite	Moto-kuruma-yu
16	1,29	7258	42,5°	simple	Ao-ne	青　根 (”)	Tertiary	Ō-yu
17	0,86	1584	53,0°	common salt	Akyū	秋　保 (”)	”	Mi-yu
18	0,75	—	44,0°	carbonated	Kawatabi	川　渡 (”)	”	Suzuki-no-yu
19	0,74	648	48,5°	”	”	”	”	Ō-yu
20	0,73	—	59,5°	”	Akayu	赤　湯 (”)	Andesite	Ue-no-yu
21	0,36	—	48,0°	—	Kawatabi	川　渡 (”)	Tertiary	Sukashi-yu

II. Temperature.

Table 11.

No.	Temp. of spring in C.	Total residue in grams	Flow of water in 24 hrs. in hectolitres	Emanation per litre of water in Mache's units	Classification	Location	地 名(府縣名)	Geology	Spring
1	108,0°	ca. 9,24	ca. 1296	0,04	earth-muriated common salt	Atami	熱海(靜岡)	Andesite	Ō-yu
2	103,0°	3,52	—	0,13	alkaline sulphur	Naruko	鳴子(宮城)	,,	Unagi-yu
3	102,0°	4,19	9000	0,06	common salt	Senami	瀨波(新潟)	—	Senami-Funtō
4	100,0°	1,12	270	—	salt	Onikōbe	鬼首(宮城)	Tertiary	Fukiage-yu
5	100,0°	—	—	0,27	common salt	Shimogamo	下賀茂(靜岡)	,,	Spring *A* (near Jiunji temple)
6	99,0°	—	—	0,22	—	Kamegawa	龜川(大分)	Andesite	Kamado-no-yu
7	97,0°	—	324	—	vitriol	Noboribetsu	登別(北海道)	Tertiary	Me-no-yu
8	96,0°	—	1800	—	,,	Miyanoshita	宮ノ下(神奈川)	Andesite	Spring *A*
9	96,0°	—	—	1,14	alkaline sulphur	Nakabusa	中房(長野)	Granite	Myōken-no-yu
10	95,0°	—	abundant	1,76	alkaline carbon-dioxated	Yumura (Hyōgo-ken)	湯村(兵庫)	,,	Ara-yu
11	95,0°	—	—	1,11	sulphur	Futami	二見(富山)	,,	Dai-san-no-yu
12	95,0°	4,06	216	—	acid alum	Osoreyama	恐山(青森)	Andesite	Shin-taki-no-yu
13	95,0°	—	—	—	—	Hokutō	北投(臺北)	Tertiary	Spring *E*
14	94,0°	—	—	0,64	—	Obama	小濱(長崎)	Andesite	Gorin-yu
15	93,0°	—	—	6,93	earth-muriated common salt	Wakura	和倉(石川)	Tertiary	Wakazaki-no-yu *No. 1*
16	91,0°	—	3060	—	iron	Furō-sen	不老泉(秋田)	,,	Shirakumo-no-taki
17	91,0°	2,52	389	0,13	acid alum vitriol	Myōban	明礬(大分)	Andesite	Jizō-no-yu
18	90,0°	1,40	1555	—	saline bitter sulphur	Yunomine	湯ノ峯(和歌山)	Tertiary	Oguri-no-yu
19	90,0°	—	3600	—	salt	Hiraochi	平落(鹿兒島)	Volc. Ash & Mud Lava	Naka-no-yu
20	88,5°	—	—	0,18	common salt	Yugawara	湯河原(神奈川)	Andesite	Uenoya-no-yu
21	88,0°	—	—	1,42	sulphur (?)	Kuzu	葛(長野)	Granite	Spring *A*
22	88,0°	0,50	—	1,97	simple	Yubiso	湯檜曾(群馬)	,,	Yubiso-no-yu *No. 2*
23	87,0°	—	4200	—	alum	Shiose	鹽浸(鹿兒島)	Volc. Ash & Mud Lava	Shimo-no-yu
24	84,0°	—	270	—	simple	Dai	臺(岩手)	Diluvium	Taki-no-yu
25	83,0°	—	130	1,13	,,	Kami-Suwa	上諏訪(長野)	Alluvium	Tajiku-no-yu
26	82,0°	0,98	5148	—	sulphur	Nozawa	野澤(,,)	Volc. Detr.	Asagama-no-yu
27	82,0°	0,40	207	—	saline sulphated bitter	Hokonagi	鉾投(鹿兒島)	Andesite	Hokonagi-no-yu
28	80,3°	—	—	0,28	salt	Urai	ウライ(臺北)	Tertiary	Spring *B* (on the left bank)
29	80,0°	0,15	4680	—	acid	Ōra	大良(鹿兒島)	Volc. Ash & Mud Lava	Ōradani-no-yu
30	80,0°	—	135	—	common salt (?)	Masan (Chōsen)	馬山(朝鮮)	—	Masan-Onsen
31	80,0°	—	—	—	salt	Shiriuchi	尻內(北海道)	—	Tono-no-yu
32	79,3°	—	—	0,18	simple	Tōi	頭圍(宜蘭)	Quaternary	Spring in field
33	79,0°	1,23	—	1,13	sulphated bitter	Asamushi	淺虫(青森)	Andesite	Tsubaki-no yu *No. 1*
34	79,0°	—	648	0,70	saline bitter	Yujiku	湯宿(群馬)	Tert. Tuff	Kubo-yu
35	79,0°	—	—	1,28	common salt	Katayamazu	片山津(石川)	Tertiary	Shiotsu-no-Tsubo
36	78,0°	2,39	—	1,87	,,	Kuradate	藏館(青森)	Alluvium	Hoyōen-no-yu
37	77,0°	—	1400	0,36	saline common salt	Shuzenji	修善寺(靜岡)	Andes. & Tuff	Ayame-no-yu
38	76,0°	—	—	0,74	salt	Ōwani	大鰐(青森)	Liparite	Kwara-no-yu
39	76,0°	1,26	389	0,64	bitter	Shido-daira	志戸平(岩手)	Tertiary	Warabi-no-yu
40	76,0°	—	—	1,40	common salt	Shibu [Hirao]	澁[平穩](長野)	Diluvium	Ō-yu *Vent No. 12*
41	76,0°	—	—	1,33	muriated sulphated bitter	Yudanaka	湯田中(,,)	Misaka Series	Ō-yu *Vent No. 1*
42	76,0°	10,03	152	2,17	earth-muriated common salt	Awara	蘆原(福井)	Alluvium	Funatsu *No. 10*
43	76,0°	—	—	0,30	—	Yunotani	湯ノ谷(熊本)	Aug. Andes.	Yunotani-Jigoku
44	75,0°	—	—	58,18	—	Misasa	三朝(鳥取)	Granite	Akazakiya-no yu

III. Flow of Water.

Table 12.

No.	Flow of water in 24 hrs. in hectolitres	Temp. of spring in C.	Total residue in grams	Discharge of solid ingredients in 24 hrs. in kilograms	Classification	Location	地名(府縣名)	Geology	Spring
1	ca. 63000	40,0°	ca. 2,72	ca. 17136	acid alum vitriol	Takayu (Yamagata-ken)	高湯(山形)	Andesite	Sugawa-no-yu
2	59530	48,5°	—	—	,,	Hokutō	北投(臺北)	Tertiary	Taki-no-yu
3	57802	37,5°	—	—	salt	Itō	伊東(靜岡)	Quaternary	Wada-Onsen
4	54000	71,5°	0,81	4374	acid vitriol	Noboribetsu	登別(北海道)	Tertiary	Taki-no-yu
5	54000	—	—	—	salt	Renge	蓮華(新潟)	Andesite	Yakushi-no-yu
6	36000	37°–38°	1,03	3708	alkaline	Kambara	蒲原(,,)	Chichibu Series	Kambara-Onsen
7	24624	40,5°	0,13	320	simple	Innai-Yunosawa	院內湯之澤(山形)	Tertiary	Yunosawa-Onsen
8	21312	55,5°	0,18	384	,,	Shu-otsu (Chōsen)	朱乙(朝鮮)	Granite	Shu-otsu-Onsen
9	12600	60,0°	—	—	alum	Shibi	紫尾(鹿兒島)	Volc. Ash & Mud Lava	Shibi-Onsen
10	10800	39,0°	0,89	961	simple	Onsei-in (Chōsen)	溫井院(朝鮮)	Granite	Onsei-in-Onsen
11	9540	53,9°	1,44	1374	iron carbonate	Anraku	安樂(鹿兒島)	Volc. Ash & Mud Lava	Anraku-Onsen
12	9450	39,1°	1,00	945	simple	Yumoto (Wakayama-ken)	湯本(和歌山)	Mesozoic.	Tatsukami-Onsen
13	9252	46,7°	0,35	324	sulphur	Myōban-yama	明礬山(鹿兒島)	Volc. Ash & Mud Lava	Iwō-yu
14	9000	102,0°	4,19	3771	common salt	Senami	瀨波(新潟)	—	Senami-Funtō
15	7776	34,0°	0,30	233	simple	Imagami	今神(山形)	Tertiary	Imakumano-Kōsen
16	7200	62,0°	1,19	857	earthy alkaline sulphur	Akakura	赤倉(新潟)	Andesite	Akakura-Onsen
17	6012	61,0°	2,28	1371	sulphur	Ōdaki	大瀧(秋田)	Alluv. Tal. Dep.	Tsuru-no-yu
18	5400	60,0°	0,57	308	hydrogen sulphide	Eino-o	榮之尾(鹿兒島)	Volc. Ash & Mud Lava	Eino-o-Onsen
19	4585	55,0°	1,90	871	acid muriated	Dake (Aomori-ken)	岳(青森)	Volc. Detr.	Dake-no-yu
20	4500	48,0°	0,22	10	simple	Yubara (Okayama-ken)	湯原(岡山)	Granite	Yakuō-tō
21	4464	63,0°	1,39	621	hydrogen sulphide	Tateyama	立山(富山)	Andesite	Tateyama-Onsen
22	4140	38,0°	—	—	sulphated bitter	Tochinoki	栃ノ木(熊本)	,,	Kwan-on-yu
23	4066	58,5°	1,91	777	,,	Iwai	岩井(鳥取)	Tertiary	Moto-yu
24	3944	62,0°	0,37	146	simple	Kaminoyama	上ノ山(山形)	Liparite	Hie-no-yu
25	3888	43,0°	0,32	124	,,	Yumura (Shimane-ken)	湯村(島根)	Granite	Shitsuni-no-yu
26	3455	39,0°	1,17	404	sulphur	Dake (Fukushima-ken)	岳(福島)	—	Dake-no-yu
27	3230	43,0°	0,29	94	simple	Arifuku	有福(島根)	Diorite	Arifuku-Onsen
28	3150	48,0°	5,03	1585	saline common salt	Kamasaki	鎌先(宮城)	Andesite	Ichijō-no-yu
29	3060	50,0°	—	—	salt	Yufuin	由布院(大分)	,,	Dakeshita-no-yu
30	3060	91,1°	—	—	iron	Furōsen	不老泉(秋田)	Tertiary	Shirakumo-no-taki
31	2772	44,0°	2,97	768	earthy common salt	Aoyama	青山(北海道)	Andesite	Furōkaku-no-yu *No. 1*
32	2700	37,5°	0,17	46	simple	Maga	眞賀(岡山)	Granite	Kin-yu
33	2592	56,5°	0,86	223	,,	Yoshioka	吉岡(鳥取)	Tertiary	Kabu-yu
34	2592	95,0°	1,86	482	alkaline	Ureshino	嬉野(佐賀)	Alluvium	Ureshino-Onsen
35	2074	100,0°	—	—	common salt	Atami	熱海(靜岡)	Andesite	Aoki-no-yu
36	1953	64,0°	1,58	309	,,	Tamatsukuri (Shimane-ken)	玉造(島根)	Tertiary	Kami-no-yu
37	1800	96,0°	—	—	acid alum (?)	Miyanoshita	宮ノ下(神奈川)	Andesite	Spring *A*
38	1800	52,0°	0,59	106	simple	Sandogoya	三斗小屋(栃木)	,,	Sandogoya-Onsen
39	1800	39,0°	0,28	50	,,	Tochiomata	栃尾又(新潟)	Granite	Tochiomata-no-yu *No. 1*
40	1730	—	0,93	161	,,	Tōgō	東鄉(鳥取)	Andesite	Yōjō-kwan-no-yu
41	1512	49,0°	0,77	116	,,	Takeo	武雄(佐賀)	,,	Takeo-Onsen
42	1320	51,0°	0,65	86	iron carbonate	Beppu	別府(大分)	,,	Kusunoki-Onsen
43	1296	38,0°	2,25	292	earth-muriated common salt	Yunogō	湯鄉(岡山)	Liparite	Sagi-no-yu

IV. The Quantity of Solid Ingredients.

Table 13.

No.	Total residue in grams	Flow of water in 24 hrs. in hls.	Discharge of solid ingredients in 24 hrs. in kilograms	Temp. of spring in C.	Classification	Location	地　名(府縣名)	Geology	Spring
	ca.	ca.	ca.						
1	65,70	—	—	—	earth-muriated iron carbonate concentrated common salt	Arima	有馬(兵庫)	Quartz Porph.	Ikeno-bō-Kōsen
2	56,58	—	—	—	,,	Karato	唐櫃(〃)	,,	Karato-Kōsen
3	42,00	—	—	—	acid concentrated alum vitriol	Isobe (Toyama-ken)	磯邊(富山)	Tertiary	Isobe-Kōsen
4	30,73	405	1245	80,0°	earthy iron carbonate concentrated common salt	Shiri-uchi	知内(北海道)	—	Shiriuchi-Onsen
5	30,28	2	6	—	alkaline carbondioxated concentrated common salt	Onishi	鬼石(群馬)	Crystal. Schist	Yashio-Kōsen
6	29,79	2700	8043	70,0°	sulphated common salt	Ryukō	龍岡(朝鮮)	Gneiss	Ryūkō-Kōsen
7	29,54	720	2127	15.5°	alkaline carbondioxated concentrated common salt	Isobe (Gumma-ken)	磯部(群馬)	Tertiary	Isobe-Kōsen
8	28,57	—	—	—	concentrated common salt	Kashio	鹿鹽(長野)	Crystal. Schist	Kashio-Kōsen
9	27,86	—	—	—	alkaline carbondioxated concentrated common salt	Haraichi	原市(群馬)	Volc. Detr.	Mine-Kōsen
10	25,49	—	—	—	acid sulphated concentrated alum vitriol	Taku	多久(佐賀)	Tertiary	Tentoku-Kōsen
11	25,15	—	—	—	muriated sulphur	Aoki	檍(宮崎)	Alluvium	Aokigahara Kōsen
12	23,31	1800	4196	78,0°	acid alum vitriol	Tsukawara	塚原(大分)	Andesite	Iwōyama-Onsen
13	23,07	—	—	—	earthy iron carbondioxated concentrated common salt	Masuyama	増山(大阪)	Tertiary	Masuyama-Kōsen
14	21,64	36	78	43 0°	earth-muriated vitriol common salt	Yunomoto (Iki Prov.)	湯之本(長崎)	Liparite	Yunomoto-Onsen *No. 2*
15	21,09	—	—	—	earthy alkaline concentrated common salt	Muko	武庫(兵庫)	Granite	Mukosan-Kōsen
16	20,93	2160	4521	82,0°	earth-muriated common salt	Wakura	和倉(石川)	Tertiary	Wakura-Onsen
17	20,40	—	—	—	earth-muriated concentrated common salt	Ōshio	大鹽(福島)	Andesite	Ōshio-Kōsen
18	19,66	—	—	53,4°	earth-muriated iron carbonate common salt	Arima	有馬(兵庫)	Quartz Porph.	Ichi-no-yu
19	15,79	630	995	74,0°	common salt	Katayamazu	片山津(石川)	Tertiary	Katayamazu-Onsen
20	15,64	—	—	—	earthy iron carbonate common salt	Daitō	大塔(大阪)	,,	Daitō-Kōsen
21	15,08	—	—	63,0°	earth-muriated common salt	Matsunoyama	松之山(新潟)	,,	Netsu-no-yu
22	14,78	270	399	44,5°	hydrogen sulphide common salt	Ōyuzawa	大湯澤(秋田)	Diluvium	*No. 38 (Ō-yu)*
23	13,76	360	495	18,7°	carbondioxated common salt	Takarazuka	寶塚(兵庫)	Granite	Takarazuka-Kōsen
24	11,50	—	—	46,0°	earth-muriated common salt	Atsushio	熱鹽(福島)	Alluvium	Atsushio-Onsen
25	11,32	—	—	60.0°	,,	Shimogamo	下賀茂(靜岡)	Tertiary	Shimogamo-Onsen
26	10,20	29	30	13 0°	carbondioxated common salt	Kawai	川合(島根)	Granite	Urisaka-no-yu
27	10,03	152	153	76,0°	earth-muriated common salt	Awara	蘆原(福井)	Alluvium	Funatsu *No. 10*
28	9,86	—	—	15,0°	earthy common salt	Masutomi	増富(山梨)	Granite	Yunokubo-gawara-no-yu
29	9,74	—	—	—	hydrogen sulphide common salt	Hiyanezaki	比屋根岬(沖繩)	—	Hiyanezaki-Kōsen
30	9,38	—	—	17,0°	iron carbonate common salt	Anamori	穴守(東京)	Alluvium	Anamori-Kōsen
31	9,24	1296	1198	108,0°	earth-muriated common salt	Atami	熱海(靜岡)	Andesite	Ō-yu
32	8,84	—	—	65,0°	,,	Obama	小濱(長崎)	,,	Fukiage-yu
33	7,81	1167	911	60,0°	common salt	Beppu	別府(大分)	,,	Higashi-Onsen
34	7,25	—	—	—	acid alum vitriol	Kusatsu	草津(群馬)	Volc. Detr.	Shiranesan-no-yu

V. Hot Spring Spas arranged according to Altitude.

Abbreviations used in the table:

auto.	automobiles	jinr.	jinrikisha	omn.	omnibuses
avail.	available	L.	Lake	R.	River
betw.	between	m.	miles	st.	station
ft.	foot or feet	mid.	middle	volc.	volcano

Table 14.

No.	Altitude in ft.	Geology	Spa	地 名(府縣名)	Situation	Means of access
1	6950	Andesite	Shibu [Suwa]	澁 [諏訪] (長野)	N. slope of Mt. Yatsuga-take (9676 ft.).	12,4 m. from Chino st. (Chino—7,4 m. by omn.—Sasahara—5 m. on ft.—spa).
2	6000	”	Meiji [”]	明治[”](”)	Near Shibu.	9,8 m. from Chino st. via. Sasahara. 2,5 m. W. from Shibu [Suwa].
3	5468	”	Sukawa	酢川(岩手)	Near the summit of Mt. Sukawa-dake (5468 ft.).	27 m. W. from Ichinoseki st. (Ichinoseki—19,6 m. by omn.—Mayu—7,4 m. on ft.—spa).
4	5300	Granite	Nakabusa	中房(長野)	On the mid. slope of Mt. Ariake (8075 ft.) of Japan Alps	14 m. from Akashina st. (Akashina—5 m. by omn.—Ariake—9 m. on ft. or horse-back —spa).
5	5180	Andesite	Manza	萬座(群馬)	At the base of Mt. Manza (6494 ft.) near Mt. Shirane.	10 m. from Kusatsu; 24,5 m. from Kawara-yu; only on ft.
6	5088	Quartz Porph.	Nikkō-Yumoto	日光湯本(栃木)	By L. Yumoto; E. of Mt. Nikkō-Shirane (7544 ft.).	17 m. from Nikkō by jinr.
7	5000	Andesite	Sandogoya	三斗小屋(”)	Near the summit of Nasu volc. (6310 ft.).	7,5 m. up from Nasu-Yumoto on horse-back.
8	4720	Granite	Kamikōchi	上高地(長野)	Betw. Mt. Yake and Hotaka of Japan Alps.	27 m. from Matsumoto st. (Matsumoto—11 m. by omn.—Shimajima—16 m. on ft.—spa).
9	4640	Volc. Detr.	Kazawa	鹿澤(群馬)	Betw. Mt. Asama and Azumaya; S. W. of Manza spa.	9,8 m. from Tanaka st. on horse-back.
10	4627	Andesite	Tateyama	立山(富山)	On the Mt. Tate-yama (9689 ft.).	32 m. from Toyama (Toyama—8,6 m. by jinr.—Kamitaki-machi—23,4 m. on ft. by steep path—spa).
11	4500	”	Renge	蓮華(新潟)	Mid. slope of Mt. Renge (10035 ft.).	23,3 m. from Itoigawa st. (steep path).
12	4500	Volc. Detr.	Kusatsu	草津(群馬)	E. of Mt. Shirane (7500 ft.)	26,2 m. from Karuizawa. 50,8 m. from Takasaki st. via Nakanojō (whence to spa 25 m. on horse-back).
13	4500	Andesite	Hoppo	發補(長野)	E. of Shibu [Hirao], on the way to Kusatsu from Shibu.	15,7 m. from Toyono st. (Toyono—10 m. by auto.—Shibu—5,7 m. on ft.—spa).
14	4000	”	Sugayu	酸湯(青森)	S. W. of Mt. Hakkōda (5184 ft.).	25 m. from Aomori by steep path.
15	3785	Tertiary	Otari	小谷(長野)	Ft. of Mt. Amakazari (6732 ft.).	39 m. from Akashina st. via Ōmachi, omn. avail.
16	3750	Chichibu Series	Shirahone	白骨(”)	N. E. of Mt. Norikura-ga-dake (10448 ft.) of Japan Alps.	29,5 m. from Matsumoto st. (Matsumoto—14,5 m. by omn.—Inekoki—15 m. on ft. or horse-back—spa).
17	3464	Granite	Kawamata	川俣(栃木)	N. of Mt. Nantai (8194 ft.).	12,3 m. from Nikkō-Yumoto; near Nishi-zawa gold mine.
18	3300	Andesite	Yunohanazawa (Hakone)	湯之花澤(神奈川)	At the ft. of Mt. Koma-ga-take of Hakone.	8 m. from Yumoto (Hakone).
19	3200	Jurassic	Kawachi	河內(石川)	W. slope of Mt. Hakusan (8867 ft.).	39,2 m. from Komatsu st. (Komatsu—19,6 m. by omn.—Onnabara). 31,9 m. from Fukui st. for 21,3 m. jinr. avail.
20	> 3000	Granite	Kashi	甲子(福島)	At the base of Mt. Asahi (6498 ft.).	14,3 m. from Shirakawa st. (Shirakawa—9,4 m. by jinr.—Mafune).
21	3000	Tertiary	Goshiki	五色(山形)	On the Itaya-tōge, near Mt. Azuma (volc., 6511 ft.).	2 m. from Itaya st., on ft.
22	3000	Andesite	Nasu-Yumoto	那須湯本(栃木)	S. E. ft. of Nasu volc. (6310 ft.).	10,4 m. from Kuroiso st., omn. avail.
23	2944	”	Takayu (Yamagata-ken)	高湯(山形)	N. ft of Mt. Zaō-dake (6034 ft.).	7,3 m. from Kaminoyama st., omn. avail.
24	2760	”	Ashinoyu (Hakone)	蘆之湯(神奈川)	By L. Ashi; at the base of Mt. Koma-ga-dake of Hakone.	8,5 m. from Yumoto (Hakone). 4,5 m. from Miyanoshita.
25	2700	Volc. Ash & Mud Lava	Kirishima	霧島(鹿兒島)	S. W. skirt of Mt. Karakuni-dake (or Kirishima), volc. (5610 ft.).	From Makizono st. to Kami-nakatsu 4 m. by jinr., then 6 m. by kago or on horse-back.
26	2700	Andesite	Irinoyu	入之湯(群馬)	E. slope of Usui-tōge (3088 ft.).	6 m. down from Karuizawa, on ft.
27	2700-2500	”	Ikao	伊香保(”)	E. slope of Mt. Haruna (4808 ft.).	16,6 m. from Maebashi st. } 20,3 m. from Takasaki st. } each by elec. tram.
28	2600	Alluvium	Suwa (Kami and Shimo)	上下諏訪(長野)	By L. Suwa, W. skirt of Mt. Yatsu-ga-take (9676 ft.).	120 m. from Iidamachi st. (Tōkyō).
29	2510	Liparite	Jozankei	定山溪(北海道)	On the R. Toyohira.	17,6 m. from Sapporo (Sapporo—6,5 m. by horse-tram.—Ishiyama).
30	2500	Andesite	Akakura	赤倉(新潟)	E. slope of Mt. Myōkō (8098 ft.).	4,3 m. from Taguchi st., jinr. avail.
31	2500	Misaka Series	Shima	四萬(群馬)	Upper course of R. Agatsuma.	11,3 m. from Nakanojō, omn. avail.
32	2400	Andesite	Unzen	溫泉(長崎)	On the mid. slope of Mt. Unzen (4300 ft.).	7 m. from Obama by chair.
33	1223	”	Miyanoshita	宮ノ下(神奈川)	On the upper reach of R. Hayakawa, at the base of Mt. Myōjin and Myōjō.	4 m. from Yumoto (Hakone).
34	1150	Quartz Porph.	Arima	有馬(兵庫)	N. ft. of Mt. Rokkō-zan (3059 ft.).	14 m from Kōbe by kago. 6 m. from Sanda st., auto. avail.

VI. Politico-economic Statistics with regard to Hot Spring Spas.

Table 15.

(A) Arranged according to Number of Visitors (1909).

No.	Number of visitors per annum	Their total stays in days	Date of discovery	Number of inns	Number of inns with private baths	Number of public baths	Total number of baths	Spa	地名(府縣名)	Population	Number of houses
1	**108 192**	***549 947***	mytholog. age	202	202	21	ca. 1000	Beppu	別府 (大分)	14045	3120
2	**91 755**	***92 098***	—	7	0	1	1	Kōjio	神鹽 (〃)	2600	—
3	**65 000**	***195 000***	270-310	13	13	2	16	Yugawara	湯河原 (神奈川)	500	80
4	**64 370**	***126 910***	—	33	33	10	43	Kami-Suwa	上諏訪 (長野)	13405	2887
5	**56 787**	—	81-113	18	8	5	13	Iizaka	飯坂 (福島)	4800	1000
6	**52 500**	***325 200***	1648-52	—	—	3	—	Ichiku	市來 (鹿兒島)	729	127
7	**45 565**	***203 152***	mytholog. age	47	0	4	4	Dōgo	道後 (愛媛)	1786	432
8	**43 731**	—	1194	9	9	3	12	Kwankaiji	觀海寺 (大分)	150	30
9	**39 297**	—	—	19	4	4	8	Yuno	湯野 (福島)	—	616
10	**35 795**	***73 136***	947-67	55	45	13	58	Asama	淺間 (長野)	1600	300
11	**35 443**	***55 325***	1458	26	17	6	26	Kaminoyama	上之山 (山形)	8600	1000
12	**35 000**	***150 000***	859	17	17	1	18	Takayu (Yamagata-ken)	高湯 (〃)	440	50
13	**34 153**	***1 039 847***	1156-59	20	—	5	—	Yamaga	山鹿 (熊本)	7541	1588
14	**33 557**	***193 217***	28 B.C.	38	12	15	94	Ikao	伊香保 (群馬)	772	373
15	**32 349**	***101 261***	bef.* 270	35	—	1	—	Takeo	武雄 (佐賀)	3200	570
16	**31 451**	***165 670***	806-10	41	—	23	—	Shiobara	鹽原 (栃木)	2000	350
17	**30 499**	***109 894***	673-86	17	7	3	10	Musashi	武藏 (福岡)	733	132
18	**28 832**	***147 489***	729-49	22	0	3	3	Yamanaka	山中 (石川)	3300	760
19	**28 704**	***96 879***	718	11	11	1	12	Awazu	粟津 (〃)	580	150
20	**27 082**	***181 604***	1596-1615	38	28	4	32	Ōwani	大鰐 (青森)	3779	615
21	**26 875**	***58 471***	1312	10	7	3	10	Akayu (Yamagata-ken)	赤湯 (山形)	4135	801
22	**26 528**	***60 395***	1598	10	10	2	—	Yumoto and Tōnosawa	湯本及塔之澤 (神奈川)	1853	309
23	**25 351**	***219 165***	720	39	0	6	6	Kinosaki	城崎 (兵庫)	1923	421
24	**25 146**	***262 491***	1409	34	34	4	38	Hinagu	日奈久 (熊本)	2403	442
25	**24 969**	***111 411***	806-10	20	25	7	32	Shuzenji	修善寺 (靜岡)	2252	355
26	**23 638**	***174 306***	668-71	45	45	3	51	Atami	熱海 (〃)	5866	893
27	**22 808**	—	—	19	6	7	13	Yufuin	由布院 (大分)	—	300
28	**22 523**	***94 168***	724-29	33	17	24	41	Hirao	平穩 (長野)	3931	747
29	**22 000**	—	717-24	17	17	1	22	Higashiyama	東山 (福島)	—	103
30	**21 267**	***79 237***	1573-92	20	14	1	15	Wakura	和倉 (石川)	576	111
31	**20 286**	***170 907***	bef.* 1624	8	3	5	8	Obama	小濱 (長崎)	2500	500
32	**20 083**	—	1884	25	25	3	30	Awara	蘆原 (福井)	1000	180
33	**19 375**	***96 759***	725	18	18	2	20	Yamashiro	山代 (石川)	2200	420
34	**18 764**	***37 875***	673-86	22	5	5	10	Bessho	別所 (長野)	1062	222
35	**16 560**	***115 920***	1736-41	18	5	2	7	Hijiori	肘折 (山形)	500	80
36	**16 324**	***56 340***	1025	10	10	1	—	Miyanoshita	宮ノ下 (神奈川)	917	163
37	**16 055**	***45 590***	947-57	20	9	7	16	Nozawa	野澤 (長野)	1659	288
38	**15 033**	***45 451***	1346-70	8	—	3	—	Matsunoyama	松之山 (新潟)	210	36
39	**13 263**	***132 636***	821	25	25	2	27	Atsumi	溫海 (山形)	—	100
40	**12 968**	***55 356***	bef.* 1276	15	—	5	—	Kannawa	鐵輪 (大分)	1000	—
41	**12 455**	***52 948***	270	19	1	1	2	Ureshino	嬉野 (佐賀)	1200	200
42	**12 441**	***53 226***	835	18	13	2	—	Tamatsukuri (Miyagi-ken)	玉造 (宮城)	—	350
43	**12 378**	***32 833***	1652-55	7	7	1	8	Katayamazu	片山津 (石川)	500	140
44	**11 365**	***79 598***	1624-44	33	33	10	—	Itō	伊東 (靜岡)	8563	1379
45	**11 361**	***50 595***	—	6	6	—	—	Tatsunokuchi	辰之口 (石川)	270	45
46	**11 288**	***22 450***	834-48	15	15	2	17	Onogawa	小野川 (山形)	175	60
47	**11 018**	***70 462***	—	9	—	6	—	Soida	副田 (鹿兒島)	800	200

* before.

No.	Number of visitors per annum	Their total stays in days	Date of discovery	Number of inns	Number of inns with private baths	Number of public baths	Total number of baths	Spa	地名（府縣名）	Population	Number of houses
48	10 151	*73 524*	1387	13	13	7	20	Dai	臺（岩手）	170	27
49	10 132	*64 605*	mytholog. age	27	—	2	—	Arima	有馬（兵庫）	1778	329
50	10 093	*47 007*	—	11	1	2	3	Dake (Fukushima-ken)	岳（福島）	230	22
51	10 039	*34 415*	1825	19	—	2	—	Funagoya	船小屋（福岡）	357	55
52	9 994	*23 601*	—	24	12	4	16	Shimo-Suwa	下諏訪（長野）	7000	1300
53	9 805	*40 653*	1573 92	4	—	3	—	Hotta	堀田（大分）	100	20
54	9 334	*67 999*	806-10	28	—	3	—	Tawarayama	俵山（山口）	716	112
55	8 637	*65 718*	1428	4	3	1	4	Kamasaki	鎌先（宮城）	141	14
56	8 300	*50 000*	1335	19	—	1	—	Murasugi	村杉（新潟）	250	33
57	7 603	*86 447*	540-71	14	—	5	—	Nasu-Yumoto	那須湯本（栃木）	700	60
58	7 133	*138 285*	1521-46	10	—	2	—	Takarazuka	寶塚（兵庫）	600	100
59	6 846	*17 879*	1661-73	8	8	2	—	Unzen	溫泉（長崎）	527	108
60	6 740	*140 200*	bef.* 642	70	—	7	—	Kusatsu	草津（群馬）	1313	300
61	6 617	*57 613*	784	6	6	0	14	Shima	四萬（〃）	320	58
62	5 984	*25 650*	—	2	—	—	2	Ashinoyu (Hakone)	蘆之湯（神奈川）	81	9
63	5 558	*56 937*	—	17	0	1	1	Myōban	明礬（大分）	280	—

(B) Arranged according to administrative district.

No.	Number of visitors (1909)	Their total stays in days	Total stays in days per visitor			Number of spas†	Prefecture (Ken)	府縣名
			Average	Max.	Min.			
1	19 891	*138 627*	7	27	1	48	Hokkai-dō	北海道
2	62 798	*372 529*	6	36	1	32	Aomori	青森
3	38 247	*224 387*	6	14	3	18	Iwate	岩手
4	28 367	*230 415*	8	26	1	39	Akita	秋田
5	65 926	*369 737*	6	17	4	27	Miyagi	宮城
6	229 618	*920 822*	4	13	1	30	Yamagata	山形
7	105 046	*355 073*	3	7	1	17	Fukushima	福島
8	128 236	*403 833*	3	19	1	45	Niigata	新潟
9	43 376	*292 516*	7	11	2	6	Tochigi	栃木
10	87 981	*378 741*	4	21	1	35	Gumma	群馬
11	7 995	*34 884*	4	8	1	11	Ibaraki	茨城
12	2 530	*11 300*	5	16	2	6	Chiba	千葉
13	3 156	*10 426*	3	8	1	7	Saitama	埼玉
14	4 158	*20 605*	5	10	2	3	Tōkyō	東京
15	119 520	*360 496*	3	6	2	8	Kanagawa	神奈川
16	109 875	*515 829*	5	19	1	21	Shizuoka	靜岡
17	31 332	*130 979*	4	30	1	11	Yamanashi	山梨
18	262 433	*723 305*	3	13	1	36	Nagano	長野
19	26 081	*89 833*	3	10	1	21	Gifu	岐阜
20	31 876	*139 451*	4	7	2	11	Toyama	富山
21	142 666	*558 156*	4	5	1	19	Ishikawa	石川
22	1 000	*3 355*	3	4	2	2	Fukui	福井
23	536	*1 179*	2	3	2	2	Shiga	滋賀
24	560	*910*	2	3	1	3	Aichi	愛知
25	4 389	*8 768*	2	5	2	5	Mie	三重
26	2 651	*1 176*	—	4	—	5	Nara	奈良
27	22 650	*105 011*	5	9	2	14	Wakayama	和歌山

† Spas refer only to those taken in calculation.

No.	Number of visitors (1909)	Their total stays in days	Total stays in days per visitor			Number of spas†	Prefecture (Ken)	府縣名
			Average	Max.	Min.			
28	6 523	*10 359*	2	6	1	4	Kyōto	京都
29	56 462	*509 675*	9	19	4	8	Hyōgo	兵庫
30	18 233	*66 327*	4	10	1	10	Tottori	鳥取
31	30 519	*86 289*	3	7	1	13	Shimane	島根
32	19 616	*65 793*	3	9	1	10	Okayama	岡山
33	6 945	*11 150*	2	11	1	7	Hiroshima	廣島
34	39 438	*227 672*	6	14	1	12	Yamaguchi	山口
35	11 252	*11 171*	—	—	—	1	Tokushima	德島
36	404	*12 091*	30	30	30	1	Kagawa	香川
37	49 165	*204 952*	4	5	2	2	Ehime	愛媛
38	2 135	*4 371*	2	2	2	3	Kōchi	高知
39	40 963	*145 614*	4	3	3	3	Fukuoka	福岡
40	420 720	*1 448 205*	3	10	1	24	Ōita	大分
41	93 366	*1 496 486*	16	30	3	4	Kumamoto	熊本
42	29 123	*193 928*	7	8	1	7	Nagasaki	長崎
43	46 980	*192 630*	4	18	3	4	Saga	佐賀
44	10 474	*47 831*	5	5	5	3	Miyazaki	宮崎
45	142 164	*981 374*	7	19	2	41	Kagoshima	鹿兒島
46	70 088	*182 175*	3	8	1	37	Chōsen	朝鮮
	Total	Total	Absolute			Total		
			Average	Max.	Min.			
	2 677 364	*12 300 947*	5	36	1	676		

VII. Summer Resorts (without hot spring) arranged geographically.

Abbreviations used in the table are the same as those in Table 14.

Table 16.

No.	Name	地　名(府縣名)	Altitude in ft.	Situation	Means of access	Number of visitors per annum*
1	Ōnuma Park	大沼公園(北海道)	400	S. slope of Mt. Koma-ga-take (3627 ft.).	Summer st., 17,5 m. from Hakodate, in 51 min.	7353
2	Lake Towada	十和田湖(青森-秋田)	1476	S. of Aomori.	From the Kosaka copper mine, via Ōyu spa, 22 m. (horse and jinr. avail).	646
3	,, Chūzenji	中禪寺湖(栃　木)	4194	S. ft. of Mt. Nantai-san (8194 ft.).	10 m. W. from Nikkō, jinr. avail.	16174
4	,, Haruna	榛名湖(群　馬)	4000	W. ft. of Mt. Haruna-Fuji (4808 ft.).	5 m. W. from Ikao spa., on ft.	35
5	Mt. Tsukuba	筑波山(茨　城)	2892	N. W. of Lagoon Kasumi-ga ura.	From Tsuchiura to the ft. of the mount. 12 m, jinr. or omn. avail.	4311
6	,, Kanō	鹿野山(千　葉)	1218	On the borders of Kazusa and Awa.	From Kisarazu st. to the ft. of the mount. 12 m., jinr. avail.	—
7	,, Mitake (Tōkyō-fu)	御　嶽(東　京)	2851	W. of Tōkyō.	8 m. W. from Ōme st., on ft.	—
8	Lake Ashi	蘆ノ湖(神奈川)	2380	11 m. S. W. from Yumoto (Hakone).	jinr. avail.	1069
9	Gotemba	御殿場(靜　岡)	1589	E. ft. of Mt. Fuji.	69 m. from Tōkyō, in 3 hrs. 48 min.	—
10	Sano Waterfall Garden	佐野瀑園(　,,　)	—	E. ft. of Mt. Ashidaka-yama (4966 ft.), near Mt. Fuji.	0,8 m. N. W. from Sano st., jinr. avail.	186
11	Mt. Fuji	富士山(靜岡-山梨)	12395	On the boundary between Kai and Suruga Provinces.	7 m. from Yoshida-guchi to Tarō-bō; 8 m. from Gotemba-guchi to Tarō-bō; 5,5 m. from Subashiri-guchi to Umagaeshi; 7,5 m. from Ōmiya-guchi to Hachiman-dō.	25500
12	Lake Shōji	精進湖(山　梨)	4000	N. W. ft of Mt. Fuji.	From Kōfu 17 m. (on ft.). From Gotemba or Ōtsuki to Yoshida by horse-tram., then 17 m. on ft.	283
13	Fujimi	富士見(長　野)	3200	S. W. ft. of Mt. Yatsu-ga-dake (9676 ft.).	109,9 m. from Iidamachi st., Tōkyō, in 8 hrs. 35 min.	—
14	Karuizawa	輕井澤(　,,　)	3270	S. of Usui-tōge (3088 ft.).	88,3 m. from Ueno st., Tōkyō, in 4 hrs. 54 min.	8599
15	Togakushi	戸　隱(　,,　)	—	E. ft. of Mt. Togakushi-yama (8000 ft.).	12 m. N. W. from Nagano, on ft.	1200
16	Lake Nojiri	野尻湖(　,,　)	—	E. ft. of Mt. Madarao-san (5062 ft.).	2,4 m. N. E. from Kashiwabara st., jinr. avail.	890
17	Yōrō	養　老(岐　阜)	—	N. E. ft. of Mt. Yōrō-san.	8,5 m. S. from Ōgaki (by light railway).	1795
18	Ōiwayama	大岩山(富　山)	700	N. extremity of the ridge adjacent to Mt. Tate-yama (9689 ft.).	13,7 m. E. from Toyama, jinr. avail. From Namerigawa st. to Kami-ichi by light railway, thence 5 m. by jinr.	4734
19	Mt. Kōya	高野山(和歌山)	2858	2,5 m. S. from R. Kinokawa. E. of Wakayama.	11 m. from Hashimoto st., of which to Kane (5 m) jinr. avail., the rest on ft. or by kago. 8,5 m. from Kōyaguchi st., of this 3,7 m. by jinr., the rest on ft. or by kago.	—
20	,, Hiei	比叡山(京　都)	2800	N. E. of Kyōto.	About 3 hrs. from Kyōto on ft.	—
21	,, Atago	愛宕山(　,,　)	3043	W. of Kyōto.	6 m. from Saga st. to the summit.	—
22	Mino-o	箕　面(大　阪)	—	N. of Ōsaka.	From Ōsaka by electric tram. in 30 m. 4,9 m. from Ikeda st. (11,5 m. from Ōsaka)	495
23	Mt. Maya	摩耶山(兵　庫)	2290	N. E. of Kōbe.	3 m. from Sannomiya; 6 m. from Sumiyoshi; kago avail.	—

* According to the statistics in 1909.

VIII. List of Watering Places (with the number of visitors in 1909) arranged geographically.

Table 17.

No.	Geographical division		Number of visitors per annum	Number of watering places*	Name of notable places
1	S. W. coast of Hokkai-dō		19 000	3	Zenibako
2	N. part of Pacific coast	from C. Ōma to C. Kurosaki	5 951	5	Same-minato
3		from C. Kurosaki to C. Inubō	81 807	22	Shōbuda, Oarai, Hira-iso
4		from C. Inubō to C. Nojima	70 678	18	Ōhara, Ichi-no-miya, Katsu-ura
5	Bay of Tōkyō (from C. Nojima to Misaki)		10 416	13	Hōjō, Tateyama
6	Bay of Sagami (from Misaki to C. Irō)		28 471	7	Hayama, Zushi, Kamakura, Katase, Ōiso
7	Bay of Suruga (from C. Irō to C. Ommae)		2 495	3	Shizu-ura, Numazu
8	Sea of Tōtōmi (from C. Ommae to C. Irako)		3 030	1	Benten-jima
9	Bays of Atsumi, Chita and Ise (from C. Irako to C. Daiō)		105 231	12	Gamagōri, Ōno, Morozaki
10	Coast of Kii (from C. Daiō to Str. Yura)		3 551	1	Myōkō-ura
11	Coast around the Bay of Ōsaka		22 613	8	Sakai, Hamadera, Suma, Maiko, Akashi, Iwaya
12	E. part of Inland Sea (coast around the Bay of Harima)		402	3	Ushimado, Hoden
13	Middle part of Inland Sea (coast around the Bay of Bingo)		1 219	7	Sensui-jima (Tomo), Itozaki
14	W. part of Inland Sea (coast around the Bays of Hiroshima, Iyo and Suwō)		5 921	5	Baishinji
15	S. coast of Shikoku		2 000	1	
16	Coast along the Seas of Hibiki-nada, Genkai and Amakusa (from C. Kawajiri to Shimo-no-seki and N. and W. coast of Kyūshū)		69 775	7	Mutsure-jima, Karatsu, Nezumi-jima
17	S. part of the Sea of Japan (from C. Kawajiri to C. Suzu)		6 123	13	Inasahama, Uratomi, Mikuni
18	N. part of the Sea of Japan (from C. Suzu to C. Ōma)		10 973	7	Shimao, Higashi-iwase, Kujira-nami, Koto-ura
	Total		449 656	136	

* Watering places refer only to those taken in calculation.

PART III

NOTES

on

Prominent Spas, Seaside Resorts,

and

Summer Retreats.

HOKKAI-DŌ

Although hot springs in *Hokkai-dō* are generally believed not to be small in number, those already known are situated mostly in the south-western portion of the main island. Of these only such ones, as located in the places accessible by some means of transportation, are utilized but not a few are neglected owing to their remote and inconvenient positions. Hot springs gushing out in volcanic regions are, as a rule, sulphur springs of high temperature. In non-volcanic districts hot springs are comparatively seldom met with and are inclined to be carbonated, saline, or weak saline springs. We are going to describe some of these hot springs that are comparatively abundant and properly taken care of.

Noboribetsu. These hot springs are the most famous in Hokkai-do and lie 4,3 m. N. W. of the *Noboribetsu* station, *jinrikisha* or coaches being available over the distance. When these springs were first discovered many years ago, no path was found to go there. It was only in the Ansei Era (1854–1860) that officials were despatched by the Shōgunate Government to lay out a road there-to. In the course of the Meiji Era (1868–1912), the road was much improved. The place is see Plate 12 600 ft. above sea-level and very rich in scenic charms in all seasons, especially in spring with various blossoms and in autumn with tinted leaves; nevertheless it is delightfully cool in summer. Baths and inns offer satisfactory accommodation and make the place an ideal holiday resort. Springs gush out from a crater on the foot of a hill, 0,2–0,3 m. from the inns up the *Noboribetsu* River. This place is the origin of the *Kusuri-e-san-betsu*, a branch of the *Noboribetsu*, and forms a basin see Plate 13 surrounded by precipices on all sides except in the S. Abundant steam with sulphurous gases is constantly issuing out with resounding noise from two or three places on its bottom and white vapour fills the whole valley. Rocks acted upon by the steam especially on the precipices on the N. and the E. side are turned to gray and loose masses sometimes with yellow ocher and sulphur. Only in some spots, there is comparatively fresh andesite. Near the crater there are several other spots, where springs of different temperature and composition occur.

Some 3,5 m. distant from the crater, we find an open-air bath of a hot spring called "*Karurusu.*" About 0,2 m. to the N. W. of the crater, there is an old craterlet with a geyser, which was throwing up water tens of feet high till 1880. Stepping a little distance further uphill we come across an oblong pond of gray-coloured warm water extending to the N. E., with the circumference see Plate 14 of 165 ft. and surrounded by rather steep hills. At the S. E. corner of this pond, there are cold and hot springs. The scenery of this place is at its best in autumn when maples turn crimson, and no holiday-maker can enjoy their stay too much. The *Shimofuri Waterfall*, sometimes called "*Kachidoki-no-taki,*" is in the upper course of the *Noboribetsu*, and there are many scenic wonders in its vicinity. *Mt. Noboribetsu* may be climbed from this place. The hot spring village has more than fifty houses inhabited by some two hundred people and also a post office. Two inns out of see Plate 7, fig. 1 and 2 ten have their own baths and besides there are five public baths. There is a billiard room for visitors' amusement. Bathers were numbered 4,975 in 1909 and their total stays 33,250 days long. In recent years foreign visitors have been gradually increasing and the average number is ten a day. Although visitors come here all the year round, this place is most prosperous in summer.

Karurusu. 8 m. N. W. of the *Noboribetsu* station; 800 ft. above sea-level. A branch of *Mt. Noboribetsu* slopes towards the place and surrounds the place on all sides, a clear stream flowing across the valley and hot springs gushing out at its eastern extremity. The whole view is very lovely. Temperature indoors neither runs above 85° F. even in dog days nor falls below 33° in winter when snow covers the grounds 4 ft. high. Five houses. Although these springs were recognized by ancient inhabitants, they came to the knowledge of people from Japan Proper about in September, 1888, when surveyers accidentally discovered them during their engagement in the survey for colonial troop barracks.

Omnibuses available over the distance of 4,2 m. from the *Noboribetsu* station (fare: 35 *sen* a passenger), and farther stage of journey, 3,7 m. by mountain road (if on horse-back, charge 50 *sen*). 8,3 m. from the *Horobetsu* station (horse, fare 60 *sen*). Three inns, all without private baths. 298 bathers in 1909, most bathers come from neighbouring places for recuperation.

There are two springs, one *Kame-no-yu* or "tortoise spring" and the other *Tsuru-no-yu* or "crane spring." The springs, it is said, are named after the famous *Karlsbad* of Austria on account of similar property. (*Karurusu* is the Japanised pronunciation of "*Karls*").

Jōzankei. 17,6 m. from Sapporo up the *Toyohira* River, 2,510 ft. above sea-level. *Jinrikisha* and coaches available. *Jōzankei* is an important place on the road to *Abuta*. Although natives knew their existence long ago, they were recorded in history for the first time in the Ansei Era (1854–1860). In August, 1869 an itinerant monk *Jōzan* opened a bath, hence the present name. The public bath in front of the place now called "*Moto-yu*" is the very one set up by the monk. Hot springs gush out among a thickly wooded valley surrounded by high mountains and penetrated by a beautiful stream of the *Toyohira* with wonderful rocks. *Naka-no-yu* or "middle spring" was accidentally discovered by a visitor to "*Moto-yu*" while sauntering in the neighbourhood some time in 1674. *Shika-no-yu* or "deer spring" was discovered in 1984–5. Three inns; baths are dug into natural rocks and cemented all over. The bathers were numbered 2,080 in 1909 and their total stays 37,276 days long.

Sea-Bathing at Zenibako. 0,5 m. N. E. of the town of *Zenibako*. The seashore is where the wide expanse of *Ishikari* Plain meets the Japan Sea to the N. W., and the range of view is broad and wide. The whole shore and the bottom of the sea 360 ft. off are of white sand. Sand dunes stand side by side on the shore and there is a salt-manufactory. There are six rest-huts for the use of bathers, besides two ordinary inns with hot sea-water bath. The place is patronized by people from *Sapporo*, *Otaru*, etc. The number of bathers was 10,000 in 1912.

Aoyama and **Miyagawa.** Both the hot springs are on the River *Yuno-kawa*, 3 m. N. E. of the *Kombu* station and 4,3 m. N. W. of the *Kariputo* station, and less than 0,2 m. distant from each other. The district is a wide highland, forming a colony dotted with 75 farm-houses and now under cultivation.

Ōnuma Park. There are two lakes at the N. extremity of *Kameda-gōri* in Oshima province, that is *Ō-numa* and *Ko-numa*, both 400 ft. above sea-level. The whole shape is like the numeral 8, the narrowest portion being called "*sebatto*." The part of the lakes to the W. of Sebatto is named "Ko-numa" and that to its E. "Ō-numa," the entire water is known again as "Ō-numa." This was certainly a crater of an ancient volcano. *Ko-numa* is 1,7 m. N. to S., the whole lakes 3,8 m. E. to W., and their circumference 21,2 m. There are three villages on the lake shore. The whole surface of water looks like a large sheet of mirror, and water is clear and drinkable, its depth being 2 or 3 to 10 fathoms. The bottom is generally of slate covered by grits, five streams contributing to the lakes on all sides; *Mt. Koma-ga-dake* rears its sword-like peaks towards the sky, and adds a great deal to the quaintness of the sight. There are islets of various shapes and sizes, more than 140 in number, the biggest 180,000 square ft. and the smallest less than 1 square ft., all of them being thickly wooded, mostly with cherry, yew, maple, etc. The lake shore has many indentations which form bays, and the water is very calm. *Ō-numa* is famous for carp, gibel, etc., their annual production amounting to Y 3,000 worth. Thus the landscape is beautiful and air is pure and invigorating. Temperature: 20° to 30° F. in winter, 40° to 60° in spring, 70° to 80° in summer, and 50° to 60° in autumn.

For the convenience of visitors a temporary station *Ōnuma-Kōen* is opened every year from May 1*st* till October 31*st*, 18,3 m. from *Hakodate*.

Inns: *Kōyō-kwan* (Maple House), *Hyakkwa-en* (Gardens of Hundred Flowers), *etc.* The former faces *Ō-numa* towards N. E., with its garden planted with maples, and commands a wide view of cloud-capped *Koma-ga-dake* and islets in the lake. The latter stands on *Ko-numa* with its fine view of white-winged vessels sailing past among many islands. Boat to hire on the lakes. Foreign and Japanese visitors are numbered more than 2,000 in August and September.

Yunokawa lies 3,5 m. N. E. of *Hakodate*, and not far from the volcano *Koma-ga-dake*. The district is flat, being located at the mouth of the *Matsukura* and facing the strait of *Tsugaru*. Its seashore is of white and beautiful sand, whence one can descry distant mountain ranges in *Mutsu* Province over the sea. The place is flanked by hills on the N. and the E. side and forms a truly quiet pleasure resort. The scenery is best in spring, although of course it is attractive through the whole year. Its climate is mild and not subject to sudden changes, thus making it a good health resort. Houses 124 and population 593. Village, post, police offices and primary school. Many shops standing side by side form a regular street. Its discovery dates back to not later than 1654, but the place was abandoned till 1886, in which year the citizens of *Hakodate*, convinced of the existence of a hot spring vein in the neighbourhood, tried to bore the earth with a machine for making a well. Their effort was in vain even when they reached 500 ft. to 1,900 ft., but overcoming extreme financial difficulty, was awarded with ample success. As the quantity of this spring amounted to 8,5 hectolitres per hour, next year they began to run the place as a public resort and since then have contrived to bore more springs, lay out a park and repair roads leading there-to, thus bringing about to-day's prosperity. Electric cars from *Hakodate* over the distance of 4,5 m. The road is good and post, telegraph, and telephone communications are sufficient. Convenient communications also with other places.

Eight hotels; the best are *Senshin-kwan*, *Rinchō-kwan*, etc., all provided with private baths and three inns also with special baths for foreign visitors. Two doctors in the town and one shampooer. The room charge for foreigners about ¥25 a month. Bathers come chiefly from Hakodate. The average visitors are 2,500 per annum; total stays 600 days long. Not a few visitors from among the crews of foreign men-of-war anchoring at Hakodate and foreign summer tourists to Hokkai-dō. The season is from April to June. *see Plate 7, fig. 3*

AOMORI-KEN

Asamushi is at the S. head of *Aomori* Bay and 7,3 m. from *Aomori*. A short distance from the station of the same name. Broad seascape with small islands dotted here and there and the abundance of pine trees add much to the charms of the surroundings. There are eight sources of hot springs. History tells us that the famous monk *Enkō Daishi* on his N. E. itinerancy happened to come here and noticed a deer bathing in the sea. Convinced of the existence of a hot spring, he persuaded the villagers to establish baths. This is generally believed to be the inception of the present baths. Naturally early inhabitants religiously adored the springs and dared not to bathe in them but used them only for the purpose of dipping and steaming hemp for clothings. Thus the springs obtained the name of "*Asa-mushi-no-yu*" or 'Spring for steaming hemp,' gradually corrupted into the present characters. 210 houses; population 1,050. Salt-manufactories. Communications also maintained by sea. The famous *Tsubaki-yama* is 12,2 m. N. to the village. 26 inns; 2 doctors. Bathers come from the neighbouring places but an appreciable number of visitors from distant countries by railway, etc. Visitors 3,373 in 1909 and their total stays 11,997 days long.

Ōwani. A few minutes' walk from *Ōwani* station on the Ō-u Line, about 7 m. from *Hirosaki*, and 270 m. from *Sendai*.

The hot springs are situated to the S. W. of Aomori-ken, near the boundary of Akita-ken, surrounded by mountains, of which *Akara-yama* to the S. and *Iwaki-san* or the "*Tsugaru-Fuji*," (4,600 ft. high) so called on account of its similarity in shape to the famous Mt. Fuji, rises to the W. of the springs. The small stream *Hira-kawa* runs through the village which has 615 houses and 3,800 inhabitants. The spa lies at an elevation of 248 ft. above sea-level. Excellent apples are grown in the neighbourhood (the yearly production ca. ¥ 15,000).

In the environs of Ōwani bath there are many hot springs, namely **Nuru-yu** on the N. E., **Yumoto** at the foot of *Iwaki-san* and **Ikariga-seki** on the S. E. and others. **Kuradate** hot springs lie on the opposite side of the river from Ōwani. One of the hot springs, *Yamabuki-no-yu*, was found before the Keichō Era (1596–1615).

No less than 32 hot springs are found in Ōwani bath in the space of half a mile. There are two resident doctors, 38 inns with private baths and 4 public baths at Ōwani Spa, in 1909 the visitors numbered 27,082, the total stays being 181,604 days.

Kuradate. The bath lies on the opposite side of the river *Hira-kawa* to *Ōwani*. The village has 469 houses and 3,400 inhabitants, 5 public baths. Each inn is provided with its own bath. The inhabitants of the villages *Ōwani* and *Kuradate* built greenhouses near the source of springs, utilizing the heat in the germination of *soja* beans and other vegetations to advantage. Kuradate has one resident doctor. One of the hot springs, "*Shimo-no-yu*," was known in the Kenkyū Era (1190–1199). Number of visitors: 1,755, their total stays being 6,157 days (1909).

Ikariga-seki. About 10 minutes' walk from the *Ikariga-seki* station on the Ō-u Line, 5 m. S. from *Ōwani*, 36 m. S. from *Aomori*. *Jinrikisha* and omnibuses available.

The springs occur in a valley which runs N. and S. between the mountains. The village is situated at an elevation of 680 ft. above sea-level and has about 1,000 inhabitants.

Post, telegraph and telephone office. Local places of interest: *Senjō-ga-taki* ('Ten thousand feet Waterfall') 5 m., *Ito-taki* ('Thread Waterfall') 2 m., *Furu-ake-fudō* 2,5 m., ruins of an old castle 2 m., etc., are all worth visiting. The hot springs are here 5 in number, of which two belong to public baths.

The hot spring "*Natsu-no-yu*" was known before 1592. Number of visitors: 3,212, their total stays being 33,304 days (1909).

IWATE-KEN

Dai. Passengers from the S. alight at *Hanamaki* station on the N. E. Main Line, 22 m. N. from *Morioka*, 91 m. N. from *Sendai*, those from the N. alighting at *Ishidoriya* station, both stations are about 6 m. distant from the springs, *jinrikisha* and omnibuses being available.

Dai is a small bathing-place with mountains on all sides, lying on the bank of the upper course of a tributary flowing into the River *Kitakami-gawa*, and at an altitude of some 1,500 ft. above sea-level. Pop. 170. A kind of porcelain called "*Dai-yaki*," produced in this village, is a speciality of this district. *Dai* Mine is about 5 m. from the place.

There are more than 14 hot springs in the village, of which seven belong to public baths.

Number of visitors: 10,151, the total stays being 73,524 days (1909). Most bathers come from neighbouring places for recuperation.

Shido-daira. About 6 m. W. from the *Hanamaki* station, 91 m. N. from *Sendai*, and 308 m. from Tōkyō, the journey from the capital taking about 13 hours. *Jinrikisha* and omunibuses available from *Hanamaki*.

The bathing-place lies on the N. bank of a small stream, the *Toyosawa-gawa*, with mountains to the E. and W., at an elevation of 700 ft. above the sea. Pop. 120.

In this neighbourhood there are *Osawa Hot Springs* (1,5 m. from *Shido-daira*) and *Namari Hot Springs* (5 m.). Report claims that the spring was already known to the people before the Enryaku Era (782-806 A.D.).

The place has only one spring and one inn. The new bath-house has recently been constructed by the keeper of the inn *Kubota Ryo-kwan*, and has no equal in its constructon and appointments in the neighbouring spas. Number of visitors: 2,914 (1909).

Ōsawa. 8,5 m. W. from the *Hanamaki* station; 1,5 m. from *Shido-daira*; 2,5 m. from *Namari Hot Springs*.

The place is situated on both banks of the *Toyosawa-gawa*, with mountains on the E., the other three sides being open country communicating with the towns. Pop. 280. Post-office in the village. 2 public baths and a playground on the hillside. The eight scenic views of Ōsawa are well known in this place for their beauty. Number of visitors: 1,975 (1909).

AKITA-KEN

Ō-yuzawa, 1,3 m. N. W. from the *Jimba* station on the Ō-u Line, *jinrikisha* available over ⅔ of the distance, is shut in on all sides by densely wooded mountains, and here being one of the three most beautiful forests of Japan. The bath-place lies at an elevation of 700 ft. above the sea, and is a quiet summer retreat. The existence of the hot springs is believed to be dated from the time of the eruption of *Bandai-san* (an active volcano in Iwashiro Province) in 1889. Number of visitors: 3,000, the total stays being 21,700 days (1909).

Akayu is situated a little higher up in the mountain 0,5 m. from *Ō-yuzawa*, the water being a carbonated spring containing iron. Number of visitors: about 1,000, the total stays being about 10,000 days (1909).

Ō-yu. From Ō-date (251,5 m. from *Fukushima* on the Ō-u Line, in 12 hrs. 27 min.) to *Kosaka* Mine (a mining town containing 14,975 inhabitants) by Kosaka Railway (14,1 m., in 1 hr. 25 min.), built specially for the better exploitation of the Kosaka Mine, thence 8,6 m. S. E. by *jinrikisha* or omnibuses.

The bath-place is a small village with 5,438 inhabitants (660 households). Electricity, generated by the waterfalls near the village, supplies both motive power and light to Kosaka Mine. The hot spring "*Kami-no-yu*" is said to have been found in the Bummei Era (1469–1487 A.D.), but the bath-houses were first constructed in the Era of Eihō (1673–1681). There are four springs in the village, not more than 0,5 m. distant from each other, the water being all weak common salt springs. Number of visitors: 2,125, the total stays being 14,875 days (1909). *see Plate 15*

An interesting excursion may be made from the spas in this region to the beautiful mountain lake *Towada* with its wonderful landscape view. **Lake Towada**, literally "Ten Inlets Lake," 5,6 m. wide and 6,2 m. long, circumference 31 m., is 1,500 ft. above sea-level, is surrounded by the Mt. *Hanabe-yama* (3,200 ft.), *Towada-dake* and *Herai-dake* (3,250 ft.). The Hakkōda mountain range towers high on the horizon to the north, giving a fine view from the springs. The shore of the lake is picturesquely studded with grotesque rock formations, and its irregular contour and many windings, from which come the principal inlets, give an interest to all lovers of nature, the inlets in number giving us the origin and meaning of the name "Ten Inlets Lake," while another attraction is found at the southern end in a number of charming little islands (*Ebisu-jima*, *Kabuto-jima*, *Yoroi-jima*, *Tane-jima*, *Hōrai-jima*, *etc.*) and the famous old Shintō temple "*Towada-jinja*" in its setting of greenery on the shore but a short distance from *Ebisu-jima*. In autumn the glories of the wonderful foliage are shown in all their splendour, as the maples turn their leaves into brilliant scarlets and reds, these being reflected in the placid waters present a sight never to be forgotten. Boating facilities give opportunity for pleasure and enjoyment while the angler will find a sporting satisfaction, the lake being abundant in trout. The outlet forms another interesting feature in the cascade "*Chōshi-no-taki*," which tumbles in a foaming spray to pour itself into the River *Oirase*. Refreshment places near the lake are open during the summer months.

Ōdaki (8,6 m. S. E. from the *Ōdate* station) lies by the S. bank of the *Yoneshiro-gawa*, Ōdaki having 300 inhabitants. The stream itself adds a beauty and distinction to the place. In the public bath there is a hot waterfall for massage. Each inn is provided with private bath. Number of visitors: 2,023, the total stays being 10,482 days (1909).

Innai-Yunosawa. 1,8 m. from *Innai* station (122 m. from *Fukushima*, in 7 hrs.) on foot. The bath-place (679 ft. above the sea) is on the E. and W. enclosed by mountains, the stream *Yunosawa-gawa* with clear water running close by the village. Pop. 800. Several waterfalls (*Yu-no-taki*, *Tonaru-no-taki*, *Ō-daki*, *Mitsuai-no-taki*, *etc.*) each a wonderful sight. In 1907 the Garrison Hospital of Akita built here a sanatorium. There are two hot springs in this spa, the flow of water being very generous. Number of visitors: 2,488, the total stays being 12,858 days (1909). *see Plate 16*

Shibukuro. The valley of the upper course of the *Tama-gawa*, which originates from high mountains, such as *Yake-yama*, *Eboshi-dake* (5,356 ft.), *Koma-ga-dake* (5,264 ft.), etc., bounding two prefectures Iwate and Akita, is generally called "Shibukuro-zawa" or simply "Shibukuro." In this valley occur a number of hot springs, of which the most noted are *Hato-no-yu*, *Tsuru-no-yu*, *Kuro-yu*, and *Kani-no-yu*.

These springs, more than 2,700 ft. above the sea, are located in Sempoku-gun, Akita Prefecture, about 34–45 m. N. E. from the *Ōmagari* station on the Ō-u Main Line, not far from Lake Tazawa, all being very difficult to be reached. Waters coming from the springs are all received by the *Tama-gawa*, and on its bed is found sinter-deposit in crust of crystalline structure. It has been lately ascertained that the crust is identical with the so-called "*Hokutōlite*," a kind of new mineral found at Hokutō Hot Springs in Taiwan. *see Plate 3*

MIYAGI-KEN

The new Riku-u Line (94,6 m.) starts from *Kogota* and is to terminate at *Sakata* Harbour on the Japan Sea. It crosses the Ō-u Line at *Shinjō* and runs along the bank of the *Mogami-gawa*. The line is now under construction and only the section to *Kawatabi* (20 m. from Kogota) has been opened to traffic. In the vicinity of *Kawatabi* and *Naruko* many hot springs are found, of which the following are noted:

Yuizumi and **Onikobe.** The hilly district N. W. of the town of *Iwade-yama* has been noted for horse-breeding for centuries, and several of the favourite mounts of the late Emperor were raised here. The neighbourhood being volcanic, hot springs are found issuing almost everywhere, especially along the upper course of the *Arao-gawa*. These springs are in two clusters, one called *Yuzumi Hattō*, or the "Eight bath-resorts at Yuizumi," this latter term itself meaning "hot spring." The other is called *Onikōbe Gotō*, or the "Five bath-resorts at Onikōbe." The eight spas of Yuizumi are *Kawatabi*, *Tanaka*, *Aka-yu*, *Moto-kuruma*, *Shin-kuruma*, *Naruko*, *Kawara*, and *Nakayama*, and these are separated from each other by a distance varying from 100 yds. to 4 m., all being situated along the highway on the plain. Though lying in out of the way places, these resorts are reputed to be the best N. of Sendai in general arrangements and accommodation. *Kawatabi* (4 m. from *Ikezuki*) has five baths and is credited with being efficacious for leg-dropsy; *Tanaka* 1,3 m. W. is shelterd at the back by hills and has three baths; *Aka-yu* lies 0,5 m. off *Tanaka*, and its three springs yield carbonic acid waters; *Moto-kuruma* is 0,5 m. W. from the above and its waters belong to salt springs; *Shin-kuruma* occupies about the centre of the eight resorts and has five springs. *Naruko*, 3 m. from Kawatabi, is a prosperous village, containing more than one hundred houses; *Kawara* lies 0,3 m. further W., while the last resort, *Nakayama*, has two springs and is bounded on one side by a river, the other three sides being shut in by mountains. The vicinity abounds in natural beauty spots such as *Kokurosaki* with its dense pine woods variegated with maples, *Ikezuki-numa*, and *Mizuno-kojima*, the latter an islet in the *Tamatsukuri-gawa* with a shrine to Benten standing on it. There are also waterfalls, pools, high cliffs, etc. Of these eight springs above mentioned the two, Tanaka and Nakayama, were completely destroyed by a terrible flood of the *Arao-gawa* in 1910.

The Onikōbe Hot Springs, being located amidst hills and therefore less accessible than those of Yuizumi, are not so generally known. Of the five resorts, the first in order is *Sabusawa*, which is 5 m. distant from Naruko; then *Mitaki*, separated by 0,8 m. from Sabusawa; *Todoroki*, 2,4 m. from Sabusawa, and lastly *Ara-yu*. The waters of all these springs except Ara-yu (sulphur spring) are alkaline salt springs. At Todoroki is a geyser, or '*fuki-age*.' Formerly there were two holes from which intermittent hot springs gushed out with a loud detonation, but in 1901 the larger of the two ceased to be active, and at present the geyser comes out only from the smaller hole, at intervals of about 2 hrs., the column shooting up about 20 ft. The water contains bicarbonate of calcium, sulphate of potash, etc., the geyser having the property of encrusting and transforming into a fossilized state any plants or objects coming within its range.

It is very interesting to see the geyser in operation. The hot liquid gushes out from a hollow (about 10 ft. long and 4 ft. wide) in rocks, which was formed by the action of the water in course of time. A few minutes before the discharge of the geyser, steam evolves this being followed by a fearful detonation, while bubbling water comes out from several spots, and at last the hot water column shoots out suddenly straight up into the air, reaching a height of about 20 ft. The evolution of bubbling water continues for about two or three minutes with the same force, forming a small pool in the hollow to the depth of about 1 ft. As soon as the evolution stops, the whole amount of hot water disappears entirely, so that the pool at once dries up, being probably received again by the same hole under-ground from which the water comes forth. This process is repeated about 12–15 times every day.

	Naruko	Moto-kuruma	Shin-kuruma	Kawara	Kawatabi	Tanaka	Akayu	Todoroki
Number of visitors (1909)	2,734	1,920	1,617	315	3,950	340	1,565	927
The total stays (in days)	12,926	7,760	5,940	1,610	16,020	1,610	7,360	5,695
Found in	835	1,781	1,844	unknown	901	unknown	1,781	1,615

Kamasaki. 3 m. from *Shiro-ishi* station on the N. E. Main Line, 189,3 m. from *Ueno*, Tōkyō, in 8 hrs. 31 min. The spa lies on the upper course of the *Kosute-gawa* and is shut in on all sides by hills. The springs are said to be efficacious especially for wounds, bruises, *kakke*, skin diseases, etc. The spa is a small village, at an elevation of 600 ft. above the sea, inhabited by only 140 souls, the springs dating back to 1428 A.D. Number of visitors: 8,637, the total stays being 65,718 days (1909). Inns: *Ichijō-kwan*, *Kimura-ya*, *Mogami-ya*. The spa is visited mostly by patients to take the cure by the waters.

YAMAGATA-KEN

Atsumi is situated on the coast lying between Niigata and Sakata, about 85 m. N. E. from Niigata (in 8 hrs. by steamship, fare Y 1,40), on the N. bank of the *Atsumi-gawa*, and is 1 m. distant from the sea. The beach of *Nezumi-ga-seki*, noted for its beautiful scenery, is 7,5 m. S. W. from the spa. The springs were found in 811 A.D., and are believed to be efficacious for anaemia, wounds and disorders of the female genital organs. The *Yunohama* hot springs lie also on the coast 17 m. further N. from the spa. Atsumi has electric light and telephone. Each inn is provided with private bath. Number of visitors: 13,263, the total stays being 132,636 days (1909). *see Plate 17*

Yunohama. 2 m. N. W. from *Kamo-machi*, the steamship plying between Niigata and Sakata calls the town *Kamo*. A white sandy beach extends from the spa towards the N. E. to Sakata, and near Yunohama issue hot springs from the water's edge on the beach, so that the spa affords also facility for hot sand baths. Good for sea-bathing. Number of visitors: 4,203, the total stays being 52,461 days (1909). The result of meteorological observations made in Kamo-machi is as follows:

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity	
	Mean				Absolute							
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean	Dir.
For the year, 1912.												
January	2,0	4,3	-0,5	4.9	11,6	-4.7	72	49,8	16	176,3	7,1	
February	4.2	7,5	1,3	6,2	21,6	-3,9	69	72,9	23	252,7	5,7	
March	4,6	8.3	1,3	7,0	19,0	-1,2	70	122,0	33	182,5	5.5	N 59° W
April	10,2	14.5	5.6	8,9	23,0	-1,2	68	175,0	44	118,3	5,2	N 89° W
July	22,1	25,5	19,2	6,3	29,1	15,1	90	142,9	32	316,4	2,7	N 75° W
December	3.6	6,6	0,7	5.9	11,4	-2,7	77	15,5	5	227,7	6,1	N 48° W
For the year, 1913.												
January	1.3	3,5	-1,4	4,9	8,2	-6,2	76	29,8	10	226,3	6,9	N 49° W
February	2.0	4,9	-1,0	5,9	14,3	-6,7	69	74,8	25	116,3	6,0	N 52° W
March	3.4	6,3	0,1	6,2	15.5	-5,0	67	134,8	36	120,9	5.3	N 64° W
April	10,1	14,7	5.2	9,5	25.4	-1,2	72	179.9	46	255,6	3.5	
May	13.5	17,6	9,5	8,1	25,2	2,9	72	177,0	40	65,3	4.2	
June	17,9	21,7	14,2	7.5	25.4	9,4	79	156,9	35	121,1	4,1	
August	22,0	26,3	18,2	8,1	29.5	15,5	82	222,8	52	273,0	3.1	
September	18.9	23,3	15,2	8,1	27,0	10,9	80	182,5	49	234.7	2.9	
October	14.7	18,5	11,1	7.4	24.7	5,2	79	133.9	39	212,7	3.9	
November	9.3	12,6	5.5	7,2	19,1	0,3	68	90,7	30	254,6	5.3	
December	4.8	7,2	1,8	5,4	18,0	-1,7	76	43.1	15	305,6	5,8	
For the year, 1914.												
January	4,0	6.9	0,8	6,0	14,8	-2,7	71	68,3	23	264.4	5.5	
February	2.7	5.1	-0,1	5,1	10,1	-3.3	71	72,8	24	130.9	4.8	
March	5.7	10,3	2,8	7.6	17,0	-2,1	69	132,0	36	127.5	4,7	
April	8,9	12,8	4,7	8,1	23,5	2,0	72	169,7	43	112,9	3.7	
May	16,1	20,3	11,7	8,7	28,4	6.0	76	175.7	40	125,0	2,0	
June	19,3	23,2	15,4	7,8	30,0	10,9	82	195,3	44	104,5	2,9	
July	23.1	26,4	19,8	6,6	31,5	14,4	86	147,9	33	349.4	3.0	

Kami-no-yama (47,8 m. from Fukushima, in 3 hrs. 28 min.) was formerly the residential seat of a small Daimyō and famed as one of the most flourishing pleasure resorts in Dewa, both on account of its hot springs and of the existence of its gay life. The spring issues near the Shintō shrine of *Hie*, the waters being conducted by pipes to the bath-inns. To the E. of the town rises the volcanic cone of *Zaō*. *Tsukioka Park*, on the W. elevation of the town, was formerly a residential site of the Daimyō and commands a fine view of the Zaō Range and the *Mae-kawa* flowing below. A Shintō shrine, dedicated to the memory of the feudal ancestors of the place, stands on the ground. The spa lies at an elevation of 574 ft. above sea-level, surrounded by mountains on three sides, viz. on the S., E., and W. Pop. 8,600. 10 resident doctors; post, telegraph, and telephone office. 6 public baths. Number of visitors: 35,443, the total stays being 55,325 days (1909). Inns: *Yone-ya*, *Kame-ya*, *Nakamura-ya*, *Yumoto-ya*.

Meteorological Observations.

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity	
	Mean				Absolute							
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean	Dir.
For the year, 1911.												
December	0,4	4,6	3,1	7,6	19,0	-8,5	83	81,9		—	1,33	
For the year, 1912.												
January	-1,04	2,81	-5,19	8,00	9.5	-9,0	81,74	74,8		—	0,97	
February	2,06	6,42	-1,92	8,33	14,5	-9,5	76,70	78,4		—	8,21	
October	11,80	16,90	7,60	9,30	25,0	1,0	81,70	112,1		26,9	1,43	
November	4,30	7,90	0,90	7,00	19,5	-6,0	82,30	73,9		64,7	1,47	
December	-0,46	2,93	-3,64	6,58	9,0	-10,0	85,30	32,7		110,2	0,97	
For the year, 1913.												
January	-2,07	1,79	-6,02	7,81	10,5	-12,5	83,47	57,6		65,5	0,62	
February	1,88	2,39	-5,95	8,12	8,0	-12,0	79,23	76,7		15,0	2,00	
March	1,15	5,55	-3,21	8,63	16,0	-9,0	77,20	119,0		24,6	2,40	
April	9,83	16,22	3,45	12,77	27,5	-4,0	71,22	138,9		37,9	1,69	
May	12,97	18,79	7,24	11,55	26,5	-1,0	72,65	126,8		60,5	2,63	
June	18,00	23,57	12,90	10,68	29,0	8,0	76,29	132,4		64,3	2,53	
July	21,03	25,22	17,35	7,84	32,0	12,0	83,53	91,4		105,8	1,23	
August	21,03	26,55	16,44	10,11	32,2	13,0	80,95	182,3		185,5	—	
September	16,61	22,58	11,72	10,83	27,5	5,0	81,59	125,3		30,4	—	
November	5,66	11,02	8,00	10,22	18,0	-4,0	80,79	77,5		37,1	—	
December	1,97	5,85	-1,64	7,50	20,5	-8,0	87,71	36,5		139,0	—	
For the year, 1914.												
January	0,25	4,34	-3,52	7,56	10,5	-9,0	80,51	78,1		19,2	2,17	
February	-0,45	3,87	-4,25	8,12	10,0	-6,5	79,34	72,9		25,6	2,03	
March	4,39	9,40	-0,22	9,63	15,5	-6,0	74,83	116,0		—	2,12	
April	7,03	12,82	1,33	11,48	25,0	-4,5	71,67	150,1		—	—	
May	15,39	22,00	9,14	12,85	29,5	2,0	72,92	165,9		63,9	2,17	

Aka-yu (36,1 m. from Fukushima, in 2 hrs. 53 min.) lies on the N. E. corner of the plain of Yonezawa, on a slope of *Eboshi-dake*, and at an elevation of 700 ft. above the sea. The spa is about a mile from the *Aka-yu* station and boasts as its sights the Eboshi Park (or *Kairaku-en*) where are planted those remarkable blossoming cherry-trees, and the *Hakuryō Pond*. It is a pleasure resort of the province, the healing waters having been used for bathing since 1312 A.D. Pop. 1,135; post, telegraph and telephone office; 2 resident doctors. Number of visitors: 26,875, the total stays being 58,471 days (1909). Inns: *Goten-mori*, *Tansan Hotel*.

Meteorological Observation.

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity	
	Mean				Absolute							
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean	Dir.
For the year, 1912.												
January	0,1	3,1	-3,7	7,0	7,8	-9,8	80	94,8		—	3,1	
February	2,1	5,2	-1,2	6,4	9,5	-10,4	75	108,2		75,7	3,1	
March	4,1	7,9	1,1	6,7	18,2	-2,0	73	146,6		115,5	4,2	
April	10,1	15,9	5,1	10,8	28,0	-2,0	65	100,6		55,9	5,1	
May	14,4	20,4	9,7	10,5	29,8	3,2	67	220,2		58,6	3,7	
June	19,6	23,3	15,9	7,0	29,7	9,4	74	140,1		58,5	2,1	
July	22,9	26,5	19,9	6,4	31,0	12,6	78	113,5		139,3	2,2	
August	24,8	29,3	21,3	7,9	33,6	16,0	74	194,0		61,6	—	
September	18,5	22,4	14,7	7,8	20,0	8,0	77	102,6		96,5	2,8	
October	12,9	18,1	8,8	9,3	25,5	3,0	74	128,5		35,2	2,2	
November	6,1	8,9	3,2	6,7	21,0	-3,0	74	73,6		56,2	3,1	
December	0,0	2,8	-2,5	4,1	9,0	-8,0	84	35,8		128,2	2,1	
For the year, 1913.												
January	-0,7	1,3	-6,0	7,3	7,0	-15,0	84	66,6		63,7	2,9	
February	-1,2	2,8	-5,4	8,3	8,0	-10,0	79	107,2		30,8	2,9	
March	0,3	4,4	-4,24	8,6	15,0	-10,0	77	154,3		42,4	3,6	
April	9,8	15,0	4,5	11,2	26,0	-1,5	69	159,7		40,1	2,5	
May	13,3	17,9	7,9	10,4	26,0	0,1	66	155,3		67,0	—	
June	18,2	23,0	13,5	9,5	27,0	7,0	73	170,5		32,3	3,2	
July	20,8	24,8	17,7	7,0	30,5	12,5	75	111,5		126,5	—	
August	21,0	25,3	17,0	8,1	31,0	12,0	71	155,4		162,9	—	
September	16,6	22,1	12,3	9,8	27,5	5,5	71	136,7		89,1	1,9	
October	12,1	17,2	7,9	9,6	21,2	2,0	74	107,3		109,6	1,7	
November	5,8	10,2	1,9	8,3	—	—	71	102,7		96,9	2,4	
December	0,0	2,2	-2,0	4,9	8,0	-8,5	78	44,6		161,8	—	
For the year, 1914.												
January	-0,2	3,7	-4,0	7,9	8,0	-10,0	73	99,9		59,5	2,3	
February	-0,4	3,7	-4,2	7,8	7,0	-9,2	74	94,7		71,3	2,0	
March	4,2	8,3	1,0	7,9	14,5	-9,0	70	135,1		32,7	3,8	
April	7,2	13,1	2,6	10,5	24,0	-3,0	65	174,6		99,0	4,1	
May	15,4	21,6	9,6	11,6	28,5	4,5	63	182,9		53,0	2,5	

Onogawa (5 m. S. W. of Yonezawa, *jinrikisha* or omnibuses available) lies on the E. bank of the upper reaches of the *Kinomo-gawa*, which runs from the foot of *Azuma-san*, and has an altitude of 1,000 ft. above the sea. The spa is shut in by mountains to the E. and W., the N. being open country felicitating communication with the town. Pop. 175. The hot springs are reputed good for disorders of the digestive system, the water being saline, colourless, and slightly alkaline in reaction. 2 public baths; 15 inns with private baths. Here one can find everywhere hot springs by boring. The springs were found before 848 A.D. Number of visitors: 11,288, the total stays being 22,450 days (1909). Inns: *Ogi-ya, Onogawa Hotel.*

Plate 18

Meteorological Observations.

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity	
	Mean				Absolute							
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean	Dir.
For the year, 1911.												
December	1,4	4.7	-3.5	1,2	14,5	-10,0	60,0	84,1		171,3	1,9	
For the year, 1912.												
January	-1,4	2,1	-4,6	-2,2	7,1	-9,0	59,3	63,1		159,9	2,3	
February	0.7	4,3	-2,4	1,6	10,0	-7,1	57,3	71,2		115,4	2,1	
October	11.4	16,8	6.7	10,1	23.3	1,5	82,9	108,0		41,4	1,5	
November	4.7	8,9	1,6	7,3	19,8	-6,4	83,7	69,3		112.4	1 5	
December	-0,2	3 0	-3,3	6,3	8,2	-9,5	85,5	46,9		228.8	1,3	
For the year, 1913.												
January	-2,3	1,5	-5,6	7,1	8,0	-11,3	83.2	58,9		155.2	1.3	
February	-1,6	2,2	-5,6	7,8	7,0	-13,7	78,0	86,3		60,6	2,2	
March	0,04	4.3	-4,2	8,5	14,0	-11,8	76.8	114.9		98,1	2,1	
April	8,2	13,6	2,8	10.8	24.0	-3,1	71,9	112,6		37.0	1,8	
May	11,8	17,3	5.9	11,4	24.5	-0,8	70,3	183,9		81.5	2,1	
June	16,8	22,2	11,2	10,9	27,0	4,8	76,0	149.3		105,1	1,3	
July	20,3	24,4	15.9	8,5	30,0	10,6	80,7	107,2		129,7	0.9	
August	20,9	26,1	16,1	10,0	31,4	10,4	76,4	181,6		254,2	1,0	
September	16.7	22,4	12,2	10,1	26,8	5,2	76,6	116,4		102,7	1,2	
October	11,3	16,6	6,8	9,8	20,2	0,2	74.7	108,0		96 5	1,9	
November	5,4	10,5	1,0	9,4	17,9	-4,8	70.8	87,8		141,8	2.2	
December	1,7	5 0	-1,7	6,7	15,8	-7,2	77,6	45,2		261,1	1,1	
For the year, 1914.												
January	0,2	4,4	-3,6	8,0	11,0	-9.8	70,3	80,0		155.7	1 1	
February	0,2	4,1	-4,6	8,7	9,7	-9.0	67,7	73,5		77.5	3.0	
March	4,0	9,0	-0,2	9,2	16,0	-8,6	66,4	106,1		64,2	1,9	
April	7.3	13,1	1,7	11,4	24,1	-3,8	66,1	162,0		147,9	2.7	
May	15,2	22,4	8,1	14,2	31,0	2,2	71,4	170,6		92,1	1,6	

Sekine-Yunosawa. About 1,3 m. S. from *Sekine* station on the Ō-u Line; also 1,3 m. W. from the next station *Ōsawa*, both an agreeable walking distance. There is only one spring, the temperature being 28° C., and one bath-house in the village.

Namegawa (2,4 m. S. W. from the *Tōge* station on the Ō-u Line and over 14,6 m. from *Yonezawa*) lies in a ravine on the slope of *Azuma-san* in Uzen Province. Waterfalls are the chief attraction of the spa. *Ō-taki*, the largest one, over 900 ft., is in a few minutes' walk, and *Takakura-yama*, wooded with old trees, affords a beautiful sight, especially in spring and in autumn, on account of rhododendrons and of maples. Number of visitors: 2,544, the total stays being 16,525 days (1909). Inn: *Fukushima-ya*. see Plate 19

Itaya (13,5 m. from Fukushima, in 18 min.) lies near the Itaya Pass through which the line is laid. From the valley of Fukushima the ground gradually ascends, and the line passes through many tunnels, 1 m. to 2 m. long, and peaks, mountain streams, and waterfalls greet the eyes of the traveller in an everchanging confusion as the train emerges from one tunnel only to enter another. The pass is about 2,460 ft. above the sea, and Tōge station, next to Itaya, bears a general resemblance to *Kuma-no-taira* in the Usui Pass. This section of the country is subject to a heavy snowfall, which not in-frequently blocks the track in winter. The waterfalls popular as beauty spots in the neighbourhood are *Nunobiki*, *Ō-taki*, and *Sangai-daki*, the first descending over 600 ft.

Goshiki lies about 2 m. from *Itaya* and amidst the mountains of the same name. The distance from Yonezawa is about 14,6 m. The spa, lying at an elevation of 3,000 ft. above the sea, affords a fine view over the surrounding mountains. Excellent skiing in winter. Only one inn. It is really a lovely summer resort, where one can enjoy cool invigorating mountain air. The springs were found previous to 686 A.D. Number of visitors: 2,860, the total stays being 31,400 days (1909). Inn: *Munekawa-ryokwan*. see Plate 20

FUKUSHIMA-KEN

Iizaka is a favourite pleasure resort of the people of Fukushima, the distance from the town being 6 m., light railway and automobiles available. The village is situated on the bank of the *Surikami-gawa*, over which a peculiar suspension bridge, called *Totsuna-bashi*, 222 ft. in length, has been constructed. The place lies at an altitude of 550 ft. above the sea. The village on the opposite side of the river is called **Yuno** and is also a bath-resort. The houses in the two villages, being constructed on the terraced banks of the stream, present a peculiar appearance; for though they are three or even four-storied structures when viewed from the river side, they appear to have only one story as seen from the road. The ground rises towards the N. W., the highest portion being *Daisaku-yama*, while an extensive plain extends towards the S. E. It is said, that *Yamato Dake* or *Yamato-Dake-no-mikoto*, a famous hero and military genius of olden times (81–113 A.D.), used the spring for the first time for bathing purposes though it is believed that the presence of the spring was already known to the people before that time. There are 7 hot springs in Iizaka, the water being all weak saline, the temperature ranging from 50° to 70° C. The water is believed to be efficacious for wounds, swellings, etc. Number of visitors: 56,787 (1909). Houses 1,000. Pop. 4,800. Inns: *Kwasui-kwan*, *Kado-ya*, *Masu-ya*, *Senshū-kaku*, *Akagawa-ya*.

The spa *Yuno* has 616 houses. There are 7 hot springs in Yuno, all weak saline, the temperature ranging from 45° to 71° C. The springs are said to be efficacious for rheumatism and other complaints. Number of visitors: 39,275 (1909); 39,533 (1910).

Higashi-yama lies 2,2 m. to the S. E. of the *Wakamatsu* station (38,7 m. from *Kōri-yama*, in 2 hrs. 55 min.) on the Gan-etsu Line and is the most popular spa in this district. Coaches and automobiles are available. It is shut in by peaks on the N. and E., its W. side only being left open and communicating with the city. The bath-houses stand on both banks of the rock and boulder strewn little stream called *Yu-gawa*. The spa lies at an altitude of 850 ft. above the sea. There are 11 hot springs, all weak saline, the temperature ranging from 38° to 61° C. Number of visitors: 7,380 (1909); 22,000 (1910). Inns: *Shin-taki*, *Mukai-taki*, *Fudō-taki*, *Nihachi-ya*, etc.

Kashi 14,3 m. W. from the *Shirakawa* station on the N. E. Main Line (115,7 m. from *Ueno*, in 4 hrs. 49 min.); from the named station 4,9 m. W. to *Mafune-mura*, jinrikisha available, from *Mafune-mura* as far as to *Uma-gaeshi* 7,3 m. on horse-back, thence only on foot.

The bath-place lies by the banks of the upper flow of the *Abukuma-gawa* on the E. slope of *Asahi-zan*, which rises to the N. E. of the active volcano *Nasu-zan* (6,300 ft.). The place, being at an elevation of more than 3,000 ft. above the sea, affords a wide range of magnificent scenery. The stream, which is bedded with huge singularly shaped rocks, and its bank dotted with old pines, wistaria, rhododendron, etc., adds charm to the natural beauty of this place. The hot springs issue from the crevices of granite rocks, and some bath-houses are built directly on the rocks. Going up the valley a little more than 2,4 m. W. towards the *Asahi-zan*, are found two waterfalls, i. e. *O-daki* and *Me-daki* (the former descends over 300 ft., the latter over 200 ft.).

Owing to their low temperature (48,5–51° C.), the waters are used only in summer for bathing, while the bath is closed during the winter. This may be found a quiet summer resort though convenience is limited there being but one inn. Number of visitors: 4,367, the total stays being 18,633 days (1910).

Nekonaki. From *Shirakawa* station on the N. E. Main Line (115,7 m. from *Ueno*, in 4 hrs. 49 min.) 14,7 m. E. to *Ishikawa-machi* by omnibus; 0,8 m. W. from *Ishikawa-machi* is situated the cold spring. Two small streams, *Kitasu-gawa* and *Tano-gawa*, run on the N. of the place, the valley extending from E. to W. The cold springs here gush out from the base of the hill. The vicinity of Ishikawa is noted for the occurence of diverse kinds of minerals, especially rare. In the granite (mostly pegmatite) are found: *Quartz, Smoky Quartz, Yellow Quartz, Smoky Crystal, Muscovite, Biotite, Vermiculite, Tourmaline, Almandine, Andalusite, Columbite, Monazite, Titanite, etc.* In the crystalline schist are found: *Rose Crystal, Fiedmontite, etc.* In the contact rock are found: *Garnet, Epidote, Zoisite, etc.* In veins of iron ore is found *Rhodonte. Monazite* sand may be here found also in the river-bed near the town, when the level of water becomes very low. The waters of *Nekonaki* are used for bathing, after they have been heated artificially. Number of visitors: 3,028, the total stays being 3,550 days (1909). Most visitors come from the neighbouring villages.

Bobata. About 4,9 m. N. from *Ishikawa-machi, jinrikisha* available. The village is shut in on two sides, W. and E., by hills. The cold springs issue from the crevice of granite rocks, the temperature being 14° C. and 27° C. respectively. On the banks of the stream there are two springs, the upper one being called "*Kami-no-yu*," the lower on the opposite side of the stream "*Shimo-no-yu*," about 0,7 m. distant from each other.

Number of visitors: 2,166, the total stays being 6,300 days (1909).

NIIGATA-KEN

Senami. Tourists coming from Tōkyō leave train at *Murakami*, the terminus of the Murakami Line, a branch of Shin-etsu Line (junction: *Niitsu*), and take *jinrikisha* from the station to the spa (about 2 m.).

During the period of oil mania, which swept this country some years ago, some capitalists of the village of *Iwafune* planned to bore the ground for oil at *Senami*. They selected a site on a sand hill near the coast, about 1,3 m. S. from the town of Senami and N. from Iwafune (sea port), and commenced the operations on July 9th, 1904. After laborious works the well attained the depth of 500 ft., and still no oil coming out, the venture was considered a failure, though the works went on. When they reached about 600 ft. in depth, the capital becoming exhausted, it was decided to give up the undertaking. One of the enterprisers made up his mind to continue boring as long as the remaining fuel could keep the boring machine going. When the well was 837 ft. deep, a small quantity of lukewarm liquid flowed from the tube, which was at first believed to be volatile oil. This was, however, not the case, but after a few hours a large amount of hot water began to shoot up into the air, even more than 90 ft. high.

Though they were disappointed, as no oil was forthcoming, their attention was now fixed upon the hot water that gushed out of the tube. It was soon discovered that the water contains mineral ingredients, of which common salt predominates. Thus the place commenced to be a thriving see Plate 21 watering-place in this region. The spa stands on a hill, wooded with pine-trees, close by the sea. The *Minomo-gawa* is stocked with salmon, and the neighbouring sea abounds in *tai* (pagrus) and *iwashi* (sardine). An island called *Aō-jima* (about 23 m. from Senami) adds to the scenic beauty of the place. The sand hill, on which the spa lies, produces *matsu-take* (mushrooms), the opposite bank of the *Minomo* being noted for *shii-take* (Cortinellus shiitake). Boiling water gushes out of

DISTRIBUTION OF MINERAL SPRINGS IN CENTRAL JAPAN

an iron pipe (4 inches in diameter), so abundantly as about 9,000 hectolitres in 24 hours. The temperature of the water, measured at the upper end of the pipe, shows 104° C. Mineral sinter, which is deposited inside the pipe, should be removed every two months. There are 13 inns with private baths in the spa. The water is said to be efficacious for dyspepsia, rheumatism, neurasthenia, etc.

Yuzawa (at Onna-gawa-mura). About 15 m. N. E. from the *Nakajō* station on the Shin-etsu Line; from Nakajō to *Shimoseki-mura jinrikisha* available. The hot springs are 0,5 m. from the village, lying on the bank of the *Ara-kawa*. Pop. 200. There are two hot springs in the neighbourhood, i. e. **Takase-Onsen** (0,7 m. E.) and **Taka-no-su-Onsen** (2,8 m. E.) up the valley. Bath-houses are built direct upon the springs, which issue from the crevices in rocks close by a stream. Number of visitors: 5,327, the total stays being 10,554 days (1909).

Takase. 0,7 m. E. from *Yuzawa*, and 2,1 m. W. from *Taka-no-su*, situated on the bank of the *Ara-kawa*. Hot spring gushes out from the bottom of the river. Number of visitors: 8,377, the total stays being 16,727 days (1909).

Takanosu. 2,1 m. from *Takase* and 2,8 m. from *Yuzawa*. It stands on the bank of the *Ara-kawa*. A wooden suspension bridge across the stream is a fine sight. The stream abounds in *ayu* (Plecoglossus altivelis). One inn with baths in the spa. The water is said to be efficacious for diseases of stomach, syphilis, etc. Number of visitors: 3,060, the total stays being 8,730 days (1909).

Murasugi. 5,5 m. S. E. from the *Suibara* station on the Murakami Line; for the further stage of journey *jinrikisha* (fare 45 *sen*) and omnibuses available. It lies at the W. foot of *Hishi-ga-dake*, with mountains on the S. and the E., open on the N. and the W. towards the plain of Niigata, and 400 ft. above the sea. The village has 250 inhabitants (33 households). There is another hot spring "**De-yu**," 2 m. N. from the spa. Fish-shaped fossils called "*uo-iwa*" are found in the neighbourhood of Murasugi (0,5 m. W.).

The springs issue from the side of granite hill and the water is conducted to baths by pipes. The discovery of the springs dates back to the Era of Kembu (1334-38). The temperature of springs is 26° C. at 31° C. of air temperature, the water containing a small quantity of solid matters. The water is therefore heated for bathing.

Since the springs were examined last year to test their radio-activity, the place has become a thriving bathing-place in the province of Echigo. A number of big *cryptmerias* dot the spa, hence *see Plate 22* the name "*Mura-sugi*" or 'village cryptomeria.' Murasugi is also a pretty forest resort of the province (pine and cryptomerias abundant in the neighbourhood). The springs are said to be efficacious especially for rheumatism, wounds and eczems. The public baths here are divided into two classes, i. e. *Ichi-no-yu* (*1st* class) and *Ni-no-yu* (*2nd* class). Number of visitors: 8,300, the total stays being 50,000 days (1909).

Deyu. 5 m. S. E. from *Suibara* station on the Murakami Line; it lies at the W. foot of *Gozu-san*, 400 ft. above the sea, only 2 m. from Murasugi. The place has mountains on the E. and W. side. Pop. 388. Found in 808 by *Kōbō Daishi*. 9 inns. 1 public bath. The hot water issuing from granite formation is conducted to the basin of a public bath called "*Chōsen-kutsu*," built on the temple-grounds of *Kwankō-ji*. Number of visitors: 2,699, the total stays being 17,354 days (1909); 23,200 bathers (1913).

The springs are said to be good for skin diseases, dyspepsia, metal poisoning, *kakke*, disorders of the female genital organs, haemorrhoids, rheumatism, etc. Near Murasugi and Deyu lies a cold spring "**Imaita.**"

Tochiomata. Passengers coming from Tōkyō take a Shin-etsu Line train to the *Raikō-ji* station (220,2 m. from *Ueno*, in 12 hrs. 2 min.), which is the junction for the Uonuma Light Railway, leading to *Ojiya*, 18,1 m. in 45 min. Ojiya lies on the W. bank of the *Shinano-gawa* and is noted for silk and hempen fabrics for summer wear, *habutae*-tissue, etc. From *Raikō-ji* the line traverses an extensive and fertile plain of Echigo irrigated by the two large rivers of *Shinano* and *Agano* and a number of smaller streams. A highroad leads from Ojiya towards the S. E. to the town of *Koide-machi* (post, telegraph, and telephone office) up the stream *Uono-gawa*, the distance being 12,2 m., *jinrikisha* (fare, 75 *sen*) and omnibuses (fare, 50 *sen*) available; from *Koide-machi* to *Kami-oritate-mura* 8,8 m. by a steep path *Yunotani-kaidō*, *jinrikisha* available (fare Y 1); from *Kami-oritate-mura* to the hot spring about 1,2 m. on foot. The bathing-place is located at the foot of

Yatsumi-yama, and on the right bank of the *Yunosawa-gawa*, a branch of the River *Sanashi*. The place, being shut in on all sides by high mountains, has a limited area and is **920** ft. above the sea. The spot, where the hot springs gush out, is of granite formation. Bath-houses for public use are built in a hollow of rocks, water issuing from their crevices.

see Plate 25

As the temperature of the water is only a little higher (39° C.) than that of the human body, bathers remain in the baths usually for a very long time, sometimes even 5–6 hours (see "*Yu-no-gō*" Hot Springs in Okayama-ken). Healing property is said to be remarkable, especially for rheumatism, chronic eczems, disorders of the female genital organs in various forms, hysteria, scrofula, skin diseases, wounds, etc.

It must be noticed that the water contains a considerable amount of radium emanation, its radio-activity being the strongest among all mineral springs in the Northern and Eastern Japan. Murasugi Cold Springs are next Tochiomata in their radio-activity (see "*Murasugi*" Cold Springs in Echigo). Moreover, the temperature of the spring here is higher than that of Murasugi. With regard to the flow of water, the former is also superior to the latter. Number of visitors: **2,007**, the total stays being **23,452** days (1909). 0,3 m. down the valley lies **Ōyu-Onsen** on the opposite side of the stream. Here hot springs are scattered all over the village. Bath can be taken in this spa in winter, as the temperature of water is higher than that of Tochiomata. But the spring is of weak radio-activity. Number of visitors: **831**, the total stays being **2,798** days (1909).

Yuzawa. 24,2 m. S. from *Koide-machi* (12,2 m. from *Ojiya* station), *jinrikisha* available (6 hrs.). It is a poor mountain hamlet with 208 inhabitants, on the bank of the *Uono-gawa*, about **1,000** ft. above the sea. Number of visitors: **5,524**, the total stays being **20,362** days (1909).

Akakura is situated at the E. base of *Myōkō-zan*, 4,3 m. W. of the *Taguchi* station (158 m. from *Ueno*, in 8 hrs. 12 min. by the Shin-etsu Line), whence *jinrikisha* available. Water is conducted from springs more than 4 m. up the mountain. The water shoots down so rapidly along a steep slope of the mountain that it keeps almost its original temperature during the descent, the loss of temperature being less than 10° C. even in winter. The inner surface of the wooden canals used for the conduct of water gets thickly covered with sediments within a few years, which, therefore, must be removed from time to time. The sediments of different colours and densities grow gradually thicker in the course of time, forming an apparent stratification, just as the year rings of trees. The thickness of the mineral sinter amounts to about half an inch in one year. The water is used for the treatment of uterus diseases, affections of stomach and intestines, diseases of the skin, dyspepsia, etc.

see Plate 6, fig. 3
see Plate 1, fig. 1
see Plate 2, fig. 3

Inns stand **2,500** ft. above the sea and command a view over the extensive plain of Echigo and the Japan Sea, while in fine weather the islands of *Sado* is visible afar. A branch bath-house has recently been established near the station, the water being brought down from the spring by pipes and is called **Myōkō-Onsen**. There are two thermal springs **Tsubame-Onsen** and **Seki-Onsen**, on the N. W. slope of the mountain, about 2 m. from Akakura. The former springs are sulphurous and the latter ferruginous saline. Flow of water (Akakura): 7,200 hectolitres in 24 hrs. The spa Akakura is noted for its high location with an extensive view and also for its cool climate in summer. Fresh sea-fish is obtainable easily from *Naoetsu*, 22 m. distant. 3 public baths; all inns provided with their own baths. Number of visitors: **2,496**; total stays: **11,925** days (1909). Inns: *Kōun-kwan, Kōgaku-rō, Akakura branch inn, Kashima-ya.*

see Plate 6, fig. 5

Myōkō-zan (8,090 ft.) is called the "*Fuji of Echigo*" and stands opposite to Mt. *Kurohime*, from which it is separated by the valley of the *Seki-gawa*. It is best to climbe the mountain by the pass leading to the hot spring which supplies water to the bath-houses at Akakura. There are two small solfataras where the hot spring gushes out. The pass becomes steeper as it ascends, iron chains being stretched in some places to aid climbers.

At its summit stands an *Amida-dō*, and is found a cold spring close by. The range of view comprises such mountains as *Asama, Fuji, Kurohime*, and *Izuna*, and also in the N. E. the Japan Sea, the plain of Echigo, and the island of Sado in fine weather. Starting from the inns at Akakura it takes six or seven hours both ways.

Matsunoyama. The highway leads from *Takada* (176,7 m. from *Ueno*, in 9 hrs. 15 min.) to *Oshima-mura* via *Yasuzuka*, thence a steep and narrow path reaches the spa village via *Murono-mura*. The place with 210 inhabitants lies at the N. foot of the *Amamizu* Range, facing the stream

see Plate 24

of the *Hifumi-gawa*, and is about 33 m. E. from Takada. There are two public baths and all the eight inns there are owned by one inn-keeper *Tanabe*.

The springs are suitable for the treatment of eczema, rheumatism, gout, affections of genital organs, urinary diseases, chronic hysteria, etc. Number of visitors: 15,035, the total stays being 45,454 days (1909).

TOCHIGI-KEN

Nasu. The village of **Yumoto** (about 3,000 ft.), which occupies a corner of the plain of *Nasu* and is the most thriving community in the neighbourhood, is really a small hamlet of little more than 30 houses, mostly bath-house inns. It is sheltered on the N. E. by the mountain range and *see Plate 25* opens towards the S. W. The springs issue from the E. bank of the *Yu-gawa* at the foot of *Nasu-dake*, and the waters are strongly sulphurous with some quantity of iron. At 0,8 m. from *Yumoto* is the **Takao-mata Hot Spring** (about 3,000 ft.), and, at about 2 m. from *Yumoto*, the **Benten Hot Spring** (about 4,000 ft.), encircled on the three sides by rocky elevations, and with a small temple for the God *Kwan-on* situated near the spring. 1,2 m. E. is found **Kita Hot Spring** (about 4,000 ft.), in a depression between hills, so that it is only between 9 a.m. and 3 p.m. that the sun shines on the place. 1 m. W., over a steep climb, is **Daimaru Hot Spring** (about 4,000 ft.) with the waters issuing from crevices in rocks, while **Sando-goya** (about 5,000 ft.) is situated 4,5 m. further on, by the new road constructed along the side of *Usu-ga-take* and commanding a wide panorama below. The waters here are partly simple thermals, partly sulphur springs.

Itamuro Hot Spring is 11 m. from Sando-goya, the road making a wide detour around the S. W. base of *Chausu-yama*. On the N. E. and W. it is shut in by the Nasu Range and only on the S. it is open towards the plain of Nasu. The bath-houses are shut up in winter, the keepers returning to their respective villages. A short cut leads from here to Yumoto, while there is a path leading S. to *Kuroiso*.

The water of Nasu Hot Spring being strongly sulphurous, a too prolonged immersion may cause skin eruption, headache, or dizziness. The sights near Nasu, besides the springs already mentioned, are *Sesshō-seki* and *Onsen-jinja, etc.*

Sesshō-seki, or "Death-stone," no longer exists, but its site is pointed out near the river-bed, about half a mile from the village. Though the stone no longer exists, the whole scene is extremely desolate.

Nasu-dake. The *Nasu* volcanic range extends over the three provinces of *Shimozuke*, *Iwashiro* and *Iwaki*, and is a lofty chain running through the central part of N. E. Japan. The range is composed of *Chausu*, *Nangetsu-san* and *Sambon-yari*. The first is a helmet-shaped active volcano, comparable to *Asama* in Shinano, and its prominence and conspicuous shape cause it to eclipse all other peaks. The ascent, 7 m. from *Yumoto*, is very easy and follows the road leading to **Benten Hot Spring**, then to **Daimaru** and **Sando-goya** bath resorts. About 2,4 m. from the last mentioned place the path divides, one branch leading to *Sando-goya*, and the other to the top.

The air is strongly charged with sulphurous gas, but otherwise the ascent is very easy, for it is practicable even in palanquins. The other path, though shorter, is far steeper and requires a guide. Striking left at the *Onsen-jinja*, a wide panorama of the *Nasu* Plain, the *Hakkō-san* Ridge, *Tsukuba*, etc., is obtained. In scenic beauty *Takaomata* surpasses all other resorts in Nasu. Continuing the ascent the path again branches, the left one leading to the top, and the right one to the *Benten* and *Daimaru* bath resorts. From this parting place upward it is a rather laborious climb up a sharp ascent and through bamboo grass, till a narrow resting-place called *Fudō-iwa* is reached. From here the rivers *Nasu* and *Shira-kawa* appear like little ribbons. Continuing the ascent we notice *Nangetsu* below us, while the side of *Chausu-yama* is brought almost alongside us. Rhododendrons, creeping pines, and other plants growing at high altitude make their appearance amidst volcanic rocks. The active volcano, with its top like an inverted helmet, is brought very near, and streaks of white smoke issuing from its fissure make a strange sight. The path leads across a small level tract called *Amida-ga-hara*, where some stone images of *Jizō* stand, and we reach *Chausu*. On its side there is a crescent-shaped cave, called "*Hakken-ishi no-omuro*," which is 5 ft. deep and exhales sulphurous smoke. Climbing still, we come to a big rock, and below it are two craters, "Male crater" and "Female crater," the former showing greater activity than the other. The two craters lie between the big rocks standing to E. and W. on the top, but small craters and solfataras are abundant. The spectacle is less awe-inspiring than that seen on *Asama* or *Aso*, but far more weird than that at *Ōjigoku* at Hakone.

5 public baths; some inns are provided with delightful hot water baths. A peculiar sort of bathing, called "*Kazoe-yu*" or 'Numbering bath,' nearly the same as the "Time bath" at Kusatsu, can be seen at some public baths at Yumoto Spa. Number of visitors: 7,603, the total stays being 86,447 days (1909). Inns: *Komatsu-ya*, *Matsukawa-ya*, *Matsu-ya*, *Tokiwa-kwan.*

Shiobara.

Nishi-nasuno (92,1 m. from *Ueno*, in 3 hrs. 30 min.) is a station where those bound for **Shiobara Hot Springs** have to leave the train, Shiobara being situated 13,5 m. to the N. W. of the station. As far as *Sekiya*, 7,3 m., where the ground begins to ascend, tramcars are in operation, seven times a day, single fares 28 *sen* ordinary class, and 42 *sen* special class. From Sekiya to Shiobara *jinrikisha* and omnibuses are in service.

Shiobara consists of 4 hamlets, called *Shimo-Shiobara*, *Naka-Shiobara*, *Kami-Shiobara*, and *Yumoto-Shiobara*, with a total population of 1,863. Hot springs issue at *Ōami*, *Fukuwata*, *Shiogama*, *Shionoyu*, *Hataori*, *Monzen*, *Sumaki*, *Furu-machi*, *Furu-Yumoto*, and *Ara-yu*, all situated along the banks of the *Hōki-gawa* or its tributaries, and within easy reach from one another. Of the above, Fukuwata, Monzen, and Furu-machi are the most thriving and provide better accommodation than the others. Shiobara is one of the most picturesque and most delightful pleasure and health resorts within easy reach of Tōkyō, affording all the year round, especially in spring and autumn, nature's charming displays of flowers, with the crimson tints of foliage in the latter season, while the crystalline stream of the *Hōki-gawa* with its interesting rocks and cascade do not fail to delight those who are susceptible to what is beautiful and romantic. In summer too the elevated situation of the place makes it a delightfully cool retrêat.

The discovery of these charming health resorts must have occured in ancient times ; at any rate the ubiquitous saint *Kōbō Daishi* is said to have first visited the place about the middle of the 9th century and bruited the efficacy of the waters. The local chieftain, *Shiobara Iyetada*, then opened roads and made the hot springs more accessible.

It was not till the Governorship of the late Viscount *Mishima*, however, that attempts were carried out on a large scale for building roads and otherwise facilitating the convenience of the journey. About 1884, Viscount Mishima as Governor of *Tochigi*, reconstructed the road, removed the rocks, and built bridges ; and his far-sighted undertakings, though stoutly opposed at that time by the Local Assembly, have been amply justified by the result, for it was from that time that Shiobara gradually grew in popularity, and to-day it contains a large number of villas of wealthy people of Tōkyō and other places ; there is also an Imperial villa in the place. Between *Sekiya* and *Ōami* (3,7 m.), the first hot springs in this series of spas, some romantic scenery begins, affording a delightful change after the journey over a flat, uninteresting plain. The *Nyū-shō-bashi*, over the small stream at the end of Sekiya, makes the beginning of the natural beauty of Shiobara proper, with the narrow valley of the mountain stream of Hōki-gawa shut in by long ridges of hills. A walk of about a mile brings us to the *Mikaeri-bashi*, spanning the stream about the cascade of the same name. Here various sights abound, chiefly falls and cascades.

Inn Tariff: *1st* class ¥ 3, tiffin ¥1,5 ; *2nd* class ¥ 2, tiffin ¥ 1 ; *3rd* class ¥ 1,5, tiffin 80 *sen* ; rooms and bath are extra. Local souvenirs of Shiobara are *Okina-ame* (a kind of sweet-meat), fossil leaves and other fossil objects, cotton fabric dyed with hot spring incrustations, Shiobara wood-work, etc.

Ōami (Inn, *Satō*). The springs issue from crevices in big rock on the N. bank of the *Hōki-gawa*. The sights near this place are mostly falls and rocks. There is also a tunnel bored through a rock measuring 102 ft. in length, 12 in height and 15 in width. The boring was done in 1884, when the new road to Shiobara was constructed. Passing through this tunnel, which is called *Hakuun-dō*, we notice on the right some basaltic columns called *Zaimoku-iwa*. The waters are saline bitter.

Fukuwata (Inns: *Masu-ya*, *Matsu-ya*, *Izumi-ya*, *Maru-ya*, *Kanō-ya*, *Yoshino-ya*, *Tama-ya*, *Makino-ya*, *Sakaguchi-ya*), 1,4 m. from Ōami, forms part of Shimo-Shiobara and is 1,150 ft. above the sea. The place is surrounded by peaks, while the Hōki-gawa flows past its N. W. boundary, the little stream of *Fudō-ga-sawa* joining the river on the opposite bank of Fukuwata proper. There are a number of hot springs, as *Fudō-no-yu*, *Iwa-no-yu*, *Same-no-yu*, *Awa-no-yu*, *Yagen-no-yu*, *Hadaka-no-yu*, and others, the waters being all alkaline. The Imperial villa is situated at this place. The sights are *Fudōga-sawa*, *Fukuwata Park*, *Onsen-jinja*, *Tengu-iwa*, etc. The Tengu-iwa, or the 'Hobgoblin Rock' overhangs the road, about 0,3 m. from Fukuwata and on it grow a number of pines. The *Nodachi-iwa*, or 'Solitary Field Rock,' is a large flat boulder under the Hobgoblin Rock and lies in the bed of the small stream called *Sayo*. Hundreds of persons may stand on this boulder. From the top of *Torito-yama* or of *Ura-yama*, rising respectively on the N. W. and the S. W. of Fukuwata, the whole panorama of *Nasuno* may be observed.

Shiogama (Inn, *Ko-ume-ya*), 0,5 m. further inward from Fukuwata, has hot alkaline springs issuing from both banks of the Hōki-gawa. The tomb of *Takao*, who was born here, stands in this place. Noted sights are *Ani-ototo-no-taki*, *Tamasudare-no-se*, *Kotarō-ga-fuchi*, *Oyakake-no-matsu*, etc.

Shionoyu, 1,600 ft. above the sea, (Inns: *Kashiwa-ya*, *Tama-ya*, *Myōga-ya*), lies in a secluded spot a mile from *Shiogama*, reached after crossing the *Shio-waki-bashi* spanning the Hōki-gawa. It lies on the bank of the another stream, called *Kanomata-gawa*, and is sheltered by mountains on E. and W. Azaleas in spring and maples in autumn make a specially gorgeous display. There are three common salt springs. Sights near this place are *Sennin-iwa*, *Shiro-yama*, *Shiyū-no-taki*, *Raitei-no-taki*, *Soren-no-taki*, *Yūhi-no-taki*, etc. All these *taki* or cascades are among the grandest of the 70 falls and cascades in Shiobara. Raitei Fall is specially famous, its height being 150 ft. and width 200 ft.

Hataori (Inns: *Nuri-ya*, *Kami-ya*, *Yamato-ya*, *Sano-ya*) lies at a distance of 0,2 m. to the N. W. of Shiogama and at the bend of the Hōki-gawa and contains five springs, all muriated alkaline. On the S. rises *Fuji* and the range of *Kijūroku*. *Fumon-ga-fuchi*, *Hōshū-no-taki*, *Kiyomi-no-taki*, etc., are among the sights here. Tradition relates that the painter named *Fumon*, believed to have been a brother of *Takao*, was drowned in the pool, which is therefore called Fumon-ga-fuchi. His Buddhist picture is kept at the Myōun-ji.

Monzen (Inns: *Yamaguchi-ya*, *Matsumoto-ya*, *Fukuda-ya*, *Aoki-ya*, *Sakamoto-ya*, *Kikuchi-ya*, *Miyata-ya*) lies N. of, and almost contiguous to, the last-named place, and about half a mile from Shiogama. Sheltered on the N. E. by *Tera-yama* and bounded on the S. W. by the Hōki-gawa, it is the most thriving village in Shiobara, possessing a village office, post-office, primary school and other public institutions. This place has five springs, all of an alkaline nature. The Buddhist temple of Myōun-ji is the largest and oldest temple in Shiobara, having been founded by *Myōun*, nurse of *Shigemori*, eldest son of *Kiyomori*. The temple preserves a long over-dress used by Takao; while on the premises stands the tomb of the founder.

Sumaki (Inn, *Nemoto-ya*) is 0,5 m. from Monzen and stands on the slopes of Kijūroku Range, the place being at an elevation of 1,580 ft. An interesting feature of the bath-room here is that several jets of hot water are brought down into the basin by pipes, these jets giving an excellent massaging effect to whatever part of the body is placed under them.

Furu-machi (Inns: *Kaji-ya*, *Kami-Aizu-ya*, *Yorozu-ya*, *Naka-Aizu-ya*, *Nasu-ya*, *Fūsen-rō*, *Kome-ya*, *Myōga-ya*, *Hitachi-ya*) stands opposite Monzen on the other bank of the Hōki-gawa, the two places being connected by an iron bridge called *Hōrai-bashi*. The hills *Ōkubo* and *Hazama* rise to the N. E., while *Kurashita* and Kijūroku stand opposite. Furu-machi is continuous with Monzen, and the houses in the two combined give the largest total in the Shiobara villages. There are six or seven springs of an alkaline nature. The sights in the neighbourhood are *Onsen-sha*, *Senshin-taki*, *Genzan-no-ana*, *Hachiman-jinja*, *Shōji-gawa*, etc. Genzan-no-ana is a cave at the N. E. base of *Goten-yama*, N. W. of Furu-machi, where *Aritsuna*, grandson of *Genzammi Yorimasa*, consealed himself. Hachiman-jinja, 360 yds. from the above, is dedicated to *Honda-wake-no-Mikoto*, and on the premises are found three of the "Seven Wonders of Shiobara," these being *Sakasa-sugi* ('cryptomeria growing upside down'), *Ichiya-take* ('bamboo grown in one night') and *Fuyu-no-tade* ('polygonum growing in winter'). The *Shōji-gawa* is included among the wonders, because fish are entirely absent from it, though they come up to near the *Hachiman-bashi* where the Shōji joins the Hōki. On the banks of the river grow *Kataha-no-ashi* ('reeds with leaves growing on one side only,' and hence regarded as another wonder). The two remaining marvels are the *Fūfu-garasu* ('pair of ravens') at *Ara-yu* and the *Fuyu-no-momo* ('winter peach') at Shiogama, but this last no more exists.

Ara-yu (Inns: *Kame-ya*, *Kami-Fuji-ya*, *Daikoku-ya*, *Tsuta-ya*, *Gensen-kwan*, *Kimijima-ya*, *Shimo-Fuji-ya*) is 7 m. from Furu-machi, up the river and via Kami-Shiobara and Furu-Yumoto, the road, which lies to the right, being fairly level. The left route is shorter, the distance being only 5 m., but the road is more laborious. There are two ponds *en route*. Ara-yu is at the greatest elevation of all the spas in Shiobara and even in midsummer the thermometer rarely goes up to 70° F. There are four springs, the waters being acid. The sights near here are *Onsen-jinja*, *Jizō* Temple, and the *Fūfu-garasu*. Shiobara is singularly free from ravens, and in this spot only a single pair is met with, which is hence regarded as a wonder.

Furu-Yumoto is found among the hills, 2 m. inward from Ara-yu, and 5 m. along the Hōki from Furu-machi. This is the pioneer hot spring in Shiobara; it is also called *Kajiwara-no-yu*, because *Kajiwara*, a follower of *Yoritomo*, is said to have bathed here when he accompanied his master on the hunting excursion at *Nasuno*. Before it was visited by a severe earthquake in 1659, the place contained over 80 houses and a fine temple, but now only one inn is left. There are two falls near here.

There are 23 public baths, 3 doctors in Shiobara. Number of visitors: 31,451, total stays being 165,670 days (1909).

Nikkō.

The glory of nature at *Nikkō* is ideally complemented by the glory of art enshrined there, for Nature's bold essay in landscape gardening with mountains, cascades, crystalline streams, ancient trees, lovely lakes, and the brilliant chromatic display of leaves in autumn, is utilised to best advantage by the cunning hand of master designers and craftsmen, who have reared amidst such surroundings gorgeous piles profusely decorated. It is not to be wondered at that foreigners should regard Nikkō as by far the most noteworthy sight in all Japan, while the tribute which Japanese pay to the romantic beauty of the place is sufficiently evidenced by that popular saying, meaning, "Don't use the word 'splendour' till you have seen Nikkō," 'splendour' being in Japanese '*kekkō*.'

Through trains run several times a day between Ueno and Nikkō. Passengers have to change at *Utsunomiya*, when going by non-through trains. Time required: about four hours. Fares: *1st* class, Y 3,60; *2nd* class, Y 2,14.

Nikkō (90,9 m. from *Ueno*, in 4 to 4¾ hrs.) is the terminus of the Utsunomiya-Nikkō Branch Line. The station (1,746 ft. above the sea-level) is situated on the right bank of the *Daiya-gawa*, along which a long town stretches on constantly rising ground from the station toward the N.W. —the distance from the station to the *Mihashi*, or 'Sacred Bridge,' which is at the centre of the most interesting section of the town, is about 1 m. There is an electric-tram service starting from the station and passing the various hotels, (and an automobile is available in summer).

Hotels: *Kanaya Hotel* (on a hill, close by the Mihashi, about 1 m. from the station), *Nikkō Hotel* (near the Park at *Nishi-machi*, a little over 1 m. from the station). Inns: *Konishi-Ryokwan*.

The Four Seasons in Nikkō.

Spring. In late spring, and in the month of May, Nikkō offers charming scenes by reason of the flowers of azalea-trees, purple, red, and white, and the delicate green shoots of larch-trees. The azaleas found here are somewhat different from those growing elsewhere. The best places for enjoying the flowers are in the neighbourhood of the street of Nikkō, Nakimushi-yama ridge, *Yashū-hara*, *Kujira-yama* on the upper course of the *Tamozawa*, the road from Nikkō to *Chūzenji* hill-sides facing *Uma-gaeshi*. Then Chūzenji, especially at *Tera-ga-saki* and *Aka-iwa* on the lake shore, and *Mae-Shirane* at *Yumoto* are also noted for the flowers. For the vivid green of the larch buds, the best places are *Senjō-ga-hara* near *Yumoto*, the S. foot of *Tarō-san*, the W. foot of *Nantai-san*, and also the W. side of Yashū-hara and Nakimushi-yama.

Summer. Refreshing cool climate, boating and fishing on Chūzenji and Yumoto Lakes, viewing the sunrise from the top of *Nantai*, gorgeous carpet of late azaleas and iris flowers at Senjō-ga-hara and neighbourhood in early July, and then warbling of Japanese nightingales and other singing birds may be mentioned as attractions of Nikkō in this season.

Autumn. Nikkō is superb in autumn for the scarlet tints of its foliage; in this respect it is considered far to excel other places noted for the autumn scarlet, such as *Usui* and *Shiobara*. By Japanese, therefore, this season is considered the best time for visiting Nikkō. The fascinating colouring begins from about the latter part of September, but the sight is generally at its best about the middle of October. The best places for seeing the autumn colouring are *Ogura-yama*, the vicinity of Kirifuri Fall, right bank of the *Daiya* as one ascends from the Sacred Bridge, and on the road between Umagaeshi and Chūzenji, *Misawa*, *Ken-ga-mine*, *Naka-no-chaya*, *Fudō-zaka*, Kegon Fall, etc. At Chūzenji the places are *Uta-ga-hama*, *Tera-ga-saki*, *Shōbu-ga-hama*, *Aka-iwa*, etc., and at Yumoto there are *Yu-daki*, *Tade-no-umi*, *Konsei-tōge*, etc. The view of the moon as reflected on the lake is a delight to Japanese artists and poets. The maples, which are the chief contributors to this chromatic splendour, are of divers varieties in Nikkō, some being peculiar to one place and others to other places. More than twenty four kinds are counted by Japanese lovers of this autumn sight.

Winter. Near Chūzenji the snow accumulates to a depth of about 3 ft. on the ground, and hence Yumoto and Chūzenji are practically deserted by holiday seekers during the cold season. The lake does not freeze thick enough for skating. However, there are great hopes that sleighing and skiing, for which excellent grounds are abundant, may become a popular winter attraction in Nikkō.

Places of interest: Nikkō Kōen, or Public Park, the Grand Cryptomeria Avenues, *Kirifuri-no-taki*, or 'Mistfalling cascade,' *Gamman-ga-fuchi*, *Sōmen-no-taki*, or 'Vermicelli cascade,' *Urami-no-taki*, or 'Back-viewing cascade,' *Jikwan-no-taki*, *Jakkwō-no-taki*, *Haguro-no-taki*, *Aioi-no-taki*, *Nana-taki*, for 'Seven waterfalls,' etc.

Nikkō to Chūzenji.

From the Mihashi to Lake Chūzenji, a distance of about 10 m., *jinrikishas*, *kago* (chairs), and saddle-horses are available; while electric trams go as far as *Uma-gaeshi* (5 m.), which is halfway up. The waterfalls *Hōdō*, *Hannya*, *Kegon* and *Shirakumo* are worth visiting.

Chūzenji.

The hamlet of Chūzenji lies on the N. shore of Lake Chūzenji, which is about 10 m. from Nikkō and 4,194 ft. above the sea-level. The place acquired its name from the temple of Chūzenji, which was established by *Shōdō-Shōnin* over 1,100 years ago.

Hotel: *Lake-side Hotel* near the bridge, *Ōjiri-bashi*. Inns: *Kome-ya*, *Tsuta-ya*, near the shore (foreign meals to order).

Lake Chūzenji. This clear, fresh-water lake, is 15 m. in circumference (its greatest length from E. to W. is about 5 m., its breath, 2,5 m.). It lies at the foot of *Nantai-san* and is surrounded by beautiful hills on the other sides. Its shores are rich in indentations, which add much to its scenic beauty. Towards the E. of *Oimatsu-ga-saki* are found the deeper parts of the lake,—soundings showing the greatest depth (i.e. off Kōzuke-jima) to be 172 metres (567 ft.). The lake, formerly devoid of fish, now abounds with trout, carp, etc., having been stocked by the Government in 1873 with *iwana* (a species of trout), in 1874 with carp, in 1875 with *hara-aka*, in 1879 with eels and lampreys, in 1882 with trout and *ame-no-uwo*, in 1890 with *higai*, and in 1892 with American trout.

Highway to Yumoto.

The highway to Yumoto (7,5 m.) starts from Chūzenji, running along the N. shore. First we pass the bronze *torii* of the Chūgūshi Shrine, then come to *Ōsaki*, where in a forest of pines, cryptomerias, birches, and maples, stand many summer villas. *Shōbu-ga-hama* (3 m. from *Ōjiri-bashi* — boat available) is an important stage-town (where horses or *jinrikisha* may be hired). Here the highway takes a sharp turn towards the N. and traverses a forest of large birches. On the way to Senjō-ga-hara, we pass *Akanuma*, a reddish-coloured marshy land, overgrown in many places with reeds.

Senjō-ga-hara is a plain, rendered very attactive in summer by the blossoms of *Yashū-bana* (a kind of azalea) and wild lilies. The place also affords a complete view of the surrounding mountains—Nantai-san, Ōmanago, Komanago and Tarō-zan towards the E., and Shirane-san, Mae-Shirane-san, and Konsei-zan to the W.

Yudaki or the 'Hot water cascade,' is formed by the waters from Yumoto Lake running down a steep rocky bed. By taking the highway towards Yumoto, we soon come to a spot whence we may look down upon the cascade, while the left-hand path brings one to a point from which one may view it from below.

One may then rejoin the Yumoto highway by a short cut which brings one out at the spot above mentioned. The cascade makes a fall of 270 ft., its waters flowing through a forest of maples and other fine trees.

Yumoto Hot Springs.

The Yumoto spa is 17 m. from *Nikkō* and 7,5 m. from *Chūzenji*,—*jinrikisha* available throughout. Hotel: *Namma Hotel*. Inns: *Kama-ya*, *Ita-ya*, etc.; these each have detached houses; foreign meals to order. Yumoto is surrounded by mountains on all sides except to the S., where it is open towards the lake. The place is at the high altitude of 5,088 ft. above the sea-level, being higher than Chūzenji by 900 ft., and than the *Mihashi*, Nikkō, by 3,060 ft. In the hottest days of summer the thermometer never registers more than 82° Fahr. It is literally a summer resort, the hotel and inns being practically closed between the middle of November and the middle of March.

Lake Yumoto, called '*Yu-no-umi*,' is 1 m. long and 0,2 m. wide and receives its waters from the *Shirane-sawa*, the *Konsei-zawa*, etc., as well as from the thermal springs. On the E. shore of see Plate 25
the lake (i. e. on the right-hand side of the road to Chuzenji) is a small peninsula, called *Usagi-jima*, which is covered by a forest of splendid conifers. In fact the lake is surrounded on all sides by a

beautiful forest, in which are found trees like *kome-tsuga, take-momi* (fir), *kara-matsu* (larch), *kara-hinoki*, and *asunaro*. There are boats for hire, either for rowing or for fishing. The lake abounds in *funa* (gibel) and eels.

There are many hot springs, which contain, as a rule, hydrogen sulphide with a slight trace of acid. For the most part they are colourless and trasparent, but some are slightly turbid. In the hotel and inns there are private baths, but public baths, of which there are more than 10, are largely patronised, as they are believed to be more efficacious than the private baths. The public baths have names, which, taking them in order from the S., are as follows :—*Kawara-no-yu, Tsuru-no-yu, Donsu-no-yu, Naka-no-yu, Taki-yu*, etc. Of these the hottest are *Ara-yu* (156° Fahr.) and *Kawara-no-yu* and *Gosho-yu* (both 149°), while *Donsu-no-yu* (105°) has the lowest temperature. Number of visitors : 1,249 (1909).

GUMMA-KEN

Ikao, Kusatsu, and other Hot Springs.

The mountainous district situated northward from *Takasaki* and *Karuizawa* is noted for the abundance of its hot springs, the waters of which possess various medical qualities, while the localities where they issue form delightful summer resorts. These hot springs are found at *Ikao, Kusatsu, Shima*, and *Sawatari*.

Kusatsu and Neighbouring Hot Springs.

Kusatsu Spa may be reached by any of these six routes :—

(a) From Ikao (also from Takasaki, Iizuka, or Maebashi) by electric tram to *Shibukawa*; from *Shibukawa* to *Nakanojō* by horse-tram ; from Nakanojō, via *Kawara-yu* (12,5 m. in 3 hrs.) and see Plate 6, fig. 2 *Otsu*, to Kusatsu by *basha* (entire distance 25 m., in 7 hrs.; fare Y 1,40).

(b) To Nakanojō, as stated above; from Nakanojō to *Sawatari* (6 m.) partly by *basha* or *jinrikisha*, and the rest on foot; from Sawatari to Kusatsu, across the Kuresaka Ridge (18 m.) on foot.

(c) From Ikao or Haruna on foot as far as *Hakojima*, near a station on the Shibukawa-Nakanojō horse-tramway, via Benten-daki, Ō-daki, etc., the path lying along the stream Numa-gawa ; the rest of the way to Kusatsu either as in (a) or (b). Between Hakojima, und Nakanojō, there is an interesting pedestrian path along the River Agatsuma-gawa.

(d) From Ikao to Haruna either on foot or by chairs (or horse-back); from Haruna to Kawara-yu (20 m. from Ikao), via Ōdo, Ōkashiwagi, either on foot or horse-back,—the path lying along the W. slope of Haruna ; the rest of the way to Kusatsu as in (a). Between Haruna and Kawara-yu, the path is rich in beautiful scenery, this part being known as the "*Yabakei*" of Kwantō.

(e) From Karuizawa or Nagano by rail to *Toyono* ; from Toyono to the Shibu Spa (11 m.) by *basha* or *jinrikisha;* from Shibu Spa to Kusatsu on foot or on horse-back.

(f) From Karuizawa or Kutsukake to Kusatsu (26,2 m.), via *Ōkuwa* (14 m.), *Hanco, Ōtsu*, etc. on foot or horse-back (fare Y 4,50).

Kusatsu Hot Springs.

Kusatsu has been celebrated from ancient times for the medical efficacy of its baths, as *Arima* has been in the neighbourhood of Kyōto. Local chronicles record the visits of many celebrated persons to *Kusatsu*, that of *Yoritomo* having especially contributed, it is said, to the spreading of the fame of the waters, which are chiefly sulphuric, the sulphur being present in the form of sulphuric acid. The other constituents are iron, alum, and arsenic. The temperature is exceedingly high, ranging from 113° to 128° Fahr. The waters have such a powerful effect on the skin that in the first stage sores are brought out on the tender parts. The chief public bath, called "*Netsu-no-yu*," stands in the village square, and people suffering from obstinate skin-diseases take courses in it. The waters are so hot that the bathing is done under semi-military discipline, with a 'bath-master' directing see Plate 9 the operation. The first process consists in stirring the waters throughly with boards to aerate and soften them (fig. 1); then the bathers pour 250 dippers of water on their heads to prevent congestion (fig. 2). At the word of command from the master they enter the bath and endure the ordeal for 3,5 to 4 min., remaining practically motionless, for even a slight agitation of the water makes the temperature doubly trying to those immersed in the bath (fig. 3). At intervals of one minute or half a minute the master cries out the time left, to which all the bathers answer in chorus. Of the various baths, *Takino-moto-yu* is 148° F. and contains sulphuretted hydrogen, iron, and acid; *Netsu-no-yu* is 144° F.; *Washi-no-yu* and *Jizō-no-yu* 140° F. (fig. 3); *Goza-no-yu* 137° F.; *Nagi-no-yu* 127° F.; *Kakke-no-yu* 143° F.; *Kompira-no-yu* 130° F. Kusatsu stands 4,500 ft. above the sea and is a clean looking village, three-storied inns with gabled fronts occupying the square. This square is full of vapour from the spring of boiling sulphur water which is brought here by wooden troughs to collect sulphur deposit (fig. 1). Kusatsu lies in a depression in a table-land, and a small stream runs through it, from the bed of which hot springs gush out here and there. *see Plate 5* *see Plate 8*

At an extreme end of the village, and isolated from the rest, is a leper's quarter (called *Yuno-sawa*) with a special bath for the afflicted. Sights near Kusatsu are *Sai-no-kawara, Kōri-dani, Jofu-no-taki, Kakomi-yama, Doku-mizu, Shirane-jinja.* From Kusatsu two roads lead N.W. to *Shinano*, one to *Suzaka* via the *Torii-tōge*, and the other to *Shibu-Onsen* over the 19,5 m. pass of the same name, a very laborious expedition. This path, however, secures one the advantage of visiting *Sirane-san* and of enjoying the milder waters of the hot springs at *Shibu*. It should be noted that those who have passed through the bathing course at Kusatsu generally make a week's stay at either *Sawatari* or *Shibu* to effect the complete after-cure of the irritated skin.

Water pipes laid from the hill, good drainage, no mosquito in summer. Number of visitors: 6,740, the total stays being 140,200 days (1909). Inns: *Ichii-Ryokwan, Shirane Hotel, Nisshin-kwan, Chōyō-kwan, Bōun-kwan.*

Shirane-san, called "*Kusatsu Shirane*" to distinguish it from *Nikkō Shirane*, is an active volcano, 7,500 ft. high, that has exploded four times during the last few decades, viz. in 1882, 1897, 1898 and 1902. It lies about 2,5 m. off the highway and requires an extra couple of hours or so to visit it. At the top three craters exist, the central one called *Yugama*, the W. one *Kare-gama*, and the E. one *Mizu-gama*. The last one contains yellowish-coloured water, while from the Yugama, which means "hot-water cauldron," dense vapour is ascending and jets of hot water containing sulphur are thrown up. The other one, "dried-up cauldron," is dry. The woods all round the mountain present a desolate appearance with their blasted skeleton trees, the effect of the recent eruptions, though the woods near *Shinano* have escaped destruction. Near *Shirane* stands *Moto-Shirane*, another cone-shaped volcano, while in front of it rises *Manza-yama*, at the base of which are the **hot springs of Manza** (5,180 ft. above sea-level).

Kawarayu, 11,3 m. S. W. of Nakanojō on the way to Kusatsu and 2,200 ft. above the sea, is situated on the high precipitous bank of the upper course of the River *Agatsuma*, opposite the peaks of Mts. *Tengu* and *Takama*. An extent of the valley in the vicinity of the spa being exceedingly beautiful in scenery, is regarded as '*Yabakei* of Kwantō (Central Japan),' as already mentioned. (*Yabakei* is a valley near Beppu, noted for its scenic beauty). The spa may be a quiet summer resort with hot springs.

Shima spa includes three hot springs, Yamaguchi, Shin-yu and Hinatami, 0,5 m. from each other, all located in Sawada-mura, 10 m. N. from Nakanojō, Kōzuke Province, *jinrikisha* and omnibuses available. The spa, 2,500 ft. high above the sea, stands by a ravine with several waterfalls on its course. The main inns own private baths and are also provided with vapour baths. The best season for visit is from May to August. The springs are noted in efficacy next to Kusatsu among all the natural baths in this district. The water is said to be efficacious especially for dyspepsia, swellings, diseases of the skin, etc. Number of visitors: 6,617, the total stays being 57,613 days (1909). Inns: *Sairyō-kwan, Sekizen-kwan.*

Sawatari (Inn, *Taishō-kwan*) is 6 m. W. of *Nakanojō* and at an altitude of 2,200 ft. above the sea. Number of visitors: 2,000, the total stays being 30,000 days (1909).

Isobe (73,9 m. from *Ueno*, in 3 hrs. 29 min., 15 m. from *Karuizawa*) is noted for mineral springs used for baths after heating. The spa is situated in a sort of ravine, by the bank of a stream, the *Usui-gawa* at an elevation of 1,200 ft. above the sea. For a distance of 0,3 m. from the station, the road is lined by cherry-trees. *see Plate 27*

Shiro-yama, 0,7 m. S. E. of the station, is the site of the old castle of Sasaki Moritsuna (end of the 12th century). The place is a low hill, with flat summit, 100 ft. above the surrounding plains, and commands a wide prospect. From here are the bizarre, jagged mountain peaks of *Myōgi-san* visible on the S. W., and Mt. *Asama* (an active volcano) with its splendid view on the W. There have recently been planted a large number of cherry-trees, which attract numerous visitors in the flower season.

The springs, though cold, are highly saline, and impregnated with carbonic acid gas. Each of them is one of the most concentrated common salt springs in Japan, the total quantity of solid constituents in 1 kilogram being more than 30 grams. In *Hara-machi*, a small town, 2,5 m. distant from Isobe, is also a cold spring, which contains more than 34 grams of solid matter in 1 kilogram of water. Carbonic acid gas is utilized here for obtaining carbonate of lime for tooth-powder and water for the manufacture of aerated water Salt, obtained by evaporating mineral water, is sold at this spa. The water is suitable for the treatment of dyspepsia, swellings, haemorrhoids, uterus diseases, etc. Number of visitors: **6,340**, the total stays being **15,451** days (1909). Inns: *Hōrai-kwan*, *Taigaku-rō*, *Isobe-kwan*, etc

See Plate 8, fig. 5

Ikao and Neighbourhood.

The spa town of Ikao may be reached by three routes: (1) From Tōkyō via *Takasaki*—Tōkyō to Takasaki by railway (63 m. in about 3 hrs.) and from Takasaki by electric car (20,3 m. in 2,3 hrs.); visitors from Yokohama may effect junction with the Tōkyō—Takasaki Line, by taking train or electric car from *Shinagawa* to *Akabane*; (2) From Karuizawa or Nagano, via *Iizuka* (immediately N. of Takasaki),—to Iizuka by rail and from Iizuka to Ikao by electric car (19 m. in 2 hrs.); (3) From Nikkō or Mito, via *Oyama* and *Maebashi*,—to Maebashi by rail and from Maebashi to Ikao by electric car (16,6 m. in 2 hrs.); between Ueno (Tōkyō) and Ikao, through tickets issued, via either Takasaki or Maebashi.

Shibukawa is a prosperous town of 7,046 inhabitants, being 9,1 m. from Maebashi, 12,8 m. from Takasaki, and 7,5 m. from Ikao, all by electric tramway. The town is picturesquely situated, being in full view of Akagi Range towards the N. E. and of *Haruna* towards the S. W., while the rivers *Tone* and *Agatsuma*, one flowing from the N. and the other from the W., join at its N. out-skirts. From Shibukawa to Ikao, electric cars available as already stated; to *Kusatsu*, *Shima*, *Sawatari*, *Kawarayu* (all spa towns), tramway (horse) as far as *Nakanojō* (13 m. in 2 hrs. 30 min. —fare 50 *sen*), from Nakanojō to the several hot springs named, either by *basha*, a rude kind of stage coach, or *jinrikisha*. There is a tramway service also between *Shibukawa* and *Numata* (13,2 m. in 2 hrs.—fare 45 *sen*); the latter town lying on the highway to Nikkō and Mt. *Shirane-san*.

Ikao is one of the most popular summer resorts within easy reach from Tōkyō and Yokohama and is situated on a mountain slope with an elevation of **2,500** to **2,700** ft. The chief attraction of this place for Japanese is the hot spring, which has the temperature of 113° F. and contains a small quantity of iron and sulphate of soda. The waters are believed to be specially efficacious for women's diseases, and hence Ikao finds more patrons among the fair sex than among the men. Ikao is essentially a spa, for the little village containing about one thousand souls consists of inns and houses selling local souvenirs, or otherwise purveying to the needs of guests staying at the inns. The principal street that divides the village into E. and W. halves makes a rather sharp ascent, graded by an almost continuous flight of stone steps. The W. half ends in a deep ravine where flows a small sream, while the other half is bounded in by a low mountain ridge. The hot waters gush out at the back of a small gully called *Yumoto*, or "Source of Hot Water," which lies about half a mile from the top of the street, and to which an excellent level road leads. At their source the waters are clear and are drunk by visitors, and from this place they are conveyed by bamboo pipes to all the bath-houses. When left to cool, the waters precipitate yellowish deposit of iron oxide. Ikao is rich in wild-flowers, lilies of various kinds being especially prominent from June to September, while in late spring the mountain sides echo with the songs of Japanese nightingales and cuckoos. For those prefer walking from *Shibukawa* as far as Ikao, a distance of 6 m., instead of travelling in the electric car, time 1 hr., it may be noted that about 3,5 m. up is a resting-station, called *Mikage-no-matsu*, named from the aged pine growing close by, where stands the stone tablet commemorating the short rest the late Empress-Dowager Eishō-Kōtaikō took when she visited Ikao. A little further on we come to the place where a wooden post is erected to mark the path leading to the Fu-nyū Fall. Ikao is a little over a mile from here. The scenery commanded from Ikao is extensive and beautiful and comprises the valleys of the two rivers *Tone* and *Agatsuma*, the mountain ranges marking the border of the vast plain of *Musashi* in which Tōkyō is situated, and then the Nikkō Range. Some of the larger hotels have suitable provision for the accommodation of foreign guests. 15 public baths, 1 spa physician and 1 dentist. Number of visitors: **33,557**, the total stays being 193,217 days (1909). Hotels: *Ikao Hotel* (semi-European style), *Lake Hotel, Hashimtoo Hotel.* Inns: *Budayu* or *Neno-Kogure, Chigira, Hōrai-kwan, Chitose-kwan,* etc.

Meteorological Observations.

Summary.

Month	Air temperature Mean	Relative Humidity	No. of hours with Sunshine Total	Amount of Precipitation Total	Wind Velocity Mean	Direction
For the year, 1913.						
January	-2,03	61,0	209,3	31,2	3,19	N 73° W
February	-0,62	60,4	191,4	23,6	3,23	N 71° W
March	1,09	58,4	228,1	52,9	3,48	N 72° W
April	9,98	73,3	186,2	68,2	3,16	S 1° W
May	11,83	71,3	230,1	169,4	3,39	S 60° W
June	16,47	80,2	168,2	230,9	2,64	S 3° E
July	19,99	87,5	157,9	196,6	2,38	S 36° E
August	20,08	83,3	184,4	237,9	2,58	S 14° E
September	16,04	81,3	144,4	182,3	2,30	S 31° W
October	11,85	80,1	141,9	219,0	2,55	S 57° W
November	5,68	67,2	170,4	70,7	2,98	N 81° W
December	1,72	61,0	173,0	36,5	2,99	N 65° W
For the year, 1914.						
January	0,37	54,4	210,1	14,6	3,20	N 61° W
February	-0,48	58,1	171,9	35,8	1,90	N 54° W
March	4,50	69,9	167,6	89,2	2,96	N 88° W
April	7,56	61,7	213,9	130,5	3,50	N 55° W
May	14,12	72,0	183,0	225,0	2,62	S 30° W
June	18,05	80,6	157,9	165,7	2,06	S 5° E
July	22,07	81,8	179,7	134,4	2,12	S 28° W
August	22,60	87,0	203,5	598,5	2,36	S 6° W
September	18,51	86,7	161,9	264,6	1,83	S 18° W
October	11,71	74,8	178,1	103,3	1,90	S 82° W

Nanae-no-taki and **Benten-daki** supply a pleasant walk, the former only about 0,5 m. from Ikao, the other side of the ravine, while the latter, formed by the water coming from Lake Haruna, is a little over 1,5 m. further on in the wood that contains *Nanae.* Nanae is so called because the little mountain torrent here divides into seven little cascades. Near the spot stand rest-houses where Japanese buckwheat vermicelli (*soba*) and other delicacies are served. *Benten* is a *bona fide* fall, some 40 ft. in height and 10 ft. wide. It is utilized for generating hydro-electricity to supply motor power to the trams from Shibukawa to Ikao. Visitors to Haruna shrine may reach Benten by returning by the path leading to it along the lake.

Garameki-Onsen is a lukewarm spring amidst hills near *Minowa,* at the S. E. foot of *Sōma-ga-dake.* It is about 2,4 m. from Ikao; the waters are alkaline and are heated before being used.

Haruna-san ranks with *Akagi* and *Myōgi* as one of the three celebrated mountains in Kōzuke Province. From Ikao to the shrine of *Haruna-jinja* the distance is about 6 m., of which the first stage of about 1,2 m. is a rough climb over the mountain slope, though practicable by "chairs" (fare Y 2) or on horseback. It is perhaps more advisable to walk. On reaching to the top of the ascent we come to a plateau, and diverging left we come after a few minutes to the *mushi-yu* (vapour-bath), about 1,2 m. away. The place was much frequented by rheumatic and other patients in order to take advantage of the sulphurous gases that used to issue from the ground; but since of late these gases ceased to issue, the vapour-bath has been closed. The twin-peaks rising on the left are *Futatsu-dake*. Advancing further and over a little ascent called *Yasemune-tōge*, the road traverses for about 2,5 m. the descending moor with *Sōma-ga-dake* standing left and *Takane* on the N., and at last we reach Lake Haruna. Sōma-ga-dake, otherwise called *Kurokami-yama*, is 4,800 ft. in height; the routes to the summit are all steep, iron-chains being stretched in some places to aid climbing. On the summit stands a 6 ft. stone statue of Taira-no-Masakado. The panorama commanded extends over a wide region, including *Fuji* nearly due S., several of the lofty ranges of Kai and Shinano and all the peaks standing close by.

Ikao-Fuji, or **Haruna-Fuji** (4,808 ft. in height) rises at the N. E. part of Lake Haruna, and is so named from its shape. At the foot is found a cattle ranch in miniature. At the foot facing the lake is a small mound called *Hitomokko-yama*. Legend says that a genius having undertaken to build this Fuji in one night, the day began to dawn while he had yet to pile on one more "mokkoful" of earth ("*mokko*" being a rope net-work mat for carrying earth and other things), and he was obliged to leave the earth where the mound stands. Hence the name, which means "one mokkoful mound."

Lake Haruna is a crater lake, about 5 m. from Ikao, and is 0,8 m. from E. to W., 1 m. from N. to S., and 2,3 m. round. The water is clear, and besides *Ikao Fuji*, there stand around the basin, *Eboshi-dake*, *Bingushi-dake*, *Suzuri-iwa*, and *Kamon-ga-dake*. The lake is stocked with salmon and other fish, a special company being organized for undertaking pisciculture here. The tea-house (Lake Hotel, branch of Ikao Hotel) on the shore serves lunch or provides accommodation for the night. The shore is noted for irises and fire-flies, while in winter the frozen surface of the lake affords excellent skating. Ice is also hewn here in winter. The outflow of the lake forms the Benten Fall. *Tenjin-tōge* is a short ascent on the road leading from the lake to the shrine. On the top stands a big *torii* for Haruna-jinja (Shintō shrine) and there are tea-houses to right and left of the road. The view of the lake from this point is really picturesque. The distance from here to the shrine is 1,2 m. Near the shrine, and beyond the small current flowing left of the road, stands a queer-shaped rock, called *Tsuzura-iwa*, because it looks like a set of gigantic trunks piled one upon another.

Yujiku hot spring (29,5 m. N. from Maebashi, and 20,4 m. N. W. from Shibukawa) is on the right bank of the *Akaya-gawa* and on a highway (*Mikuni-kaidō*), with mountains on the S. and N. Pop. 500. In the neighbourhood are several springs: **Hōshi-Onsen** (7,2 m.), **Yushima-Onsen** (2,5 m.), **Sasa-no-yu** (2,5 m.), etc. There are five springs in Yujiku, the temperature of water being widely different from one another. Number of visitors: 1,500, the total stays being 5,000 days (1909).

Yubiso. 15. m. from *Numata*, and 25,4 m. N. from *Shibukawa*; from Shibukawa to Numata (13,2 m.) horse-tramway available and the rest only on foot. The place (1,500 ft. above the sea) lies on the right bank of the *Yubiso-gawa*, the upper course of the *Tone-gawa*. Pop. 194. The water is said to be especially efficacious for rheumatism. **Yubara-Onsen** is about 2,5 m. distant. Number of visitors: 495, the total stays being 3,382 days (1909).

Yubara. 23 m. N. from Shibukawa. 2,5 m. S. from *Yubiso-Onsen*. Pop. 398. 3 springs. Number of visitors: 519, the total stays being 1,908 days (1909).

Irinoyu, 8,5 m. N. W. from *Yokokawa* station on the Shin-etsu Line, lies on the E. slope of *Usui-tōge*, about 2,700 ft. above the sea, 6 m. from *Karuizawa*. The place is shut in by hills on all sides. Maple trees are found in the surrounding hills. Only 1 inn with baths. Number of visitors: 121, the total stays being 966 days (1909).

Nashiki-Kōsen. 2,5 m. W. from the *Kami-kambai* station on the Ashio Line (junction: *see Plate 28* *Kiryū*). The spa, 1,490 ft. high above the sea, is situated in a gorge at the foot of *Mt. Akagi*, a stream with clear water running near by. Thickly wooded hills surrounding the place keep the air always fresh and bracing. The garden of an inn *Nashiki-kwan* is planted with cherries, plums and peaches, and affords a beautiful sight in spring. It is a quiet summer retreat for inhabitants in the vicinity.

IBARAKI=KEN

Hiraiso, 2,4 m. N. of *Minato*, Pop. 7,856, is noted both as a watering-place and also as the foremost fishing centre in *Hitachi* Province. The view of the waves from the N. height of this place is very grand, and the height bears the name of *Kwantō-jō* (' Wave-viewing station ') specially bestowed by *Rekkō*, the celebrated prince of Mito in the middle of the 19th century. *see Plate 29*

Ōarai lies to the S. of Hiraiso and is the most noted pleasure resort in this district. The coast is dotted with rocks and backed by a low ridge. This shore is noted for shell-fish, particularly ear-shell. The place can be reached from Mito either by *jinrikisha*, 9 m., or by descending the *Naka-gawa* by steamer as far as *Iwai*, whence the distance is 1,4 m. and is covered by *jinrikisha*. Aged pines grow in the precincts of *Isozaki-jinja*, a Shintō shrine, from which a good view of the ocean is obtained. *see Plate 30*

KANAGAWA=KEN

Hayama lies, 3,7 m. of the S. of *Zushi*, (33 m. from Tōkyō, in 1 hr. 23 min.), and as it projects far more into the sea it commands a better view than does the latter. On the S. lies a pine-clad point called *Chōja-ga-saki* with an inn (*Chōja-en*) built on it ; this is an excellent spot for bathing. An Imperial villa and the retreats of many notable personages stand here. Pop. 6,620. Number of visitors : **1,551**, the total stays being **29,096** days (1909). *see Plate 31* *see Plate 32*

Ōiso (40,8 m. from Tōkyō, in 2 hrs. 5 min.). The Japanese people, though living so close to the sea, never appreciated the benefits of sea-bathing, till Dr. Matsumoto Jun, the surgeon general of the Army, taught them to resort to seaside places, by first inducing a friend of his to open a seaside hotel at Ōiso (1886). Ōiso is now of full of villas and has grown to be a flourishing town with a population of 8,000. The late Prince Itō had a villa here, and the town thus became a centre of reliance whither statesmen flocked at times of political calm or stress. Ōiso, one of the most popular watering-place, is also a delightful winter resort, the climate being mild in winter. Number of visitors : **17,502**, the total stays being **107,796** days (1909). Inns : *Shōsen-kaku*, *Tōryū-kwan*. *see Plate 33*

Hakone and Neighbourhood.

Hakone, the name of a large mountainous district, justly famous on account of its hot springs, beautiful scenery, and salubrious climate, is easily reached from Tōkyō or Yokohama by taking the Tōkaidō Line to Kōzu (48 m. from Tōkyō), thence by electric car to Yumoto Spa, which lies at the entrace to the interior of Hakone.

Tramway from Kōzu : 39 trips each way between Kōzu and *Yumoto* (Hakone), the distance being covered in a little over an hour. Tariff: between *Kōzu* and *Odawara*, 1*st* class, 45 *sen*; 2*nd* class, 30 *sen*; 3*rd* class, 15 *sen*; between *Kōzu* and *Yumoto*, 1*st* class, 90 *sen*; 2*nd* class, 60 *sen*; 3*rd* class, 30 *sen*.

Hakone may also be reached from two other directions, viz. from *Mishima* and *Gotemba*, both being stations on the Tōkaidō Line. (1) *Mishima* to *Odawara*, via the Hakone Pass. This is a part of the old Tōkaidō Highway, traversed so frequently by *Daimyōs* with their vast retinues on their periodical visits to *Yedo* (Tōkyō). Between Mishima and Odawara, via the Hakone Pass, the distance is 19 m.—roughly 9,5 m. up and the same down. The strictly mountainous part consists of about 17 m. of narrow, slipperly and steep pathway. After gaining the summit and descending slightly, we come to *Hakone-shuku* (Hakone-machi)—a hamlet on the shore of the beautiful Lake of Hakone (*Ashi-no-ko*, lit. 'a sea of reeds'). In feudal times there stood at this spot a barrier gate, where all the travellers passing through the Tōkaidō were examined. (2) From *Gotemba* to *Yumoto*. This road leads to the ridge of *Otome-tōge* (5 m. from Gotemba). Whence in 0,7 m. to *Sengoku-bara*, after which via the famous Miyanoshita Spa to *Yumoto*. This path is entirely outside the old Tōkaidō.

Hakone as a Popular Resort. Hakone is the name of an extensive mountainous region, which separates middle Japan from the Eight provinces of *Kwantō*. With the beautiful lake of *Ashi-no-ko*, the numerous hot springs, and splendid mountain scenery, the place fairly rivals *Nikkō* as a popular resort. If Nikkō may boast of its matchless shrines, Hakone's chief distinction lies in its plentiful spas and its charming views of *Fuji*. The hot springs are 12 in number and of different compositon, as will be shown later on. Hakone has also a beautiful climate : the annual average temperature at *Yumoto* being 58° Fahr. (min. 19° and max. 92°) and at Hakone-machi 50° Fahr. (min. 10° and max. 88°). In spring the cherry-blossoms of *Kowakidani*, in summer the luxuriant verdure of the mountains and valleys, as well as the lake Ashi-no-ko (with facilities for boating), in autumn glorious tints of manifold leaves, and in winter the superb snow scenes are all so many attractions of Hakone. To persons interested in science, Hakone offers many opportunities of investigation, with its two-fold volcanic craters, a rare species of salamander (*Sanshō-uwo*), and its varied forms of vegetation, to one moreover interested in Japanese history, Hakone will be found interesting on account of its associations with *Yoritomo, Hōjō Sōun, Hideyoshi*, etc.

Itinerary in Hakone. Undoubtedly the best plan for visitors to Hakone is to make *Miyanoshita* their headquarters. Miyanoshita is 4 m. from *Yumoto* and may be reached by *jinrikisha* in 1 hr. or on foot in 1 hr. 15 min. (there is a good road, though steep, by the *Haya-kawa*). The chief recommendation of Miyanoshita, besides its excellent baths, pretty surroundings, and salubrious atmosphere, is the hotel *Fuji-ya* (European style), which provides excellent accommodation. From here short excursions may be made, either in 'sedan chairs,' *kago, jinrikisha*, automobile, or on foot, to neighbouring places of interest. For example, a day's excursion may be tried, taking in *Kowakidani, Ashi-no-yu, Moto-Hakone* (or *Hakone-machi*), and from either one of the last-named places boat may be taken across the lake to *Umijiri*, thence coming back to Miyanoshita by way of *Ubako, Ōwakidani*, and *Kiga*.

Twelve Hot Springs of Hakone. The old-time 'Seven hot springs of Hakone' have been increased to twelve by the recent openings of five new ones:

Yumoto, situated at the foot of *Yuzaka-yama* and on the right bank of the *Haya-kawa*,—waters almost pure, with little trace of minerals.

Tōnosawa, 0,3 m. higher up from *Yumoto*, on the new road,—waters also of the same quality as Yumoto.

Miyanoshita, 3,5 m. yet higher up on the same road,—waters contain salt and soda. The place is 1,300 ft. above sea-level.

Sokokura, situated close to *Miyanoshita*,—waters also of the same quality as the above mentioned.

Dōgashima, near *Sokokura*,—waters almost pure, containing scarcely a trace of minerals.

Kowakidani, 2,000 ft. above sea-level and at the base of *De-yama*,—waters contain acid and iron.

Kiga, 1,300 ft., situated at the base of Ninotaira plateau and by the Haya-kawa,—waters contain salt and soda.

Gōra, 2,600 ft., and at the base of *Sōunjigoku*,—waters contain acid and sulphur.

Sengokubara, close to Gōra,—waters also of the same quality as the above mentioned.

Ubako, 2,877 ft., and situated at the base of *Kami-yama*,—waters contain a small quantity of salt and soda.

Ashi-no-yu, 2,760 ft., on a hill at the base of *Koma-ga-take*,—waters contain much sulphur.

Yunohana-zawa, 3,300 ft., at the foot of *Koma-ga-take*,—waters contain much sulphur.

Geography of the Hakone District.

The mountains of Hakone, together with Fuji, the Ashigara group, and other mountains in the N., such as *On-take, Asama*, and the Usui Ridge, constitute a thick wall on the W. and N. W. side of the Kwantō District (*Kwantō* means 'E. of the Barrier,' referring to Hakone where the famous barrier gate stood). These mountains send their off-shoots into the little peninsula of *Izu*, as if to make the separation between the regions E. and W. of these mountains even more secure. Among the Hakone group of hills, the better known are *Kintoki-zan, Koma-ga-take, Myōjin-ga-take*, and *Kami-yama* (4,788 ft.)—the last named being the highest peak in the group. The Hakone and Ashigara groups from a watershed from which flow rivers either towards *Sagami-nada* or the Bay of *Suruga*.

These mountains are all cone-shaped, with a blunt apex, a sure evidence that they owe their existence to volcanic eruptions. As may be seen from the plains of *Suruga* (e. g. from *Sano* on Tōkaidō Line) they have a long sloping base, with an angle of 7° to 12°. Most of these cone-shaped hills show at their summits traces of both older and more recent volcanoes, having double crater ridges. For instance, *Kintoki, Myōjō, Kurakake, Yamabushi, Mikuni, Umijiri, Nagao* and *Otome* are remnants of the older crater ridges, while *Futago, Kami-yama, Koma-ga-take* are the remaining portions from the ridges of the newer craters. Lake Hakone, where in clear weather is reflected the peerless form of *Fuji, Sengokubara* over which graze hundreds of cattles, and *Miyagino*, which is covered in summer with plantations of Indian corn, are none other than the sites of once active volcanoes. There are two rivers which drain the E. side of this watershed—the *Haya-kawa* and the *Sukumo-gawa*. The Haya-kawa has its source at *Ashi-no-ko* and, after irrigating Sengokubara, forms a rapid at *Chōshi-no-kuchi*, then, after crossing the Miyako Plain, it is enriched at *Sokokura* by the waters of the *Jakotsu-gawa*; now winding through the valleys lying between the *Myōjō* and *Sengen* hills, the Haya-kawa is finally joined at Yumoto by the *Sukumo*, to flow further on to Sagami-nada. (The new road leading from Yumoto to the other hot springs lies mostly along the course of the Haya-kawa). The Sukumo has its origin in *Kurakake-yama*, and, before it meets the Haya-kawa, is joined at *Hata-juku* by the *Taki-zaka*. On the banks of the streams grows *Yama-wasabi* (Eutrema), which is sold as a preserved article of food, and in the river are found *Sanshō-uwo*, a kind of salamander. (The old Tōkaidō road lies along the course of this stream).

Some of these old volcanic peaks will repay climbing on account of the panoramic view obtained from the top. The upper and lower peaks of *Futago-yama* ('Twin hills'), which are the southernmost of the Hakone group and close to the lake, are very pretty mamelons, though the ascent is somewhat steep. *Kami-yama* is the highest of all the peaks of Hakone, and from its summit may be enjoyed the grandest view of any in this district. *Koma-ga-take* will repay the climber by affording the completest view of Lake Hakone.

In Hakone there are many fissures or holes whence issue hot vapours or steam. Such are *Ōwakidani*, *Sōunjigoku*, *Iwō-yama* and *Yunohana-zawa*, which emit either sulphur dioxide or sulphuretted hydrogen; at *Kowakidani* the exhalation consists chiefly of steam. The emission takes place with the greatest force at Ōwakidani ('Valley of the Greater Boiling'), otherwise called *Ojigoku*, or 'the Big Hill.'

Hot Springs.

Yumoto (Inn: *Fukuzumi* on the right bank of the Haya-kawa, excellent accommodation) is the oldest known spa in Hakone, being situated at the gateway, so to speak, which leads to all the other spas. Here the old and new roads branch off to the right and left, the one along the *Sukumo-gawa*, leading finaly to Hakone-machi and Mishima, and the other (new road) along the Haya-kawa, leading to Miyanoshita and other spas. *Jinrikisha* is available over the whole of the new road.

The hot waters issue at the S. foot of *Yuzaka-yama*, whence they are conveyed in pipes to Yumoto. Specialties: toys, lacquer wares, cabinet work, marquetry works (desks, book-cases, screens, etc.).

Tono-sawa (Inns: *Shin-tamano-yu*, *Suzuki*—famous on account of its third story flat being made of *Jindai-sugi*, cryptomeria wood long buried in the earth—*Ichino-yu* and *Fukuzumi*) is reached after an ascent of 0,3 m. on the new road from Yumoto. The spa houses are situated by the two bridges spanning the Haya-kawa, at a place among the mountains where it makes an S-shaped bend. Cool and closed in by mountains, the place makes a fine summer resort. Electric Power House, situated near Tōno-sawa, supplies power to the Yokohama Electric Light Company.

Miyanoshita. Hotel: *Fujiya Hotel* is a splendid establishment—the buildings being partly in European and parlty in Japanese style (European Building: 15 special double rooms, with private bath—Tariff, American plan ¥18; 24 ordinary double rooms—Tariff, ¥13–15; 28 single rooms—Tariff, ¥ 6,50–8,00. Japanese Building: 27 single rooms fitted up in European style—Tariff, ¥ 6,50–7,00). The hotel can accommodate altogether 130 guests. *Nara-ya* is also a first-class establishment, in both Japanese and European style, with 73 rooms—Tariff, ¥ 3,50–7,00. The late Emperor once stayed here when he visited Hakone many years ago. *Ryōun-kwan*, also a good Japanese inn, boasts of possessing a bath tank where *Toyotomi Hideyoshi* frequently bathed during his siege of Odawara. (Curio shop, Nakada Shōkwai).

Miyanoshita is 4 m. from Tōnosawa, the road making many turns as it follows the course of the Haya-kawa. In 0,8 m. from Tōno-sawa we come to a cascade, *Tokiwa-no-taki*, and in 2 m. more, to *Ōhira-dai*, a level spot whence Mt. Fuji is visible, and also Miyanoshita itself, only 1 m. off across a dale. Miyanoshita is a wide, level tract or terrace in the valley of the Haya-kawa, and is 1,223 ft. above sea-level. This wide flat is surrounded on nearly all sides by mountains—*Myōjin-ga-take* and *Myōjō-ga-take* across the river to the N. E., *Koma-ga-take*, *Kamuri-ga-dake*, and *Hōrai-zan* towards the E., and a chain of hills running from the S. W. towards the E. Only in the E. is a little opening, whence the blue waters of Sagami-nada may be seen. Miyanoshita is pre-eminent throughout Hakone on account of its excellent hotel accommodation, fresh air, and convenient location for making short excursions.

Dōgashima (Inns: *Ōmi-ya*, *Yamato-ya*) is situated 0,2 m. below Miyanoshita, close to the Haya-kawa. Being in the bottom of a valley, it is very quiet and secluded. In its neighbourhood are two cascades—*Shirabe-no-taki* and *Shiraito-no-taki*.

Sokokura (Inns: *Tsuta-ya*, *Ume-ya*, *Sengoku-ya*) is practically a part of Miyanoshita. It is a cluster of houses lying on the bank of the *Jakotsu-gawa*, which pours its waters into the Haya-kawa in the form of a cascade.

Kiga (Inns: *Kame-ya, Sengoku-ya*) is situated 0,4 m. up from Miyanoshita, on the right bank of the Haya-kawa. The spa is situated on a level space, surrounded by hills on all sides, except towards the S. E. It is a very secluded spot, somewhat similar to Tōnosawa.

Miyagino is a cultivated plain extending on both sides of the Haya-kawa and reached in about 0,3 m. from Kiga. Now studded with farm-houses, it formed originally a part of a large volcano, the rest of the crater becoming filled with water and being known as the *Ashi-no-ko*. To the S. E. of the village are found many cryptomeria trunks long buried in the earth, which on account of the peculiar colouring of the wood are much prized as building material, being known as the *Jindai-sugi* or cryptomeria wood of the mythological age. Specialty: buckwheat-rolls, to be eaten with soy.

Gōra, the most recently discovered of the 12 hot springs, is situated on a level tract on a slope of *Sōun-zan* and is drained by two streams on the E. and the W. Its altitude is from 1,813 ft. to 2,322 ft. Gōra is favoured with natural advantages which should make it the very center of Hakone. It commands a wide prospect, which includes Miyanoshita and the larger part of the valley of the Haya-kawa, and also the sea beyond. The air is fresh and comparatively dry, with plenty of sunshine. Above all the mineral waters are practically inexhaustible, as they are conveyed from the stream flowing from the Ōwakidani springs. A scheme is on foot to extend as far as Gōra the electric tramway from *Kōzu*, now reaching to *Yumoto*, and large pleasure garden, with band-stand, swimming tank, club house, and recreation hall, has already been laid out. It is believed that the electric tramway will probably be completed in a few years.

Sengokubara (Inn, *Ishimura*) consists really of two springs, one lower down (1,2 m. from *Miyagino*) and the other about 0,3 m. higher up. The two springs are resorted to by the inhabitants of the neighbourhood.

Ōwakidani, or the 'Valley of the Greater Boiling,' is otherwise called Ōjigoku, or the 'Great hell,' (0,7 m. from the lower waters of Sengokubara and 1,3 m. by a round-about path from Gōra). It is a gorge full of solfataras, which from its middle part up to the top for about 0,8 m. literally reeks with sulphurous fumes. Wherever a little hole is dug—1 or 2 ft. deep—out start steam and fumes. The ground everywhere presents a light brownish colour and overlying crust is so weak and unreliable that no step is safe unless directed by a guide. There is very little vegetation. The hot mineral waters, which collect into a stream, are made somewhat lower down to form a reservoir, whence they are conveyed to Gōra and also to Sengokubara. At the head of the gorge one may obtain superb view of Fuji and other mountains, a singular contrast to the weird and desolate scene of the solfataras below.

Ubako (Inn, *Shūmei-kwan*), 0,9 m. from Ōwakidani and the innermost of the 12 baths, is situated on the S. slope of *Kamuri-ga-dake*, at an altitude of 2,877 ft. Towards the W. lie the pasture lands belonging to the village of Sengokubara, and beyond them the Ashi-no-ko and Mt. Fuji, while in the N. there looms up the hill, *Dai-ga-take*. The hot waters bubble out of rock crevices, and bath-tanks have been improvised by excavating rocks. In the neighbourhood of the tanks, fossil leaves or twigs are sometimes found.

Umijiri, at the N. end of Lake Ashi-no-ko and reached in about 1 m. from the Ubako Spa, is the outlet for Ashi-no-ko, where the Haya-kawa has its source. From Umijiri to Moto-Hakone and Hakone-machi there is a regular boat service.

Kowakidani (1 m. from Miyanoshita; Hotels: *Mikawa-ya, Kaikwa-tei*). Kowakidani is situated on a slope of *Kojigoku-yama*, and at an elevation of 2,000 ft. Opposite the spa, across the valley of the *Jakotsu-gawa*, there rise tall peaks of *Myōjō-ga-take* and *Myōjin-ga-take*. In the neighbourhood of the spa there have recently been planted 10,000 cherry-trees and a large number of maples and azaleas, so that the place is destined to be one of the most attractive places in Hakone. A little higher up (0,4 m.) the hill Kojigoku-yama is a cave which constantly emits sulphurous fumes.

Chisuji-no-taki, or the 'Waterfall of 1,000 threads,' is in the upper course of the Jakotsu-gawa, where the waters of the river dash down from innumerable crevices on a high cliff, giving the appearance of thousands of white threads hanging down from the height above.

Ashi-no-yu (4,5 m. from Miyanoshita by the new road or 2,7 m. by the old road).

Inns: *Matsuzaka-ya* (17 European rooms, besides 100 Japanese rooms); *Kinokuni-ya*.

The road winds through the valleys and round the base of a hill for about 2,5 m., until we reach a flat space called *Benten-yama*, whence a good view may be obtained of Sagami-nada, the peninsula of Misaki, and the distant hills of *Awa* and *Kazusa*, while the nearer mountains in sight are *Iwō-yama* to the left and *Futago-yama* and *Koma-ga-take* on the other side. Ashi-no-yu, a little below this elevation, is 2,760 ft. above sea-level and is delightfully cool in summer. In winter the place is well protected from the N. W. cold winds by Koma-ga-take. The only draw-backs are the occasional thick fogs of summer and the heavy snows of winter.

Yunohana-zawa (Inn, *Bōsenkaku*), about 0,6 m. N. of Ashi-no-yu and 1 m. from Kowakidani by a short cut, is situated in a valley at the S. base of Koma-ga-take. The place is at an altitude of 3,300 ft. It lies on the road leading from Ashi-no-yu to the top of Kami-yama.

Moto-Hakone (Inns: *Matsuzaka-ya* and *Sakamoto-ya*, both facing the Lake Ashi-no-ko, on the surface of which on a clear day the reflected figure of Fuji may be seen—the famous *Sakasa-Fuji*, 'inverted Fuji.' *Matsuzaka-ya* has 13 rooms fitted up in European style, as well as Japanese rooms). Moto-Hakone is a village of 40 houses and is 2,2 m. (by the new road) from Ashi-no-yu.

Moto-Hakone (lit. 'Original Hakone') was the chief village of the mountain district of Hakone, before Hakone-machi was founded in 1618 as a barrier town. Though it has since been overshadowed by the new Hakone, there is no question that the place is most picturesquely situated. Shut in on one side by a thickly-wooded hill, on the other side a charming vista opens out showing one of the finest views of Fuji, as well as its inverted image reflected in the lake, and to the left the Imperial villa on a small headland projecting into the lake.

Ashi-no-ko, or Lake Hakone as it is generally called by foreigners, has a maximum length of 3,4 m. from N. to S. and is 1,4 m. from E. to W. in its greatest width; its circumference being about 9,8 m. It is in the form of a gourd, with a narrow middle part where the promontory *Tōga-shima* protrudes. The Imperial villa, *Hakone-Rikyū*,—a building partly in Japanese style and partly in European—stands on the edge of this promontory. The scenery of the lake, if inferior to that of *Chūzenji* near Nikkō or that of *Nishi-no-umi* at the N. base of Fuji, is charming enough to attract numerous visitors in summer. There are rowing-boats for hire, as well as Japanese house-boats with boatmen, and, as already remarked, there is a regular ferry service maintained between Hakone-machi (via Moto-Hakone) and Umijiri at the N. end of the lake.

Hakone-machi (0,6 m. from Moto-Hakone; Inns: *Ishiuchi Ryokwan*, *Enshū-ya*, *Hakone Hotel*) is reached from Moto-Hakone by a road which is overshadowed by an avenue of tall cryptomerias, round the ancient branches of which twine ivy and parasitic orchids, imparting a venerable aspect to their stately hosts. At a spot about 0,2 m. from this side of the town, there are the remains of the old barrier gate, where formerly all travellers through the Tōkaidō, from the greatest town to the humblest, were examined, the custom being only abolished with the Restoration of 1868. The barrier, it will be noticed, was most strategically situated, being across a narrow pathway with a high and steep hill on one side and the lake on the other.

The villagers mostly made their living as inn-keepers till about 20 years ago, when the Hakone tunnels of the Tōkaidō Railway were opened to traffic. Since then the village, which had been never too prosperous, rapidly declined. Within recent years, however, the place has become quite a popular summer resort for both Japanese and foreigners. There are many houses to let, where Europeans bringing their servants with them may set up housekeeping. Some of the inns, like the Hakone Hotel, have rooms fitted up with beds and furnish European food.

Summary.

Spa	Altitude above sea-level in ft.	Population	Number of houses	Number of baths	Number of inns	Number of visitors in 1919	Their total stays in days
Yumoto and Tōnosawa	150	1,853	309	6	10	26,528	60,395
Miyanoshita	1,300	917	163	13	10	16,324	56,345
Kiga	1,300	70	13	3	2	1,297	1,947
Ashi-no-yu	2,760	81	9	2	2	5,984	25,650
Gōra	2,600	8	2	1	1	190	572
Ubako	2,870	13	1	1	1	1,708	10,903
Yunohana-zawa	3,300	7	1	1	1	181	848

Yugawara, situated in a quiet, pretty spot by the *Fujiki-gawa*, is 350 ft. above the sea-level and is 7,2 m. from Hakone-machi (the path lying across the *Jikkoku-tōge*). It is walled in on three sides by mountains—on the N. by the Hakone hills, on the S. W. by *Higane-yama* (Jikkoku-tōge) and *Izusan*; being open only on the S. E. towards Sagami-nada.

Odawara-Atami Light Railway (15,8 m.) lies mostly along the coast, on rocky cliffs skirting the group of Hakone hills, excepting at one place—*Yoshihama*—where the tracks lie close to a sandy beach. All along the route there is a splendid view of the sea with its numerous isles. Nine trains run daily from each end, between 6 a.m. and 3 p.m.; the time required to cover the entire distance being 2,5 hrs., and the fare, *2nd* class ¥ 1,20, *3rd* class 70 *sen* (no *1st* class cars).

Yugawara (also called *Mongawa*) is a station of the light railway (10,8 m. from *Odawara*, in 2 hrs.; fare *2nd* class 90 *sen*), 1,9 m. from the hot springs of Yugawara; from the station to the spa *jinrikisha* (fare 20 *sen*), also *basha* (fare 20 *sen*, for exclusive hire 80 *sen*) available. Pop. 500; 2 public baths; 1 doctor. Number of visitors: **6,500**, the total stays being **195,000** days (1909). Inns: *Nakanishi-ya*, *Ueno-ya*, etc.

SHIZUOKA-KEN

Izusan (14,4 m. from Odawara, by light railway in 2 hrs. 20 min.; fare, *2nd* class ¥ 1,17).

Izusan spa, near the station, is situated on a rocky cliff facing the sea, inns being built close to its edge. It is reached from the station by a steep path down. Walled in on three sides by hills and rocks, it is open towards the sea, with a full view of Vries Island and the headland of *Awa*. Hot water bubbles up from rocky crevices with violent force, 42 ft. above the sea. The water is called *Hashiri-yu* ("Running Hot Water"). Pop. 1,370. The springs are said to be good for brains. There are 8 inns, each provided with its own baths. In *Sagami-ya*, the best inn in Izusan, is a large swimming bath, 60 ft. in length and 18 ft. in width. Hot water massage by "*Yudaki*" (hot waterfall) can be taken in almost all inns. Number of visitors: **2,768**, the total stays being **19,363** days (1909). Inns: *Sagami-ya*, *Enoshima-ya*, etc.

Atami (15,8 m. from Odawara, in 2 hrs. 30 min.; Inns: *Atami Hotel* or *Higuchi*, with both *see Plate 34* European and Japanese accommodation, *Fuji-ya*, *Suzuki*, *Sagami-ya*) is a fashionable watering-place, with a resident population of 5,866. Surrounded by hills on three sides and open towards the sea on the S. E., it is warm in winter (lowest temperature 35° Fahr.) and cool in summer (highest temperature 85° Fahr.). Its beach offers excellent sea-bathing, and the scenery is charming. The prospect takes in towards the left *Izusan* and *Manazuru-ga-saki* Promontories, and yet further off the mountains of Awa, while towards the right stand out *Uwomi-ga-saki* Promontory and Vries Island smoking in the distance, with the pretty little islet of *Hatsu-shima* in between. Atami has many attractive walks, either by the seashore or on the hillsides.

The hot waters, which contain a large quantity of salt, have their source in a powerful geyser. It is called *Ō-yu*, or the 'Great Hot Water.' The geyser breaks out once in about 4 hrs., when it shoots forth boiling water and steam with great force and noise. Originally the jet shot straight upward, but it is now partially smothered by placing a big stone over it. Sometimes the geyser continues active for more than 12 hrs., such cases occurring several times a year. The waters are transparent, with a temperature of 209–220° Fahr., and are carried through pipes to the various bath-houses. Near the geyser is an inhalation house (*Kyūki-kwan*), into which the steam from the geyser is conveyed for the benefit of patients suffering from bronchial and lung troubles. There are doctors connected with the house.

Formerly there were in Atami seven springs in all, but the number of the springs has considerably increased (about 20), since the people has begun to bore the ground for finding hot springs, in consequence of which the world-famous intermittent spring has never been in full play and the discharge of water decreased remarkably. The springs of Atami are believed to be efficacious especially for the treatment of rhematism and eye diseases.

Geologically *Atami* forms part of an extinct crater, the hills behind it—*Iwato-zan*, *Higane-yama*, *Karuizawa-tōge*, *Takichi-yama*—forming one-half of the old crater wall, while the other half has been submerged by the sea. The geyser is a faint reminder of the crater's former activity.

Atami Park is situated on a hillside 0,6 m. N. of the town. The Park contains more than 3,000 *ume*-trees, which blossom early in January, about two months before the flower season in Tōkyō, also peach-trees, and several splendid old pines and cypresses (*hinoki*), with a pretty, silvery stream winding through the *ume*-grove.

Higane-yama, popularly known as *Jikkoku-tōge*, is a high ridge lying on the path between Hakone-machi and Atami. The ridge, which is 2,684 ft. high, is reached after a steep ascent of 3,6 m. from Atami. The upper portions are bare of trees, being covered only by low shrubs. The view from the top is superb, embracing all the surrounding provinces, as its name of Jikkoku-tōge (lit. 'Ten Province Pass') indicates. On the summit is a stone monument giving the points of the compass. The first object to strike the eye is Fuji, which bursts upon one's gaze as one gets to the top, and is followed by other well-known views of the surrounding provinces—mountains of the Ashigara and Hakone groups, of Kai and Shinano, the *Fuji-kawa*, the classical beaches of *Miho-no-matsubara*, *Tago-no-ura*, and *Kiyomi-gata*, the towns of *Numazu* and *Mishima*, the Izu hills of Izu Province, such as *Amagi* and *Managi*, the town of Atami and its neighbouring sights, the islands of *Hatsu-shima*, *Ōshima* (Vries Is.), *To-shima*, *Nii-jima*, etc., the mountains of Awa and Kazusa, etc.

Number of visitors: 23,638, the total stays being 174,306 days (1909).

Itō (13 m. S. from Atami). There is steamship service which connects Itō with Atami, Kōzu, Odawara, and Tōkyō (*Reigan-jima*). A road leads from Itō to Shūzenji (12 m.), *jinrikisha* and omnibuses available. The spa lies on the E. coast of Izu Peninsula, and is surrounded on three sides by hills, a branch range of *Amagi-san* and *Hakone-yama*, while, it is open to the sea on the E. A small stream of the *Matsu-kawa* runs through the spa town towards the E. It is divided into two parts, *Matsubara* and *Kusumi*, separated by the Matsu-kawa. The place is protected by the hills from the N. W. wind, which prevails in winter in this region, and warm and fresh sea breezes make it one of the best winter resorts with a mild climate. The island of *Hatsu-shima* lying near the coast and the mountain range of Awa and Kazusa far beyond present a very fine view. It is noticeable that the spa stands on a vein of hot springs. Hot springs are found almost everywhere. But those which are now open to public use, such as *Shishido*-Onsen, *Deki-yu*, *Wada-Onsen*, *Shin-Onsen*, *Yuda-Onsen*, *Me-no-yu*, etc., have been known to people from ancient times and are believed to be most efficacious, especially *Deki-yu* and *Shin-Onsen* for diseases of the skin, wounds, and disorders of the female genital organs, and *Wada-Onsen* for rheumatism.

In the whole town of Itō there are at present more than 300 baths, of which 10 are for public use; 33 inns with private baths. Close by *Shin-yu* is a special bath for oxen and horses. In the Era of the Tokugawa Shōgunate government the water from the spring *Deki-yu* was transported in wooden barrels to Tōkyō for bath. The spa is also an excellent place for sea-bathing in summer. Pop. 8,563 (1,379 households). Lake "*Yoshida-no-Ōike*" with beautiful scenery, is near Yoshida-mura (S. of Itō). The lake is stocked with carps and *funa* and a great place for fishing. Number of visitors: 11,365, the total stays being 79,568 days (1909). Inns: *Denko-en*, *Tōkyō-kwan*, *Masu-ya*.

Shuzenji (3,1 m. from Ōhito; *jinrikisha* fare 25 *sen*; omnibus 15 *sen*) claims with Atami the honour of being the most popular spas in Izu. A temple founded here in the Daidō Era (806–9) by Kūkai or Kōbō-Daishi has given rise to the name of this place. It is bounded on the N. and S. by mountain ranges, which leave a narrow strip of land extending from E. to W., watered by the *Katsura-gawa* which joins the *Kano-gawa*. Several hot springs issue from the bed of the Katsura, and of these the one called *Dokko* is left to the common use of the public from ancient times, and is most noted for its remarkable efficacy for rheumatism. The spring "*Dokko-no-yu*" is said to have been discovered in the Era of Daidō (806–10) by the famous priest Kūkai. Of the six other public baths the most noted are *Sugi-no-yu* or "Cryptomeria hot spring," *Ishi-yu* or "Stone hot spring," *Chigo-no-yu* or "Child hot spring," and *Ayame-no-yu* or "Iris hot spring." The spa lies at an altitude of 250 ft. above the sea. Pop. 2,250; 355 houses; 14 hot springs. Number of visitors: 24,969, the total stays being 111,414 days (1909). Inns: *Arai*, *Kiku-ya*, *Asaba*, *Yomo-rō*, etc.

Asahi Waterfall is found to the W. of Shuzenji and measures over 300 ft. high and 15 ft. wide, the water being divided into two parts in the middle, and beautifully reflecting the morning light. Its water flows into the Kano-gawa.

Summary.

Spa	For the year, 1909	Spring (March, Apr., May)	Summer (June, July, Aug.)	Autumn (Sept., Oct., Nov.)	Winter (Dec., Jan., Feb.)	Total
Izusan	Number of visitors	*973*	*616*	*619*	*560*	*2,768*
	Their total stays (in days)	6,813	4,429	4,355	3,786	19,362
Atami	Number of visitors	*6,804*	*3,986*	*4,434*	*8,414*	*23,638*
	Their total stays (in days)	54,631	27,904	32,867	58,904	174,306
Shuzenji	Number of visitors	*9,104*	*6,405*	*5,673*	*3,787*	*24,969*
	Their total stays (in days)	38,959	34,273	20,787	17,402	111,411

Nagaoka. 0,6 m. W. from the *Nanjō* station on the Sunzu Electric Tramway which leads from *Mishima* to *Ōhito* (10,6 m. in 1 hr.); *jinrikisha* (fare, 20 *sen*) and omnibuses (fare, 15 *sen*) available. Pop. 358. The springs were found in 1907, and are said to be efficacious for rheumatism and eczema. Mt. Fuji forms a sublime view from the spa. On account of the mild climate of this place, a number of wealthy people have built villas here. 1 public bath, 14 inns, 1 doctor. Number of visitors: 8,229, the total stays being 27,966 days (1909). Inn: *Yamato-kwan.*

Kona, 0,5 m. W. from the *Nanjō* station, has 5 baths, of which 1 is for public use. The water is said to be efficacious for scald. Pop. 586. Number of visitors: 7,331, the total stays being 12,757 days (1909).

Hatage. 2 m. W. from the *Daiba* station on the Sunzu Electric Tramway; *jinrikisha* (fare, 35 *sen*) and omnibuses (fare, 12 *sen*) available. Pop. 360. 5 inns with private baths. There are 8 hot springs in the spa, efficacious for diseases of the skin and venerial diseases. Number of visitors: 1,514, the total stays being 28,382 days (1909).

Funabara. 7 m. S. W. from *Ōhito, jinrikisha* (fare, 56 *sen*) and omnibuses (fare, 30 *sen*) available. The spa is 7,5 m. S. W. from Shuzenji, 1,3 m. N. from *Yoshina*, and 7 m. E. from *Tohi.* It is penetrated by a stream called *Funabara-gawa.* It is a quiet summer retreat and the cold is not very intense even in winter. Number of visitors: 1,630, the total stays being 6,160 days (1909). Inn: *Shūfū-kwan* (*Suzuki*). The private bath of the inn is called *Kōgyoku-yu* and believed to be efficacious for skin diseases, haemorrhoids, gonorrhoea, uterus diseases, dyspepsia, etc.

Yoshina. 8 m. S. from Ōhito, *jinrikisha* (fare, 56 *sen*) and omnibuses (fare, 32 *sen*) available. The place lies on the bank of the *Yoshina-gawa* at the N. foot of Amagi-san, at an altitude of 360 ft. above the sea. The spa is shut in on two sides by mountains densely wooded with pines and cryptomeria. The springs were found in the Era of Eihō (1081–84) and said to be efficacious for rheumatism, uterus diseases, haemorrhoids, dyspepsia, etc. Pop. 240. Indeed it is a quiet spa. Number of visitors: 2,345, the total stays being 14,319 days (1909). Inn: *Tōfu-ya.*

Mt. Amagi, 4,981 ft. high, forms the backbone of the peninsula, being part of the Fuji volcanic chain. The whole mountain extends for 14,6 m. from S. to N. and 2,4 m. from E. to W. and its summit is 7,3 m. uphill from Yugashima. It is densely wooded and partly an Imperial game preserve. The southern foot of Amagi-san is also rich in hot springs.

Yugashima is found about 7,3 m. to the S. of Shuzenji, sheltered on the S. by the range of Amagi. The inns with baths stand close by the banks of the river *Kano-gawa.* The spa (625 ft. above the sea-level) is a quiet summer resort in Izu Province. 7 springs, 2 public baths, 1 doctor. Pop. 1,630. Number of visitors: 2,732, the total stays being 6,493 days (1909). Inns: *Yumoto-kwan, Ochiai-rō.*

The road from here to Shimoda Port at the southernmost extremity of the peninsula, about 24,4 m., leads over the Amagi Pass, but is negotiable by *jinrikisha* or omnibuses.

Yugano (26,3 m. S. from Ōhito) lies at the S. foot of Amagi-san on a highway leading to Shimoda (sea-port), and on the bank of the *Kawazu-gawa.* The water is said to be efficacious for eye diseases. Pop. 340. Number of visitors: 50, the total stays being 106 days (1910).

Konabe. Near Yugano there is another hot spring called Konabe, with 205 inhabitants, 1 public bath, and 2 inns. The water is believed to be efficacious for diseases of the skin, swellings and wounds.

Yatsu (30 m. S. from Ōhito and 9,3 m. N. from Shimoda) stands on the E. coast of the peninsula, facing the stream *Kawazu-gawa.* Pop. 335. 1 public bath. 2 inns. Efficacious for syphilis, haemorrhoids, uterus diseases, eye diseases and dyspepsia. Number of visitors: 176, the total stays being 344 days (1910).

Rendaiji. 2,3 m. N. from Shimoda, *jinrikisha* available. The place, lying on the bank of the *Inōzawa-gawa,* is bounded on the S. and N. by hills and situated along a highway leading to Shimoda. 2 public baths. 6 inns with private baths. Efficacious for swellings, diseases of the skin, uterus diseases, syphilis, rheumatism, etc. Number of visitors: 1,852, the total stays being 2,369 days (1909).

Kōchi. 2,5 m. N. from Shimoda by the highway of Shimoda-kaidō. The place is penetrated by the *Inōzawa-gawa.* The spring was found in 1839. The efficacy of the water is said to be the same as that of Rendaiji. There are 132 houses and 4 inns in the hamlet. Number of visitors: 431, the total stays being 468 days (1909).

Shimoda has a hot spring called *Akama-Kōsen* near the sea coast. It is 6–7 ft. above the sea-level and close to the Inōzawa-gawa.

Shimogamo. 7,5 m. S. W. from Shimoda, *jinrikisha* available. From the bank of the *Aono-gawa* issue several hot springs, the water being all alkaline common salt springs. Efficacious for swellings and uterus diseases. Pop. 2,834. 5 inns. Number of visitors: 4,030, the total stays being 4,093 days (1909).

Tohi. 20 m. S. W. from Numazu (in 2 hrs. by steam-boat, fare, 25 *sen*). The place (30 ft. above the sea) lies on the W. coast of Izu Province, facing Suruga Bay. Pop. 3,627. *Mt. Fuji* and *Miho-no-matsubara* are visible from the spa. 3 public baths. 11 inns. 2 doctors. The water is said to be efficacious for rheumatism, dyspepsia, diarrhoea, catarrhs of intestines, disorders of the female genital organs, eczema, etc. Number of visitors: 17,148 (1913). Inns: *Asaka*, *Meiji-kwan*.

YAMANASHI-KEN

Yumura, 0,8 m. S. from *Kōfu* (80,3 m. from *Iidamachi*, in 6 hrs. 13 min.), lies on a path leading to *Mitake*, on a flat ground at the foot of *Yumura-yama*. Pop. 200. The springs are said to have been found in 809 by Daigaku Zenshi. On account of easy access from Kōfu, the spa is mostly patronized by its citizens. Number of visitors: 14,088 (1909).

Masutomi. 12,8 m. N. from *Nirazaki* station (88,3 m. from Iidamachi, in 6 hrs. 52 min.) on the Central Main Line (Iidamachi–Nagoya), and 15,5 m. from *Hinoharu* station (7 hrs. 39 min.). The place is 23,5 m. distant from Kōfu. There are two routes to reach the village of *Masutomi*, where are cold springs of the strongest radio-activity in Japan.

(a). Starting from Nirazaki station and going N. by a highway, which leads to Iwamurada near Komoro (Shinano Province) along the valley of the *Shio-kawa*, we reach *Mamyōda* via *Shimo-jō*, *Naka-jō*, and *Odagawa* (*jinrikisha* available as far as Mamyōda); from Mamyōda the way diverges into two, the left one leading to *Wakamiko* (Pop. 2,818) and the right to *Kami-kandori* via *Fujita*. Proceeding farther up the valley of the Shio-kawa, with the two mountains *Kana-ga-dake* (5,544 ft.) and *Kaya-ga-dake* (5,874 ft.) on the right, we come to *Higashi-muki*.

(b). One who starts from *Hinoharu* station goes at first to Wakamiko and then across the *Sudama-gawa* going N. E. the road meets with the route (a) near *Higashi-muki*.

A small distance to the hamlet the way ascends by degrees, the banks of the Shio-kawa becoming higher and steeper. Here hills stand direct from the brinks of the stream on both the sides, agitated water forming abysses and cascades here and there, while old pine-trees grown on quaint-shaped rocks add to the charms of the sight. The abysses are called "*Sen-ga-fuchi*" or 'one thousand abysses.' *see Plate 35, fig. 4* A little up the stream, there is a poor bathing-place "*Azuma-Onsen*" at the foot of a rocky and precipitous hill. The way now leads across the stream to *Negoya*. The two big *keyaki*-trees (Zelkova acuminata), which stand on the ground of *Negoya-jinja* (Shintō shrine), are said to be more than one thousand years old. A little farther we cross again the Shio-kawa and soon come to a small hamlet called *Taira*.

After passing the place we descend to the stream, on which stands the village of *Egusa* (Pop. 2,423). From Egusa we must climb *Torii-zaka*, one of the steepest passes in Kai Province, the ascent being about 0,8 m. A good example of the erosion of rocks by water can be seen from the village on the S. slope of the hill, which may interest geologists. Though the ascent is not more than one mile, it is indeed a laborious work, the path being very steep and stony. When we reach the top, we can get a picturesque view over the valley of the Shio-kawa, the hamlet *Hishi* lying below on its bank. The *Hishi-jinja*, one of the places of historical interest in the vicinity, stands close by the stream.

Passing through the hamlet, and turning right, we begin again to climb over "*Nagasaka-tōge*" or 'long pass,' the ascent being longer than over Torii-tōge, but not so steep. From the top of the pass a splendid, panoramic view of the surrounding mountains can be had—*Kimbu-san* (8,647 ft.), *Mizugaki-yama*, a branch peak of the Kimbu-san Range on the N. E., and *Koma-ga-dake* (9,900 ft.) of Kai Province on the S. W.

Coming down the pass, the road leads to a hill with two hamlets at its foot. The one lying on the S. side is called "*Hinata*" meaning 'sunshine,' and the other on the N. side "*Hikage*" meaning 'shade.' In front of the latter hamlet flows a small stream called "*Hontani-gawa*," which is an upper course of the Shio-kawa. A small hamlet *Oshiba-mura* with a dozen houses, lying on the opposite side of the stream forms an entrance to the cold springs of *Masutomi*. While crossing the bridge, we see gas rising from the bed of the stream, and at Ōshiba-mura we come across several springs for the first time. One spring, issuing from the hill-side near Ōshiba-mura, is called *Ginsen-tō* or "Silver Spring," the water being carbonated and calcareous. The bath-house, having been destroyed, is now under construction. After passing through an extensive region belonging to the paleozoic system, our eyes are greeted by granite rocks here.

About 0,4 m. up the stream there is on the right bank another hamlet with some 30 households, called *Higashi-obi*. It is a poor mountain hamlet, most of whose inhabitants are farmers and some miners for rock crystals or tungsten at the foot of Kimbu-san. At a little distance from the hamlet, is found a tract of land, which is famous for a large number of cold springs of strong radio-activity. *see Plate 10, fig. 2 and 4* These springs, issuing from hill-sides, gorges, and the bed of the stream, are equally located on a granite formation, not very distant from one another, and the water contains as its main constituents common salt and bicarbonates of the alkaline-earth metals, impregnated with a large amount of carbonic acid gas. The water is moreover, endowed with strong radio-activity. The water of various sources, which shows strong radio-activity, is of low temperature, so that it must be previously heated for bath. *Kinsen-tō* or "Gold Spring" seems to have been known to people for a long time and is used for bath, on account of its comparatively higher temperature (33° C.), but the water shows the weakest radio-activity of all the springs in the neighbourhood. This is, however, only one spring used for bath, though its equipments are very poor, while others remain even now in a state of *laissez-faire*.

Several springs produce a considerable quantity of gas, rich with radium emanation. Both water and gas can undoubtedly be utilized with good results for medical purposes, internally or externally, but no arrangement has yet been made for that end. The place is delightfully situated amidst scenic surroundings. The upper course of the Hontani-gawa is a rival in the beauty of natural *see Plate 35, fig. 2 and 3* scenery with *Mitake* of Kai province. The scenery consists in densely wooded peaks, fantastically shaped rocks, narrow ravines, and blue meandering streams, all these intermingled with trees. Rhododendrons in late spring and tinged foliage in autumn are also attractive.

Mt. Kimbu is noted for its crystals and scheelite. There is also the site of an old gold mine, carried on by *Takeda Shingen*. On the valley, into which the spring water flows, near *Kinsen-tō*, *see Plate 2, fig. 1* leaves of some trees are covered with mineral sinter. The water is barrelled here and conveyed on horse-back to Hinoharu station to be again sent to Tōkyō. In the N. of the Hontani-gawa there is another branch called *Kamase-gawa* of the Shiokawa, nearly paralled with the former. This stream supplies water to a group of hamlets, such as *Shiokawa*, *Gōdo*, *Mikado*, *Wada*, and *Kuromori*, the last lying on the uppermost bank of the stream. This group is generally called "*Nishi-obi*" and *see Plate 35, fig. 1* possesses a large number of cold springs producing carbonic acid gas on the bank of the Kamase-gawa. The surrounding scenery is also attractive. Going farther up the valley, we come to a pasture called "*Matsudaira Bokujō*," from which *Mizugaki-yama* with ragged peaks is in full view. The ascent of this mountain is very hard, but a trip even to its foot does not fail to interest one. On account of their inconvenient location, Masutomi cold springs are still left to their own devices. The springs were first examined a few years ago for their radio-activity by M. Minagawa, an expert of Yamanashi-ken, but it was Dr. Ishizu, an expert of the Tōkyō Imperial Hygienic Laboratory, that determined at their sources the quantity of radium emanation contained in the water and brought the fact to public notice.

Kurobira is a watering-place, situated on the N. slope of Mitake, about 14 m. distant from Kōfu. The springs are found in the 3rd year of Genroku (1619) by a Shintō priest of *Mitake-jinja*. Though the baths are poor, the road leading from Kōfu via Mitake is beautiful and worth travelling.

Mitake is noted for the best natural scenery in the neighbourhood of Kōfu, from which to *Kin-ō-jinja* on the *Shimmichi* ('New Road') is 11 m. To the foot of *Wada-tōge*, about 1,4 m., *jinrikisha* are available. After reaching the foot of Wada-tōge, an ascent of about a mile brings us to the top, from which a fine view can be obtained. On descending the pass we come to a cultivated plain, then proceed for about 2,4 m. round the foot of *Takasago-yama*, and find ourselves on the bank of the *Ara-kawa*, where the grove of *Tenjin-no-mori* stands. Here begins sight No. 1 of the beauties of Mitake. From the grove we follow the valley of the mountain stream for about 5 m. N. The foaming torrent as it dashes against the fantastic rocks that intercept the current, the cliffs rising here and there on the banks, the waterfalls tumbling down by the road-sides, all combine to attract the attention of those who are succeptible to what is beautiful and sublime.

At times the path leaves the valley and the sound of the dashing torrent is heard far below our feet. The grove at this place is called *Tenko-rin* ('Heaven's Drum Grove'), and leaving the grove we come to an open place, but soon rejoin the valley and find ourselves confronted with a column-like gigantic rock rising perpendicularly several hundred feet. This is called *Kakuen-hō* and is considered one of the best sights in Mitake. Near this column there is the *Kinkei-kwan Hotel*, which occupies a site of great scenic beauty. Still climbing upward, we come to statue erected in memory of the famous road-maker, and near it stands a stone monument with an inscription giving the history of this singular exploit. Continuing the ascent a stone gate is met with, and at a short distance from it the bridge *Shōsen* spans the mountain torrent. The views commanded from the bridge are really romantic. Then comes the *Senga-daki* cataract, the most interesting of all in Mitake, and next the second stone gate, after which we reach the somewhat open space occupied by the village of *Ikari*, where the road-maker lived and died, and at last, after a mile's progress, the Shintō shrine of *Kin-ō* is reached, 10 m. from Kōfu, quite impressive in its structure and solemn surroundings. The best time to visit Mitake is in autumn, when the valley is ablaze with the crimson tints of maples and other leaves.

Mt. Kimbu-san can be climbed from this place. The crystals obtained from the mountain are noted for their quality, and their yearly output amounts to Y 100,000, then come those obtained from *Takemori-yama*. Tungusten is extracted from the crystal-bearing veins. The crystal produced in Kai are purple, black, *mizuiri* (containing water), *kusairi* (containing leaves), and brown, and these are worked into balls, rosaries, rings, stamp stones, stationaiy articles, hair-ornaments for women, and other decorative wares.

Kami-Sekisuiji (2 m. N. from Kōfu) lies on the slope of *Sekisuiji-yama*, on which extends a dense state-owned forests, commanding a fine view over the plain of Kōfu and *Mt. Fuji* beyond. The spring is said to have been found in the Tenshō Era (1573–92). Number of visitors: 350, the total stays being 9,450 days (1909).

Shimobe (22 m. S. from Kōfu, and 10 m. S. from *Kajikazawa*) lies on the E. bank of the *Fuji-kawa*, about 9 m. lower than Kajikazawa, at the foot of *Amaga-take*. Near by the spa runs a small ravine, from whose bank the cold springs gush out. The baths are said to have been used by Takeda Shingen for the treatment of wounds. People believe that the water is efficacious especially for bruises, wounds, and itches. Number of visitors: 4,979, the total stays being 26,248 days (1909).

NAGANO-KEN

Suwa (121,7 m. to Kami-Suwa from *Iidamachi*, in 11 hrs. 5 min.; 130,9 m. from *Nagoya*; 70 m. from *Nagano*). The two Suwas (*Kami-Suwa* and *Shimo-Suwa*) are almost continuous along the shores of the Lake Suwa, and seem to lie on subterranean beds of hot springs, as hot water issues wherever a bore is made. In the depth of winter the lake is alive with skaters and a grand meet is held at the Suwas. Pop.: 13,405 at Kami-Suwa; 6,630 at Shimo-Suwa. Takashima Castle Grounds in Kami-Suwa mark the site where in the feudal days the Daimyō named Suwa resided; now the grounds constitute a public park.

Lake Suwa-ko is at the greatest elevation of all the largel akes in Japan, it being 2,600 ft. above the sea. In circumference it is about 10 m. and has lofty ridges surrounding it. At its N. W. end is an outlet, which forms the headwaters of the *Tenryū-gawa*. From another corner the lovely shape of *Fuji* is seen far away rising above the shoulder of the nearer ranges. The sight of the lake from the top of *Shiojiri-tōge* is extremely pretty. The lake produces carp, gibel, eel, and other fresh-water fishes.

Geologists say that the lake is gradually silting up, and that the old castle grounds at Kami-Suwa, which are now found at an considerable distance from the shore, were formerly at the edge of the lake. The appearance of cracks on the surface of the frozen lake is generally regarded as a sign that the ice can be walked upon with safety, this phenomenon arising from the fact that the increase of volume of the water when throughly frozen causes the central part to rise up and finally to crack. The lake does not appear to be of volcanic origin.

Shrines of Kami-Suwa and Shimo-Suwa. The one at Kami-Suwa is called *Ichi-no-miya* and is situated in grounds rendered very impressive by patriarchal cryptomerias; it is noted also for its beautiful architecture. The shrine at Shimo-Suwa is somewhat inferior in general appearance to the other. 10 public baths, 27 doctors, 1 hospital (Kami-Suwa). Number of visitors: 64,370, the total stays being 126,910 days (1909). Inns: *Botan-ya, Nunohan, Suwa Hotel, Kogetsu-kwan.*

4 public baths (Shimo-Suwa). Number of visitors: 9,994, the total stays being 23,601 days (1909). Inns: *Kame-ya, Maru-ya.*

Meteorological Observations.

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation
	Mean				Absolute					
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total
				For the year, 1911.						
January	-2,6	2,6	-7,9	10,5	9,0	-14,7	82	—	—	70,8
February	0,9	5,8	-4,0	9,8	14,3	-10,1	60	—	—	39,5
March	4,6	9,7	-0,5	10,2	19,9	-11,4	69	—	—	87,5
April	9,9	15,5	4,3	11,2	25,5	-5,8	63	—	—	199,2
May	13,8	20,4	7,1	13,2	26,4	0,0	57	243,9	56	61,8
June	19,3	24,2	14,5	9,7	29,4	10,5	68	174,9	41	361,2
July	22,4	27,0	17,9	9,1	33,5	13,4	71	179,7	41	231,3
August	22,8	27,1	18,5	8,6	30,9	15,9	71	191,4	46	306,7
September	20,4	24,7	16,2	8,6	28,4	8,5	73	161,6	43	160,3
October	12,0	16,6	7,5	9,1	24,1	1,8	71	159,2	46	71,4
November	8,5	13,2	3,8	9,4	18,5	-2,0	68	177,6	58	68,6
December	1,1	5,8	-3,6	9,4	1,33	-8,6	69	167,8	56	—
				For the year, 1912.						
January	-1,8	3,3	-6,8	10,1	7,4	-15,6	73	190,9	62	50,1
April	10,3	16,6	3,9	12,7	27,9	-5,4	51	234,0	60	123,0
May	14,3	20,1	8,6	11,4	28,4	2,5	57	229,3	53	91,0
June	18,2	23,4	13,0	10,4	27,3	6,9	65	196,6	45	110,8
July	22,3	26,7	18,0	8,7	31,9	12,6	68	109,2	38	235,9
August	23,8	29,3	18,3	11,0	32,5	15,0	66	246,6	60	119,5
September	17,9	21,8	13,9	7,8	30,5	8,0	74	118,7	32	241.7
				Forthe year, 1913.						
January	-4,8	1,9	-11,6	13,5	7,2	-20,6	83	191,3	62	26,1
February	-1,8	4,2	-7,7	11,9	10,4	-17,4	72	193,8	64	38,0
March	1,6	7,6	-4,3	11,9	19,8	-12,0	57	233,7	63	43,5
April	11,0	16,7	5,3	11,4	27,2	-2,0	61	177,6	45	107,2
May	13,2	19,3	7,3	12,1	26,0	0,3	59	225,4	52	162,1
June	18,0	22,9	13,0	9,9	28,1	6,3	66	169,0	39	167,2
July	22,5	27,9	17,1	10,8	32,6	11,6	66	211,6	48	129,6
August	22,5	27,8	17,1	10,7	32,1	11,2	65	204,1	49	117,0
September	17,3	22,3	12,4	9,9	26,2	6,1	66	162,1	44	73,6
October	13,0	17,8	8,2	9,6	22,7	2,3	69	162,7	47	109,5
November	6,1	11,6	0,7	10,9	16,9	-3,9	69	174,5	57	99,3
December	1,5	6,3	-3,2	9,5	14,1	-14,1	68	170,6	57	51,8
				For the year, 1914.						
January	0,1	5,2	-5,0	10,2	13,5	-10,0	63	198,1	61	32,9
February	-0,6	4,8	-6,0	10,8	10,1	-13,4	67	179,0	59	45,9
March	5,1	10,3	0,0	10,3	17,3	-6,4	68	178,1	48	113,0
April	8,4	14,8	2,0	12,8	25,5	-6,7	54	214,4	55	48,8
May	15,2	20,7	9,7	11,0	25,8	0,3	62	170,3	39	229,5

Asama (2,4 m. to the N. E. of *Matsumoto*) is a popular resort (1,600 ft. above the sea) for Matsumoto residents. Here hot water issues everywhere, but great inconvenience is occasioned by the scanty of ordinary water. The place is provided with many inns where comfortable accommodation may be obtained. *Hino-ya* and *Nishi Ishikawa-ya* are among the first-rate establishments. Pop. 1,600. Number of visitors: 35,795, the total stays being 73,136 days (1909).

Meteorological Observations.

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation
	Mean				Absolute					
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total
For the year, 1911.										
January	-2,3	2,5	-7,1	9,6	8,7	-13.5	77	140,0	—	54 5
February	1,1	6,6	-4.4	11,1	15,5	-10,5	73	179,8	59	34,4
March	4.8	10.4	-0,8	11,2	20,5	-13,2	67	172,2	44	89,4
April	9,9	16.3	3.5	12,8	25 0	-5.5	62	195,5	50	172,6
May	14.1	21,7	6,5	15.3	27,0	-2,0	59	253,8	58	—
June	19 8	26,0	13,7	12,3	31,0	9,6	79	170.0	39	345,4
July	22,9	28,1	17.7	10,4	33,9	13.0	70	178,8	40	243.9
August	23.6	28,8	18,5	10.3	31,8	15,8	74	195,1	47	174,0
September	21,3	26,5	16,1	10,4	31,5	8,6	74	162,3	44	123,1
October	12,4	17,6	7,2	10,4	25,5	1,5	69	150,7	43	71,1
November	9.1	14,0	4,1	9,9	20,4	-3,4	64	153,1	50	68,1
December	1.4	6,2	-3 4	9,6	12,9	-8,8	77	142,9	48	31,0
For the year, 1912.										
January	-1,9	3,3	-7,0	10,4	8,5	-15,9	61	157.1	51	33,0
April	11,0	17.9	4,1	13,8	29.0	-3,4	57	227,8	58	69,6
May	14,5	21,3	7,8	13.5	29,5	1,0	62	230,2	53	72,3
June	11,5	24,5	13,0	11,5	29,0	4.7	67	178,1	41	138.5
July	23,3	28,1	18.5	9,6	32,6	12,4	68	170,0	38	142,1
August	24,2	29,8	18,5	11,2	32,6	14.0	77	223,4	54	160,6
September	—	—	—	—	—	—	—	103,2	28	—
For the year, 1913.										
January	-4,9	1,0	-10,9	11,9	5.9	-18,7	74	146,8	47	40,3
February	-1,2	4,4	-6,9	11,3	13,4	-17,8	64	156,6	51	32,0
March	2,0	8,4	-4,4	12,7	21.4	-12,3	51	196,5	53	15,8
April	10,9	18,0	3.8	14,1	28,5	-9,9	58	159,1	40	101,5
May	13,7	20,6	6,8	13,7	26,6	0,1	59	206,3	47	121.4
June	18,7	23,9	13,4	10,5	28,5	6,1	63	161,6	37	167,2
July	23,0	28,5	17,5	11,0	33,0	11,9	63	192,8	47	67,7
August	22,9	28,2	17,5	10,7	33.4	11,9	67	187,8	45	147,7
September	17,4	22,7	12,2	10,5	26,2	4,5	70	165,8	45	52,4
October	13,0	18,3	7,6	10,7	22,1	-1,0	79	147,5	48	97,6
November	6.3	12,1	0.5	11,6	18,9	-4,6	78	156,3	51	71,8
December	1,9	6,3	-2,5	8,8	15.1	-17,8	76	151,8	59	35,4
For the year, 1914.										
January	0,3	5,9	-5,2	11,0	13,5	-13,8	70	156,9	51	18,1
February	-0,7	4,9	-6,3	11,3	11,0	-15,6	72	160,1	53	24,1
March	5,8	11,5	0,2	11,3	17,9	-6,3	76	172.9	58	96,7
April	8,6	15,9	1,4	14,5	26,0	-7,1	52	198,5	51	39,1
May	15,5	22,1	8,9	13,2	28,0	-1,5	66	156,1	36	166,0

Yamabe (2,4 m. E. of the *Matsumoto* station) offers only poor accommodation. 2,000 ft. above the sea. Pop. 300. Number of visitors: 9,119, the total stays being 34,057 days (1909). Inns: *Izumi-ya*, *Marunaka-ryokwan*.

Tenryū-kyō. As the shortest natural route connecting *Nakasen-dō* region with the *Tōkai-dō*, the descent down the rapids of the *Tenryū-gawa* formerly played an important part in the economic relations and transportation facilities between these two highways in the middle part of the main island of Japan Proper. For one who starts from either from Tōkyō or Yokohama and has to return to the same place after enjoying the adventure, four days will be required. The best plan is to stop overnight at either Kami-Suwa or Shimo-Suwa; to halt at either *Iida* or *Tokimata* on the 2nd day; the 3rd day is devoted to the passage down from Tokimata, the night being spent at *Hamamatsu*, on the Tōkai-dō Line; and on the 4th day one returns to one's starting-point.

From Tokimata to *Mitsujima*, 19,5 m. in about 4 hrs. In about 30 min. from Tokimata we see Plate 36 come to the picturesque gorge called *Tenryu-kyō*, which marks the entrance to the romantic rapids and races that are to follow.

Nakabusa. There are two routes to reach the mountain spa *Nakabusa*:

(a) *Hotaka-guchi.* From *Akashina* station, crossing the *Kawate-Kaidō*, we reach *Hotaka-machi*, then across the *Karasu-gawa*, come to *Nishi-Hotaka-mura*, and going over the Pass *Ō-tōge* and up the stream *Nakabusa-gawa*, reach the place, the whole distance being over 15 m. From Akashina 2,5 m. to Hotaka, *jinrikisha* scarcely available, thence 3,7 m. only on foot.

(b) *Ariake-guchi.* Going from Akashina 2,5 m. N. along the Kawate-Kaidō, we come to *Nanaki-mura*, then turning left towards the S. foot of *Ariake-san*, reach *Furu-umaya* of *Ariake-mura* (2,5 m.), *jinrikisha* available so far (fare, 55 *sen*); from Furu-umaya, passing through the plain at the foot of Ariake-zan, *Miyagi* is reached, where porters for baggages and guides can be hired. From Miyagi we go 5 m. up the stream to *Shinano-zaka* by a road maintained by the Forestry Department (*Nakabusa-Rindō*), and cross the gorge and over the peak, around the middle slope of Ariake-zan, the ascent being very steep. The road coming from Hotaka meets that coming from Ariake-guchi at this point. Ascending 2,5 m. farther from Shinano-zaka, we reach at last the bathing-place of Nakabusa. Fee for carrying baggage from Miyagi to Nakabusa: 10 *sen* per *kwamme* (8,3 pounds) as a rule; for fragile articles 50 % more, and for articles longer than 3 ft. and wider than 2 ft. double the ordinary rate. Guide 50 *sen*; horse Y 1,50; *kago* Y 2,50.

Nakabusa lies at the middle of the slope of *Ariake-zan*, at the foot of the Hakuba Range, the place being the first step for those who want to climb the Japanese Alps. The spa is surrounded on every side by lofty mountains. The eminent peaks, such as *Hakuba-san*, *Ō-renge*, *Yari-ga-take*, *Shakushi-dake* and *Eboshi-dake*, rise high in the sky far beyond, while the stream *Nakabusa-gawa* with clear water runs near the spa. A dense forest with big and old trees is in its neighbourhood. " Plate 37 The place is 5,300 ft. above the sea-level. Everywhere within about 0,3 m. in the gorge issue hot springs, the flow of water being abundant. There are three bath-tanks, of which the one called '*Kashikiri-yu*' is for reservation. Besides the usual baths, special arrangements for hot water massage (*Takino-yu*) and for vapour bath, as well as for swimming, are provided outside. The water is alkaline, containing hydrogen sulphide, iron, alumina, etc., and claims to be efficacious for dyspepsia, disorders of the brain, wounds, syphilis, rheumatism, *kakke*, disorders of the female genital organs, etc. The discovery of the springs dates back to the Era of Enryaku (782–806). Number of visitors: 22,000 (1912).

Shirahone. The spa is situated at the N. E. foot of *Norikura-ga-take*, which rises on the boundary of the two provinces, Shinano and Hida. *Yake-ga-take* stands to the N. of the spa by which a small stream runs; on the opposite side of the stream there is a high and steep bank, forming a precipice hanging over the water. The springs are said to be efficacious for diseases of the stomach.

Norikura-ga-take may be best climbed from the spa (in 6–7 hrs.).

Number of visitors: 3,000 (natives) and 50 foreigners (1912).

Kamikōchi. 27 m. W. from *Matsumoto*; from Matsumoto to *Shimajima* in *Azumi-mura*, 11 m., *jinrikisha* available (fare 66 *sen*), thence on foot. The spa lies on a flat plateau enclosed by high mountains, at an elevation of 4,720 ft. above the sea. *Kasumi-dake* rises to the S. E., *Yari-ga-take* to the N. W., *Hotaka-ga-take* to the N. W., and *Yake-ga-take* to the S. of the spa.

The two mountains, Yari and Yake, can be climbed from this place. *Shirahone* hot springs are 12 m. N. from here. The air being bracing and the heat moderate in summer, it is fast growing popular as a summer resort and has begun to be noticed by foreigners. At present there is only one inn in the spa. Number of visitors: 397, the total stays being 786 days (1909).

Kuzu. 21 m. N. W. from *Akashina* station, *jinrikisha* available throughout. The spa lies at the foot of the mountains *Takinosawa-dake* and *Nanakura-ga-take*, on the bank of the upper course of the *Takase-gawa*, at an elevation of 2,847 ft. above the sea The three mountain lakes, *Kizaki*, *Naka-ami*, and *Aoki*, are about 7 m. N. E. There are 6 hot springs now in use and only one inn in the spa. Number of visitors: 2,417, the total stays being 10,585 days (1909).

Shino-noi Line. This Line leads from *Shiwojiri* and connects with the Shin-Etsu Line at *Shino-noi*, the total extension being 42,1 m. via this Line, through trains run between Tōkyō (*Iida-machi*) and *Nagano* on the one hand and between *Nagoya* and Nagano on the other, the former occupying 13 hrs. 41 min. and the latter 10 hrs. 52 min. The presence of the mighty range recently called the 'Northern Alps of Japan' is prominent feature of the district traversed by this line.

Japan Alps.

This is the title of a volcanic range extending through the central part of *Honshū* or the Main Island of Japan, and forming the boundary between Suruga, Kai, Tōtōmi, Shinano, Hida, Etchū, and Echigo. It consists of three lofty ridges called respectively Southern, Middle, and Northern.

(1) The '**Southern Alps of Japan**' are made up of the Akaishi Ridge, which, rising in the Atsumi Peninsula in Mikawa, passes to the N. of Hamana-ko Lagoon, winds between the valleys of the rivers *Kamanashi* and *Tenryū*, and ends at the shore of Lake Suwa-ko. This range furnishes a good example of upheavals caused by the sliding of strata. Of the spurs of clusters of peaks in this range, those that attain an elevation of approximately 10,200 ft. above the sea are *Akaishi* (10,145 ft.), *Shirane-san* (loftiest point 10,332 ft. and including *Kita-dake*, *Aino-take*, *Notori-san*), and *Koma-ga-take* of Kai Province, in which *Jizō*, *Hō-ō*, and Koma-ga-take itself all rise about 10,000 ft. above the sea.

(2) The '**Middle Alps of Japan**' are constituted by the Kiso Range, which rises in the Chita Peninsula in Owari, enters Shinano, where it sends up *Ena* and Koma-ga-take and forms a watershed for the Kiso and the Tenryū, finally terminating at the S. end of the Matsumoto Plain. The cluster of peaks with Koma-ga-take of Shinano as their monarch forms the highest elevation in this chain.

(3) The '**Northern Alps of Japan**' is the title applied to the Hida Range, which forms the majestic chain that extends from N. to S. on the E. boundary separating Hida and Etchu from Shinano. This comprises *On-take* 10,447 ft., *Norikura* 10,142 ft., *Jōnen-take* and *Otenjō-dake* 10,447 ft., and *Shiratori-dake*. Other noted peaks slightly lower than the above are *Tsubame-dake*, *Kasa-ga-take*, *Goroku-take*, *Washiba-dake*, and *Tsurugi-ga-dake*. Running further N. it sends up *Tate-yama*, and finally descends into the Japan Sea in the steep precipices of *Oyashirazu*. The ranges extends for a distance of 98 m. with a breadth of 37 m.

Prof. Shiga, in his 'Essay on Japanese Scenery,' writes that the 'Japan Alps' are a medley of volcanic upheavals that have burst through granite strata form the wildest and grandest solitude of rocky pinnacles and wooded peaks in Japan. It is such a solitude, that in summer at some hot springs human faces are rarely seen for weeks at a time, the only living creatures that meet the eyes of solitary travellers or mountaineers in this wild tract being the golden-coloured eagles that soar above the mountains, and pretty deers that stare stolidly at the strange figures. A peculiar species of swallow, haunting cascades or falls, and sluggish salamanders, hiding in mountain creeks, characterize this region as compared with the original Alps. Then in their comparatively primitive aspect the Japanese Alps compare favourably with their somewhat vulgarized prototype, at the Rev. Walter Weston, who is probably the highest authority on the 'Alps of Japan,' writes in his excellent work on this particular subject.

Those in Tōkyō or Yokohama who wish to explore this region should take the first train at Ueno and stop a night at *Matsumoto*. The next day Norikura-ga-dake is climbed, then we descend to Shirahone Hot Springs, and, after attacking the *Abō-tōge* (6,396 ft. above the sea) on the boundary between Shinano and Hida, *Iwō-ga-take*, *Hotaka-ga-take*, *Yari-ga-take* (11,578 ft.) and *Kasa-ga-take* are climbed in succession; to be followed by the ascent of the peaks on the boundary between Shinano and Etchū, such as *Shishi-ga-take*, *Harinoki-tōge* (8,200 ft.), *Daikoku-dake*, *Yari-ga-take*, and so forth. *Shirouma-dake* and *Dairenge-san* (9,610 ft.), between Etchū and Echigo, are next attempted, and after a rest at **Renge Hot Springs**, 5,445 ft., where a single inn stands, we descend to *Kotaki-mura* on the bank of the *Itoi-gawa* and finally emerge on the town of the same name after a walk of 11 m. Thence we return to our starting-point by train via *Naoetsu*.

For those starting from either Ōsaka or Kōbe the first objective is *Takayama*, the principal city in Hida. Then proceeding along the road for Matsumoto, the first real ascent is tried at *Norikura-ga-take*, after which, following the itinerary mentioned above, one enters Etchū via *Harinoki-tōge*, to end the adventure with the ascent of the Tateyama Range. Tateyama commands one of the grandest and most magnificent views in Japan, and, though inferior in height, is said to surpass the European Alps in so far as regards the number of lofty peaks that can be descried from the top. Descending to *Ashikura-ji*, one then proceeds to *Toyama*, not quite 17 m. distant, and then back home by train. The expedition requires about one month, whether one starts from Tōkyō or Ōsaka.

Ascent of Norikura-ga-dake.

Norikura-ga-dake stands over 10,400 ft. high above the sea and is the sixth highest peak in Japan Proper. There are six ascents, of which, two are from Shinano, viz. from *Ōnogawa-mura* and **Shirahone Hot Springs**, and the other four from Hida, viz. from *Nomugi*, *Aoya*, *Iwaidani*, and Hirayu Hot Springs.

(1) From **Shirahone Hot Springs** the path leads in about 5 m. to the cultivation plot at the headwaters of the Ōno-gawa, and 1,4 m. farther on to *Kanayama-taira*, where galena ores are said to have been extensively mined by *Takeda Shingen* (1521–73), and the working of which is still being carried on. Ascending the slope, a little further on the path comes to a small stream strongly smelling of sulphuretted hydrogen, issuing from a crevice a little higher up. This place is 8,500 ft. above the sea. We soon enter the crawling pine zone, with rhododendron shrubs flowering here and there. At an altitude of 10,000 ft. the path leads over hardened lava and scoriae, making the climbing very laborious, and soon the summit is reached. Near it is an old crater 984 ft. in diameter, the wall of which rises steeply at its E. side, but is much lower on the N. N. W. On the elevated side a small shrine dedicated to *Asahi-Gongen* and also a stone post for triangular survey are found. No less than 47 small tarns also exist about this place, most of them dry. From the cultivated plot to the summit the distance is about 7 m.

(2) From **Hirayu Hot Springs** the path leads in about half a mile to the smelting works, then to a magnificent cascade 600 ft. in height tumbling down rocky sides. The path makes plenty of ups and downs, leads past the mine office, through a pine wood, and after an hour's climb over places strangely devoid of rocks and water, enters the crawling pine zone. Passing over *Yatsu-ga-take* which forms an ante-peak, as it were, to Norikura, we find *Ebiko-dake* rising on the right. Going up still higher we find, when we reach Lake Ōnifu, that *Ebiko* is now below us, and from three sides of the lake rugged peaks shoot up. The water is yellowish and the whole scenery strikes one as uncanny. Then begins a scramble over sharp slopes, the path passing along a narrow ridge like a horse's back, while now and then even such a path is absent. The crawling pines become scarce, but alpine plants take their place. Past *Tsuru-ga-ike* tarn and in sight of another tarn called *Kame-ga-ike*, an altitude of over 10,000 ft. is registered. The upward journey over volcanic rocks is a tedious process, the path making ups and downs. No. 5 tarn is seen to the left. Then there is another high elevation to be attacked, the path to it being strewn with large lava blocks, and finally we reach the summit of Norikura-ga-dake. The twin peaks bound in a lake, the largest tarn existing at such an altitude in Japan, for in diameter it measures 1,000 ft. On the right peak stands the Shintō shrine of *Asahi-jinja*, while the left one is sacred in honour of *Ontake-jinja*, and it is this latter peak that forms the highest point in Norikura-ga-dake, its summit, according to the latest calculation, rising 10,630 ft. above the sea. The views obtained from this vantage point vie in grandeur with those from the top of On-take.

Ascent of Yari-ga-take.

Yari-ga-take ('Spear peak') is, next to Fuji, the highest mountain in Japan, being 11,600 ft. above the sea. The following description of the ascent of this peak is based on the '*Yari-ga-take Tankenki*' (Exploration of Yari-ga-take) of Mr. *Kojima Usui*, who is an acknowledged Japanese authority on mountaineering.

At Shimajima Village a guide is hired. Four miles on there is a mineral spring called *Furohira*, and thence the track leads, over the *Tokumoto-tōge* (7,100 ft.) between *Nabekaburi-yama* and *Kasumi-dake*. The path then makes a descent and leads to a hut in a dense forest on the banks of the *Azusa-gawa*, 7 hrs. from the starting point. In the river trout abounds, and beyond towers up the sublime granite ridge of *Hotaka* resembling in its situation and outline a mountain near Chamonir in the European Alps. From the hut to the top 9 to 10 hrs. are taken; then down to the hunter's cave at *Akasaka* (6,400 ft.) 2 hrs. 30 min. are required even by the hardest climbers. From the cave the path is led along a mountain stream which has to be forded here and there, and in 3 hrs. the snow-streaked granite giant of Hotaka rises on the left, while on the right stand well-wooded and milder ranges. The peaks rising about are all of granite and in their spiry shapes remind the beholder of the wild mountain landscapes that are found in Chinese paintings. Nowhere in Japan, except at remote places in *Yamato*, can such primitive grandeur and sublime solitude be found as in this neighbourhood. From the hunter's cave the forest zone is left, and the path begins to ascend over snow-fields. Continuing the upward journey, the presence of huge boulders indicates the nearer approach to the summit. Some are piled up, others threaten to tumble down, while here and there they form natural arches, and stepping from one stone to another, or clambering over boulders or across snow-fields, and sometimes crawling over risky spots the summit is reached at last. At this spot a single rocky pinnacle is seen to shoot up perpendicularly, its sides falling away sheer all round like a spear-point, the S. E. corner alone exhibiting a slight slope. On the descent a sturdy man can reach the hunter's cave in 2 hrs 30 min., hence 12 hrs. 30 min. to Shimajima.

The views from the summit embrace to the N. the innumerable peaks, many of them nameless, of Shinano and Etchū; to the W., Kasa-ga-take; to the S., the ridge of Hotaka and Norikura, and beyond, the peaks of On-take and to its E. Koma-ga-take of Shinano; and to the S. W., the lofty range forming the boundary between Shinano and Kai, and far away, for the distance is 85 m. ast he crow flies, Fuji lifts up her noble head. The view of Japan Sea to the N. W. is generally obscured owing to mist.

Ascent of Hotaka-ga-take. This is also called *Myōjin-dake* and ranks third on the list of high mountains, it standing 11,500 ft. above the sea. The ascent is made from *Higashi-Hotaka-mura*, 6 m. to the S. W. of the station, *Tokugō* being the usual starting-point. From the village to the summit it is an ascent of a little over 17 m., and though involving hard strain the journey can be accomplished in one day, viz. 6 hrs. in ascent and 5 in descent. Hotaka stands before us soon after the start as a granite cliff shooting up 5,000 ft. from the ravine of the *Azusa-gawa*. The trouble with this mountain is that no track has yet been made to facilitate the ascent, so that the climber has to force his way through tall bamboo-grass and to scramble up rocks by dint of holding on to shrubs or creepers. At 8,500 ft. above the sea there is a snow-covered slope making an angle of about 40°, and, when this is safely climbed, large masses of smooth rock bar the passage. Scrambling over it we at length reach the ridge from which rise several peaks, of which the one on the extreme left is the highest, with a summit consisting of broken blocks of granitic rock. The panorama viewed from here is practically identical with that seen from Yari-ga-take.

Nakabusa Hot Springs lie to the W. of Hotaka and is 14.5 m. distant from Matsumoto. The spa occupies a solitary spot surrounded by high mountains and deep valleys and is resorted to by students who are anxious to utilise their summer holidays to the best advantage for the body and the mind.

Ascent of Ariake-yama, 8,075 ft. is best made from the hot springs, the ascent being divided into 9 stages, each covering about 0,5 to 0,6 m. and indicated by a post. At the 6th stage the twin mountains of *Chō-ga-take* and *Amakazari* rise, the S. one connected with *Kasumisawa-zan* and the N. one with *Ariake*. At the 7th stage the road becomes steeper and here the *Ōjigoku-dani* ('Big Hell Valley') is found. At this spot one part of the road has been washed away by heavy rain, leaving a huge rock overhanging above, while a dense mist always obscures the abyss. From the opening at the 8th stage, the town of *Ōmachi*, the two lakes of *Kozaki* and *Nakatsuna*, and then the noble ridge of Hida are seen. At the top stands a *torii*, a little beyond which we come to the small Shintō shrine of *Ariake-jinja*. The panorama of the Matsumoto Plain unfolded below and of the rivers and surrounding mountains well rewards one for the toil of the ascent.

Hirao. There are five hot springs noted for their efficacy in *Hirao-mura*, viz. *Kambayashi*, *Kutsuno*, *Shibu*, *Andai* and *Yudanaka*. These springs, not distant from one another, can be easily reached from the station *Toyono* (141,5 m. from Ueno, in 7 hrs. 35 min.), the distance being 10 m. Automobiles, omnibuses, and *jinrikisha* are available. Post, telephone and telegraph office. The five springs are situated on the bank of the *Yomase-gawa*, Kambayashi lying on the uppermost portion and Yudanaka on the lowest.

	Kambayashi	Kutsuno	Shibu	Andai	Yudanaka
Population	9	907	915	200	1,900
Houses	3	194	200	50	300
Inns	1	2	13	7	10
Springs	—	—	common salt	simple	bitter
Diseases that may be cured	—	—	rheumatism, paralysis	disorders of the brain, diseases of the stomach and intestines	venerial diseases, disorders of the female genital organs, dyspepsia
Private baths	2	1	8	3	2
Public baths	1	3	7	3	10
Doctors	0	0	1	0	2
No. of visitors	222	297	10,063	4,601	7,340
Total stays (in days)	723	509	52,984	18,155	21,797

Meteorological Observations.

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation
	Mean				Absolute					
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total
For the year, 1911.										
January	−2,4	1,9	−6,6	8,5	9.3	−12.3	70	—	—	—
February	0,1	4,0	−3,8	7,8	10,6	−10,3	71	—	—	41,1
March	3 5	7,8	−0,9	8,7	15,9	−9.3	74	—	—	69,0
April	9,3	14,5	4,1	10,4	27,0	−6,6	68	187,8	48	126,6
May	13,9	20,0	7,8	12,2	25.3	0,1	59	263.4	60	49,1
June	18,6	23,3	14,0	9,3	28,1	9 0	76	206,8	47	252,5
July	22,2	26,5	17,9	8,6	31,7	12,2	74	197.3	44	183,1
August	23,3	28,1	18,6	9,5	31.7	16.0	73	214,1	51	224.1
September	20,6	25,6	15,6	10,0	31,8	9,6	73	180,9	49	139.1
October	12,5	16.9	8,1	8,7	26,6	2,4	71	154.4	44	90.4
November	9,0	13.7	4.4	9.3	20,6	−1,6	70	164,8	54	76,0
December	1,3	5,2	−2,5	7,6	14.1	−8,1	77	155,8	52	41.7

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation
	Mean				Absolute					
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total
For the year, 1912.										
January	-1,9	1,9	-5,8	7,7	5,9	-11,3	70	132,6	43	70,3
April	9,4	15,0	3,8	11,2	25,0	-6,1	59	234,5	60	44,3
May	13,4	18,7	8,1	10,6	28,5	3,0	65	224,1	51	93,3
June	17,4	21,8	13,0	8,8	27,0	6,5	69	212,3	48	82,0
July	21,5	25,6	17,5	8,0	30,5	11,0	74	205,3	46	256,6
August	23,4	28,2	18,6	9,5	31,4	14,0	74	270,8	65	155,9
September	17,4	21,5	13,3	8,2	28,1	7,0	78	136,2	37	154,9
For the year, 1913.										
January	-3,5	0,7	-7,7	8,5	5,9	-12,4	75	127,0	41	60,0
February	-1,2	3,4	-5,7	9,0	14,1	-12,3	73	165,0	54	60,4
March	0,6	5,3	-4,0	9,3	15,8	-11,8	74	218,4	59	34,9
April	10,1	15,4	4,7	10,8	28,1	-4,6	68	214,9	55	86,8
May	12,5	18,0	6,9	11,0	23,7	0,6	68	224,9	51	105,0
June	17,3	21,6	13,0	8,7	29,0	5,5	71	202,5	46	128,9
July	21,3	25,6	16,9	8,7	30,5	10,7	75	204,1	46	82,2
August	21,3	26,0	16,7	9,2	31,0	13,0	72	230,5	—	171,0
September	16,5	21,1	11,9	9,2	25,1	5,2	74	175,9	47	33,1
November	5,9	10,0	1,7	8,3	18,4	-1,7	75	136,6	45	103,4
December	1,4	5,2	-2,5	7,7	13,8	-10,9	76	156,9	52	59,8
For the year, 1914.										
January	0,1	4,6	-4,5	9,1	13,3	-10,4	75	168,1	55	39,4
February	-1,0	2,9	-4,8	7,7	8,6	-10,8	75	168,8	56	39,9
March	4,6	9,1	0,2	8,8	19,6	-5,6	72	195,0	53	59,2
April	7,8	13,3	2,3	11,0	24,0	-5,3	68	217,9	55	75,9
May	15,2	20,4	9,9	10,6	29,0	0,4	70	211,3	48	104,5

Kakuma. 1,2 m. S. from Shibu hot springs. Pop. 280. 3 springs, 6 public baths, 6 inns, of which two are provided with private baths. The water is said to be good for *kakke*, brain, and diseases of the skin. Number of visitors: 2,110, the total stays being 8,511 days (1909).

Bessho. 7 m. S.W. from *Ueda* (113,4 m. from Ueno, in 6 hrs.) on the Shin-etsu Line, *jinrikisha* and omnibuses available. The spa is shut in on the two sides, S. and W., by hills and penetrated by the *Yu-kawa*, hot springs issuing from its S. bank. Pop. 1,396 (294 households), 22 inns, 5 public baths, 5 inns with private baths, and 2 resident doctors in the village. Number of visitors: 18,764, the total stays being 37,875 days (1909).

Meteorological Observations.

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation
	Mean				Absolute					
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total
For the year, 1911.										
February	1,8	6,3	-2,8	9,2	14,0	-8,8	68	—	—	46,7
March	5,6	11,1	0,1	11,0	20,0	-8,8	69	—	—	62,0
April	10,8	16,5	5,1	11,4	30.4	-5,8	66	185,4	47	164,2
May	14.7	21,7	7,6	14,1	27,9	0.8	57	193,4	44	44,4
June	20,1	25,6	14,5	11,0	30,9	10,0	78	117,5	27	335,6
July	23,9	28,7	19,0	9,8	33,9	13,0	88	118,8	27	224,4
August	24,6	29,6	19,6	10,0	33,4	16,5	72	164.7	39	260,1
September	21.5	26,7	16,4	10,3	31,9	9,9	88	113,6	31	145,3
October	14,0	18,7	9,2	9.5	28,9	1,8	69	144,5	42	74,3
November	10,2	15,4	5,0	10,4	25,5	0,0	70	109,0	36	65,9
December	1,9	6,5	-2,7	9,2	12,5	-7,8	77	91,7	31	35,2
For the year, 1912.										
January	-0,3	4,6	-5,2	9,8	10,5	-10,3	75	138.9	45	35,7
April	11,1	17,9	4,4	13,5	27,9	-4,8	50	239,9	61	75,2
May	15,2	21,6	8,8	12,8	31,4	2,9	61	212,8	49	87,1
June	18,9	24,5	13,4	11,1	29.4	5,9	70	163,0	37	201,8
July	23,5	28,3	18,8	9,6	34,1	12,5	70	144.7	33	192,0
August	24,9	30,7	19,1	11,5	33,4	15,0	69	236,5	57	82.7
September	18,9	23,3	14,5	8,8	29,9	9,5	79	92,0	30	182,8
For the year, 1913.										
January	-3,3	1,6	-8,2	9,8	5,4	-13,3	73	152,1	49	37,1
February	-0,5	4,5	-5,4	10,0	15,0	-11,2	68	162,3	53	37,8
March	2,3	8,2	-3,7	11,9	19,5	-11,2	61	206,3	56	37,1
April	11.6	18,0	5,1	12,9	28,9	-2,2	70	193,2	49	108,2
May	13,6	20,0	7,1	12,9	27,0	0,8	65	235,1	54	111,3
June	17,8	22,7	12,8	9,9	27,9	7,4	67	161,9	37	158,5
July	22,2	27,2	17,3	9,9	31,9	11,5	71	187,0	42	66,2
August	21,9	26,6	17,2	9,4	30,9	12,5	73	171,9	41	198,0
September	17,0	21,7	12,2	9,5	27,0	5 4	75	154,9	42	41,2
October	12,8	17,6	8,0	9,6	21,0	0,5	77	125,9	36	—
November	6,1	11,5	0,7	10,8	18,2	-3,8	71	154,1	50	85,5
December	1,7	6,6	-3,2	9,8	13,3	-10,0	72	161,3	54	44 6
For the year, 1914.										
January	0,9	6,8	-4,9	11,7	13,9	-10,2	68	178,8	58	21,0
February	-0,6	4,4	-5,6	10,0	11,4	-13,2	70	155,3	51	32,0
March	5,8	10,9	0,6	10,2	19,2	-6,4	69	164,3	44	84,4
April	8,4	14,7	2,1	12,6	26,1	-3,7	55	196,6	50	50,6
May	15,1	21,0	9,1	11,9	29,2	-0,1	63	174,7	40	135,1

Nozawa, 24 m. N. E. from *Toyono* station, *jinrikisha* available, lies on the right bank of the *Chikuma-gawa*, with hills on the N., S. and E., at an elevation of 993 ft. above the sea. The springs were found in the Tenryaku Era (947–57). Pop. 1,659, 7 public baths, 12 inns, 1 doctor. The spa may become a lovely summer retreat, the climate being moderate during the summer months. Number of visitors: 16,055, the total stays being 45,590 days (1909).

Meteorological Observations.

Summary.

Month	Air temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation
	Mean				Absolute					
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total
				For the year, 1913.						
April	8,9	14,7	3,1	11,6	25,7	-3,7	70	183,9	47	75,7
May	12,5	18,0	7,0	11,0	25,4	0,3	65	199,2	46	110,7
June	17,3	22,1	12,5	9,6	28,0	4,4	73	157,6	36	111,8
July	21,2	26,0	16,5	9,5	31,5	9,8	75	148,8	33	96,0
August	21,5	26,4	16,6	9,8	29,6	12,7	71	184,8	44	262,4
September	16,6	21,3	11,9	9,4	25,1	5,2	70	128,1	34	39,3
October	12,5	17,0	7,9	9,1	23,3	1,4	76	113,4	33	129,4
November	5,7	9,7	1,7	7,9	17,0	-1,4	80	110,3	36	185,9
December	1,5	5,4	-2,3	7,8	14,5	-9,2	75	87,8	31	164,5
				For the year, 1914.						
January	-0,1	4,5	-4,8	9,3	12,5	-11,0	66	117,8	38	286,0
February	-0,6	3,4	-4,5	7,9	8,4	-10,5	64	105,6	35	187,7
March	4,4	8,7	0,0	8,4	19,5	-6,5	68	147,8	40	94,8
April	7,8	13,4	2,2	11,1	24,0	-5,5	65	151,4	38	111,2
May	15,1	20,8	9,4	11,4	28,5	0,0	65	169,1	39	112,7

Karuizawa (88,3. m. from Ueno, in 4 hrs. 54 min.) being situated at an elevation of 3,270 ft. above the sea, has recently risen to be a highly popular summer resort, especially for foreigners, as the place is easily accessible from Tōkyō. It extends 4,6 m. from E. to W. and 6 m. from N. to S. and is shut in on three sides—N., S., and E.—by mountains, with an opening only in the S. W. direction. The grassy moors in the S. W., the only open direction, are bounded at their W. extremity by the sharp ridge of *Yakaze*. These moors occupy about two-thirds of the whole area of Karuizawa. The land is generally elevated towards the N. E. and slopes towards the S. W., and the streams, of which the *Kawagoe-ishi-kawa* is relatively the largest, all rise in the N. and flow W. It was by Archdeacon Shaw of the S. P. G. Mission and Prof. Dixon, then of the Imperial Tōkyō University, that Karuizawa as a summer resort was first introduced to the foreign public. They visited the place in 1886, and spent the summer at the houses of certain of the inhabitants. The villa built in 1888 by the Archdeacon on the top of *Ōkatsuka* was the first foreigner's house erected here. Several other foreigners followed his example, until before long Karuizawa, which was otherwise doomed to decay, blossomed forth as a prosperous village. The grateful villagers have erected a monument in memory of the Archdeacon. Visitors to Karuizawa in 1911 numbered 6,597, i. e. 5,406 Japanese and 1,191 foreigners, and the number of days they stayed there aggregated 121,644.

The meteorological records for the years 1911 and 1913 are as follows:

Meteorological Observations.

Summary.

Month	Air Temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation
	Mean				Absolute					
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total
For the year, 1911.										
January	-2,6	3,3	-8,5	11,8	10,2	-13,7	65	—	—	32,0
February	1,6	8,2	-4,9	13,0	14,0	-12,1	59	—	—	11,7
March	4,4	11,4	-2,7	14,1	17,5	-11,7	61	—	—	—
June	16,0	20,3	11,6	8,7	22,1	7,7	73	67,5	15	419,8
July	19,1	23,4	14,8	8,5	29,7	11,3	84	124,8	28	375,2
August	20,8	25,3	16,3	9,0	29,6	12,3	82	116,4	28	405,1
September	18,5	23,4	13,6	9,8	30,1	7,6	72	118,2	32	178,3
November	7,4	14,1	0,8	13,2	22,4	-6,5	66	108,0	35	44,8
December	-0,3	6,5	-6,6	13,2	15,0	-11,0	61	146,1	49	2,7
For the year, 1913.										
January	-6,7	-0,7	-12,7	12,0	4,0	-21,5	84	180,9	59	35,2
February	-3,9	2,0	-9,7	11,7	9,4	-20,8	76	197,1	65	31,5
March	-1,3	5,3	-7,9	13,2	17,4	-15,3	81	198,7	54	44,7
April	8,0	18,4	1,2	13,6	27,5	-8,3	81	170,0	43	94,9
May	9,7	16,3	3,0	13,4	20,6	-5,0	64	196,4	45	153,6
June	14,7	20,3	9,1	11,2	26,2	0,8	70	129,0	30	177,3
July	18,4	23,5	13,2	10,2	29,7	7,6	78	147,1	33	95,1
August	17,9	23,8	12,0	11,8	28,4	7,0	79	198,6	48	333,2
September	14,1	19,2	9,1	10,0	22,6	2,8	78	155,0	45	73,2

In the summer season Karuizawa is well provided with various devices for social entertainments and sports, such as concerts, theatricals, Karuizawa Athletic Association, Asama Climbing Society, etc., many of these organizations having been originated by foreigners. Horse for hire, the charge for horses is 40 *sen* an hr. without groom, 10 *sen* extra with groom; Y 2 for half a day with groom, and Y 3 a day with groom.

Karuizawa has many beautiful sights and places for excursion in the neighbourhood, such as the *Usui-tōge*, *Kose Spa*, *Hanare-yama*, *Zekkei-hō*, *Kama-no-hashi*, *Iriyama-tōge*, *Wami-tōge*, *Asama-yama*, *Myōgi-san*, *Nunobiki-yama*, *Akaru-san*, *Oshidashi-iwa*, 'Cathedral Rocks,' etc.

Hotels: *Mampei Hotel*, 1 m. from the station; Charges, American plan, 1st class Y 8, 2nd class Y 6, 3rd class Y 4; *Karuizawa Hotel*, 0,9 m. from the station; Charges, American style, 1st class Y 7, 2nd class Y 5, 3rd class Y 3; *Mikasa Hotel*, 2 m. from the station; Charges, à la Française, 1st class Y 12, 2nd class Y 8, 3rd class Y 5. There is also a pension called 'Greta Bank' managed by foreigner. Inns: *Tsuru-ya*, *Banshō-ken*, *Fuji-ya*, *Abura-ya*, *Kōsei-kwan*, *Ichida-ya*, *Ebisu-ya*.

GIFU-KEN

Ena Mineral Springs are located on a highland, more than 1,200 ft. above sea-level, covering *Koaza-Kitsumi* and *Wakayama*, *Oaza-Takayama*, *Fukuoka-mura*, Ena-gōri, Mino Province.

This highland is bounded by the River *Tsukechi* on the E., the River *Ama* on the W., the River *Kiso* on the S., and Mt. *Tobi-iwa* and *Su* on the N. Overlooking the grand plateau of *Naegi*, the visitor commands a distant, panoramic view of the highest peaks of the 'Japanese Alps,' such as *Ena*, *Kazagoe*, *Koma-ga-dake*, *Mi-take*, *Norikura*, etc. There are countless caves, large and small, clear streams invariably flowing out of them. These are the so-called "Eight Hundred and Eighty Valleys" (a name given by Kōbō-Daishi, the much revered ancient priest). Water of all these streams are strong radio-active. Foot-paths, suitable for sauntering, thread their way beside the *see Plate 39* streams and also encircle the foot of the highland. Thus the whole district forms a natural park on a large scale.

The district enjoys a mild climate, which does not vary very much; the temperatures ranging from 30° F. in winter to 80° F. in summer.

The place lies about 5 m. from the *Nakatsu-gawa* station on the Central Railway Line (about 3 hrs. from Nagoya); and there is a good scenic road over which *jinrikisha* and *kago* are available. *see Plate 38* Some of the chief attractions on the way are the Kiso rapids, wonderful rocks on the site of Naegi Castle, etc.

The whole district is of granite formation and produces various kinds of minerals, numbering more than fifty. The more important of them are *naëgite*, *fergusonite*, *zircon*, *bismuth*, *tin sand*, *tungsten*, etc. Besides, there are such precious stones as *rutile* (?), *sapphire*, etc., and one can pick up *morion* and *topaz* anywhere.

These are produced not only at *Takayama* in Fukuoka-mura, but also at *Fukuoka* in Fukuoka-mura, in *Naegi-machi*, and *Hirukawa-mura*, all in Ena-gōri.

Rock-crystal was found in 1873 at *Aza-Wakayama*, *Ōaza-Takayama*, *Fukuoka-mura*, and later in 1884 when tin sand was discovered on the same spot, the Mitsui Company organized Tōnō-Saikō-sha (Mining Company in Eastern Mino), which carried out the mining enterprise on a large scale to their immense profit. Afterwards the work was handed over to local capitalists who still run it. At first the tin sand produced here was found to contain various minerals above referred to but these mixtures were discarded as useless and offensive, as they made refining difficult and greatly decreased the percentage of production of the refined mineral, especially so in the case of tungsten, naëgite, etc., forming small particles. But in 1894–5 "*kinkō-seki*" alone was found useful for colouring chinawares and porcelain and has since then maintained some market value. In 1911 the importance of tungsten was first known and the mineral was discovered at Ōaza-Takayama in Fukuoka-mura and also in Hirukawa-mura, where it is still being mined. With the progress of chemistry and various scientific investigations, it became a problem whether this mineral contains radium or not. While the scientists were discussing it in the next year Kanroku Yoshimura, the land-owner of the Yunoshima mineral spring, supposed that this spring contains radium emanation and spread the news. In February, 1913, Mr. Y. Morimoto, Tōkyō, tested the spring and found the rumour true. The land-owner then entrusted Mr. Morimoto with the entire management of this spring, and he immediately applied for analysis to the Tōkyō Imperial Hygienic Laboratory of the Department for Home Affairs. Expert Mr. Kinugasa and Assistant Mr. Nishihara were despatched to the spot and the analysis confirmed the fact that the spring in question contains a large amount of radium emanation. Since then Dr. Ishizu and Dr. Tokunaga and other famous men have visited the place and observed the promising feature of this tract of land.

The district, on the whole, forming a highland, the climate is healthy, air invigorating, and scenery grand. As the thick forests of Kiso are not very far, and better still, the means of access not lacking, it is believed that the district would become a suitable summer sanatorium if proper accommodation were provided for it. At present no bathing arrangements are made.

TOYAMA-KEN

Ogawa. 0,7 m. from *Tomari* station on the Hokuroku Main Line. Springs issue from a hillside on the upper course of the *Ogawa* (7,5 m. S. E. from the Tomari station). Formerly there used to be several inns with private baths at the source of springs, but they were completely destroyed by an inundation in 1909, and now the water is conducted by wooden pipes to the town. Number of visitors (before inundation): 5,705, the total stays being 37,756 days (1909). *see Plate 7, fig. 2 and Plate 10, fig. 1*

Futami, Kuronagi, and **Kanetsuri.** The three hot springs, mentioned above, can be reached from the *Mikkaichi* station on the Hokuroku Main Line. Starting from the station and going 7,5 m. towards the S. E., we come to *Aimoto-bashi*, which spans the *Kurobe-gawa* at the end of the village of *Aimoto-mura*. The bridge was constructed on the cantilever principle and enjoyed formerly the reputation to be one of the three most ingenious bridges in Japan. It is about 240 ft. in length and about 50 ft. above the surface of the water, for the Kurobe-gawa runs here between precipitous banks, the colour of water as seen from the bridge being emerald green.

About 7,5 m. up the Kurobe-gawa there are *Kuronagi* Hot Springs, at the point where the *Kurobe-gawa* joins its affluent *Kuronagi-gawa*. The place is at an elevation of 640 ft. above the sea-level. 3,8 m. farther from Kuronagi up the river Kurobe-gawa lie *Kanetsuri* Hot Springs at the foot of *Higashi-Kanetsuri-yama*, which has a shape of temple-bell.

On the upper course of the Kuronagi-gawa are situated *Futami* Hot Springs, about 1 m. distant from Kuronagi. The springs have their source in a cave between two rocks standing on the river-bed. These two rocks, larger and smaller, are tied together by a large *shime-nawa* (straw rope with tufts of the same material), with a *torii* on one of the rocks. On account of the resemblance of these rocks to the "Wedded Rocks" of *Futami-no-ura* (Ise Province), the springs are called "Futami-Onsen." The spa is resorted to mostly by the inhabitants in the neighbourhood. *see Plate 40 and Plate 7, fig. 2*

	Kuronagi	Kanetsuri	
Number of visitors:	243	1,000	(1909)
The total stays (in days):	1,291	7,000	(„)

Ōiwayama. 13,7 m. E. from *Toyama*, *jinrikisha* (fare, 66 *sen*) available, and 5 m. S. E. from *Kami-ichi-machi*. The place is situated at the N. extremity of the ridge adjacent to Mt. *Tate-yama*, at an elevation of about 700 ft. above the sea, surrounded on three sides by mountains and open on the N. toward the plain of *Etchū*, commanding an extensive view of the Bay of Etchū and Noto. On a rocky precipice here stands a famous temple called *Nisseki-ji* (Shingon Sect), and behind the temple are found several waterfalls, of which *Ō-taki*, the largest one, presents a wonderful sight. Close by the waterfall stands a stone statue of *Fudō-son*, which is said to have been sculptured by *Shaku-no-Gyōki* in the 2nd year of Jinki Era (726 A.D.). Even now bathing in the waterfalls is popularly believed to be efficacious for curing mental derangement and also eye diseases, and thus the place is visited by sick people all the year round. The place has a small temple for those bathers coming for recuperation, who shut themselves up therein during certain numbers of days. The place, being located amidst beautiful surroundings, may be said to be one of the most pleasant summer retreats in the province. There are six inns in the place. Number of visitors: 4,734, the total stays being 9,167 days (1909). *see Plate 41*

Ōmaki. 11,5 m. S. E. from *Fukuno* station on a private railway, "Chū-etsu Line" (*Takaoka—Jōhana*). From the station 4 m. E. to *Inami-machi*, *jinrikisha* available. The spa lies on the E. bank of the *Imizu-gawa* (also called *Shō-gawa*) at an altitude of 850 ft. above the sea. The bath-tank is constructed close by the stream and covered with stones. The place is beautifully located amidst densely wooded hills. Number of visitors: 4,296, the total stays being 20,439 days (1909). Farther up the stream is **Soyama-Onsen** and 5 m. down **Yuyama-Onsen.** *see Plate 42*

ISHIKAWA-KEN

Yamanaka, 5. m. to the S. E. of the *Daishōji* station (87,7 m. from *Maibara*, in 5 hrs. 30 min.), Electric Tramway available (30 min., fare, 50 *sen*), is a picturesque retreat (240 ft. above the sea) with hills on three sides and the *Daishōji-gawa* traversing the open portion. High banks bound the stream, which is clear and bright. The place is noted for lacquer-wares. Pop. 3,300. Number of visitors: 28,832, the total stays being 147,495 days (1909). *Kakke* patients resort to the spa very often. Inns: *Yoshino-ya*, *Mitani-ya*, *Ōgi-ya*. *see Plate 43*

Meteorological Observations.

Summary.

For the year, 1911.

Month	Air Temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity	
	Mean				Absolute							
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean	Dir.
January	2,79	6.52	-0.72	7,23	15,9	-3.9	81,14	47,76	26	46,1	1,7	—
February	4,05	7,22	0 67	6,53	14,3	-4.9	77,0	61,97	20	159,8	1,39	S 63° W
March	6,57	11,12	2,49	8,63	18,2	-3,0	79,0	81,46	22	238,5	1,69	S 57° W
April	10,96	15,34	6,2	9,04	29.3	-1,5	76,0	120,63	31	206,6	2,48	N 71° W
May	15,8	20,9	10,5	10,4	25,4	3.0	69,7	213,97	49	98,2	2,41	S 5° E
June	20,0	23,9	16,2	7,69	27,8	11,0	79,1	86,57	20	335,4	4.31	S 11° E
July	24,1	28,3	20,3	8,0	33,9	13,4	79,0	110,80	25	88,1	1,7	S 30° E
August	24.6	28,9	20,6	8,2	34,2	16,5	79,0	162,55	39	292,3	1,7	S 56° E
September	22,4	27,0	18,5	8,5	34,2	13,0	80,0	124,25	34	320,3	1,8	S 36° E
October	14,6	19.3	10,8	8,5	26,3	7,5	80,0	125,65	36	236,1	2,0	S 63° E
November	11,8	16,0	7,9	8,4	23,4	-3,1	77,0	90,00	29	335,5	2,2	S 12° E
December	4.6	8,0	1,8	6,1	18,3	-1,8	85,0	54,35	18	221,9	2,1	S 35° E

Yamashiro Spa is separated from the station *Iburi-bashi* by about 3 m., with horse-trams running, and by half a mile more from *Daishōji*, the two spas, Yamanaka and Yamashiro, being about 2,5 m. from each other. Though somewhat inferior to Yamanaka in scenery, Yamashiro possesses better accommodation both for lodging and bathing. The fact that here are situated the principal kilns of *Kutani-yaki* pottery adds special importance to this place. Pop. 2,300. Electric bath. The water is said to be efficacious for rheumatism and brain disorders. Number of visitors: 19,375, the total stays being 96,795 days (1909). Inns: *Ara-ya*, *Kura-ya*.

Meteorological Observations.

Summary.

For the year, 1911.

Month	Air Temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity	
	Mean				Absolute							
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean	Dir.
January	2,89	6,35	-0,06	6,42	16,3	-3,8	79,13	45,6	22	117,3	3,09	N 21° E
February	3.94	7.42	0.76	6,66	15,0	-5,0	76,15	62,4	20	154,4	3,14	N 41° W
March	6,15	11,22	1,85	9,37	18,4	-3.3	76,5	94,82	26	197,6	2,82	N 23° W
April	10,6	14,91	6,29	8,62	28,1	-1,9	71,8	132,93	34	182,3	3.39	N 25° W
May	15,4	19.96	9,96	10,0	24,6	2,3	67,3	240,23	55	95 9	2,54	S 86° W
June	19,7	23,15	16,2	6,94	27,3	11,1	77,1	117,32	27	313.8	2,20	N 62° W
July	24,0	27,9	20,5	7,3	32,7	13,3	81,0	153.61	35	175,6	2,40	S 85° W
August	24,7	28,8	20,7	8,0	33,7	16,5	83,0	194,55	47	259,7	1.90	N 54° W
September	22,4	27,0	18,5	8.5	32,8	13,0	83,0	141,64	38	279,6	2,00	S 55° W
October	14,9	19,9	10,8	9,1	26,5	7,4	82,0	121,2	35	257,5	2,30	S 4° E
November	11,4	16,0	7,0	9,0	22,8	1,9	79,0	92,0	30	267,4	3,20	S 8° W
December	5.1	8,6	1.7	6,9	18,6	-1,9	87,0	55,2	18	187,8	3,10	S 3° E

Katayamazu is 2 m. N. W. of the *Iburi-bashi* station and can be reached by omnibus or *jinrikisha*. The spa (Pop. 500) lies on the lake side of *Shibayama-gata* (about 10 m. in circumference), and is 1,5 m. distant from the sea. The spring issuing from bed of the lake was found in the Era of Shō-ō (1652–5), but used first for bathing in 1883, after the shore of the lake had been partly reclaimed. The water is said to be efficacious for dyspepsia. The lake abounds in fish, especially terrapin (*dorogame*). Number of visitors: 12,378, the total stays being 32,833 days (1909). Inns: *Hoshi*, *Kami-ya*.

Meteorological Observations.

Summary.

For the year, 1911.

Month	Air Temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity	
	Mean				Absolute							
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean	Dir.
January	2,9	6,2	0,0	6,24	16,1	−2,7	63,0	57,18	19	68,9	0,59	—
February	4,3	7,03	0,97	6,06	—	—	79,8	71,7	23	85,4	0,96	N 76° E
March	6,72	10.7	3,02	7,68	19.5	−2,2	80,8	113,47	31	68,9	2,38	N 74° E
April	—	—	—	—	—	—	78,4	98,28	25	30,8	2,18	N 25° E
May	—	—	—	—	—	—	74,6	215,46	49	21,1	4,30	N 56° E
June	20,7	23.7	17,8	5,9	28,8	11,0	82,0	138,98	32	281,8	1,34	S 43° W
July	25,2	29,1	21,6	7,5	34,0	13,9	81,0	150,10	34	102,2	1,20	S 30° W
August	25,6	29.7	21,9	7,9	34,0	18,0	83,0	177,25	42	294,5	1,20	S 34° E
September	23,3	27,8	19,2	8,6	34,8	13 8	82,0	110,3	30	207,3	1,10	S 24° W
October	15,6	19,8	11,9	8,0	27,7	8,2	81,0	95.3	27	214,4	1,30	S 24° E
November	11,6	16,1	7,9	8,2	24,0	2,9	80,0	66,9	22	253,1	2,30	S 10° E
December	5,2	8,3	2,3	6,0	18,5	−0,7	85,0	—	—	223,1	2,60	S 29° E

Awazu (95,3 m. from *Maibara*, in 6 hrs.) is separated from the station of the same name, by a little over 2 m. and reached by horse-trams (fare, 12 *sen* special, 8 *sen* ordinary). Pop. 600. The water is believed to be efficacious for venereal diseases.

Sanko-dō ("Three Lakes Hall"), 2 m. from the station and 2 m. from the next station *Komatsu*, is so called from the three lakes or lagoons, *Kiba-gata*, *Shibayama-gata*, and *Imae-gata*, which may be viewed from here. Number of visitors: 28,704, the total stays being 96,879 days (1909). Inns: *Morimoto*, *Yude*.

Wakura, 6 m. to the N. W. of *Nanao* (40,8 m. from *Kanazawa*, in 3 hrs.), omnibuses, *jinrikisha* or steamships available, is one of the most noted spas in Japan for medical efficacy (for rheumatism, wounds, dyspepsia, etc.). The waters are alkaline, colourless, and somewhat bitter in taste, the temperature being as high as 183° F. The springs come out from the sea-bed close to the shore. The island of *Noto* and the smaller islands of *Tsukune-shima*, *Tane-shima*, *Kara-shima*, and others that lie in front of this town very much heighten the attractiveness of its scenery. On *Uki-shima*, which lies close to the shore, stands a small temple dedicated to the Goddess Benten. Number of visitors: 21,267, the total stays being 79,237 days (1909). Inns: *Wakasaki-kwan*, *Koizumi*.

Yuwaku (9 m. S. E. from Kanazawa) lies on the bank of the upper course of the *Asano-gawa*, at the foot of a mountain lying on the boundary of Kaga and Etchū. The water is claimed to be efficacious for syphilis. Number of visitors: 4,030, the total stays being 18,127 days (1909).

Tatsunokuchi (8,3 m. N. E. from *Komatsu* station on the Hokuroku Main Line) is situated on the S. bank of the *Tetori-gawa*. The water is said to be good for the treatment of diseases of the skin. Number of visitors: 11,361, the total stays being 50,595 days (1909).

Fukatani. 3 m. N. E. from Kanazawa and 7 m. S. from *Tsubata* station. The springs are believed to be efficacious for haemorrhoids. Number of visitors: 9,393, the total stays being 17,268 days (1909).

FUKUI=KEN

Awara is situated near the *Awara* station on the Mikuni Line (Kanatsu—Mikuni), a branch of the Hokuroku Main Line. The springs are located at the N. corner of the plain extending between Mikuni and Fukui, bounded by hills on the N. Before 1884 this region was a marshy ground grown with reeds, hence the name 'Plain of Reeds.' In consequence of floods in that year the hot springs were found. The sea bathing place of Mikuni is about 2,5 m. N. from the spa. Inns, 25 in number, are all provided with private baths. The spa is resorted to by people from Fukui and also from Kyōto and Ōsaka. Number of visitors: 20,083 (1909); 41,986 (1913).

MIE=KEN

Komono (Yunoyama Hot Spring) (11 m. N. W. of *Yokkaichi* station and 23,2 m. from Nagoya, in about 1 hr.) is at *Yunoyama*, close to the village of Komono. The place is surrounded
see Plate 44 on three sides by hills, while on the E. it offers a fine prospect of the bay and the hills of Owari and Mikawa beyond. A light railway leads as far as Yunoyama. In the upper course of the River *Mitake-gawa*, on which Yunoyama is situated, there is a waterfall called "*Ao-taki*," which is one
see Plate 45 attraction of that spring town. The hot water is believed to be efficacious for *kakke* (beri-beri), lung troubles, diseases of the stomach, etc. Number of visitors: 2,376, the total stays being 5,497 days (1909). Inns: *Kotobuki-tei*, *Ise-ya*.

Toba (81,8 m. from Nagoya, in 3 hrs. 42 min.). Formerly the castle town of the Daimyō Inagaki, Toba is a very pretty place, open to the sea toward the S. E., and surrounded by mountains on the N. W. The port, situated at the entrance of the Bay of Ise and right opposite to the Irako Promontory on the coast of Mikawa, is protected from rough seas by numerous pretty islets and is a haven of refuge for coasting steamers. Pearl culture:—Mr. *Mikimoto* carries on the pearl-culture industry with great success at Ago Bay, not very far from Toba, and at Toba he has made arrangements for showing foreign visitors the method of gathering pearl-oysters by female divers, *ama*. The female divers of Toba,—bare to the waist, their lower limbs clad in a red garment—who plunge into the deep sea and fish up pearl-oysters, are an exceedingly hardy race. They are certainly worth seeing. Castle site, now owned by the Navy Department, affords a very fine view of the sea and islands.

Hiyori-yama, literally 'Weather Hill,' is situated at the N. W. end of Toba port. It commands a splendid view, not only on the beautiful islet-studded sea in front (often compared to *Matsu-shima*), but also of the distant mountains of Shinano, Kai, and Suruga,—*Fuji* among others.

Hinoyama, about 4 m. from *Futami-ga-ura*, is within a few minutes' walk from Toba station.
see Plate 46 The extensive range of view from it and the superb excellence of its scenery rank it among rare scenic spots in this country. Tourists visiting Toba are advised to make ascent of this hill, as they are sure to be amply compensated for the time and exertion required. Recently the roads have been much improved to make the ascent easier and cottages built on the hillside for travellers who can take rest and have refreshments. Hinoyama is also known as *Kakehi-yama*, the name having been originated in the historical fact that Kuki Yoshitaka, a feudal lord who was a naval commander under Taikō Hideyoshi, designed to supply water to the castle of Toba from a spring on that hill by means of *kakehi* (bamboo tubes).

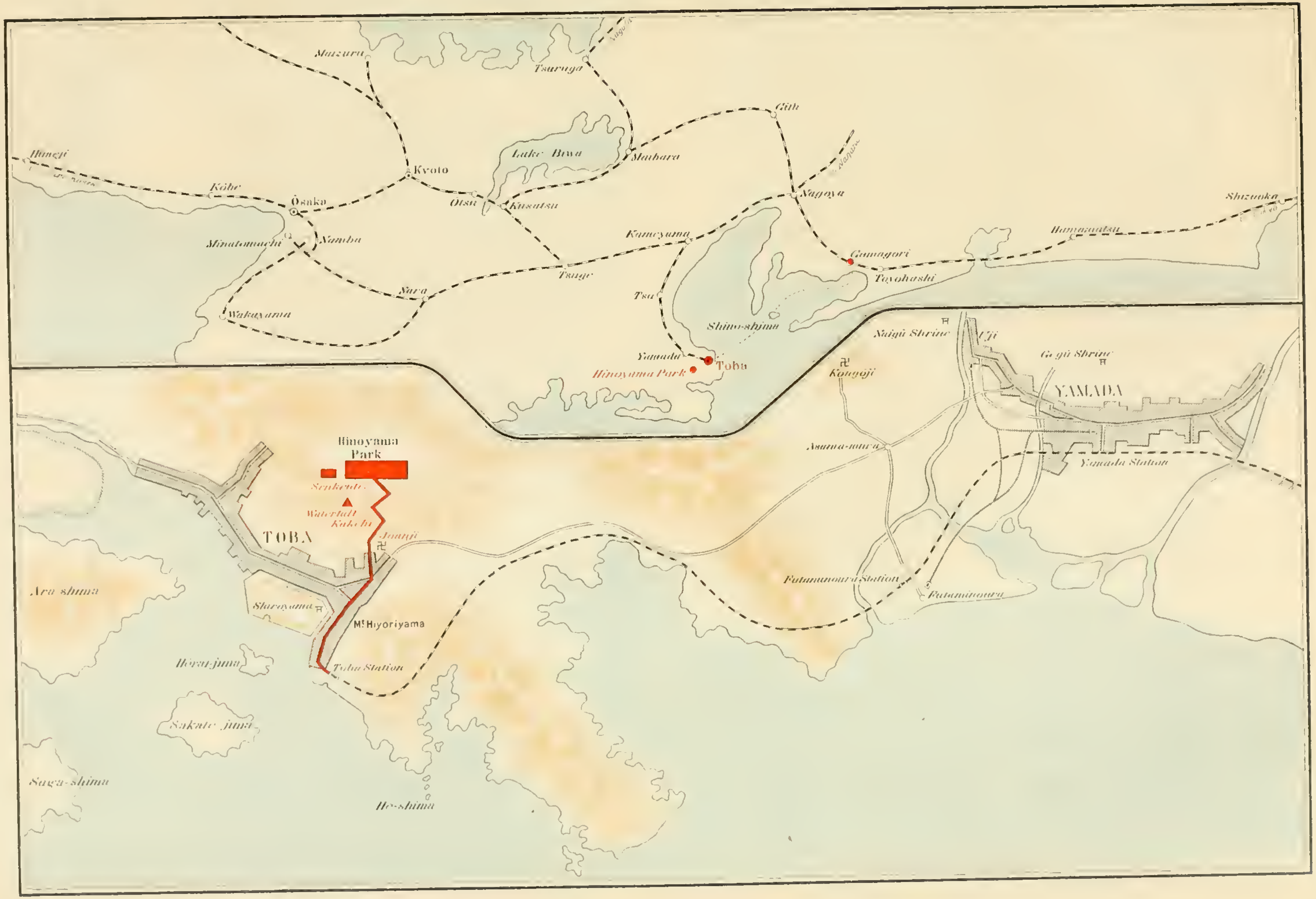
Toba, the "Town of Longevity." According to the recent report of the town headman, Toba has 1,233 houses and 6,419 inhabitants, of this small population happy people who are more than seventy years old number 220. It is not without reason that Toba is called the "Town of Longevity."

NARA=KEN

Rokuyō-Kōsen, 0,7 m. S. from *Nara*, is situated on the road '*Nabari-Kaidō*,' on the bank of a stream, the cold spring issuing from its bed. Number of visitors: 15,043 (1909).

Shiraya-Kōsen is on the S. E. of Mt. *Yoshino* (famous for cherry blossoms) and is situated
see Plate 47 on the upper course of the River Yoshino. The spa is on all sides shut in by wooded hills. The river abounds in "*ayu*" fish. Mineral water is said to be efficacious for dyspepsia, carcinoma of stomach, uterus diseases syphilis, gonorrhoea, consumption, etc.

THE HINOYAMA RECREATION-GROUND NEAR TOBA AND ENVIRONS.



WAKAYAMA-KEN

Sedo-no-Kanayama (Yuzaki). The spa lies 12,5 m. S. W. from *Tanabe* (75,4 m. S. from *Wakayama*). From Wakayama to Tanabe, *jinrikisha* available along the highway, or steamships; from Tanabe to the spa by ferry. The hot springs are located on the S. side of a small peninsula projecting from the W. coast of Kii. Here hot springs come forth partly from the beach and partly from the bottom of the sea, so that hot sand bath can be taken in this spa. One of these springs, called "*Kin-cki-sen*" or "*Saki-no-yu*," issues from the fissure of rocks close by the sea, forming a gourd-shaped bath-basin. The bath stands in the open air and bathers have a beautiful view of the surroundings. The spa affords also facility for sea bathing and those visitors may also amuse themselves with fishing. The climate being very mild, it is a delightful resort. Number of visitors: 5,339, the total stays being 44,597 days (1909). *see Plate 48*

Yunomine (Shimura-Onsen). 42 m. E. from Tanabe (Kii Province), no *jinrikisha* available. The springs are 2,6 m. S. W. from *Hongū-mura*, which lies on the bank of an affluent of the *Kuma-no-gawa*, 24 m. up from *Shingū-machi*. The place is enclosed on every side by mountains, and situated at an elevation of 630 ft. above the sea. These hot springs, 3 in number, prove efficacious in diseases of the skin, the water containing sulphide. The "*Tsubo-yu*" comes forth from a cave of rocks on the river bed, the cave itself forming a bath. It is so narrow that only one person can bathe in. Number of visitors: 5,985, the total stays being 15,614 days (1909). *see Plate 49*

Katsu-ura. Near the sea-port *Katsu-ura* on the S. coast of Kii Peninsula is **Soto-no-yu Hot Springs**, facing the sea on three sides and enjoying a mild climate both in winter and in summer. High cliffs stand close to the spa. The place has every facility for fishing and sea bathing. The adjoining sea is noted for whale-fishing. The slope of a hill behind the place is a recreation ground, open to the public, from which a charming view of the famous waterfall of *Nachi* can be obtained. *see Plate 50*

KYŌTO-FU

Kasagi (37,7 m. from *Minato-machi*, in 2 hrs. 18 min.) is rich in the beauties of mountain and stream. *Kasagi-Onsen* (205 ft. above the sea), 0,2 m. N. E. from the *Kasagi* station on the Kwansai Line and by the River *Kizu-gawa*, is a hot cabonated spring. Many people resort here, not only on account of the spa, but for the beautiful country life and the fishing in summer.

Kasagi-yama (0,1 m. from the station) is easily climbed, as it is but 0,5 m. from the foot to the summit. It is a famous spot, being the place where the Emperor Godaigo-Tennō took refuge when he fled from Kyōto. The temple *Kasagi-dera* (at the summit), where the Emperor once stayed, has since been almost entirely destroyed by fire. The temple grounds contain a large number of *ume* (plum) and cherry-trees, while the view of the surrounding country is splendid. There are also a number of large, singularly shaped rocks, to which various names have been given, such as *Yakushi*, *Miroku*, *Kokūzō*, *Kasagi-ishi* (the largest of these is about 150 sq. ft. in area). **Kasagi-ishi.** A story goes that the Emperor Temmu-Tennō (in the 7th century) was once caught in a tremendous rain-storm on this hill, when the Kokūzō-Bosatsu appeared and gave him shelter. The Emperor thereupon vowed to dedicate a temple to this deity, as a thank-offering for the kindness done him, and as a pledge he took off the hat he was wearing and laid it on a rock,—hence the name of the rock and the hill (*Kasagi* meaning "hat laying down"). The famous *Tsukigase* plum grove may be reached from the next station *Shima-ga-hara* (7,8 m. from Kasagi). The hot springs issue from the fissure of granite rocks on the *Kizu-gawa*. Number of visitors: 1,236, the total stays being 2,636 days (1909).

ŌSAKA-FU

Hamadera (9,3 m. from *Namba* station, in 30 min.) is a long sea-beach extending for 1,4 m.; it is covered with large pines and its scenery is supposed to fairly rival that at *Suma* and *Akashi*. The place is a favourite resort of Ōsaka people. Pop. 600. Bathers number about 800,000 per annum. *see Plate 51*

Meteorological Observations.

Summary.

Month	Air Temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity
	Mean				Absolute						
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean
For the year, 1911.											
June	21,9	26,0	17,9	8,1	29,5	13,5	79,0	147.3	34	288,8	—
July	25,3	30,8	21,4	9,3	34,9	17,1	82,0	245,2	56	220,1	—
September	24,2	29,6	20,3	9,3	35,1	15,7	81,4	199,7	54	188,3	—
October	16,4	22,3	11,5	10,7	27,5	6,5	73,4	185,6	53	69,5	—
November	12,1	17,7	7,0	10,7	22,6	1,2	71,8	173,5	56	68,1	—
December	6,8	11,8	2,1	9,7	20,6	-1,9	70,9	173,3	57	25,4	—
For the year, 1912.											
February	8,0	12,7	2,7	10,0	22,6	-3,3	73,8	154.4	49	132,7	—
March	8,3	13.3	3.3	10,0	21,5	-0,8	72,2	156,6	42	98,0	—
November	10,2	15,7	5,4	10,3	22,0	0,2	71.5	153.1	49	50,7	3,8
December	6,7	12,0	1.5	10,5	20,1	-1,9	73,1	146,5	48	109,2	5,2
For the year, 1913.											
January	4,0	8,7	-0,3	9,0	12,7	-3,8	70,4	150,6	48	51,3	5,8
February	5,0	10,0	0,7	9,3	17,3	-5,0	67,6	178,6	58	54,5	5,8
March	6,3	12,2	0,2	12,0	18,6	-4,0	68,8	219,2	59	51,6	4,2
April	14,1	20,0	8,7	11,4	27,1	0,0	74,5	181,0	46	70,9	3,7
May	16,5	22,4	10,8	11,6	29,3	4,6	74,8	230,3	54	189,3	3,0
June	21,5	25,6	17,8	7,8	30,3	11,7	77,9	180,6	42	116,7	3,0
July	25,4	31,1	20,7	10,3	34,9	13,2	73,6	281,3	64	24,2	3,7
August	26,2	32,5	21,0	11,5	36,1	17,8	72,6	246,7	60	81,7	3,2
September	20,9	27,0	16,0	11,0	32,0	9,7	72,3	198,7	54	68,1	2,7
October	15,9	22,6	11,3	11,4	27,5	3,8	74,8	205,2	59	173,1	3,3
November	9,9	17,0	4,7	12,3	21,9	1,0	71,8	181,8	59	98,0	2,7
December	6,4	11,8	2,2	9,5	18,9	-1,9	70,0	149,2	49	77,2	5,1
For the year, 1914.											
January	4,6	10,4	-0,3	10,7	18,0	-4,6	67,9	177,0	55	27,5	4,5
March	9,6	15,2	4,9	10,2	22,0	-1,5	74,0	—	—	159,6	3,4
April	12,0	17,2	6,9	10,3	24,5	1,0	72,3	—	—	80,0	3,4
May	18,4	23,6	13,4	10,2	27,9	4,0	77,1	—	—	236,0	1,9
June	22,1	26,7	18,0	8,7	32,2	13,7	80,3	—	—	187,9	1,9

HYŌGO-KEN

Takarazuka (15,6 m. N.W. from Ōsaka, in 53 min., by railway or by electric tram). The watering-place is situated on the W. bank of the *Muko-gawa*, at the foot of Mt. *Muko-san*, and at an elevation of 82 ft. above the sea. In the spa there are two springs, one on the left bank of the stream and the other on the opposite side, both being carbonated springs. Both the springs are only for public use. The inhabitants of Ōsaka and its neighbourhood resort to this place for amusement rather than for recuperation. A few years ago a large bathing-establishment with a swimming-tank was built here and since then the place has grown popular rapidly.

About 1 m. farther up the stream is also a carbonated spring. The water is bottled for export by the Clifford-Wilkinson Tansan Mineral Water Co. Number of visitors: 7,133, the total stays

The Principal Mineral Waters bottled for Sale and Export.

Wilkinson-Tansan.

Wilkinson-Tansan.

Reynell's
Hirano Water.

Nunobiki Tansan.

Nunobiki Tansan.

Hirano Water
(*Peacock Brand*).

Hirano Water
(*Mitsuya Brand*).

Hirano Water
(*Peacock Brand*).

being 138,285 days (1909); 161,512, the total stays being 28,000 days (1913). Hotel: *Takarazuka Hotel.* Inns: *Fundo-ya, Kotobuki-rō, Kiyama.*

Takarazuka Tansan Works. Over twenty five years ago a young Englishman, Clifford Wilkinson by name, was hunting near Kōbe. He came to a hamlet called Takarazuka and stopped to quench thirst at a deliciously cool, fragrant, sparkling spring, whose bright water gushed out of the ground under his feet. When he had finished his hunting expedition, his attention was drawn to the delightful taste of the water, and he brought back a bottle of it and presented his friends with it. He was gratified to learn how highly it was appreciated, for one and all decided that it was the best they had ever tasted. The next morning he went again to Takarazuka and carried back a big sack of filled bottles on his back. The waters were also demanded and satisfied by all his comrades. This was the beginning of the famous industry and since that occasion the Tansan factory was erected on the site of the wonderful spring at Takarazuka. The waters issuing from the big well, 29,5 ft. *see Plate 53* deep, built in by a two feet concrete wall surrounded by natural rock, flow down through three separate rows of filters, by which every impurity and iron oxide can be rid off. The factory has bottling, labelling, filling, corking and inspection departments, all being models of neatness and *see Plate 54* freedom from filth or dirt. In the bottle washing department every bottle is soaked for 15 min. in pure mountain water and afterwards brushed and rinsed inside and outside. The gas is produced from Brunner and Mond's bicarbonate of soda and sulphuric acid by the gas generators and pumps, the latest up to date machinery. The bottling machines are fitted with Automatic Feed Corking Appliances which avoid the corks being touched by hand. In the bottle examining and labelling department each bottle lies on the shelf for 24 hrs. or more and is then reexamined and packed. *see Plate 52* The Tansan Works cover about 4,000 *tsubo* (16,000 sq. yds.), the capacity of the spring about 40 million bottles per annum and the present output about 30,000 daily, 90 per cent of which is exported. Analyses have been made by the most celebrated analyst in Europe, in America, also in Ōsaka and Hongkong.

Hirano. The mineral springs are situated at *Hirano* in *Tada-mura*, Hyōgo Prefecture, about 8 m. N. W. from Ōsaka. The water issues from the crevices of rocks in a valley surrounded by *see Plate 55* hills and is claimed to have curative power for various kinds of diseases, such as chronic catarrh of the stomach and bowels, female diseases, anemia, lung and throat affections, etc. It is, however, used only for drinking.

The Imperial Mineral Water Co. The water bottled in this works is called Hirano Water from the name of the locality where it is produced, and has two brands, "*Mitsuya*" (Three Arrows) and "*Kujaku*" (Peacock). Hirano Water is noted for its hygienic properties as well as its being entirely free from alteration or fermentation. The Hirano spring dates back to 970. It was first known as the sacred water of *Tada* and, it seems, appreciated not only as a beverage but also as a panacea for all kinds of ailings. Towards 1881, some of the parties interested in the locality attempted to bottle the mineral water, but it proved a failure. The matter then came under the notice of an English expert Mr. Gallan in the employ of the Kawasaki Dock-yards, Kōbe. He persuaded some of his countrymen of furnishing him with necessary funds, and having made necessary preparations to make the water a common beverage, he offered it to the general public. This was in the year 1884. Subsequently the spring was owned by a Japanese millionaire, Mr. Iwasaki. In 1905 the enterprise was placed under the control of the "Mitsuya" Brand Hirano Spring Water Semi- *see Plate 56* Partnership Co. Again in 1907 the present Imperial Mineral Water Co. was organized by some *see Plate 52* prominent men with a capital of ¥ 600,000, and took over the management.

With regard to the equipment of the works, in addition to the appliances hitherto used, the company has purchased the machines of the most recent type, those used at the Apollinaris Works in England. The water is produced at the springs at the rate of 600,000 gallons per diem with 28,000 cubic feet of natural carbonic acid gas. The demand for Hirano Mineral Water is on the increase year after year, the output for the year 1914 amounting to 11,800,000 bottles, of which about 10 per cent is exported to foreign countries, especially to China, Australia, India and Java. Besides bottling the Hirano Water, the company also takes an active part in the sweet aerated water trade of Japan which business attains very considerable dimensions in the summer time when the demand for non-alcoholic beverages is largest.

Reynell's Hirano Water. The spring is situated at the same place, not far from the spring above mentioned. In 1884, Mr. Reynell imported the necessary machinery and began bottling the water for use. The flow of water from the spring is continuous, yielding a full supply all the year round. At present the water is bottled by the Hirano Mineral Water Co., Ltd. The works are fitted with modern and improved appliances for bottling the water, the capacity being a turn-out of 3,500 dozen bottles a day. The company has now considerably increased the export of the water to foreign countries including China, the United States, Strait Settlements, the Phillipines, Hongkong, etc., and the popularity of this water is yearly increasing.

Takedao (20,8 m. from Ōsaka, in 1 hr. 22 min.) is also a pretty spot with cold mineral springs. Between *Namaze* and *Dōjō*, which is the station next to *Takedao*, the trains run through a valley shut in by high hills over tracks of a very steep gradient, passing through eleven tunnels in a distance of 7,5 m. This part of the route is full of romantic scenery, and is compared by many to *Yabakei* of Ōita Prefecture. Visitors to Arima Hot Springs may alight here at *Sanda*. The spa is situated in a gorge on the bank of the *Takedao-gawa*, at an elevation of 340 ft. above the sea. Those wishing to avoid the discomforts of city life can live here quietly. Number of visitors: 1,802, the total stays being 6,705 days (1909).

Namaze (16,8 m. from Ōsaka, 1 hr.) is close by *Namaze* hot spring, and being surrounded on all sides by hills, forms a nice, quiet resort.

Nunobiki mineral spring is situated on the upper course of the *Shin-Ikuta-gawa*, at the foot of *Nunobiki-yama*, where is the reservoir for the water system of Kōbe. The famous waterfalls *Nunobiki*, of which the lower called *me-daki* is 43 ft. high and the upper called *o-daki* 80 ft., are splendid views.
see Plate 57 The place is one of the most delightful spots in the vicinity. The water is bottled by Nunobiki Tansan Works for sale.

Arima. There is a highway from Kōbe, via *Tennō-goe*, 14 m. on which *jinrikishas* are available (fare, Y 1,50), or the visitors may go by train to *Sumiyoshi*, whence *yama-kago* or Sedan chairs are available (fare, Y 1,40) across *Rokkō-zan* 7,3 m.). Those from Ōsaka will naturally take the Fukuchiyama Line as far as *Namaze*, whence *jinrikisha* for 6,8 m. to the spa town (fare, 70 *sen*), or railway as far as *Sanda*, whence 6,8 m. to Arima by *jinrikisha*, the fare being 50 *sen*. The spa
see Plate 58 town is situated in a valley surrounded by Rokkō-zan and other hills, being open only to the N. The place itself, being 1,155 ft. above sea-level, is cool in summer, the mercury never rising above 85° F. while in winter the temperature is comparatively warm (35° F. on the coldest days). The town contains about 400 houses, with a population of 2,000. The local specialties are basket-ware, Arima-earthen-ware, etc. The spa town has been famous throughout Japan from time immemorial. Special bath-houses have recently been built (fee, 20 *sen* per bath). The water is alkaline, containing a large quantity of iron, salty in taste and turbid in colour, making reddish-brown deposits. The water is said to be efficacious for dyspepsia, uterus diseases, consumption, diseases of the skin, etc. The place also possesses a mineral spring (called "*Teppō-sui*"), containing carbonic acid gas, the water of which is bottled and exported. Among temples, *Onsen-ji*, *Onsen-jinja*, and *Zempuku-ji* may be visited in the course of a walk.

Tsutsumi-ga-taki is a small waterfall (30 ft. high) in a pretty neighbourhood, which is especially beautiful in autumn. *Kado-yama* is a hill to the N., also called *Arima-Fuji* on account of its likeness to Mt. Fuji. Number of visitors: 10,132, the total stays being 64,605 days (1909); 9,793, the total stays being 40,455 days (1913). Inns: *Hyōe*, *Ikeno-bō*, *Nikai-bō*, *Gosho-no-bō*, *Naka-no-bō*; Hotels for accommodation of foreigners: *Sugimoto*, *Masuda* and *Arima*.

Kinosaki (99,2 m. from Kyōto, in 5 hrs. 30 min.) is a popular spa town, the hot springs having been known since the 7th century. The town is situated at the foot of a hill called *Kuruhi-*
see Plate 59 *dake*, on the W. bank of the *Asago-gawa* (the lower course of the *Maruyama-gawa*) and within 2 m. of the sea-port of Tsuiyama. Kinosaki is noted for its beautiful scenery and salubrious climate. The spring water is colourless and alkaline. Products:—articles made of mulberry-wood and straw fancy-goods. Places of interest: **Onsen-ji**, a buddhist temple, half-way (about 0,3 m.) up the hill *Kanro-hō*, to the W. of Kinosaki, is believed to have been founded by Dōchi-Shōnin, who discovered *Mandara* hot spring, during the Yōrō Era (717–23). Within the temple grounds are two smaller shrines, dedicated to *Kan-on* and *Yakushi*. *Hiyori-yama* is a hillrock, N. of Kinosaki, which has recently been turned into a public park. It commands an excellent view of the surrounding regions and of the sea.

Gembu-dō, or basalt grottoes, are situated on a hillside about 2,4 m. from Kinosaki, on the road to Toyo-oka. They may easily be seen from the train, on account of their curious formation. In fact the train stops here at certain times during the year. There are three grottoes, the one on the left-hand side being 78 ft. wide at the entrance and 102 ft. deep. The middle one is 72 ft. wide at the entrance and 84 ft. deep, and drops of water trickle down its walls collecting into a transparent pool below. The right-hand one is 78 ft. wide at the entrance and 102 ft. deep, and outside the grotto, right over the entrance there leaps a waterfall. Looked at from a little distance these grottoes indeed present a curious sight; the way thousands of these basalt pillars* stand clustered together, or piled up one upon another, gives them the appearance of a colossal bee-hive. On the left-hand side of the grottoes, there appear cut deep into the rock the three Chinese characters "*Gembu-dō*," the facsimile of the hand-writing of a famous scholar-poet, *Shibano Ritsuzan*.

*Professor S. Shiga in his "Natural Scenery of Japan" says: "Of the basalt pillars found in the country the most noted are those at the *Gembu-dō* in Tajima. They are in shape octagonal, heptagonal, hexagonal, or pentagonal, jet black and flinty in appearance, and 20 to 30 ft. long. They may be counted by the thousand, each pillar showing a cleavage at every foot or 8 inches throughout its length, thus giving the appearance of a post composed of slabs. If taken out one by one, they would make excellent building material, cut to order, and with the finest touch of nature's workmanship."

Number of visitors: 25,351, the total stays being 291,165 days (1909); 41,435, the total stays being 181,993 days (1913). Inns: *Yuto-ya*, *Miki-ya*, *Nishimura*.

Yumura. 5 m. S. from *Hamasaka* station on the San-in Main Line (124 m. from Kyōto, in 6 hrs. 45 min.), *jinrikisha* available. The spa is situated on the N. W. portion of Tajima Province, on a highway, at an elevation of 150 ft. above the sea. Close by the right bank of a small stream called *Haruki-gawa* gush out several boiling hot springs, of which one is now used for bathing. *see Plate 5, fig. 5* Another one, which issues near the edge of water, is called *Ara-yu* on account of its violent force. The discharge of water is considerable and the spring is used by the villagers for boiling their foods *see Plate 8, fig. 2* and also for softening vegetable fibres. Eggs can be half-boiled for about 2 minutes, while it requires 3–4 minutes to have coagulated. The spring is distinguished by its abundant flow of water as well as by its high temperature (93–5° C.).

In cold days the place, where the spring gushes out, is entirely covered with vapour, so that nothing is visible in the neighbourhood. Several persons have been wounded by falling into boiling water. The water of the stream being warmed by the spring, a washing-place is provided at the *see Plate 8, fig. 4* foot of the bank for the use of villagers.

TOTTORI-KEN

Iwai. 2,4 m. from the *Iwami* station (132,7 m. from Kyōto, in 7 hrs. 17 m.). *Uradomi* and *Ajiro* are little sea-ports close to Iwami. The sea between these two places is dotted with innumerable pretty islands and is known as the Matsushima of the Japan Sea; the most noteworthy of these islands are *Sengwan-matsu-shima* and *Natane-jima*, the former so called on account of its beautiful pines and the latter on account of its being covered in spring with the yellow blossoms of *natane* or rape-seed plants. The spa is the most noted in Tajima Province and lies at an elevation of 40 ft. above the sea. There are 1 public bath and 8 private baths in the spa. Pop. 855. Number of visitors: 3,014, the total stays being 30,451 days (1909). Inn: *Kishima-ya*.

Tottori (114,1 m. from Kyōto, in 8 hrs.) is the capital of Tottori Prefecture, and the next city in importance to *Matsue*. It is situated in the valley of the *Sendai-gawa*, in the E. part of Tottori Prefecture. Formerly a castle-town of the Daimyō Ikeda, the city greatly declined after the Restoration, but with the recent opening of railways it has entered upon new era of prosperity. Tottori has 32,682 inhabitants (6,422 households); its busiest streets are along Wakazakura-Kaidō and Chizu-Kaidō.

Yoshikata Hot Springs are at a distance of 0,8 m. from the station. The springs were found by chance in 1906 when the ground was bored by a proprietor of a factory to get water for a boiler. Since then several springs have been found and bath-houses built. The water here is pumped up, heated, and then conveyed to bath-tanks. Number of visitors: 5,160, the total stays being 6,292 days (1909). Inns: *Tottori-Onsen*, *Takasago-Onsen*.

Yudani (12 m. S. from Tottori) is situated in a mountain-glen, at an elevation of about 300 ft. above the sea. The discovery of the cold springs dates back to the age of mythology, but the place has been almost neglected owing to the uneasy access and the low temperature of the spring. Number of visitors : 101, the total stays being 500 days (1909).

Yoshioka. 7 m. W. from Tottori, and 5 m. S. W. from *Koyama* station, next from Tottori. The hot springs are situated on the S. W. part of Lake Koyama, enclosed on three sides by hills. Besides the 6 main springs, there is also a sulphur spring "*Eta-no-yu*," especially provided for the lowest class of people, *eta* (outcasts). Number of visitors : 3,216, the total stays being 11,793 days (1909).

Koyama (146,8 m. from Kyōto, in 8 hrs. 6 min.) is a station whence it is 1 m. to Lake *Koyama-ike*, 9 m. in circumference, the 4th largest in this district. The lake contains seven pretty islets, and its fine scenery may be enjoyed from a railway train. Karo Port is situated N. E. of the lake on the estuary of the *Karo-gawa*. The harbour is shallow and offers no anchorage for large vessels. It is, however, an important port in Inaba Province, there being a regular steamship service to and from *Sakai*. The place is an important fishing centre.

Hamamura (154,9 m. from Kyōto, in 8 hrs. 29 min.) is a spa town known as *Hamamura-Onsen*. On the opposite side of the railway line is found another hot spring, *Kachimi-Onsen*. Number of visitors : Hamamura—700, the total stays being 900 days (1909); Kachimi—75, the total stays being 300 days (1909).

Matsuzaki (165,5 m. from Kyōto, in 9 hrs.) is close to *Tōgō-ike* (lake) and the hot springs. This beautiful lake produces an excellent kind of eel largely sent to Kyōto and Ōsaka. The hot springs, two in number, are found on the banks of the lake ; the one on the N. side being called **Tōgō-Onsen** and the other on the S. side, **Asōzu-Onsen.** Tōgō-Onsen gushes up from the bottom of the lake, 0,3 m. from the station (Inn : *Yōjyō-kwan*). The Tōgō Hot Springs are conveniently located and afford every facility for boating, sailing, and fishing. The place is resorted to by the citizens of Matsue and Tottori during the summer season. Asōzu-Onsen (Inn : *Asahi-kwan*) is 2,4 m. from the station, with a ferry service between. Number of visitors : Tōgō-Onsen—1,272, the total stays being 1,425 days (1909); Asōzu-Onsen—305, the total stays being 1,800 days (1909).

see Plate 5, fig. 2

Misasa. 5,5 m. from *Agei* station (168,9 m. from Kyōto, in 9 hrs. 15 min.) on the San-in Main Line, and 5 m. S. E. from *Kurayoshi*. The spa is delightfully situated on the W. bank of the *Misasa-gawa*, which being originated in the boundary of the three provinces, Inaba, Hōki, and Mimasaka, flows from the E. to the W. The place has wooded hills on two sides, N. and S., and is about 50 ft. above the sea. Though the place itself forms a flat land with slight inclination, it has only a limited area, not more than 1 m. in length and some 0,2 m. in width.

see Plate 60

In this small space gush out in series a large number of hot springs of high medicinal value, their sources being located mostly near the stream. No less than 30 springs are found in the village, not very distant from one another. All these springs belong to simple thermals, except *Naka-no-yu* which contains sulphides. The temperature of these springs ranges from 45°–75° C. and the flow of water is abundant. There are 4 public baths, and the most noted one called "*Kabu-yu*" or "Stump Bath" is on the outskirts of the village a small distance (0,2 m.) up the stream from the others located in the centre of the spa. This spring was so named from the tradition that one day a white wolf dag the root of an old oak-tree out of the ground, and went to sleep on the stump as his pillow, which enabled people to notice the warmth of the spot. Then they began to bore the ground and discovered the hot spring.

The spring is said to have been found by the inhabitants in the 2nd year of the Chōkwan Era (1165 A.D.). Formerly it was called "*Makura-kabu-yu*," but now simply "*Kabu-yu*" or "*Moto-yu*." It was in the 1st year of the Shōhō Era (1644 A.D.) that the existence of springs in the village proper was first noticed by the inhabitants. Since then many springs have been found and thus there are more than 30 baths at present in this small village. Besides the inns with private baths, there are several houses provided with baths of their own. The rise of gases is observed at every spring, their amount being somewhat different. The water proved exceedingly efficacious for certain cases of dyspepsia, haemorrhoids, diseases of the female genital organs, especially so for rheumatism and neuralgia. This fact can be explained, though not wholly, from the results of our examination of the spring with regard to their radio-activity. As easily seen from the tables previously inserted in this book, the water of these hot springs is generally of strong radio-activity and sometimes contains the largest quantity of radium emanation of those of all hot springs in Japan. Taking also the temperature and discharge of water into consideration, the spa affords the best advantage for the so-called emanation therapy.

On the opposite bank of the *Misasa-gawa*, which separates *Yamada-mura* from *Misasa proper*, gushes out another spring "*Yamada-Onsen*." There are two baths, the one being for public use and the other for private. From a bridge, "*Ō-iwa-bashi*" or "Big Rock Bridge," which spans the Misasa-gawa at the W. end of the village, an abyss called "*O-iwa-buchi*," bounded with huge rocks, may be seen below. A precipitous and rocky hill, "*Kompira-yama*," grown with old pines, standing on the N. bank of the stream, presents a fine view from Misasa spa. A narrow gorge behind the hill has another spring and is called "*Yu-dani*," meaning 'Hot Spring Valley.' The village of Misasa has a population of about 500 (90 households). Post, telegraph, and telephone office. *see Plate 11*

A highroad, *Anagamo-Kaidō*, leads from Misasa to *Tsuyama* (45,1 m.) via *Monzen-mura*, the mountain pass of *Ningyōyama-tōge* and **Okutsu** hot springs. About 3 m. E. from the spa is *Sambutsu-ji*, a famous Buddhist temple, situated at Monzen-mura, *jinrikisha* available thereto. The temple, which belongs to the Tendai Sect, was founded by *En-no-gyōja*, who some 1,200 years ago first explored the mountain. Ascending the mountain, at the foot of which the temple stands, we come to *Monju-dō* and *Jizō-dō* (shrines) and a belfry. Ascending still farther we come to *Oku-no-in*, or the innermost shrine, which is within huge cave. This is popularly called *Nageire-dō* or "Thrown-in Shrine"—meaning that the shrine was first constructed outside and inserted as a whole. This shrine, together with the other shrines above-named—*Monju-dō* and *Jizō-dō*—as well as their archives are under the "special protection" of the government, while the image of the *Zō-ō-Gongen* and a copper mirror owned by the temple are registered as "National Treasure." *see Plate 11, fig. 3*

Kurayoshi, which is a town of considerable importance (Pop. 8,000), being the trading centre for the E. half of Hōki Province. Products:—raw silk, grey cotton, rice-husking implements, *kasuri* (blue figured cotton fabric). The town is also noted for its beautiful Park *Uchibuki-Kōen* which occupies the site of the former castle. It is a fine specimen of landscape-gardening, and has a public meeting hall. *Agei* station is about 3 m. N. E. from Kurayoshi and reached by light railway in 13 min. *Sekigane* Hot Springs can be reached from Kurayoshi along the Sekigane-Kaidō, which leads to Tsuyama via the mountain pass of *Ōhazama*.

Misasa-Onsen is visited mostly by the inhabitants in the neighbourhood, but also by people from the Prefectures of Okayama, Hyōgo, and Shimane. Number of visitors: 2,515, the total stays being 8,957 days (1909). The high value of the water has been known for a long time to the native inhabitants, but not yet brought to public notice. The locality is well suited for being a pleasure resorts, and better still, the water is exceptionally strong in radio-activity. It is hoped that some arrangements will be made to employ water in every form of application at the fountain source, and conform with the other conditions that modern emanation therapy requires, and also providing necessary accommodation for visitors of higher classes.

Sekigane. 6,5 m. S. W. from *Kurayoshi*, *jinrikisha* available. The spa is situated on the E. bank of a narrow gorge of the *Tenjin-gawa*, at an elevation of about 500 ft. above the sea. It has 750 inhabitants, 8 baths, and 5 inns with private baths. The discovery of the spring dates back to the Era of Enryaku (782–806). On the temple-grounds of *Jizō-in* near the spring there is an old Bo-tree (*bodaiju*), 15 ft. in circumference, its branches and leaves extending over the bath-house, which is noted for its curious shape resembling an umbrella. The place is the site of the castle of a Daimyō Yamana, and is now a park (*Kamei-Kōen*), from which may be obtained a fine view of *Daisen*, the highest mountain in the San-in-dō. The water is said to be used beneficially for the treatment of rheumatism and diseases of the skin. Number of visitors: 1,875, the total stays being 3,891 days (1909).

Kaike. Near the mouth of the *Hino-gawa*, 2,5 m. N. E. from *Yonago*, hot springs gush out of the bottom of the sea, about 1 m. off the shore. The water is conducted by pipes into baths.

SHIMANE-KEN

Tamatsukuri is the most noted hot spring in Shimane Prefecture, about 1,3 m. S. from *Yumachi* station (223,8 m. from Kyōto, in 12 hrs.) on the San-in Main Line. It lies on the banks of a small stream at the base of *Kwasen-zan*, which produces red and blue agates, the latter being highly prized on account of rarity. *Tamatsukuri-jinja* stands at an end of the spa, and beautiful Lake Shinji is visible from the place. The spa is resorted to by the citizens of Matsue. The air temperature lately measured by the village office is as follows:— *see Plate 5, fig. 1*

Month	Min.	Max.	Month	Min.	Max.	Month	Min.	Max.
January	48,5°	51,2°	May	64,3°	71,3°	September	74,7°	83,8°
February	45.0°	49.6°	June	73.5°	77,0°	October	64,1°	60,7°
March	45.5°	55,9°	July	71,6°	82,4°	Novemder	53.9°	56,3°
April	61,2°	63,4°	August	86,7°	87,7°	December	47,2°	54.9°

Number of visitors : **7,550**, the total stays being **8,510** days (1909). Inns : *Hosei-kwan*, *Tōfu-ya*. *Matsue*, noted for beautiful scenery, is about 3,3 m. from the spa.

Matsue (219,7 m. from Kyōto, in 11 hrs. 49 min.; Inns : *Minami-kwan*, *Iwata*, *Ichimonji-ya*, *Akagi-kwan*) is situated at the W. end of a narrow strip of land lying between Lake *Shinji-ko* and *Naka-no-umi*, being pierced by the *Ōhashi-gawa* which connects the two lagoons, while in the background rise the Shinji hills. The city was founded by the Daimyō *Horio* in the 17th century, when he received this region in fief from *Tokugawa Iyeyasu* and built his castle on the Gokuraku-ji hill. Since then the place has changed its master twice, the last Daimyō who held it being *Matsudaira*. Matsue, being thus situated by a lake and river, enjoys many facilities of communication and transportation. Thus equipped the city forms a most important distributing centre and with a large population (36,209) is justly regarded as the first metropolis of the San-in District. Besides, it is rich in natural scenery and is considered by some to resemble Geneva, Switzerland. From the famous bridge, *Ōhashi* (more than 600 ft. long), the view takes in Lake Shinji-ko, Naka-no-umi, Mt. Daisen, and Sambe-yama, while the houses on the shores of the lake are reflected in its clear waters.

Lake Shinji-ko. The lake, which is 9,8 m. from E. to W. and 3,7 m. from N. to S., is 31,9 m. in circumference. It is the 6th largest lake in Japan. The Magata Channel connects it with *Naka-no-umi*, while the *Sada-gawa* constitutes its outlet to the sea. The lake abounds in carp, gibel, *suzuki* (a kind of perch-sea-wolf), and white-bait (*shira-uwo*). The suzuki found in Sung-kiang, in China, which are so justly famed—with large mouth, small scales, and double set of jaws. *Kugedo-no-iwaya*, or the " Divine Cave of Kugedo," is situated at a point 7,3 m. from Matsue, in a cliff projecting 100 ft. into the Japan Sea. Its opening is just large enough to admit a small boat, but it becomes roomy inside. As one finds oneself inside, the echoes of the sound of angry waves resounding from the walls will be almost deafing and unbearable. The cave is believed to have been the birth-place of the god *Sada*.

Gakutō. 0,5 m. S. from *Shōbara* station and 13,6 m. W. from Matsue. The spring is located on a rice-field and has nothing attractive in the neighbourhood.

Ushio. 11 m. S. E. from *Shinji* station and 8 m. S. from Matsue. The spa lies on the S. bank *see Plate 61* of the *Ushio-gawa*, at an elevation of **300** ft. above the sea and 2,5 m. distant from *Daitō-machi*. The water being lukewarm, a cylinder filled with charcoal is laid in it to keep its temperature. The spring comes forth from a crevice of rocks, which form the bottom of the bath, and bathers drink fresh water direct from this crevice by bamboo pipes. The water is claimed to be efficacious for wounds, diseases of the skin, and rheumatism. Number of visitors : **2,153**, the total stays being **6,629** days (1909).

Yumura. 17 m. S. from Shinji station and 27,7 m. from Matsue. The spa is situated on the bank of the *Ii-kawa*, at an elevation of **600** ft. above the sea. Here springs gush out from a crevice *see Plate 6, fig. 4* of granite rocks close by the stream and bath-house is built direct over the source of springs. It is a quiet watering-place in Izumo Province. Number of visitors : **350**, the total stays being **912** days (1909).

Kawai. 3,7 m. S. E. from *Ōta-machi* and 3,8 m. S. W. from Matsue. The place lies on a road leading to *Shigaku* Hot Springs, at an elevation of **300** ft. above the sea.

Tōkōji spring is claimed to be efficacious for chronic catarrh of thes tomach and the intestines, disorders of the female genital organs, and brain diseases, while **Urisaka** spring, 1,4 m. distant from Tōkōji, is said to be used beneficially for swellings, diseases of the skin, catarrh of the stomach and the intestines, etc.

Ikeda (9,7 m. S. E. from Ōta-machi) lies on the road leading to Shigaku, at the foot of *Sambe-yama*.

Koyabara (11 m. S. E. from Ōta-machi) lies at the foot of Sambe-yama, at an elevation of **900** ft. above the sea. *Shigaku-Onsen* is 5 m. S. E. from this place. The production of gas from the spring is abundant and the water is conducted into the bath by wooden pipes, laid about 15 ft. under the ground. Number of visitors : **310**, the total stays being **577** days (1909).

Shigaku. 12 m. S. E. from Ōta-machi (7,3 m. S. W. from *Oda*, the terminus of the San-in Main Line, automobile service once daily); from Ōta-machi to the spa *jinrikisha* available. The spa is situated on the S. E. slope of *Sambe-yama* (4,600 ft.), at an elevation of 1,500 ft. above the sea. It has a Pop. of 109 (36 households) and 3 inns with baths. A beautiful, panoramic view of the surrounding mountain ranges in the distance may be had from the place. The view of groups morning mist, which hover over the valley of the *Gō-gawa* like so many islands in the air, is one of the eight sights of Shigaku. *Mt. Sambe* is noted for its curious shape, resembling three pots standing upside down, and with its foot forming a vast plain of lava. This mountain is dotted with pine-trees and presents a fine view. The foot of the mountain is now used as parade grounds for an Artillery of the 5th. Division of the Army. A beautiful mountain lake called *Ukinuma-ike* is at the S. end of the plain. The ascent of Sambe-yama (an extinct volcano) is a delightful excursion from the spa. Near the old crater there are several spots emitting carbonic acid gas. Hot springs gush out from some caves on the slope of Sambe-yama, about 0,6 m. from the spa. The flow of water is remarkably abundant, and forms a rivulet of hot water in the valley, by which mills are worked. *see Plate 5, fig. 4* *see Plate 6, fig. 1*

The inner surface of the wooden conduits which convey hot water, gets gradually covered with a thick layer of incrustation, which is to be removed every two or three years. This incrustation is refined and many ornamental articles may be made of it. It is recorded that the spring was formerly lukewarm, but since the great earthquake of Iwami Province, experienced in 1873, its temperature has considerably hightened. The springs are believed to be efficacious for diseases of the stomach and the intestines and disorders of the female genital organs. The spa being situated very high, is one of the most lovely summer resorts in the whole San-in district. Number of visitors: 3,174, the total stays being 10,030 days (1909). *see Plate 1, fig. 2 and 3*

Tombara lies on a highway, which leads from Matsue to Hiroshima, at the N. foot of *Kotobiki-yama* (3,400 ft.), at an elevation of 1,400 ft above the sea.

Kasubuchi (5 m. S. E. from Shigaku) lies on the N. bank of the *Gō-gawa*, on a highway leading from *Ōmori* to *Miyoshi*. The water has not yet been used for any purpose.

Yunotsu, 7,2 m. S. W. from Ōmori silver mine, is a sea-port lying between *Hamada* and *Kizuki*. On account of easy means of access from the neighbouring sea-ports, the spa is much resorted to by their inhabitants. The water is believed to be efficacious for diseases of the skin, dyspepsia, and uterus diseases. Number of visitors: 6,540, the total stays being 26,080 days (1909).

Fukumitsu (2 m. S. W. from Yunotsu) lies at an elevation of 300 ft. above the sea. The water is claimed to be beneficial for diseases of the skin, dyspepsia, and uterus diseases.

Arifuku (11 m. N. E. from Hamada) is situated in a gorge, at an elevation of 900 ft. above the sea, along the highway leading Ōta-machi to Hamada. Number of visitors: 9,308, the total stays being 27,893 days (1909).

Mimata is but a poor bathing-place near Arifuku.

Hirose (8 m. S. from *Arashima* station on the San-in Main Line) was found a few years ago and has now two inns and one public bath.

OKAYAMA-KEN

Okayama (240,2 m. from Shimonoseki, in 9 hrs. 10 min.; 89,1 m. from Kōbe, in 3 hrs. 6 min.) is a city with a population of 94,000 (16,500 houses), situated on the lower course of the *Asahi-gawa*, 7,3 m. from its mouth, in the middle of a wide plain, with low hills on the N. side.

Chūgoku Railway. Tsuyama Line: from Okayama to *Tsuyama* 35,3 m. in 2 hrs. 15 min. Tsuyama is a large town (Pop. 16,500) on the way to the San-in-dō. From this town on to *Yonago* (61 m.) there is a famons road called "forty times zigzagging path" ('*Shijū-magari*'), over which *jinrikisha* with two pullers can hardly pass; there are highways also to Tottori (50,8 m.) via *Chizu*, and to *Kurayoshi* (47,7 m.) via *Ningyō-sen* Pass.

Yunogō. 14 m. S. E. from *Tsuyama* (terminus of the private Chugoku Railway which runs between Okayama and Tsuyama) via *Kurashiki* in Bitchū Province. Coming from the E., the spa may be reached from *Wake* or *Kamigōri* station on the San-yo Line. The spa is situated on the W. bank of the *Yoshino-gawa*, at an elevation of 240 ft. above the sea. Springs issue from a fissure of rocks, upon which a bath was constructed. The emission of gas is abundant. On account of the low temperature of water bathers remain usually in it for a very long time, generally for

2–3 hours, sometimes even for 6–7. It is not seldom that some inhabitants of the village sleep in bath through the whole night. The gas being almost nitrogen, the Yunogō Springs furnish a valuable thermal effervescing bath, slightly alkaline and salt, at 35° C. On entering such an effervescent bath below skin temperature there is a momentary chilliness, soon succeeded by a sence of prickling or warmth, due to the collection of innumerable bubbles on the skin. The increasing feeling of warmth soon overcomes the feeling of cold, because the relative heat of the gas more than neutralises the relative coolness of the water.

The discovery of the spring dates back to the Era of Jōkwan (861 A.D.) and the water is said to be efficatious especially for bruise, wounds, fractures, itches, etc. The spring water is barrelled and transported to the neighbouring town, especially to Ōsaka for bathing purpose. There are 1 public bath and 1 inn with baths in the spa. Number of visitors: 11,075, the total stays being 35,860 days (1909).

Maga (27 m. W. from Tsuyama and 5 m. from *Katsuyama*) lies on the W. bank of the upper course of the *Takeda-gawa*, at an elevation of 940 ft. above the sea. During the summer months the citizens of Okayama resort to the spa. Number of visitors: 6,470, the total stays being 14,930 days (1909).

Yubara (6 m. N. from Maga) lies on the upper valley of the *Asatsu-gawa*, surrounded on the E. and W. by mountains, at an elevation of 950 ft. above the sea. It is also a summer resort.

Kaidani (2,5 m. N. from Okayama) lies along the highway leading from Okayama to Tsuyama. A cold spring is located in a narrow gorge.

Takebe, about 0,4 m. S. E. from *Fukuwatari* station on the private Chūgoku Railway (18,8 m. from Okayama, in 1 hr. 53 min.), lies on the W. bank of the *Asahi-gawa*, 209 ft. above the sea and opposite to Fukuwatari. Number of visitors: 112, the total stays being 917 days (1909).

HIROSHIMA-KEN

Tomo (8,5 m. from *Fukuyama*) at the S. E. extremity of a small peninsula, and 5,5 m. by sea from *Onomichi*, is an old port now little frequented by steamers on account of its shallow waters, but which was in olden days a very important voyage station, where are entertained on their passage all the messengers from foreign countries (e. g. Chōsen) to the Court of Japan. There are numerous
see Plate 62 picturesque islands in the neighbourhood of Tomo, the most famous among them being *Sensui-tō*. *Fukuzen-ji* (Buddhist) and *Nanakusa-jinja* (Shintō) are both noted for fine scenery. Tomo is famed for *hōmei-shu*, a kind of liquor. **Abuto Kwan-on** (2,4 m. S. W. from Tomo), a temple dedicated to Kwan-on, or the Goddess of Mercy, stands on the top of a craggy promontory (*Kwan-on-zaki*). The temple, 28 metres high, is reached by a covered pathway of steep stone steps and commands a view of unsurpassed beauty.

YAMAGUCHI-KEN

Yuda is on the Light Railway running between *Yamaguchi* and *Ogōri*, about 2 m. S. E. from Yamaguchi. The place has a sanatorium of the 5th Division of the Army (Hiroshima). Number of visitors: 7,868, the total stays being 14,599 days (1909).

Kawatana (17 m. N. from *Shimonoseki*) is on the highway, which leads from Shimonoseki to the villages on the N. coast of Nagato Province, about 1,3 m. distant from the sea. Springs issue from a granite formation, the water being radio-active and noted for its efficacy all over the province. Number of visitors: 914, the total stays being 3,428 days (1909).

Fukawa. 15 m. N. from the nearest station on the Ōmine Line (Asa—Ōmine) and 5 m. S. W. from the sea-port of *Senzaki*. The place is on the highway, which leads from *Ozuki* to Senzaki via *Tawarayama*, on the bank of a stream, and at an elevation of 200 ft. above the sea. Springs, two in number, were found in the 36th year of the Ōshō Era (1428). *Fukawa-yaki*, a kind of pottery produced in this village, is noted in the neighbourhood.

Tawarayama (22 m. N. from Ozuki station on the Sanyō Line) lies on the highway leading to Senzaki via *Fukawa-Yumoto*. The place is shut in on every side by mountains and about 1,000 ft. above the sea. The spa is one of the most famous resorts in Nagato, visited mostly by the inhabitants of the Sanyō district. Number of visitors: 9,334, the total stays being 67,999 days (1909).

EHIME-KEN

Matsuyama (5,9 m. from *Takahama*, in 34 min.) is the capital of Ehime Prefecture, with a population of 44,166, and has become well known as a place where a large number of Russian captives were quartered in 1904–5. It has light railways running in different directions to Dōgo, Gunchū, Morimatsu, Yokogawa-mura, and Takahama.

Dōgo is situated about 1 m. N. E. of Matsuyama (light railway and electric tramway), at the foot of a hill, and 35 ft. above the sea. The springs were discovered, according to mythology, see Plate 63 by *Ōnamuchi* and *Sukuna-hikona* at a prehistoric time, there being records of the visits paid by early Emperors, such as Keikō, Chūai, Tenchi, etc. The most famous bath-tanks are *Tama-no-yu*, *Kami-no-yu* and *Yōjō-yu*, which are in each case built of granite stones, with a three-storied building see Plate 64 rising above each. In these upper storied rooms, tea and cakes are served to visitors, while on the third floor of Kami-no-yu is found the so-called "bathers' club," where means are provided for indoor amusements of various kinds. The town of Dōgo contains a permanent population of 2,000, many of whom engage directly or indirectly in the business of inn-keeping. Dōgo has a small public park and temples,—*Isaniwa-jinja* (Shintō), *Ishide-ji* (Buddhist), and the site of Imperial lodgings in former days, which may be visited in the course of a walk. The special products of the place are carved-wood articles (*Fusō-boku*), *Dōgo-Sembei* (a cracknel of wheaten flour), *Yugeta-ame* (glutinous-jelly), etc. Dōgo is the only hot spring in Shikoku Island, and is resorted to by people from all places in the south-western part of Japan, on account of the facility of access. Number of visitors: 45,565, the total stays being 203,152 days (1909),

Meteorological Observations.

Summary.

Month	Air Temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity
	Mean				Absolute						
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean
For the year, 1911.											
January	4,8	9,91	0,38	9,52	15.7	-4,8	76,3	120,48	38	65,2	2,3
February	5.5	10,6	0,6	9,9	14,6	-4,9	71,9	163,05	53	24,8	2,8
March	8,9	14,1	4,0	10,1	23.3	-1,1	75,1	155,61	42	123.9	3.3
April	12,4	18,5	6,8	11,7	22,7	0,4	75,6	211,85	54	178,5	3,0
May	16,5	22,6	11,1	11,5	26,6	4,0	79,8	198,35	46	129.4	2,2
June	21,1	25,6	17,4	8,2	29,4	13,6	84.3	112,2	26	315,2	2,2
July	25.42	30,21	21,42	8.79	33.5	16,4	79,7	222,45	51	157,7	2,32
August	25,9	31,1	21,7	9,4	33,6	19.3	82,0	212.9	52	103,8	2,2
September	24,2	29,7	19,9	9.7	33.6	13,2	82,0	158.5	43	316,4	2,0
October	15.9	22,4	11,0	11,4	28,6	6,5	79,0	167,4	48	111,6	2,1
November	12,2	18,2	7,1	11,2	22,8	0.5	79,0	134,2	44	71,7	2,3
December	6,3	11,7	1,7	10,0	21,2	-1,6	74,0	140,5	46	63,0	2,3
For the year, 1912.											
January	4,5	9,1	0,3	8,8	13,0	-4,2	72,0	129,34	41	50,7	2,8
February	7,5	12,6	2,7	9,9	19,2	-3,2	74.0	133.39	45	108,0	2,8
March	8,9	14,2	3,8	10,3	22 6	-0,6	75.0	172,13	46	123,6	2,6
April	13,1	18,7	7.3	11,3	25,1	1,6	74,0	201,99	52	156,9	3,0
May	17,0	23,0	10,8	12,2	28,8	5,1	75 0	235.35	55	54,9	2,9
June	21,3	27,0	16,2	10,8	30,4	12,3	78,0	209,34	49	84,3	2,2
July	25,2	29,8	21,7	8,1	33.6	16,2	82,0	147,92	34	191,8	2,2
August	26,0	31,8	21,5	10,3	33,9	18,4	79.7	263,6	64	35,0	2,0
September	21,13	26,1	16,9	9,1	32,7	10,8	83,9	127,2	31	299,1	1,74
October	15,9	22,2	10,3	12,0	26,6	5,7	82,0	176,67	50	122,7	1,9
November	10,0	15,8	4 9	10,9	22,4	-1,2	78,0	142,84	46	75.1	2,0
December	6,8	12,2	2,2	10,0	20,1	-1.9	77,0	112,38	37	111,9	2.3

Month	Air Temperature						Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity
	Mean				Absolute						
	Mean	Max.	Min.	Range	Max.	Min.		Total	%	Total	Mean
For the year, 1913.											
January	4 0	9.5	-0,4	9,9	14,2	-3,5	74,0	129,1	41	51,1	2,7
February	4.7	9.8	0,0	9,8	14.7	-8.3	71 0	120,6	39	47,3	3,3
March	6,7	12,4	1,0	11.5	19,1	-3.5	67,0	184,8	50	40,9	3,0
April	14,4	20,1	9,4	10,8	26,8	2,1	79,0	160,2	41	136,7	2.4
May	16,5	22,8	10.5	12,3	26,5	5.3	77.0	228,5	53	181,7	2,4
June	18,8	25,4	16,7	8.7	32,0	11,5	81,0	120.39	28	—	2,2
July	24.4	29.5	19,56	9,94	33,8	14.3	77,0	250,8	57	69,0	2,4
August	25,0	30.3	20,7	9,7	33.5	16,6	81,0	227,39	55	—	2,0
September	21,0	26,6	16,1	10,6	31,3	10,3	79.0	178,53	48	68.5	1,8
October	16,6	23.4	11,5	12,0	28,5	5,0	79,8	181,82	52	47,3	2,0
November	11,5	18,5	6,2	12,3	24.6	1,9	78,0	142,8	46	95,9	2,0
December	6,6	12,0	2,4	9,7	19,4	-2,1	76,0	76,65	25	118,9	3,1

FUKUOKA-KEN

Futsukaichi (56,5 m. from Moji, in 2 hrs. 29 min.) is 0,3 m. from a hot spring, **Musashi-Onsen** (Inn, *Enju-kwan*), to the W. of which rises the hill, *Tempai-zan*, where *Michizane* is said to have prayed in the direction of Kyōto. Halfway up (1,4 m.) the slope is found a waterfall called *Ryū-ō-no-taki*, and beside it a huge stone, all associated with the memory of Michizane. Number of visitors: 32,532, the total stays being 221,975 days (1909). The springs are said to be efficacious for rheumatism.

Meteorological Observations.

Summary.

For the year, 1911.

Month	Air Temperature			Relative Humidity	No. of hours with Sunshine		Amount of Precipitation	Wind Velocity
	Mean	Absolute						
		Max.	Min.		Total	%	Total	Mean
January	4,90	18,1	-2,8	75,3	88,2	28	69,4	3,84
February	5,23	15,5	-3,6	74,6	94,95	31	33,0	4,04
March	9,01	21,7	-0,2	76,9	127,54	34	208,4	4,81
April	12,37	24,4	0,2	75,4	185,29	48	122,0	4,36
May	17,11	26,2	2,4	78,8	173,93	41	94,9	3,27
June	21,39	31,7	14,0	85,3	123,41	29	315,8	3,49
July	25,47	33,5	17,6	82,4	181,81	42	245,9	4,37
August	26,22	34,4	19,9	83,7	215,08	52	77,6	3,83
September	23,96	32,3	12,4	85,3	152,82	41	283,9	3,13
October	15,92	26,1	6,4	79,3	167,11	48	110,0	3,64
November	12,07	23,2	0,6	79,6	137,43	44	129,2	3,86
December	6,27	17,0	0,2	75,7	95,49	31	58,1	3,51

Hainu-zuka or *Hain-zuka* (77,4 m. from Moji, in 3 hrs. 28 min.) is the chief station leading to the basin of the River Yabe. Tram-car from the station, on the one hand to *Okawa-machi* at the mouth of the river, and on the other to *Fukushima-machi* (8,3 m.).

see Plates 65 and 66 **Funagoya-Onsen** is a mineral spring on the River Yabe, 2,4 m. from the station. The water is said to be efficacious for anaemia and catarrh of stomach and intestines. *Hyūgami-iwa*, a highly picturesque spot believed by some people to be even superior to the famous *Yabakei* in Buzen, is

22 m. from the station on the upper course of the River Yabe, and between the two villages of Ōbuchi and Yabe. Number of visitors: 52,379, the total stays being 69,676 days (1909).

ŌITA-KEN

Beppu (81,9 m. from Moji, in 4 hrs. 17 min.). It is situated on the Bay of Beppu, with the beautiful hill of Tsurumi behind, and is famous throughont Japan on account of its hot springs (Pop. 14,045, households, 3,120). It enjoys ample steamship communication with all inland sea-ports, and with Kōbe and Ōsake (services maintained by the Ōsaka Shōsen Kwaisha). The town is built on ground undermined by volcanic vapour and hot water. The springs are alkaline and carbonated, containing iron, while some contain much sulphur, and are regard as highly efficacious in various complaints. On the beach also there are springs where people bathe, half burying their bodies in sand. *see Plate 69* In the town are half-a-dozen public bath-tanks, while the more important inns own private baths.

Baths in the Neighbourhood: **Kwankaiji-Onsen** (2 m. to the W. of Beppu), high up on the side of *Tsurumi-dake*, with a fine view of the bay (Inns; *Matsu-ya, Sakamoto-ya*); about 0,2 m. or 0,3 m. higher up is *Ue-no-tano-yu*, on the N. side of which is a valley (called *Jigoku*) filled with sulphureous steam; 1,6 m. N. E. of Kwankaiji is **Hotta-Onsen** (Inns: *Kanata-ya, Hama-ya*); at the foot of *Yufu-dake* (called Bungo-Fuji), 7,3 m. from Hotta-Onsen via Kusu-Kaidō (Highway to Kusu), are Takemoto and three other baths, while going 3,7 m. the other way (i. e. towards the N.) from Hotta we come to **Myōban-Onsen** (Inns: *Okamoto-ya, Ebisu-ya*); about 0,7 m. from Myōban-Onsen we come to **Bōzu-Jigoku** (a geyser of boiling mud) and again 0,7 m. farther on from it, **Umi-Jigoku**, *see Plate 5* a boiling blue pond covered with steam; 0,5 m. from Umi-Jigoku is **Kannawa-Onsen**, a popular resort *see Plate 7, fig. 3* having a famed vapour-bath (Inns: *Fuji-ya, Yorozu-ya, Tokiwa-ya*); 1 m. N. E. of Kannawa is **Shibaseki-Onsen**; 1,2 m. again from Shibaseki, **Chi-no-ike-Jigoku** or "Blood-coloured boiling pond". *see Plate 67* The shore as well as the bottom of the pool is covered with ochreous sinter deposits, composed chiefly of iron oxide and clay (see Part II, p. 153), which are at present used only for dyeing towel, bath-dress and other cotton fabrics, just for the object of *souvenir* sold to visitors. The villagers were, however, quite ignorant of utilizing the sinter deposits for a valuable form of medical baths (uiz., Mineral-Mud Bath), till Dr. Ishizu, expert of the Tōkyō Imperial Hygienic Laboratory, taught them for the first time the utilization of the mud for that purpose in Aug., 1909. Since then the neighbouring inhabitants have begun to experience themselves the value of this kind of bath.

The pond may be only one place in Japan, which can supply a sufficient quantity of mineral sinter for preparing mud-baths. The locality affords also facility for providing with hot water douche, hot waterfalls and inhalation-house. It is hoped that some suitable arrangements will be made to employ the mud in this valuable form of application and also providing necessary accommodation for bathers. About 0,5 m. from Chi-no-ike, we reach the sea-shore town of Okoshi, where is **Kamegawa-Onsen** (Inn: *Muro-ya*); from Okoshi to Beppu is 4,4 m.

Meteorological Observations.

Summary.

Month	Air Temperature					Relative Humidity	Amount of Precipitation	Wind Velocity
	Mean			Absolute				
	Mean	Max.	Min.	Max.	Min.		Total	Mean
For the year, 1911.								
January	6,9	9,7	−0,2	18,3	−6,0	66,5	69,2	1,7
February	7,7	10,6	0,7	15,8	−4,5	64,6	17,0	1,5
March	10,7	13,4	4,3	22,3	−4,2	70,7	162,7	2,0
April	15,7	19,2	10,9	29,5	5,7	64,9	80,4	1,2
May	19,3	22,3	12,8	27,5	5,6	72,7	250,5	0,9
June	22,7	26,7	15,8	36,8	10,2	78,2	445,3	0,7
July	27,1	28,7	16,7	32,7	11,8	76,6	68,8	1,1
August	27,0	28,7	21,5	31,6	15,5	75,2	153,8	1,3
September	26,1	27,1	21,6	30,0	15,0	75,0	311,6	1,4

Month	Air Temperature					Relative Humidity	Amount of Precipitation	Wind Velocity
	Mean			Absolute				
	Mean	Max.	Min.	Max.	Min.		Total	Mean
For the year, 1912.								
September	23,6	25,9	18,7	30,6	12,4	70,3	318,9	1,1
October	19,6	22,0	13.3	29,2	8,3	73,0	33.4	1,6
November	14,1	15,9	7,9	22,1	2,0	76,3	40,5	3,1
December	11,0	13,1	4,9	22,3	0,1	78,0	70,6	3,0
For the year, 1913.								
January	7,8	10,8	2,3	16,8	-0.9	57.5	70,4	2,8
February	7,8	10,6	2,4	13.7	-0,3	60,4	19 0	2,1
March	10,1	13,2	3,8	21,0	0,0	52,0	38,5	2,1
April	15,9	19,0	10,5	24,6	3,8	70,0	136,2	1,4
May	19,7	22,1	12,3	26,9	5,9	61,6	121,3	1,7
June	22,7	25,2	13,3	32,0	10,0	76,5	220,6	2,2

Summary.

Spa	Number of Public baths	Number of Vapour baths	Number of Hot Waterfalls	Number of Sand baths	Number of Inns	Number of Visitors in 1909	Their total stays in days
Beppu and Hamawaki	8	—	—	5	202	108,192	540,947
Kwankaiji	1	1	1	—	9	43.731	—
Hotta	1	1	1	—	4	9,805	40,652
Myōban	1	—	—	—	17	5.558	36,937
Kannawa	3	2	—	—	15	12,968	35,356
Shibaseki	1	1	1	—	2	14.650	—
Kamegawa	2	1	1	1	26	63,942	—

KUMAMOTO-KEN

Hot Springs of Aso.

Aso-san. A celebrated volcano, 26,8 m. E. of Kumamoto, and situated at the intersection of two volcanic ridges, one beginning in the Loochoo Islands and extending as far as the Japan Sea, via *Kaimon-dake*, *Sakura-jima*, *Kirishima-yama*, and *Aso-san*; while the other ridge runs E. to W. from the N. of Shikoku towards Amakusa, via *Yufu-dake* (in Bungo), *Hisazumi-dake*, *Aso-san*, *Kimbō-san*, and *Unzen-dake* (the last in Shimabara Peninsula). This volcano, being thus at the intersection of two ridges, is the most active crater of all (some of the craters mentioned above, e. g. *Kimbō-san*, near Kumamoto, are already entirely extinct). Aso-san is a general name comprising five volcanic peacks, the active one being called *Naka-dake*, while the other four (extinct) are (1) *Kishima-dake*, to the N. W. of Naka-dake, (2) *Eboshi-dake*, S. of Kishima-dake, (3) *Taka-dake* (5,500 ft.) highest of all five, E. of Naka-dake, (4) *Neko-dake*, a jagged, saw-like peak, E. of Taka-dake. To the S. and N. of these five peaks lie two plains, the N. one being called *Aso-dani* (1,620 ft.) and S. *Nangō-dani* (1,470 ft.), containing altogether three towns and eleven villages and a population of 40,700.

Ascent: from Kumamoto to *Ō-tsu* 12,2 m. by light railway; from Ōtsu to *Tateno* (Pop. 3,000), about 6,5 m.; from Tateno two roads branch off, (1) one along the *Kuro-kawa* or "Black River," an affluent of the Shira-kawa, leading to *Aso-dani*, (from Tateno to Miyaji 12 m.), while (2) the other leads by Shira-kawa into *Nangō-dani*, the plain to the S. of Aso-san. On both paths *jinrikishas* are available as far as the foot of the five peaks. If we take the 1st road, we soon come to *Sugaru-ga-taki*, a majestic waterfall plunging from a high precipitous volcanic rock covered by a thick grove of large trees; now passing on by a gradual ascent we reach the highest point across the ridge, *Futae-no-tōge*, when suddenly we realize that we are standing on the edge of an almost perpendicular precipice, and that there lies before us the plain of *Aso* and the five peaks; descending the precipice we soon come to the town of *Miyaji* (Pop. 3,900). At Miyaji is an ancient temple (1,700 years old), *Aso-jinja* (Shintō) which is dedicated to the god, *Take-iwatatsu-no-Mikoto*.

At Miyaji we may stop over-night. From Miyaji, we come to *Bōju-mura*, which is at the foot of *Naka-dake*, the active volcano. Here begins the ascent, which is by no means steep, and from half-way up we find all signs of vegetation gone, and everywhere ejected lava stones; and coming to the lip of the crater, we see the crater like a huge blacksmith's bellows sending up columns of sulphur smoke, and loud detonations. From the rest-house at the base of the cone, the climb to the lip and back again will occupy nearly an hour. Now on the return journey, we take the other of the two roads to Tateno and come first to **Yu-no-tani**, where there is a geyser of red mud and burning water, then to **Taru-tama** and **Jigoku** hot springs; from here going W. we come to **Tochinoki** hot springs, a well-known bathing-place, and thence along the River Shira-kawa we come to Tateno, whence we started by the 1st road. *Tochinoki* hot springs are said to be found in the 4th year of the Kwambun Era (1665). Number of visitors (Tochinoki): 10,412, the total stays being 29,760 days (1909).

Yamaga. 17 m. N. from Kumamoto and 11 m. N. from *Ueki* station on the Kagoshima Main Line, *jinrikisha* available. The spa town (Pop. 7,541) lies on the highway, which leads from Ueki to *Kurume* via *Fukushima* and at the N. end of the plain of Kikuchi extending to the foot of *Aso-san*. The spa is much resorted to by the inhabitants of the two provinces of Higo and Chikugo. The water is believed to be efficacious for gout and syphilis. Number of visitors: 34,153, the total stays being 1,039,847 days (1909).

Hinagu-Onsen, a carbonated spring, is 6 m. from *Yatsushiro* (fare, 50 *sen* by *jinrikisha*). It is a favourite resort of people from all parts of Kyūshū (Inns: *Kimpa-rō*, *Yanagi-ya*). *Kōda-yaki*, produced at Kōda between Yatsushiro and Hinagu, is a kind of faïence, introduced by Korean potters. Number of visitors: 25,146, the total stays being 262,494 days (1909).

NAGASAKI-KEN

Shimabara Peninsula, known on account of its famous volcano, *Unzen-dake*, which is situated almost in the center of the peninsula. On the W. coast is situated the port of Obama, on the E. the historical town of Shimabara, and on the S. the port of Kuchinotsu. Highways from Nagasaki lead, the one via *Uki* and *Chijiwa* to Obama, and the other via *Isahaya* (by Rys.) and along the coast of *Ariake-no-umi* to Shimabara (a part of the way by light railway). Steamer Passage from Mogi Port to Obama costs 60 *sen*.

Obama.

Obama is situated on the west coast of the Shimabara Peninsula at a distance of 20 m. across the Chijiwa Sea from Mogi. There are several saline springs of intermittent nature, possessing great efficacy for rheumatic complaints. The Ikkaku-rō Hotel has good foreign accommodation and is well patronised throughout the year; visitors to Unzen find it advantageously situated for passing a night or obtaining meals *en route* to or from the hill resort. There are no less than fifty inns for the accommodation of Japanese. The baths are separated from the inns, being mostly on a rocky beach. The beach is reserved for recreative purposes. Obama has a good water supply, water-works having been constructed there in 1907. *see Plate 4 fig 1*

The climate in winter is warm and attracts many visitors. Within a short distance of the town is a white sandy beach, with pine groves extending several hundred yards. The beach is excellent for sea-bathing, and shelters are provided for the convenience of bathers. A mile and a half from Obama on the road to Unzen is *Binkushi*, and one mile higher up is *Kago-tateba*, which in olden days was a station at which the bearers of *kago* (palanquins) of nobles stopped to rest, hence the name. The place is now marked by a house. This point is half-way to Unzen and commands a splendid view of Ariake Bay, over the Aino isthmus, the lovely hamlets of *Obama*, *Chijiwa*, *Aino*, *Moriyama*, and *Uki*, and the Chijiwa Sea at the foot of the mountain. Number of visitors: 19,387 (natives), the total stays being 164,560 days (1909); 899 (foreigners), the total stays being 6,347 days (1909)—22,638 (natives), the total stays being 180,410 days (1913); 1,834 (foreigners), the total stays being 28,470 days (1913). Hotel: *Ikkaku-rō*; Inn: *Tsuta-ya*.

Unzen Resort.

How to reach Unzen. There are two routes from Nagasaki, one by sea, and the other overland. In the former, *jinrikisha* is to be taken as far as *Mogi*, via *Tagami* (fare, ¥ 1,20 with two coolies), then to Obama by steamer (fare, 1st class 90 *sen*; additional charges:—5 *sen* transit tax, 4 *sen* pier dues, and 5 *sen* sampan fare). Two direct services are available daily. From Obama the ascent to Unzen, a distance of seven miles, can be made in a chair carried by four coolies (fare, ¥ 3,00), a *jinrikisha* drawn by two coolies (fare, ¥ 2,00), or by horse carriage (fare, ¥ 3,00). The road is very good, and even ladies can easily walk up to Unzen. The overland journey is made by rail from Nagasaki to *Isahaya* on the Government Line (fare including transit tax, 1st class 88 *sen*, 2nd class 53 *sen*), thence to *Aino* by the Shimabara Light Railway, a private line (fare, 1st class 44 *sen*, 2nd class 27 *sen*). From Aino, *jinrikisha* (fare, 45 *sen*), *basha*, or motor-bus (fare, 35 *sen*) is taken to *Chijiwa*, via the Chijiwa slope, and then on to Obama, via *Tomitsu-zaka*, giving a view of the beautiful coast scenery. The fare is ¥ 1 by *jinrikisha* and by motor-bus 70 *sen*.

Unzen can be reached from Chijiwa direct, along the route that traverses the beautiful valley of the River Chijiwa. The ascent is shorter than any other, and can be made by chair or on horseback.

Time required for journey. From Nagasaki to Aino, via Isahaya, where cars are changed to the Shimabara Railway, the time required is two hrs. by rail, and from Aino to the Chijiwa Hotel is half-an-hour's journey by motor-bus. After resting at the hotel, Unzen can be reached by chair at noon. From Aino to Obama direct by motor-bus takes an hour; the journey from Obama to Unzen, by chair, occupies two and a half hours. Only one motor-bus, accommodating five passengers, is now running between Aino and Obama, but another will be ready for service by the summer. If the sea-route is preferred one has to start from Nagasaki at 7 a.m. by *jinrikisha* (two men) to Mogi; from the latter place Obama is reached at 9,30 a. m. by steamer. After a rest at the Ikkaku-rō Hotel, Unzen can be reached at noon by chair (four coolies) or *jinrikisha* (two coolies).

Unzen, the joint name of the three hamlets of *Furu-yu*, *Shin-yu*, and *Ko-Jigoku*, is a favourite summer resort of European residents from the neighbouring regions, as well as from China ports
see Plate 11, b and Philippines. The place being situated high up (2,400 ft. above sea-level) on a mountain is noted for its cool, bracing atmosphere and splendid scenery,—the hot mineral springs on account of their efficacy in many kinds of disease being a special attraction. From experience, Japanese regards a course of these upper springs at Unzen as necessary for making a complete recovery after passing through a preliminary course at the Obama baths.

Climate. According to the observations taken by the Nagasaki Observatory, the climatic conditions of Obama and Unzen compare with Nagasaki and some other places as follows:—

Spring (March, April, May).

	Temperature (Centigrade)	Humidity (per cent)	Rainy days
Unzen	8,9°	80	37
Obama	13,9°	78	28
Nagasaki	13,1°	74	28

Summer (June, July, August).

	Temperature (Centigrade)	Humidity (per cent)	Rainy days
Unzen	19,9°	90	54
Obama	24,6°	83	39
Nagasaki	23,8°	82	49
Hakone	20,5°	83	—
Ikao	20,4°	—	55

Autumn (September, October, November).

	Temperature (Centigrade)	Humidity (per cent)	Rainy days
Unzen	12,8°	83	31
Obama	17,8°	76	27
Nagasaki	17,2°	70	28
Hakone	14,3°	81	—
Ikao	12,8°	—	25

Winter (December, January, February).

Unzen	2,4°	82	42
Obama	7,5°	73	
Nagasaki	6,6°	67	42
Hakone	2,7°	70	—

Ascent. From Obama to *Bingushi*, via *Yunosaki*, 1 m.; from Bingushi to *Kago-tateba*, 1 m.; from Kago-tateba to *Fuda-no-hara*, 1,8 m.; from Fuda-no-hara to Unzen, 1,2 m. Between Fuda-no-hara and Unzen, the path—famous for its fine views—lies on a wide plateau occupied by rice-fields and a few remains of *Mammyō-ji* temples, which at one time numbered three hundred, all occupied by Buddhist monks. They were all destroyed by fire in the Shimabara rebellion, having been attacked by the Christians who had fortified themselves in the Hara Castle at Arima. Only the fragments of a large *torii* (gateway) are now to be seen. The road divides here, the left one leading to *Shin-yu* ('New Spring'), Unzen, and the other to *Ko-Jigoku*, which is half a mile distant. These roads are quite flat.

Ko-Jigoku. The bath-house at Ko-Jigoku is supplied from a spring of boiling water which is worth seeing. An attractive waterfall, called *Issaikyō-no-taki*, about twenty feet high, is near here, being in the stream which has its source in the springs Shin-yu and Ko-Jigoku.

Unzen Park. The Park occupies a tract of land with stretches of hills lying between the peaks *Kinugasa-yama* and *Ya-take*, the whole covering an area of 200,000 square yards. Many geysers, sending up boiling water to some height, exist on the E. side of the Park. Paths have been made to render the geysers accessible, and benches have been placed near them for the convenience of visitors. The Park is aglow which azalea blossoms in May. Being cooler than *Ikao* and *Hakone*, Unzen forms an ideal summer resort in Kyūshū. There are two tennis-courts, both open to the public on payment of regular fees, and attached to them is a pleasant pavilion. A large meeting hall, 364 square yards, is in course of construction and will be available for athletic purposes in wet weather.

Shin-yu ('*New spring*') and **Furu-yu** ('*Old spring*'). The Shin-yu bath-house is located in the Park and is connected with the spring at the foot of *Ya-take*. It has four bath-tubs, which are clean and always overflowing. A post-office is opened every year on June 1st and closed on October 31st. It transacts telegraphic, telephonic, and money-order services, etc., and distributes mails twice daily.

Furu-yu is situated 600 yards away from Shin-yu and the springs are similar to those at the latter place. The water, being acid hydrogen sulphide spring, containing a small quantity of iron oxide and alumina, is said to be efficacious, especially for rheumatism, dyspepsia, disorders of the female genital organs, syphilis, etc. Number of visitors: 6,103 (natives), the total stays being 10,075 days (1909); 743 (foreigners), the total stays being 7,804 days (1909)—6,275 (natives), the total stays being 18,825 days (1913); 1,274 (foreigners), the total stays being 36,220 days (1913). There are about a dozen inns.

The golf links covering 208,000 sq. yards are open to the public. A pavilion will shortly be built with toilet, dining, bar, and dressing-rooms. While the course cannot yet be described as in perfect condition, it is hoped that it will be made one of the best in the Far East before long, as no pains are being spared by the authorities to improve it. The site is naturally suited for the pastime and is very attractive, especially in May when the azaleas are in bloom.

Unzen is situated in a hollow of two peaks, *Fugen-dake* and *Myōken-dake*; while in their neighbourhood are several other smaller peaks, such as *Eboshi-dake*, *Azuma-dake*, *Mai-dake*, *Ro-no-ki-dake*, *Mai-yama*, *No-dake*, *Kinugasa-yama*, *Taka-dake*, etc.

Nita and Fugen Peak. Half a mile up the steep path from the golf links is the little plateau of *Nita*, commanding a fine view of the coast of *Higo*. Two miles higher one reaches the summit of *Fugen-dake*, (4,800 ft. above the sea-level). At the summit is a large perpendicular rock about 50 ft. high, on the N. side of which icicles may be found hanging as early as November. From here may be enjoyed an extensive panorama of indescribable beauty (which will repay all the labour of climbing), embracing the hills of *Hizen* and the plains of *Chikugo*, as well as the active volcano of *Aso* in Higo and *Kirishima-yama* on the boundary of *Osumi* and *Hyuga*, and the islands of *Amakusa*. The prospect also takes in on the other side the promontories jutting forth outside of

Nagasaki harbour, and the famous Gotō group of islands at a further distance. Two miles higher one reaches the summit of *Fugen-dake*. In autumn peak looks as if covered with brocade, the effect of the maples, and evergreen trees. For more than half the way the ascent can be made either on horseback or in a chair carried by four coolies. Near the top are found several large caves called *Kaza-ana* ('Wind holes'), inside which hang long icicles like swords, the temperature never rising above 2° C. even in mid-summer. The caves are used for storing silk-worm eggs.

Myōken-dake may be reached in 2 hrs. from *Fugen-dake*,—the path leading partly through brushwood, till an old extinct crater is reached and crossed (the path through the crater lying over a large volcanic rock), the rest of the way thence to the summit being a very precipitous ascent. The panorama from the summit is similar to that from *Fugen-dake*.

Chijiwa. (Hotel: *Chijiwa Hotel*). It is situated about 6 m. from Furu-yu, Unzen. The road from it to Unzen is now steep, but within the next three years it will be improved so as to allow the passage of vehicles. Chijiwa is chiefly noted for its sea-bathing, on a fine sandy beach sheltered by a beautiful ridge of pine-trees. Good pedestrians will enjoy making an excursion to the town of Shimabara, 12,2 m. down the coast on the other side where Obama is situated. The road lies at first between *Unzen-dake* on the left and *Taka-dake* on the right, then down to a valley, passing by a dried-up lake, now ascending, now descending by a path amidst boulders and then through a forest of pines and camphor-trees, till *Mino-kawa* (a hamlet 5 m. from Unzen) is reached. From here the road is less steep and soon becomes quite level, and at *Nakakobe* we come in sight of *Mai-yama*, which rises like an immense wall, screening the town of Shimabara from the volcanic craters behind.

Michi-no-o hot spring (5 m. by rail from *Nagasaki*, in 15 min.) is said to be efficacious in rheumatic complaints and stomach troubles (private bath provided). Near the station is the village of *Urakami*, known in connection with the history of Roman Catholicism in Japan. This and most of the neighbouring hamlets are inhabited by Roman Catholics, who were found in large numbers at the time of the Restoration (1868). Christianity was never entirely eradicated here, nor from some other places in *Kyūshū*, notwithstanding ruthless persecutions continued for several centuries. Number of visitors: **245**, the total stays being **332** days (1909).

SAGA-KEN

Karatsu hot spring (25 m. from *Kubota*, in 1 hr. 50 min.), a town situated at the mouth of the *Matsuura-gawa*, faces the Bay of Karatsu. In ancient times this place as well as Hakata assumed importance in connection with intercourse with Chōsen. It is now a special exporting port (chief
see Plate 70 export, coal), with a deep anchorage at *Nishi-Karatsu*, nearly 1 m. W. of the town. The place is also noted for its pottery (called *Karatsu-yaki*).

Karatsu, formerly the castle-town belonging to Daimyō *Ogasawara*, was called *Bukaku-jō*, or "Flying-Stork Castle," a pretty name which arose from the fancied resemblance of its E. and W. beaches, covered with pines, to the outstretched wings of the bird, the castle itself corresponding
see Plate 71 to its long neck and crest. The E. beach, called *Niji-no-Matsubara*, may be reached by a tramway (2 m.); the castle grounds have been turned into a public park; and the W. beach is a famous bathing-resort. S. of the latter rises a hill called "*Hirefuru-yama of Lady Matsura-Sayo-hime*."

Nanatsu-gama, 2,4 m. from *Karatsu*, is noted on account of its curious shaped rocks of basaltic formation. Seven caverns exist at the lower part of the rocks, looking like so many ovens, hence the name.

Number of bathers (Karatsu): **14,001**, the total stays being **210,015** days (1909). Inns: *Hakata-*
see Plate 72 *ya*, *Shin-iwai-ya*, *Kaihin-in*, *Kimpa-rō*, etc.

Takeo (33,1 m. from *Tosu*, in 1 hr. 13 min.) is well known for its hot mineral waters (carbonated spring, containing alkali). It is picturesquely situated, being surrounded on three sides
see Plate 73 and 74 by well-wooded hills. The springs are said to be efficacious for dyspepsia, haemorrhoids, rheumatism, syphilis and diseases of the skin.

Ureshi-no-Onsen, also a carbonated hot spring, is 7,3 m. from Takeo. Inns: *Tōkyō-ya*, *Tōyō-kwan*, *Hillside Hotel*. Efficacious for rheumatism, neuralgia, syphilis and diseases of the skin.

Arita (42,2 m. from *Tosu*, in 1 hr. 47 min. and junction for the Imari Branch Line) is situated in a narrow valley surrounded by wooded hills, being noted for its pottery made with the clay brought from a neighbouring hill, *Izumi-yama*. Most of the inhabitants (6,000) are engaged directly or indirectly in porcelain manufacture. The most famous of the manufactories is *Kōran-sha*, producing annually wares worth Y 175,000. The art was first introduced here in 1592 by a Korean artist, brought over by *Nabeshima*, Daimyō of Hizen, while the distinctive process of decorating with vitrifiable enamels was later taught by a Korean artist domiciled in Nagasaki, and was afterwards much improved by native artists. The wares soon attracted the notice of Dutch traders at *Dejima*, Nagasaki, who exported many pieces. The Arita pottery, however, attracted the general notice of Europeans for the first time at the Philadelphia Exposition in 1876. At present large quantities are exported, in some years valued at Y 700,000.

Imari (by Imari Branch Line from Arita to Imari, 8,1 m., in 33 min.) is a sea-port town, with 4,200 inhabitants. It is known as the export place of Arita porcelain (hence these wares are popularly called *Imari-yaki*). Since the opening of the railway, however, the prosperity of Imari has much diminished.

Spa	Elevation above the sea	Population	Number of Inns	Number of Visitors	The total Stays (in days)
Takeo	about 100 ft.	3,200	35	32,349	101,261 (1909)
Ureshino	about 400 ft.	1,200	18	10,851	47,794 "

KAGOSHIMA-KEN

Anraku. 5 m. S. E. from *Makizono* station and also 5 m. N. from *Kokubu* in Satsuma Province, *jinrikisha* and omnibuses available. Here several cold springs gush out of the banks of a stream, the water being mostly ferruginous and carbonated. Number of visitors: 23,000, the total stays being 11,500 days (1909). *Myōken-yu* Spa is about 0,5 m. distant from Anraku.

Hot Springs on Mt. Kirishima.

Myōban-Onsen. From the *Makizono* station on the Kagoshima Line to *Kami-nakatsu-mura* 4 m., *jinrikisha* and omnibuses available, thence 5 m. by *kago* or on horseback. The spa, 741 ft. above the sea, lies on the slope of *Karakuni-dake* (5,610 ft.), one of the peaks of *Kirishima-yama*, an active volcano, commanding an extensive view including the Bay of Kagoshima. The ever-changing view of *Sakura-jima* on misty days never fails to be attractive. Here the thermometer never registers higher than 80° F. even on the hottest days in summer. Number of visitors: 4,850, the total stays being 32,125 days (1909).

Eino-o-Onsen. The spa is within only a few minutes' walk from Myōban-Onsen. Water of high temperature conveyed by wooden pipes is mixed with cool water and pours itself into bath-tubs, forming waterfalls, which are called "*Utase-yu*" meaning 'hot spring for massage.' The flow of water is exceptionally abundant.

Eino-o Spa is at the highest elevation of all hot springs on Mt. Kirishima. The panoramic view over a valley and the beautiful Bay of Kagoshima is delightful. Number of visitors: 1,024, the total stays being 4,470 days (1909).

Iwō-dani-Onsen. The spa lies W. of Myōban-Onsen. The flow of water is so considerable that it overflows into a stream of hot water. There are vapour baths and hot waterfalls in the place. Number of visitors: 5,865, the total stays being 28,800 days (1909).

All these hot springs mentioned above issue from crevices of an old crater on the S. of a volcanic peak of *Onami-ike* on Mt. Kirishima.

Ibusuki is situated at the S. end of Satsuma Province, facing the entrance of Kagoshima Bay. This district is distinguished by the occurrence of many hot beach baths on the sea-shore, just like *Beppu* in Bungo Province. Here people dig holes in the beach to dip themselves in hot water which issues almost everywhere. The place where such beach baths can be taken, covers no small area, extending from *O-aza-Nishikata* to *Jyū-nichō*, including *Higashikata* and *Jitchō*. These places are on a highway and may be easily reached by *jinrikisha* from Kagoshima, but sea-route is preferable, as daily steamers call at such neighbouring ports as *Miya-no-hama* and *Minato-ura*.

Shibatate Hot Spring is at *Ō-aza-Nishikata*, about 1 m. N. W. from the port of *Minato-ura*.

Nigatsuden Hot Spring is 1,4 m. S. E. from Shibatate. At *Jitchō*, S. of *Nishikata*, is **Yaji-no-yu Hot Spring** and at *Minato-ura*, **Sansetsu Hot Spring**. Within a small distance from *Minato-ura* occur **Kata-no-Onsen** and **Suri-no-hama Hot Springs**.

CHŌSEN (KOREA)

On-yō. From *Keijō* to *Ten-an* (60 m. in 2 hrs. 20 min.) by railway from Ten-an to the spa 8,7 m., automobiles available. The spa is situated on a hill-side facing a stream. The place has see Plate 76 250 inhabitants (69 houses) and 3 baths, of which one is occupied by the garrison hospital as sanatorium. A rocky hill called *Sekka-zan* is noted for its beautiful scenery. This place is a favourite resort of the upper classes in Keijō and has telephone connections with *Keijō* and *Jinsen*. Number of visitors: 8,032, the total stays being 3,789 days (1913).

Jujō-Onsen. 7 m. from *Taiden*, automobiles available. The spa is situated not far from Jujō see Plate 75 on the plain of Taiden, with hills on the S. and N. It has 210 inhabitants. Spring water issuing from a well, 31 ft. in depth, is conducted by iron pipes to bath-tubs. Number of visitors: 3,836, the total stays being 9,731 days (1913).

Tōrai-Onsen. 3,3 m. from *Fuzanchin* station by light railway in 50 min. The spa lies on the highway which leads from *Fuzan* to *Keijō*. It is situated in the central portion of a plain, surrounded by mountains and traversed by a stream. There are 5 inns provided with private baths. This is the most noted hot spring in Chōsen, resorted to by inhabitants of *Fuzan*. Number of visitors: 3,836, the total stays being 9,731 days (1913).

TAIWAN (FORMOSA)

Hokutō. The spa is situated in a gorge, about 7 m. from *Hokutō* station. Boiling sulphur water breaks forth from hollows and pools on hill-sides, accompanied by gas and white fumes which fill the gorge all over. The outflow of these springs forms a number of steaming runnels which unite altogether into a stream rushing down the valley. Solfataras and old craters occur here and there in the vicinity. The spa has three most noted hot springs, viz., *Taki-no-yu*, *Kaikōsha-no-yu*, and *Tetsu-no-yu*, which may be regarded as typical of all the springs in the neighbourhood.

Taki-no-yu. The hot springs originate from pools in a small flat tract of land in a deep gorge, N. W. of *Kaikōsha* (military casino). The bottom of the pools consists of muddy sand, and their edges are covered with yellowish-brown or reddish-brown sinter deposits which change into yellowish colour on rainy days. The pools from which the springs issue, receive all water from the baths of both *Kaikōsha* and *Hoshi-no-yu* as well as a ravine at the N. corner. Most of jets are on the S. side of the pools, but change their position from time to time. The flow of water from each spring is also subject to variation. Some of these springs produce more or less gas.

Kaikōsha-no-yu. The place has two springs, both located close to the military casino, the one gushing out of flat ground and the other of crevices of rocks. The hot water is first caught in a wooden tank and then conveyed by bamboo pipes to bath-houses at Kaikōsha and Hoshi-no-yu. see Plate 3 Sinter crust deposited on the river-bed in the vicinity and known as *Hokutōlite* is radio-active. (For Particulars see Chapter on "the Sinter Deposits".)

Tetsu-no-yu. The spring is on the W. side of the Hokutō sulphur pit, and within one hour's walk from the Hokutō Hotel, hot water gushiug out of a large circular hollow on the hills. Here geysers are found every few yards.

Kwanshirei, about 11 m. from *Kōhekiryō* station, S. of *Kagi*, is a small mountain hamlet see Plate 77 situated in a ravine with hot springs. The springs, two in number, gush out of sedimentary rocks composed of clay and limestone. The production of gas is abundant from one spring. Water is alkaline and its flow not large.

Suwō (So-ō) is a cold spring near the sea-port of the same name in *Giran-cho* (S. E. from the town of *Giran*), lying on the N. E. coast of the island, about 50 m. from Keelung by steamship. There is also a railway communication between *Tōwi* and Giran, but sea-route is preferable.

It is a simple carbondioxated spring, faintly mineralized, used internally and externally.

ILLUSTRATIONS

OF

Hot Spring Spas, Seaside Resorts,

and

Summer Retreats.

Noboribetsu Spa, the most noted hot spring resort in Hokkaidō.
A distant view from the spa of Jigoku-dani or "Hell Valley," sending up sulphurous water and white fumes. (p. *1*)

Noboribetsu Spa, 4,3 m. from Noboribetsu station, Hokkaidō.
Jigoku-dani or "Hell Valley," sending off sulphurous steam and boiling mud and water—the source of "*Taki-no-yu.*" (p .1)

Noboribetsu Spa.

Oku-no-yu (the innermost hot springs) flowing down into *Ō-yu-numa* or "Large Hot Spring Lake." (p. 1)

Ō-yu Hot Springs, near Kosaka Copper Mine, Rikuchū Province.
The beautiful mountain lake *Towada-ko* with wonderful scenery is about 14 m. from the spa. (p. 5)

Waterfall "*O daki*," about 50 ft. high near the spa.

Innai-Yunosawa, a small hot spring spa, 66 m. S. of *Akita*. (p. 5

Atsumi Hot Springs, on the Japan Sea coast, 8 hours by steamer from Niigata. (p. 7)

Onogawa Hot Springs, near *Yonezawa*, on the upper reaches of the Kinomo-gawa. (p. *10*)

Waterfall "*Kame-daki*," near the spa

Namegawa, a small hot spring spa, about 15 m. from *Yonezawa*, situated on the northern slope of Azuma-san, Uzen Province. (p. *11*)

Goshiki Hot Springs, about 2 m. from *Itaya* station and 14.6 m. from *Yonezawa.*
The spa being situated amidst the Itaya mountains on the slope of *Azuma-san,* its vicinity is excellent for skiing. (p. *11*)

Senami Spa with a geyser, near *Murakami*, situated on a hill wooded with pine-trees, close by the sea.
The spring was found by accident during the period of oil mania in Echigo Province. Boiling hot water shoots up into the air more than 90 ft. high. (p. *12*)

Yakushi-dō, a temple dedicated to the God of Medicine, erected about 500 years ago.

Waterfall "*Junkei-no-taki*," more than 60 ft. high (about 1.2 m. from the spa).

Waterfall "*Kozundani no-taki*," more than 50 ft. high (1 m. from the spa).

Public bath.

Murasugi Spa, 5.5 m. S.E. from *Suibara* station on the Niitsu-Murakami Line, Echigo Province.
It is a pretty forest resort (abundant pines and cryptomerias), and the spring water is strongly radio-active. (p. 43)

Tochiomata, a small hot spring spa, about 22 m. from *Ojiya* station, Echigo Province.
The water is of the strongest radio-activity of all mineral springs in the north-eastern Japan. (The quantity of radium emanation amounts to 56,4 Mache's units). (p. 14)

Matsuno-yama Hot Springs,
about 33 m. E from *Takada*, Echigo Province. (p. 14)

Nasu-Yumoto Hot Springs, a popular bathing resort at the foot of *Nasu-dake* (an active volcano), seen from Shirakawa-Kaidō. The spa, about 3,000 ft. above sea level, commands a wide panoramic view. (p. *15*)

Yumoto Hot Springs, Nikkō,
a lovely summer resort on Lake Yumoto, 5,100 ft. above the sea. Steaming sulphurous water bubbles up from the bottom of the lake. (p. *19*)

Isobe Spa

with the most concentrated cold salt springs in Japan, on the bank of the Usui-gawa, opposite *Mt. Myōgi.*
About 74 m. from Ueno station (Tōkyō). (p. *21*)

Nashiki-Kōsen with cold springs, 1,490 ft. above the sea,
a summer resort on *Mt. Akagi.* (p. 24)

Hiraiso, 10 m. N.E. of *Mito*, noted both as a watering-place and the fishing center in Hitachi Province.
From a height called "*Kwantō-jō*" on the northern side of the place a grand view of dashing waves can be obtained. (p. 25)

Ōarai, the most noted pleasure resort in Hitachi Province. The coast is dotted with rocks and backed by a low hill. Old pine-trees grow in the precincts of a Shintō shrine, from which a fine view of the ocean is obtained. (p. 25)

Hayama, a popular seaside resort, about 20 m. from Yokohama
The beach of *Isshiki*. An Imperial villa stands in the south of the beach. (p. *25*)

Hayama, a popular seaside resort, about 20 m. from Yokohama.
The beach of *Hori uchi* has many villas of wealthy people. Good for sea-bathing. (p. 25)

Sea-bathing at *Teru-ga-saki.*

Bathing-place with rest-huts, seen from the sea.
A group of three big pine trees shows the villa of Baron Iwasaki.

Ōiso, the most noted bathing resort in Japan, with many picturesque villas overlooking the sea, 22 m. from Yokohama. (p. 25)

Atami Spa, a favourite winter resort,
with the famous intermittent hot spring. (p. 30)

The upper course of the *Kamas. gawa,* near *Gōdo,* Nishi-ebi.

3

A picturesque ravine, a little up the stream of *Hontani-gawa* from "*Kinsen-tō.*"

2

"*Yai-te-iwa,*" a huge rock standing on the upper course of the *Hontani-gawa,* about 1 m. from the bath "*Kinsen-to.*"

4

"*Sen-ga-fuchi*" or 'Thousand Abysses,' on the way to Masutomi.

Masutomi Mineral Springs, 24 m. N. of *Kōfu,* Kai Province.

The water, though cold, is of the strongest radio-activity of all mineral springs throughout Japan. The place, located at high elevation and surrounded by picturesque scenery, is a pleasant summer resort. (p.p. *33* and *34*)

Tenryūkyō, a famous picturesque gorge of the *Tenryū-gawa* which marks the entrance to the romantic rapids and races that are to follow. The descent of the Tenryu-gawa Rapids by *Prince Arthur of Connaught* in September, 1912, is the latest instance of this exciting passage having been undertaken by a distinguished person. His exalted position may be said to have raised the fame of the rapids to one of an almost international character. (p. 38)

Nakabusa Mountain Spa,
5,300 ft. above sea-level, situated on the middle slope of *Ariake-san*
at the foot of the Hakuba Range, the best starting-point for the ascent of the
"Middle Alps of Japan." There are outdoor arrangements for hot water massage as well as for vapour-baths. (p. *38*)

1

3

2

4

Ena Mineral Springs. (p. 46)

1. A huge rock with flat top called "*Odori-iwa*," is said to have been often visited by the Daimyō for picnic parties.
2. A bridge spanning the *Tsukechi-gawa*, the affluent of the River Kiso, near *Naegi*.
3. Overlooking the Kiso rapids with picturesque scenery.
4. Platforms made of huge rocks at a point where the River Tsukechi narrows considerably.

Ena Mineral Springs, located on a highland near *Naegi*, on the northern bank of the Kiso Rapids, Mino Province.
The district produces some kinds of radio-active minerals, such as *naëgite*, *fergusonite*, etc. Spring water is almost pure and contains a considerable quantity of radium emanation (281 Mache's units). (p. *46*)

Futami Hot Springs, east of *Toyama*.
Water issues from a cave under the "Wedded Rocks" in a ravine. (p. 47)

Ōiwayama, about 14 m. E. of Toyama, Etchū Province.
On a rocky precipice stands a famous temple called *Nisseki-ji*, and behind the temple are found several waterfalls, of which *Ō-taki*, the largest one, presents a wonderful sight. Even now bathing in the waterfalls is popularly believed to be efficacious for curing mental derangement and eye diseases, and thus the place is visited by sick people all the year round. (p. 47)

Ōmaki Hot Spring, south-west from *Toyama.* (p. 47)

Yamanaka Hot Springs, a picturesque summer retreat, south-east of *Kanazawa*.
The picture shows *Korogi-bashi*, a famous bridge spanning the stream bounded by high rocky banks. (p. *47*)

Komono Hot Springs (Yunoyama), 11 m. north-west of *Yokkaichi*,
a quiet summer retreat, about 2,500 ft. above the sea and with a fine bird's-eye view. (p. 50)

"*Ao-taki*" Waterfall, over 150 ft., is one of the attractions of **Komono Spa.** (p. *50*)

Bird's-eye Views from Hino-yama of the Harbor of Toba, Shima Province.

Hino-yama, [illegible] within a few minutes' walk from Toba station. It covers an area of about 100,000 *tsubo* (over 82 acres), including level spots here and there. The extensive range of view from it and the superb excellence of its scenery rank it among rare scenic spots of this country. [illegible] make ascent of this [illegible] sure to be amply compensated for the time and exertion required. [illegible] the roads have been much improved to make the ascent easier and cottages built on the hill side for travellers who can take rest and have refreshments. Hino-yama is also known [illegible] having been originated in the historical fact that *Kuki Yoshitaka*, a feudal lord who was a naval commander under *Taikō Hideyoshi*, designed to supply water to the castle of Toba from a spring on that hill by means of *kakehi* (bamboo tubes). [illegible]

Toba, the "Town of Longevity." According to the recent report of the town headman, Toba has 1,233 houses and 6,419 inhabitants, and of this small population happy people who are more than seventy years old number 220. It is not without reason that Toba is called the "Town of Longevity." (p. 50)

Shiraya Mineral Springs, S. E. of *Yoshino* noted for cherry-blossoms, situated on the upper course of the Yoshino-gawa abounding in "*ayu*" fish. (p. *50*)

Sedo-no-Kanayama (Yuzaki), a lovely seaside resort with hot springs, about 75 m. S. from Wakayama, Kii Province.
The coast near "*Saki-no-yu*," issuing from the fissure of rocks close by the sea, forming a gourd-shaped bath-basin. (p. *51*)

Yunomine Spa, on the Kumano-gawa, about 20 m. up from *Shingū-machi*, Kii Province.

Hot springs gush out from the banks as well as bottom of a small stream called "Oto-gawa." (p. *51*)

Villagers boiling cereals and vegetables in hot springs. From a geyser boiling up to a height of more than 10 ft., hot water is conducted by wooden pipes into a bath, about 15 m. down the stream.

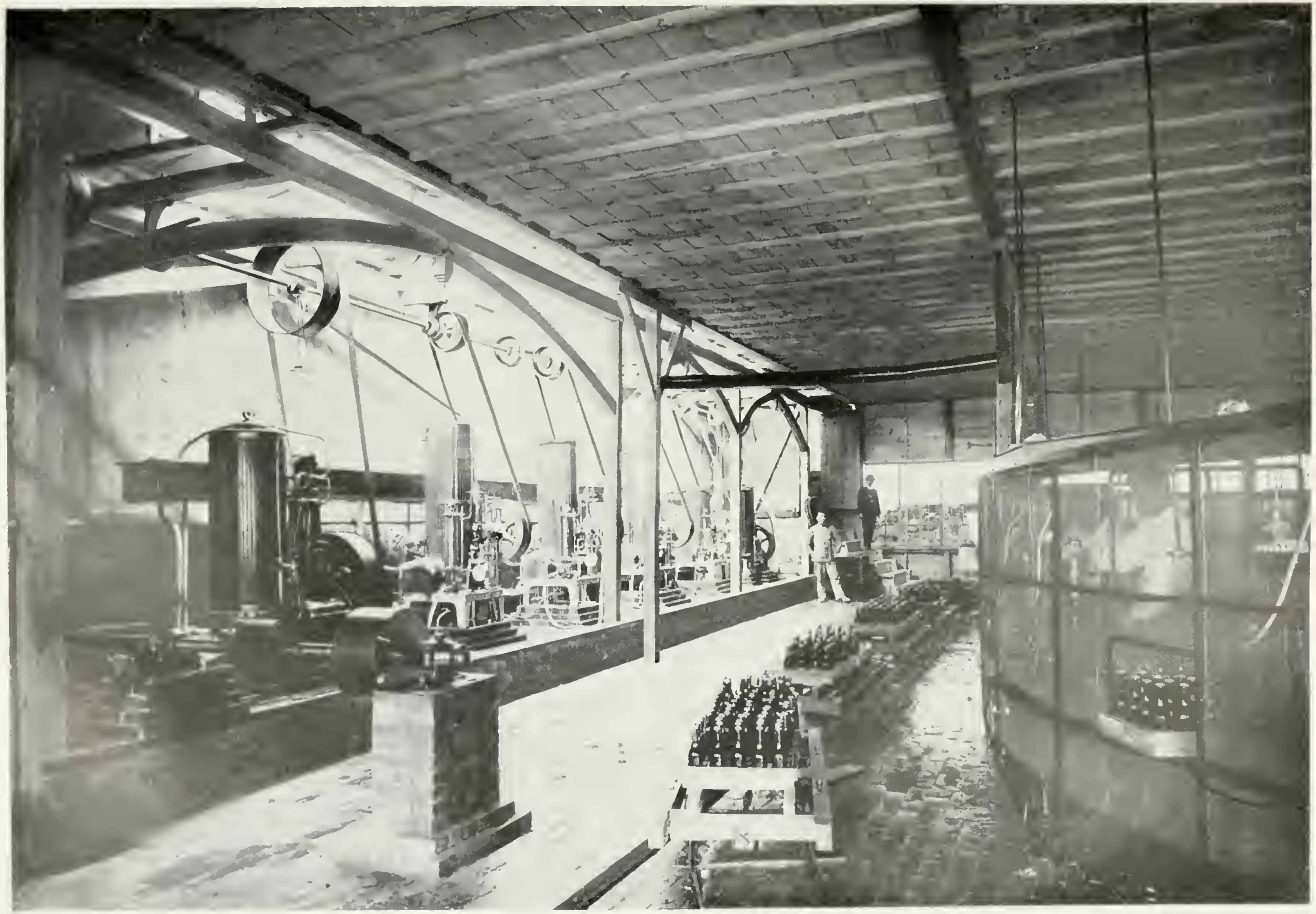
Soto-no-yu Hot Springs, near *Katsu-ura,*
on the southern coast of Kii Peninsula, situated at the base of high cliffs, commanding magnificent seascape.
The spa enjoys a mild climate both in summer and winter. Fish of all kinds are abundant in the adjoining sea. (p. 57)

Hamadera, a favourite sea-bathing resort near *Ōsaka.*
The sandy beach here is studded by old pine-trees. Awaji Island is just opposite to the place and the Rokko Mountain Range is seen to the left. Bathers are free from the danger of under-currents. During the summer season large crowds come for a day's pleasure, by electric cars from Osaka. (p. 57)

The Clifford-Wilkinson Tansan Mineral Water Works, at *Takarazuka*, near Ōsaka. (p. 53)

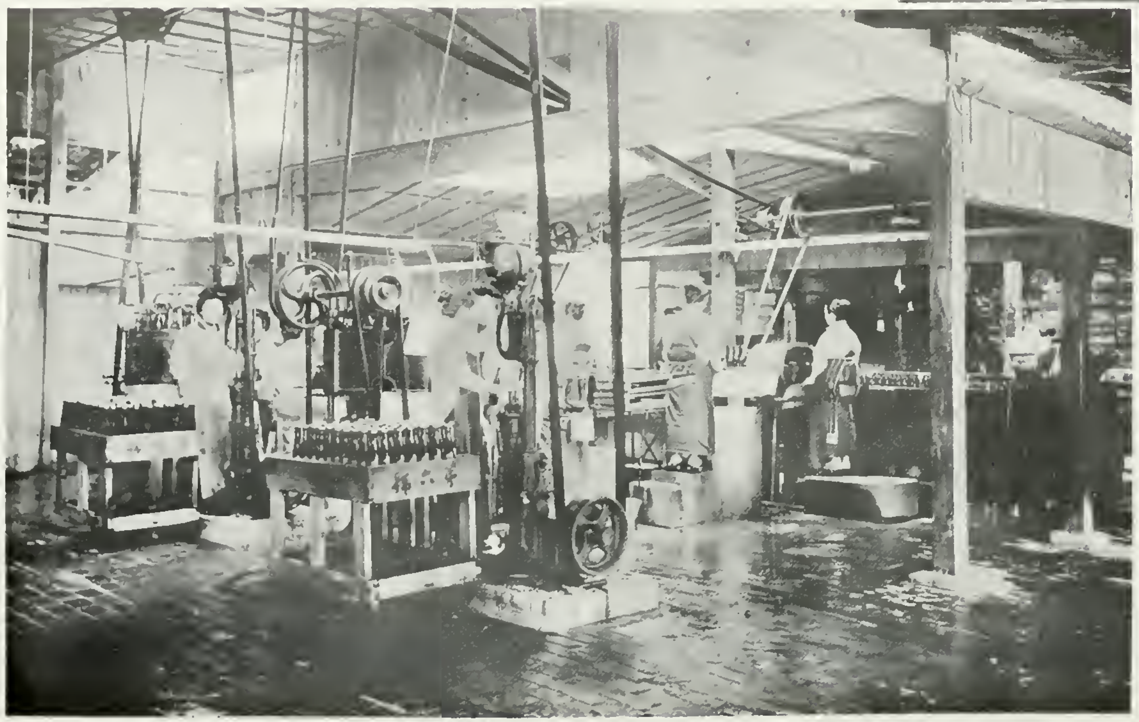
The Clifford-Wilkinson Tansan Mineral Water Works.
Three separate rows of filters purifying water of iron and other matter. (p. 53)

A ravine at *Tada-mura*, near Ōsaka, close to the spring of the famous "Hirano Water" (bottled by Teikoku Kōsen Kabushiki Kaisha or the Imperial Mineral Water Co., Ltd.). (p. *53*)



Interior of the Hirano Water Works of the Imperial Mineral Water Co., Ltd.
Carbonating and Bottling Department. The factory is one of the most perfect bottling works in Japan. (P. 53)

Nunobiki Tansan Factory,
situated at the foot of the picturesque hills behind Kōbe, close to the famous Nunobiki Waterfall from which the name is taken. (p. *54*)



Bottling and Corking Department.

Arima Spa, 1,150 ft. above the sea,
one of the most noted hot springs throughout Japan, situated in a valley surrounded by Rokko-zan and other hills.
The spa is a favourite summer resort near Kobe and Osaka. The springs contain a
considerable quantity of common salt and iron. (p. 57)

Kinosaki, about 100 m. from *Kyōto*, the most noted hot springs in the whole San-in district, known since the 7th century. (p. *54*)

Misasa Spa, 5.5 m. S.W. from the *Agei* station on the San-in Line, Hoki Province.
The hot springs are unsurpassed in radio-activity by any others throughout Japan. The quantity of radium emanation contained in the most active spring amounts to 142 Mache's units. At present hot springs containing the emanation of more than 30 Mache's units, number 9 in the spa. (p. 56)

Ushio, a small hot spring spa, 8 m. S. of *Matsue*, Izumo Province. (p. 58)

Port Tomo and the Island of Sensui-tō, one of the most charming sights in the **Inland Sea,** 12 m. from Fukuyama. There are numerous picturesque islets, large and small, around the island. The beautiful sheet of water, dotted with fishing boats and white winged vessels sailing past, presents delightful scenery. (p. *60*)

Dōgo Spa, a watering resort of the most ancient origin in Japan, is in Shikoku and has a three-storied bath-house and a pretty park. (p. 61)

Dōgo Spa.

Public Bath with "Bathers' Club," where tea and cakes are served to visitors in the upper stories, while on the third floor means are provided for indoor amusements of various kinds. (p. 67)

Funagoya Mineral Springs, near *Haimu-zuka* (77 m. from Moji).
A view of the spa from the River Yabe-gawa. (p. *62*)

"*Tama-ga-se*," a shoal on the River Yabe-gawa, near **Funagoya Mineral Springs.** (p. 62)

Shibaseki Hot Springs, near *Beppu,*
a quiet pleasure resort, situated in a ravine on hill-side.
Hot water, conducted by bamboo pipes and forming a row of waterfalls, is used for massage. (p. *63*)

Umi-jigoku, near *Beppu*,
a boiling pond (60 ft. in diameter at the widest part)
covered with rising steam, shot with blue and green, presenting a curious sight. (p. 63)

Beppu Spa, on the beautiful Bay of Bungo, called as the Japanese Riviera by foreigners, is a delightful winter resort enjoying a mild climate. Open-air beach baths, called "*Suna-yu*," where hot springs bubble up through sand, are the specialty of the place. Takasaki-yama (2,067 ft.), an extinct volcano, rises at the southern end of the spa town. (p. 63)

The Western Beach or "*Nishi-hama*" of **Karatsu Bay** (popular for sea-bathing), seen from Maizuru-Kōen. (p. *68*)

The Beautiful Bay

The Eastern Port (right) on the estuary of the *Matsu-ura-gawa*

A sandy beach (left) with pine-groves extending hundreds of yards, called "*Niji-no-matsubara,*"

of Karatsu.
is shallow and offers no anchorage for large vessels.
presents a charming view and is suitable for bathing. (p. 68)

Karatsu, a town situated at the mouth of the Matsu-ura-gawa, facing the Bay of Karatsu, noted for beautiful scenery of the beach and also for its pottery. (p. *68*)
The picture shows some inns at Karatsu, which may be regarded as the type of Japanese inns of country fashion.

Takeo Hot Springs, 33 m. from *Tosu* in Kyushu,
surrounded by wooded hills. Behind the spa town is Sakura-yama Park, noted for its landscape-gardens and natural scenery. (p. *68*)

Cherry blossoms at their best in Sakura-yama Park, **Takeo Spa.** (p. *68*)

Jujō Hot Springs, about 7 miles from *Taiden*, Chosen. (p. 70)

Kwanshirei Hot Springs, near *Kōhekiryō* station,

south-east of *Kagi* in Taiwan Formosa). (p. 70)

On-yō Hot Springs, about 9 m. from *Ten-an,* Chōsen, a favourite resort of the upper classes in Keijō. (p. 70)

INDEX

(The Roman figures refer to the numbers of Parts of the volume.)

ERRATA.

Pt. II, pp. 1–55, Electric conductivity, for $\chi_{18} \times 10^{-4}$, read $\chi_{18} \times 10^{4}$.
,, p. 18, Table 16, No. 2, Classification, for sulphur, read acid vitriol.
,, ,, ,, No. 3, Temp. of spring in C., for 100,0°, read 103,0°.
,, p. 29, Table 27, Emanation per litre of water in 10^{-10} curies, for 21,05, read 12,05.
,, p. 49, The hot spring "Goza-no-yu," Temperature, for 53,9° C., read 63,9° C.
,, p. 61, The cold spring "Anamori-Kōsen," Calcium ion, for 0,7183 grm., read 0,1873 grm.
Pt. III, p. 9, line 6 from top, for 1,135, read 4,135.
,, p. 30, line 9 from top, for 6,500, read 65,000.

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