STATE OF WASHINGTON
MON C. WALLGREN, *Governor*

Department of Conservation and Development
ART GARTON, *Director*

BIENNIAL REPORT NO. 1 *

of the

DIVISION OF MINES AND GEOLOGY

For the Period Commencing October 1, 1944
and Ending September 30, 1946

By
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Supervisor

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DIVISION OF MINES AND GEOLOGY

SHELDON L. GLOVER, *Supervisor*

GENERAL STATEMENT

The following report applies to the Division of Geology and the Division of Mines and Mining for the period of October 1, 1944 to September 30, 1945, and to the Division of Mines and Geology, a combination of those other agencies, for the period of October 1, 1945 to September 30, 1946.

As in previous years, every effort was made to increase the available information on Washington's mineral resources, aid in their proper development, and further their use. To gain these objectives, investigations were continued throughout the state in connection with the occurrence of specific mineral substances of economic value. Surveys completed during the biennium just ended include those of occurrences of tungsten, sodium sulphate, magnesium sulphate, sodium carbonate, gypsum, pumice, and pumicite. The information so obtained makes a valuable addition to the many bulletins and reports previously available on other mineral substances and which are used by all who are interested in our mineral resources. Other surveys under way but not completed will be continued as rapidly as possible to further the acquisition of needed data. Many additions were made, also, to the voluminous files of field notes and index cards covering all minerals occurring in the state. These files now include thousands of items and represent 45 years of continuous investigations.

The average citizen, none too familiar with geology and the mineral industry, and belatedly recognizing the economic importance of our mineral resources, is prone to advocate elaborate surveys to investigate these resources. A common expression is that "Washington is a treasure chest of unknown and undeveloped minerals." This, of course, indicates a desirable awareness of the value of our mineral supplies, but it also indicates a lack of appreciation of what has been done during the past 45 years and what is being done and should be done in regard to mineral studies.

Much remains to be accomplished—the complete story may never be written—but a very large amount of information is available to the public and is continually being augmented with new material. This is constantly drawn upon in field and office conferences and in handling correspondence pertaining to all aspects of the mineral industry. The acquisition of new or more complete information on the resources of given areas or on occurrences of specific minerals throughout the state is not accomplished by the application of mass-production methods. Rather, the best economic results, considering efficiency and cost to the State, are obtained through carefully planned, detailed field and laboratory investigations conducted by trained specialists experienced in this kind of work. These men must not only be able to observe and properly interpret geologic evidence but must have the ability to determine what additional research is needed and to complete the highly essential supplemental laboratory work. Finally, they must be able to prepare intelligible reports that will be recognized as authentic by other specialists and which will be useful to the average citizen who looks to them for information.

FORMATION OF THE DIVISION OF MINES AND GEOLOGY

On October 1, 1945, by order of Mr. Art Garton, Director, Department of Conservation and Development, and at the suggestion of the Governor's Advisory Commission, the Division of Geology and Division of Mines and Mining were combined in one agency,

the Division of Mines and Geology, with offices at the State Capitol, Olympia. The purpose of this change in departmental organization was to simplify administration, prevent overlap and duplication in equipment and activities, and to centralize in Olympia all matters pertaining to the two original divisions.

Geologic investigations as a function of the State Government began with the appointment of George A. Bethune as State Geologist in 1890, with office in Tacoma. After two years this early work was discontinued for lack of further appropriation. It was resumed in 1901 with the establishment of the Board of Geologic Survey and the appointment, by the Board, of Henry Landes as State Geologist. For 20 years the office of the Washington Geological Survey was maintained at the University of Washington, Seattle. On April 1, 1921 the Administrative Code was adopted by the Legislature, and the duties and functions of the Board of Geologic Survey devolved upon the Director of the Department of Conservation and Development, the activities to be carried on by the Division of Geology. The first supervisor of this newly formed Division was Solon Shedd. He retired in 1925, to be succeeded by Harold E. Culver, but throughout the whole 24-year period from 1921 to 1945 the Divisional office was maintained at the State College of Washington, Pullman.

In 1935 the Legislature passed the Mines and Mining Act, whereby the Director of the Department of Conservation and Development was given the duty, through an appointed supervisor, of carrying on what, in effect, were nearly the identical activities of the original State Geologic Survey and its successor agency the Division of Geology. The first supervisor of the Division of Mines and Mining was Thomas B. Hill; the office was in the quarters of the Department of Conservation and Development, Olympia. In 1941 he was succeeded by Sheldon L. Glover, formerly the assistant supervisor of the Division of Geology, and the Olympia office and staff were enlarged to carry on adequately the activities specifically authorized by the Mines and Mining Act.

For four years thereafter (from November 1, 1941 to October 1, 1945) these two divisions of the Department of Conservation and Development were concurrently engaged in the investigation of the state's mineral resources, studying all phases of geology that were prerequisites to a proper understanding of our mineral deposits, preparing reports for publication, and aiding in every possible way in the development and utilization of these natural resources. Through careful collaboration and coordination of activities the two supervisors prevented a duplication of field investigations and a waste of funds. However, it was impossible to operate the separate offices without considerable duplication in the matter of files, records, library, and laboratory facilities, and without some inconvenience to the public who were unaware of which office had the particular data desired.

On October 1, 1945, therefore, the two divisions were combined by administrative order. All files, records, field notes, reports, maps, library volumes, and bulletins of the Division of Geology were moved to Olympia and there added to the similar material of the Division of Mines and Mining. The supervision of the combined Division of Mines and Geology was given to the writer, at the same time retaining the benefit of Dr. Culver's long experience with the Division of Geology by appointing him Geologist Consultant for the new organization.

The personnel of the Division of Geology was transferred to the new division, though by that time it only consisted of a secretary, Dorothy Rinkenberger, all other former staff members having left to enter the armed services or to take employment in industry. The personnel of the Division of Mines and Mining became the staff of the new division; it included W. A. G. Bennett, Ward Carithers, and A. K. Guard, geologists; Stephen H. Green, mining engineer; and A. B. Fosseen, nonmetallic research engineer. Later in the

biennium Grant M. Valentine and Marshall T. Huntting, geologists and former members of the staff of the Division of Geology, were employed, upon their discharge from the army, to replace Ward Carithers, who resigned to become Mine Geologist for the Howe Sound Company, and A. K. Guard, who also entered the employ of the Howe Sound Company. Other additions to the staff, temporary and for specific projects, were Charles D. Campbell, geologist; M. S. Pechet, mining engineer and geologist; Melvin C. Schroeder and William N. Schlax, Jr., field assistants; and C. L. McConnell, draftsman.

To care for the greatly increased volume of books and records of all kinds and to allow such increase in the Olympia staff as was necessitated by taking over certain activities theretofore only carried on at Pullman (i.e., accumulation of oil and gas drilling records), arrangements were completed whereby a marked increase in office space was made available. The new Division now has adequate quarters for offices, library, laboratory, and storerooms and is in a position to carry on from one central location coordinated state-wide investigations and to supply information from the center of State Government to all who are concerned with geology, mining, and mineral resources.

GENERAL ACTIVITIES

Many of the activities of the Division are of a continuing sort and follow a certain pattern, year after year. Other activities are of a project nature; each one may require a great deal of time and attention until completed and then become subordinate to other projects. Examples of the project variety of activity are the tungsten and saline-lake investigations mentioned on following pages.

The principal continuing activity is responding to personal requests for specific information. This service is handled by correspondence or by conferences in the office or in the field. The requests are of infinite variety, having to do with everything pertaining to mineral occurrence and development, with markets and use, with availability of mineral supplies, and with all phases of general and economic geology. Every effort is made to give sympathetic, courteous attention to all inquirers and to provide immediate answers to requests and problems. The volume of correspondence and the number of personal calls at the office indicate the appreciation with which this service is received.

Many inquiries and requests involve matters that can be handled inadequately, if at all, by correspondence. New occurrences of minerals are commonly reported; these may have unusual aspects of value or location that make a field inspection desirable. Reported oil seeps must be seen to be evaluated. A farmer may ask about some physical condition of his land but be unable to describe the feature. A prospector may need advice in some unusual situation, or he may merely need guidance and encouragement. Mining meetings, technical discussions, and industrial conferences require attendance. All such matters call for individual handling, but several calls or investigations are made during one trip, if they can be so scheduled, in the interest of efficiency and to conserve transportation facilities.

Periodically through the years the state experiences cycles of considerable activity in testing for the occurrence of oil and gas. As no general laws regulate such drilling, the operators are called upon and their consent obtained for filing with the Division the logs, cores, cuttings, and other pertinent records acquired during their exploratory work. This material is kept confidential on request, but it becomes a part of an invaluable record and is of the greatest importance to all future operators. Cataloguing the data and preparing permanent useful files of the cores and cuttings require careful attention.

The maintenance of concise usable files on mines, prospects, and mineral occurrences is a constant activity that provides one of the Division's best working tools. The subject matter is acquired in many ways. Most of it is obtained during field investigations; the

rest, from conferences and correspondence and from the results of work conducted by other agencies or individuals. The highly varied information is carefully evaluated, catalogued as to subject, and incorporated for ready reference in constantly expanding files.

The Division is always prepared and willing to cooperate with other State agencies in matters of mutual interest; also, certain departments may have occasional use for geologic work or advice and are free to call on the Division for aid as required. Cooperation is maintained with Federal agencies, particularly the U. S. Bureau of Mines in the collection of statistics of mineral production and the U. S. Geological Survey in topographic mapping.

Many other operations of the Division require more-or-less regular attention, such as the maintenance and building up of its comprehensive technical library; of the exhibit material of ores and rocks; of the mineral samples from mines, prospects, and undeveloped occurrences; and of the voluminous maps pertaining to the state.

ECONOMIC IMPORTANCE OF THE MINERAL INDUSTRY IN WASHINGTON

Mining is a major industry in Washington and makes an important contribution to the economic welfare of the state. This is not only evidenced by the new wealth that comes from the development of minerals and mineral aggregates but by the great number of subsidiary and associated industries, such as machinery and supply houses, treatment plants, and manufacturers who serve the mines or are able to operate here because raw materials are available and are produced. The direct money value of the mining industry is indicated in the accompanying table of mineral production; the indirect value is, of course, far greater in amount.

Statistics are given for the latest year (1944) for which complete details are available. The production figures for seven previous years are also given to permit comparisons to be made and to indicate trends up to and through the war years. An all-time high of $37,593,000 was reached in total value of output for 1943. The average annual production for the 1935-44 ten-year period was $28,231,959. Although the 1944 production of $36,320,000 was one and one-quarter million dollars below the value of the 1943 output, it was well above the average figure for the past 10 years, and it is safe to assume that the figures for the years 1945 and 1946, when available, will also be above that general average.

SELECTED MINERAL PRODUCTION① —1937 Through 1940

Product	1937		1938		1939		1940	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clay and clay products		$ 1,120,083		$ 1,017,568		$ 1,083,659		$ 1,288,353
Coal, short tons	2,001,449	6,325,000	1,566,973	4,939,000	1,690,000	5,256,000	1,650,352	5,221,717
Coke, short tons	14,656	87,936②						
Copper, pounds	128,000	15,488	12,034,000	1,179,332	17,996,000	1,871,584	19,224,000	2,172,312
Gold, troy ounces	36,310	1,270,850	74,175	2,596,125	90,420	3,164,700	82,136	2,874,760
Lead, short tons	2,830	333,940	4,284	394,128	3,718	349,492	2,555	255,500
Lime, short tons	65,272	647,692	34,025	348,332	47,485	484,667	53,428	582,416
Magnesite, short tons	—③—	—③—	—④—	—④—	—④—	—④—	—④—	—④—
Manganese ore, long tons	—③—	—③—	—④—	—④—	—④—	—④—	—④—	—④—
Mercury, flasks (76 lbs.)	—④—	—④—	—④—	—④—	—④—	—④—	—④—	—④—
Portland cement, barrels	—④—	—④—	—④—	—④—	—④—	—④—	—④—	—④—
Sand and gravel, short tons	9,376,644	6,818,154	6,015,812	2,861,309	11,918,217	6,048,619	6,987,761	4,278,251
Silver, troy ounces	126,304	97,696	380,938	246,263	442,063	300,067	365,175	259,680
Stone, short tons	2,027,420	1,909,604	2,321,210	1,849,051	2,329,020	2,020,445	2,347,190	1,941,820
Zinc, short tons	4,116	535,080	11,402	1,094,592	10,131	1,053,624	11,560	1,456,560
Miscellaneous⑤		7,584,670		4,641,304		9,957,166		7,758,819
Total		$26,658,257		$21,167,004		$31,590,023		$28,090,188

SELECTED MINERAL PRODUCTION① (Cont.)—1941 Through 1944

Product	1941		1942		1943		1944	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clay and clay products		$ 1,235,737		$ 1,021,735		$ 1,027,236		$ 1,197,449
Coal, short tons	1,841,274	6,478,674	1,953,209	7,549,352	1,527,544	6,729,906	1,515,000	7,196,000
Coke, short tons					14,853	—②—		
Copper, pounds	17,372,000	2,049,896	16,060,000	1,943,260	14,630,000	1,901,900	12,338,000	1,665,630
Gold, troy ounces	84,176	2,946,160	75,396	2,638,860	65,244	2,283,540	47,277	1,654,695
Lead, short tons	3,903	444,942	4,851	650,034	5,022	753,300	5,825	932,000
Lime, short tons	62,309	656,362	55,864	623,766	—④—	—④—	55,241	667,546
Magnesite, short tons	—③—	—③—	—④—	—④—	—④—	—④—	—④—	—④—
Manganese ore, long tons	—③—	—③—	—④—	—④—	—④—	—④—	—④—	—④—
Mercury, flasks (76 lbs.)	—③—	—③—	—④—	—④—				
Portland cement, barrels	—④—	—④—	—④—	—④—	—④—	—④—	—④—	—④—
Sand and gravel, short tons	5,583,285	2,476,834	8,172,550	4,094,900	5,183,374	3,403,720	6,946,153	4,076,976
Silver, troy ounces	402,030	285,888	369,038	262,427	370,440	263,424	321,608	228,699
Stone, short tons	2,148,970	1,757,873	1,965,820	1,809,757	2,031,810	2,499,550	2,538,690	2,756,332
Zinc, short tons	14,320	2,148,000	14,398	2,678,028	12,203	2,635,848	11,904	2,714,112
Miscellaneous⑤		8,026,515		12,387,424		16,094,576		13,230,561
Total		$28,506,882		$35,659,543		$37,593,000		$36,320,000

①Compiled by State Division of Mines and Geology from statistics of U. S. Bureau of Mines, as published in Mineral Resources of the United States, 1926; and Minerals Yearbook, 1937 and later years.
②Not included in state total, in order to avoid duplication.
③Included in "miscellaneous."
④Includes minerals indicated by "③" above, also, in various years, the following: Arsenious oxide, diatomite, iron ore, magnesium, magnesium sulphate, peat, pulpstones, pumice, ground sand and sandstone, silica (quartz), talc, soapstone, tungsten ore, and other minerals.

Holden Mine, Howe Sound Company, Chelan Division, Chelan County, Washington.

LABORATORY RESEARCH

Studies of any of the great variety of mineral substances occurring in the state not only involve careful identification of the materials themselves, but determination of their physical properties, origin, associations, and alteration products. From the results of such work, conclusions are drawn as to necessary treatment and best economic utilization of the given material; the possible occurrence of other materials of value, not previously recognized; the probable continuity of the occurrence; and the variations that are to be expected as mining progresses. To carry on these investigations, the laboratory

of the Division has equipment for conducting ordinary qualitative analyses, microchemical analyses, mineralogic or "blow-pipe" analyses, and screen analyses. For petrographic and polished-section work in this connection, there are available a diamond saw and two laps for making thin sections and polished sections; Baush and Lomb LC petrographic, CM metallographic, and CTA-8 binocular microscopes; a refractometer, and a complete set of oils for determining index of refraction in steps of two thousandths from 1.400 to 1.700 and in steps of one hundredths from 1.700 to 1.800. All members of the staff have immediate access to the laboratory equipment and use it constantly in the preparation of reports and in the research that forms a major part of mineral-resource investigations.

MINERAL IDENTIFICATION SERVICE

As a State service, the general public is advised that the Division is glad to examine in the laboratory any samples of rocks and minerals from the state that may be submitted. No charge is made for this service, as no equipment or materials are required that are not already available and in use for the necessary work of the Division. Quantitative analyses and assays are not made, but minerals and mineral aggregates are identified for the sender, and, on request, suggestions are made as to their possible economic value and markets and as to the desirability of having assays made and of carrying on exploration and development.

The large number of samples constantly being received indicates that this available information is appreciated by prospectors and miners as well as by fishermen, hunters, and others who occasionally find materials with which they are unfamiliar but which may have commercial value. It saves them the expense of unwarranted assays while obviating the possibility of overlooking something that may have value. The senders are urged to mention the locality where the samples were obtained. This permits the Division to apply an intimate knowledge of the geology of the state and to draw better conclusions as to the economic importance of the particular occurrence. Benefit accrues not only to the man who submits the sample but to the Division, which gains through increasing its extensive fund of factual data on mineral occurrences.

MINERAL EXHIBITS

A determined effort has been made during the past several years to collect characteristic examples of all minerals and aggregates occurring in Washington that have present or probable future economic value. The samples, on display at the Divisional offices, have a decided general interest but are particularly useful for prospectors and miners who wish to familiarize themselves with the various materials, and for industrialists who may be unaware of the occurrence here of certain substances. The collection is strictly a working exhibit and is used to marked advantage in conferences when the availability and properties of various resources are under discussion.

Samples are selected from this collection for display at special meetings where it is desirable to publicize the state's resources. In this way, exhibits were arranged for the Exposition of Chemical Industries, held in New York in February 1946; at the Sportsmen's Show, held in Seattle in April 1946; at the Pacific Northwest Parade of Progress, held in Seattle in June 1946; and at the National Chemical Exposition, held in Chicago in September 1946. Insofar as possible, samples are also supplied to individuals and concerns who have a special or particular need that may result in the utilization or development of our mineral resources.

PUBLICATIONS

Reports of general interest to the mining industry are published as expeditiously as possible. However, much of the work of the Division is of such nature that publication of the results obtained is not feasible or desirable. For example, the activities com-

ing under the head of individual aid to prospectors and small-mine operators and the work necessitated by increasingly numerous inquiries covering the whole field of mineral occurrences, development, and utilization are originally of limited interest. These activities are handled through personal correspondence and conferences, commonly of confidential nature. They are of basic value to the mining industry and to the general industrial development of the state, but they do not result in specific reports for regular distribution. Other activities are of broader interest and are primarily designed to supply information that can be published. The following reports were distributed during the biennium just past or were prepared and are nearly ready for distribution:

Some magnetite deposits of Stevens and Okanogan counties, Washington, by W. A. Broughton. 1945. 24 pp. 5 pl. Prepared and published during the first half of the biennium by the Division of Geology as Report of Investigations No. 14.

Tungsten resources of Washington, by Harold E. Culver and W. A. Broughton. 1945. 89 pp. 23 pl. Prepared prior to the second half of the biennium by the Division of Geology and published during the second half by the Division of Mines and Geology as Bulletin No. 34.

Manganese deposits of the Olympic Peninsula, Washington, by Stephen H. Green. 1945. 45 pp. 5 pl. Prepared and published prior to the second half of the biennium by the Division of Mines and Mining as Report of Investigations No. 7.

Geology and ore deposits of the Sultan Basin, Snohomish County, Washington, by Ward Carithers and A. K. Guard. 1945. 90 pp. 3 pl. Prepared prior to the second half of the biennium by the Division of Mines and Mining and published during the second half by the Division of Mines and Geology as Bulletin No. 36.

1945 Directory of Washington mining operations, by Stephen H. Green and Ward Carithers. 1945. 48 pp. (Mimeographed). Prepared and published during the first half of the biennium by the Division of Mines and Mining as Information Circular No. 11.

1946 Directory of Washington mining operations, by Stephen H. Green. 1946. 57 pp. (Mimeographed). Prepared and published during the second half of the biennium by the Division of Mines and Geology as Information Circular No. 12.

Coal and coal mining in Washington, by Stephen H. Green. A revision and reprinting of Division of Mines and Mining Report of Investigations No. 4. (In preparation).

Pumice and pumicite occurrences of Washington, by Ward Carithers. (In preparation).

Saline-lake deposits of Washington, by W. A. G. Bennett. (In preparation).

COAL

The Division does everything possible to aid coal mining through consideration of basic, general conditions affecting the industry and of the problems of the individual producer. It does not compete with private engineers and consultants, but through office conferences and by frequent personal visits to the various operating properties can render valued assistance in many ways.

Coal is one of the most abundant and valuable resources of the state. Some 138 million tons have been mined up to and including 1945, yet it is estimated that there are in excess of 60 billion tons still in reserve. This places the state in a singularly favorable position, for the reason that areas amply supplied with coal have always become dominant industrially. Though the general coal-mining conditions here are possibly less favorable than those obtaining in most of the large eastern fields, the proximity of the coal areas to the principal consuming centers and also to tidewater, a mild climate that

insures favorable transportation and working conditions throughout the year, ample railroad facilities, and excellent highways are all advantages that help to overcome possible drawbacks.

The product of the various coal areas of the state can meet every requirement of the fuel-consuming markets, as it embraces every rank of coal from subbituminous to anthracite. One important feature is the fact that the only large and commercially important supply of coking coal in the Pacific Coast States is located in Pierce County. This fact is unquestionably of marked significance in connection with the needs of electrometallurgical and electrochemical industries now in operation or in prospect. During the war the amount of annual coal production dropped, owing principally to labor shortage; many miners were drafted and many more left the mines to enter other employment where the wages looked more attractive. It is expected that in the near future this condition will be alleviated and that production will gradually increase. For the past few years approximately 1,500,000 tons of coal have been imported annually from other areas. This means a definite financial loss to this state, and every effort should be made to bring our output back to normal as rapidly as possible.

Considerable interest in producing coal by stripping operations has recently arisen. In 1943 strip mines accounted for 1.8 percent of the state's output, in 1944 it was 3.1 percent, and in 1945 it was 5.5 percent. A new and larger strip mine will be in operation shortly, and still another area has recently been drilled and proven to contain approximately 5 million tons amenable to stripping. Further investigation will unquestionably uncover other areas suitable to this method of extraction. A mining cost of about $1.00 per ton can be realized in strip mining, allowing a considerable expenditure for beneficiation without exceeding a total cost that is well within an economic marketing price range.

Southwestern Washington, with its vast reserves of subbituminous coal, presents a special problem that calls for early solution. The high moisture content of this coal makes it a rather unsatisfactory fuel in its raw form, but the potential possibilities of carbonization, complete gasification, or briquetting could readily change the position of this area from its present low status to that of one of the best in the entire state. The beneficiation of this rank of coal has been definitely and successfully accomplished elsewhere, and there is no reason why the same results could not be attained in this area.

Of particular interest at the present time is a project, authorized on August 14, 1946 and financed from the research funds of the Department of Conservation and Development, to study and report on the entire fuel situation of the state. A contract has been entered into with the Battelle Memorial Institute of Columbus, Ohio,—a nonprofit industrial-research organization eminently fitted to conduct the investigation—to determine the actual status of our fuel situation. The survey, through an exhaustive study of competitive fuels—their present and probable future availability, prices, and all other factors bearing on use—will determine how serious our fuel problem is and the anticipated effect on industry. With all facts known, it may become apparent that there exists no cause for alarm. On the other hand, if it is proved that our fuel problem is as critical as it appears, then consideration can be given to corrective measures, such as, for example, the feasibility and cost of a centrally located plant in the coal fields to produce gas or gas and by-products from coal, the gas to be piped to supply the industrial and domestic needs of the principal centers of population in western Washington.

LIMESTONE INVESTIGATIONS

Limestone has so many fundamental applications in industry that every effort is made to acquire all possible information on occurrences in Washington. During the last three years particular attention has been given to deposits situated west of the Cascade

Range, the objective being to publish an up-to-date economic report on this resource. All known occurrences have been visited and briefly examined, so that preliminary data are available for general use without having to await the completion of the detailed surveys now underway.

The final, complete investigation is slow and laborious work, sometimes in difficult terrain, and involves accurate interpretations of stratigraphic and structural evidence. For example, one of the most promising localities is Jackman Ridge, north of the Skagit River east of Concrete, in Skagit County. This is a steep, mountainous country (35- to 55-degree slopes), covered with dense brush and having sparse outcrops. Existing maps are of little use in the absence of known landmarks, so section corners must be found and the exposures tied in by tape and compass. The known limestone bodies consist of several outcrops, each occupying less than an acre, that have been thought by their owners to represent three parallel continuous beds that dip southward, down slope toward the Skagit River. However, work completed so far shows that the beds dip northward at a low angle into the mountainside and that the separated outcrops are a part of one bed, offset by faulting. The tonnage in sight is considerable, so a large quantity of stone can be removed by quarrying before stripping becomes a problem; thereafter underground mining must be employed. The indications are that large reserves of high-quality limestone exist in this area, but much work remains to be done before all desired information is obtained. When the investigation in that area is finished, the many other occurrences in western Washington will be similarly studied.

SALINE-LAKE DEPOSITS

Many lakes in Grant and Okanogan Counties contain strong saline brines, and most of these have, as well, solid deposits of crystalline salts of sodium sulphate, sodium carbonate, or magnesium sulphate. Several companies and individuals have attempted to mine these salts, but efforts have not been too successful, particularly with regard to the production of sodium compounds. In recent years there has been a marked increase in the market demand for such salts and a similar increase in production is reported from other western states. Also, new processes have been worked out in the last 10 or 15 years to recover not only a specific salt but the several that are commonly present in the brines. Because of these changes in demand and in recovery techniques, it is probable that the Washington deposits have a definite future value.

The significance of our saline lakes was noted in an early Washington Geological Survey report (1902), and they have been described briefly in later accounts, but no report dealing exclusively with the lakes has been published. As the need for detailed information became increasingly evident, an investigation was started in early October 1944 and continued till mid-December, then resumed in March 1945, carried on through the spring and early summer, and completed in November.

All lakes having saline characteristics were investigated; the more important ones were mapped topographically by plane-table on a scale of 100 or 200 feet to the inch and were tied to corners or quarter-corners of sections. Before the lakes became dry in the late fall they were inspected by boat to determine the depth of the brine and the distribution and size of the crystal accumulations. By October 1945 most of the lakes were dry and these were drilled with an Iwan, post-hole type earth auger for sampling, and a coal auger where boring became difficult at depth in the bottom muds. Bedrock was reached in many lakes. The maximum depth of salt was found to be about 10 feet. The lakes range in size from 3 to 20 acres and contain different amounts of crystal that are as much as 90,000 tons in a given deposit. Additional amounts of salts are held in solution as brine in the various lakes.

A bulletin is now in preparation which will give the results of this investigation and include maps of the many lakes and analyses of some 80 samples of salts. This will prove timely in view of a marked increase in interest shown in our saline resources. Incidentally, the potential value of the state's saline resources, assuming complete recovery were possible, is approximately $50,000,000 at present prices, or roughly 6 percent of the total mineral wealth produced to date from the state.

PUMICE AND PUMICITE OCCURRENCES

Considerable general and some detailed information have been available on our pumice and pumicite deposits, but, owing to the lack of any particular market value, these materials were never given much attention. The situation changed with remarkable suddenness in 1945, when the manufacturers of concrete blocks became interested in pumice as a lightweight aggregate. Since that time more inquiries have been received for information on the location and physical properties of Washington pumice than for any other single resource.

Pumice in the "Popcorn" Pit, near Kosmos, Lewis County, Washington.

As soon as it became apparent that the interest had a sound economic basis, a survey was started to investigate all areas where pumice occurred, ascertain the extent and thickness of deposits, and obtain representative samples for laboratory study. As pumicite, a related material, originates in the same way and has some properties and uses in common with pumice, it was convenient to investigate this at the same time.

This work has now been completed and a report prepared on all phases of the subject that are of general interest. The two pumice areas of the state—northeast of Mount St. Helens and east of Glacier Peak—are described, some 134 stratigraphic sections through pumice beds are given, and 27 screen analyses are included. The pumicite occurrences are more widespread, though the material is most abundant in the south central and southeastern part of the state. As with pumice occurrences, information is given

on location, stratigraphic details, and physical properties. This report, now being printed, provides most useful information for prospective producers and users of these materials, and, from present indications, will be in particular demand.

Mining pumice at the Patty Pit, on the Entiat River, Chelan County, Washington.

TOPOGRAPHIC MAPPING

Topographic maps are such a basic necessity to so many services and activities of present-day civilization that the need for continuing and expediting our mapping program is considered to be of paramount importance. Investigations or construction projects carried on in geology, hydraulics, power development and distribution, reclamation, soil surveys, flood control, and aeronautics, to mention only a few outstanding instances, are greatly handicapped or even prevented unless accurate topographic maps are available. It is natural, therefore, that those who have the welfare of the state in mind and look to its maximum orderly development should be vitally interested in mapping progress.

Various Federal agencies carry on mapping programs, but the United States Geological Survey, Topographic Branch, is the one charged with the production of a standard atlas of topographic quadrangles, covering the whole nation, and is the principal mapping agency. The first quadrangle in this state to be surveyed by the U. S. Geological Survey was the Snohomish, finished in 1895. Since then, through the use of Federal funds alone, 48 quadrangles have been mapped by the Survey. When it was found that the available funds, staff, and equipment of the Survey were not equal to the production in the required time of certain maps, the U. S. Army surveyed 56 quadrangles for purposes of national defense. These maps are similar in style and in size to those made by the U. S. Geological Survey and, for most purposes, may be used with those of the standard atlas. In addition, 14 quadrangles have been mapped by the U. S. Geological Survey and the U. S. Army under cooperative agreements.

In order to speed up the mapping of Washington, the Legislature of 1903 provided for the participation by the State in the topographic surveying program, authorizing the

Board of Geologic Survey to cooperate with the U. S. Geological Survey if the latter would agree to meet the Board's expenditures. An appropriation provided for by the Legislature of 1909 first made this cooperation effective and initiated a mapping program that has been more-or-less continuous ever since. Under this beneficial cooperative arrangement, the mapping of 51 quadrangles has been completed, and mapping is now underway on 4 additional quadrangles.

PRESENT STATUS OF TOPOGRAPHIC MAPPING IN WASHINGTON

	Number of quadrangles	Area① (in sq. miles)
Mapping completed by U. S. Geological Survey	48	27,811.69
Mapping completed by U. S. Army	56	8,128.91
Mapping completed by U. S. Geological Survey in cooperation with the U. S. Army	14 (includes 1 irregular)	608.78
Mapping completed by the State of Washington in cooperation with the U. S. Geological Survey or U. S. Army	51	16,520.91
Total mapping completed	169	53,070.29 (Percent of state, 77.83)
Mapping authorized by U. S. Geological Survey	5	2,676.84
Mapping authorized through cooperation of State with the U. S. Geological Survey	Part of 4	Remapping
Total mapping authorized	5	2,676.84
Total, mapped and authorized	174	55,747.13 (Percent of state, 81.75)

①Exclusive of salt water areas.

Area of state yet to be mapped, not now authorized, 11,808.82 square miles, or 17.32 percent of the total land area.

The cost of topographic mapping varies greatly from place to place, depending on the cover and relief of the given area. For example, the Mount Constance quadrangle, in the Olympic Mountains, cost approximately $18,000; the Chehalis quadrangle, a rolling lowland country, cost about $14,500; and the Connell quadrangle, a treeless region of scant relief, cost $12,800. These are all 30-minute quadrangles on a scale of approximately one-half inch to the mile and with 50- or 100-foot contour interval. The much more useful 15-minute quadrangles, on a scale of about one inch to the mile and usually with a 20- or 25-foot contour interval, have a cost approximately double that of 30-minute quadrangles for given areas but unquestionably warrant the added expense. All the more recent mapping and that planned for the future is at most on the 15-minute basis.

Lists of the quadrangles of Washington are given in the following tables. These may be used with any map of the state that gives latitude and longitude, in order to determine the location of a given quadrangle; or they may be used to ascertain the name of the quadrangle that includes any given area.

In the first table the quadrangles are arranged alphabetically, followed by the index number of the map, the contour interval in feet, the date or dates of mapping (not the date of publication), the mapping agency, and any pertinent remarks. The index system used is the conventional one, in which the symbol for each map consists of the latitude and longitude of the point on the map nearest the equator and Greenwich meridian (southeast corner of the map) plus the extent of the area in minutes of latitude and

longitude. Example: Aberdeen quadrangle, southeast corner, latitude North 46° 45′, longitude West 123° 45′, area 15′ of latitude and longitude, indicated by the index symbol N4645-W12345/15. Abbreviations used for the mapping agencies are as follows: USGS, U. S. Geological Survey; USA, U. S. Army; State co-op., State of Washington in cooperation with a Federal agency; USBR, U. S. Bureau of Reclamation.

In the second table the quadrangles are arranged numerically by the index system to facilitate finding the quadrangle name when only the geographic location is known. The listing progresses across the state in sequence from east to west, beginning with the most southern quadrangles and continuing northward.

Those maps made by the U. S. Geological Survey or by the Survey in cooperation with the State are obtainable for 20 cents per map from The Director, U. S. Geological Survey, Washington 25, D. C.; those made by the U. S. Army, from the Commanding Officer, Army Map Service, 6161 MacArthur Boulevard, Washington 16, D. C. Also, the larger stationery stores commonly carry stocks of these maps, so purchases may be conveniently made there.

TOPOGRAPHIC QUADRANGLES OF WASHINGTON ARRANGED ALPHABETICALLY

Including tentative names of quadrangles not yet mapped as of September 30, 1946

Quadrangle Name	Map Index Numbers	C'ntour interval in feet	Date Mapped	Mapping Agency or Status	Remarks
Aberdeen	N4645-W12345/15	20	1935-39	USA	Inc. remapping of S½ Hoquiam
Allyn	N4715-W12245/15	20	1938	USA	
Anacortes	N4830-W12230/15	50	1940	USA	
Anatone	N4600-W11700/15	50	1944-45	USGS State co-op.	
Anderson Island	N4700-W12230/15	20	1939	USA	
Arlington	N4530-W12000/30	50	1912-13	USGS State co-op.	52.3 percent in Washington
Asotin No. 1	N4615-W11700/15		1945-46	USGS State co-op.	In preparation
Astoria	N4600-W12345/15	20	1935-36	USA	14.1 percent in Washington
Bacon	N4715-W11915/15				88.8 percent mapped by USBR
Badger Pocket	N4645-W12015/15	25	1935-36, 38	USGS State co-op.	
Beverly	N4645-W11945/15	25	1909-10	USGS State co-op.	
Birch Bay	N4845-W12250			Unmapped	30′ lat., 5′ long.
Bissell	N4800-W11800/30			Authorized	
Black Rock Spring	N4630-W12000/15	25	1936	USGS State co-op.	
Blaine	N4845-W12230/15	20	1905	USGS	15′ lat., 20′ long.
Blalock Island	N4530-W11930/30	50	1906	USGS	28.3 percent in Washington
Boylston	N4645-W12000/15	25	1938-39	USGS State co-op.	
Bridal Veil	N4530-W12200/15	100	1939	USA	66.2 percent in Wash. A portion of NW¼ of Mt. Hood and Vic.
Brookfield	N4615-W12330/15	100	1940	USA	98.3 percent in Washington
Camas	N4530-W12215/15	25	1916/34, 37	USGS State co-op.	74.6 percent in Washington
Cape Disappointment	N4615-W12400/15	20	1936	USA	
Cape Elizabeth	N4715-W12415/15			Unmapped	
Cape Flattery	N4815-W12430/15	20	1934-35	USA	
Cape Shoalwater	N4630-W12400/15	20	1936	USA	
Cathlamet	N4600-W12315/15	20	1936	USA	25.8 percent in Washington
Cedar Lake	N4700-W12130/30	100	1910-11	USGS State co-op.	
Chehalis	N4630-W12230/30	50	1913-14	USGS State co-op.	See Tenino & Yelm
Chelan	N4730-W12000/30	100	1897-98	USGS	
Chewelah	N4800-W11730/30	100	1924, 27	USGS State co-op.	
Chiwaukum	N4730-W12030/30	100	1900-01	USGS	
Chopaka	N4830-W11930/30	100	1902-03	USGS	
Clallam	N4815-W12415/15	20	1934-35	USA	11.3 percent in Washington
Clatskanie	N4600-W12300/15	25	1940	USA	35.7 percent in Washington
Clayton	N4745-W11730/15	25	1939	USGS State co-op.	
Clear Lake	N4815-W12200/15	50	1941	USA	NE¼ Mount Vernon
Colockum Pass	N4700-W12000	50	1919-20	USGS State co-op.	15′ lat. and 30′ long.
Colville	N4830-W11730/30	100	1927-29	USGS State co-op.	
Connell	N4630-W11830/30	50	1916	USGS State co-op.	
Corfu	N4645-W11915/15	25	1921	USGS State co-op.	
Coulee City	N4730-W11900/30			Unmapped	14.2 percent mapped. See Grand Coulee

TOPOGRAPHIC QUADRANGLES OF WASHINGTON ARRANGED ALPHABETICALLY (Cont.)
Including tentative names of quadrangles not yet mapped as of September 30, 1946

Quadrangle Name	Map Index Numbers	C'ntour interval in feet	Date Mapped	Mapping Agency or Status	Remarks
Coupeville	N4800-W12230/15	20	1936	USA	
Coyote Rapids	N4630-W11930/15	25	1913-14	USGS State co-op.	
Davenport	N4730-W11800/30			Unmapped	
Deception Pass	N4815-W12230/15	50	1940	USA	
Destruction Island	N4730-W12415/15			Unmapped	
Dungeness	N4800-W12300/15	20	1936	USA	
Eatonville	N4630-W12200/30	100	1930, 32, 34	USGS	See Ohop Valley
Edmonds	N4745-W12215/15	25	1942	USA USGS	NW¼ Snohomish
Elk Park	N4730-W12345/15			Unmapped	
Ellensburg	N4630-W12030/30	100	1899	USGS	
Ephrata	N4715-W11930/15				19.7 percent mapped by USBR
Everett	N4745-W12200/15	25	1942	USGS USA	NE¼ Snohomish
Ford	N4645-W12315/15	20	1937-38	USA	
Forks	N4745-W12415/15	20	1934-36	USA	
Fort Columbia	N4615-W12345/15	20	1938	USA	82 percent in Washington
Friday Harbor	N4830-W12300/15			Unmapped	30.2 percent in Washington
Gate	N4645-W12300/15	20	1937-38	USA	
Gig Harbor	N4715-W12230/15	20	1938	USA	
Glacier Peak	N4800-W12100/30	100	1897-99	USGS	
Goldendale	N4530-W12030/30			Unmapped	60.1 percent in Washington
Grand Coulee		5 & 20	1929-30		4 special sheets
Grayland	N4645-W12400/15	20	1938-39	USA	Inc. remapping of S½ of Ocosta
Hanford	N4630-W11915/15	25	1922	USGS State co-op.	
Hillsboro	N4530-W12245/15	25	1939	USA	2.05 percent in Washington
Hood River	N4530-W12130/30	100	1925-26	USGS	60.9 percent in Wash. Inc. a portion of N½ of Mt. Hood and Vicinity
Hoquiam	N4652½-W12345/15	25	1911-12	USGS State co-op.	See Aberdeen & Humptulips
Humptulips	N4700-W12345/15	20	1935-39	USA	Inc. remapping N½ Hoquiam
Jameson	N4730-W11930/30			Unmapped	
Kalama	N4600-W12245/15		1940	USA	83.3 percent in Washington
Kanaka Bay	N4815-W12300/15			Unmapped	4.1 percent in Washington
Keller	N4800-W11830/30			Authorized	
La Center	N4545-W12230/15	20	1939	USA	
Lake Crescent	N4800-W12345/15	50	1918	USA, USGS State co-op.	
Lake Nahwatzel	N4700-W12315/15	25	1939	USA	
Lake Pleasant	N4800-W12415/15	20	1934-35	USA	
Lake Tapps	N4700-W12200/15	50	1941-42	USGS USA	SE¼ Tacoma
La Push	N4745-W12430/15	20	1934-36	USA	
Limekiln Rapids	N4600-W11645/15		1944	USGS State co-op.	22.2 percent in Washington
Lookout Mountain	N4545-W12200/15	20	1939	USA	
Malaga	N4715-W12000/15	25	1911-12	USGS State co-op.	
Marblemount	N4830-W12100/30			Unmapped	
Marcus	N4830-W11800/30	100	1935-36	USGS	
Marysville	N4800-W12200/15	25	1941	USGS USA	SE¼ Mount Vernon
Mazama	N4830-W12000/30			Unmapped	
Medical Lake	N4730-W11730/15	25	1939-40	USGS State co-op.	
Meskill	N4630-W12300/15	20	1937-38	USA	

TOPOGRAPHIC QUADRANGLES OF WASHINGTON ARRANGED ALPHABETICALLY (Cont.)
Including tentative names of quadrangles not yet mapped as of September 30, 1946

Quadrangle Name	Map Index Numbers	C'ntour interval in feet	Date Mapped	Mapping Agency or Status	Remarks
Metaline	N4830-W11700/30	100	1931-32, 34	USGS	
Methow	N4800-W12000/30	100	1897, 99	USGS	
Mobray	N4700-W12330/15	20	1939	USA	
Moclips	N4700-W12400/15	20	1935-39	USA	Inc. remapping N½ of Ocosta
Mohrweis	N4715-W12315/15			Unmapped	
Montesano	N4645-W12330/15	20	1938	USA	
Moses Lake	N4700-W11915/15	25	1910	USGS State co-op.	
Mount Adams	N4600-W12100/30	100	1903-04	USGS	
Mount Aix	N4630-W12100/30	100	1900-02	USGS	
Mount Angeles	N4745-W12315/15	50	1944	USGS	NW¼ Mount Constance
Mount Baker	N4830-W12130/30	200	1907, 09	USGS	
Mount Constance	N4730-W12300/30	100	1930-31, 34	USGS	See Mount Angeles
Mt. Hood and Vicinity	N4518-W12139	100	1907, 09-11	USGS	14.4 percent in Wash. Ca. 26' lat. and 36' long. See Bridal Veil and Hood River
Mount Olympus	N4745-W12330/15	100	1935	USA	
Mount Rainier	N4630-W12130/30	100	1924	USGS	See Mount Rainier National Park
Mount Rainier National Park	N4644-W12130	100	1910-11, 13	USGS	16' lat. and 25' long. Inc. N½ Mount Rainier
Mount St. Helens	N4600-W12200/30	100	1913-14, 16	USGS	
Mount Spokane	N4745-W11700/15	50	1939	USGS	NE¼ Spokane
Mount Stuart	N4700-W12030/30	100	1896-97	USGS	
Mount Tom	N4745-W12345/15	100	1935	USA	
Mount Vernon	N4800-W12200/30	50	1909	USGS State co-op.	See Clear Lake, Marysville, Mount Vernon, and Stanwood
Mount Vernon	N4815-W12215/15	25	1940	USGS USA	NW¼ Mount Vernon 30 min.
Newport	N4800-W11700/30	100	1930, 35-36	USGS	
Oakesdale	N4700-W11700/30	50	1903	USGS	
Ocosta	N46521/2-W12400/15	25	1913	USGS State co-op.	See Grayland and Moclips
Ohop Valley	N4645-W12215/15	50	1942	USGS USA	NW¼ Eatonville
Okanogan	N4800-W11930/30	100	1903	USGS	
Olequa	N4615-W12245/15	20	1940	USA	
Olympia	N4700-W12245/15	25	1934	USGS State co-op.	
Omak Lake	N4800-W11900/30			Unmapped	
Orcas Island	N4830-W12245/15+	50	1941	USGS USA	
Osoyoos	N4830-W11900/30	100	1902	USGS	
Othello	N4645-W11900/15	25	1922	USGS State co-op.	
Ozette Lake	N4800-W12430/15	20	1934-35	USA	
Pacific Lake No. 1	N4715-W11830/15			Unmapped	
Pacific Lake No. 2	N4715-W11845/15			Unmapped	
Pacific Lake No. 4	N4700-W11830/15			Unmapped	
Palisades	N4715-W11945/15				9.9 percent mapped by USBR
Pasco	N4600-W11900/30	50	1904, 14	USGS State co-op.	
Pendleton	N4530-W11830/30			USGS	0.6 percent in Washington
Peola	N4615-W11715/15	50	1942-43	USGS State co-op.	
Pierce	N4730-W12330/15			Unmapped	
Pigeon Springs	N4600-W12230/15	100	1940	USA	
Pleasant Lake					See Lake Pleasant

TOPOGRAPHIC QUADRANGLES OF WASHINGTON ARRANGED ALPHABETICALLY (Cont.)
Including tentative names of quadrangles not yet mapped as of September 30, 1946

Quadrangle Name	Map Index Numbers	C'ntour interval in feet	Date Mapped	Mapping Agency or Status	Remarks
Point Misery	N4730-W12245/15	20	1936	USA	
Point Roberts	N4850-W12300			Unmapped	2.6 percent in Washington
Pomeroy	N4600-W11730/30	100	1936-37	USGS	
Port Angeles	N4800-W12315/15	25	1917	USGS	
				USA	
Port Crescent	N4800-W12330/15	25	1917-18	USGS	
				USA	
				State co-op.	
Port Gamble	N4745-W12230/15	20	1936	USA	
Portland	N4530-W12230/15	25	1939-40	USGS	55.7 percent in Washington
				USA	
Port Orchard	N4730-W12230/15	20	1936	USA	
Port Townsend	N4800-W12245/15	20	1936	USA	
Potlatch	N4715-W12300/15	20	1938	USA	
Priest Rapids	N4630-W11945/15	25	1913-14	USGS	
				State co-op.	
Prosser	N4600-W11930/30	50	1915	USGS	
				State co-op.	
Pullman	N4630-W11700/30	50	1903-05	USGS	
Pysht	N4800-W12400/15	50	1918	USGS	
				USA	
				State co-op.	
Queets	N4730-W12400/15			Unmapped	
Quilcene	N4745-W12245/15	50	1936	USA	
Quinault Lake	N4715-W12345/15			Unmapped	
Quincy	N4700-W11945/15	25	1909	USGS	
				State co-op.	
Raft River	N4715-W12400/15			Unmapped	
Reardan	N4730-W11745/15	25	1942	USGS	
				State co-op.	
Red Rock	N4645-W11930/15	25	1909	USGS	
				State co-op.	
Republic	N4830-W11830/30	100	1901	USGS	
Richardson	N4815-W12245/15	50	1941	USGS	
				USA	
Riparia No. 1	N4645-W11800/15			Unmapped	
Riparia No. 3	N4630-W11815/15			Unmapped	
Riparia No. 4	N4630-W11800/15			Unmapped	
Ritzville	N4700-W11800/30			Unmapped	
Rock Lake	N4700-W11730/30			Unmapped	
Saddle Butte	N4600-W11715/15	50	1943	USGS	
				State co-op.	
St. Helens	N4545-W12245/15	25	1940	USA	18.9 percent in Washington
Samish Lake	N4830-W12215/15	25	1917	USGS	
				USA	
Satsop	N4715-W12330/15			Unmapped	
Schrag	N4700-W11845/15	25	1923	USGS	
				State co-op.	
Scooteney Lake	N4630-W11900/15	25	1922	USGS	
				State co-op.	
Seattle	N4730-W12215/15	25	1893	USGS	SW¼ Snohomish
Shelton	N4700-W12300/15	20	1939	USA	
Skamokawa	N4615-W12315/15	100	1940	USA	
Skykomish	N4730-W12100/30	100	1897, 1902	USGS	
Slate Pass	N4830-W12030/30			Unmapped	
Snohomish	N4730-W12200/30	50	1893-95	USGS	See Edmonds, Everett and Seattle
Snoqualmie	N4700-W12100/30	100	1900-01	USGS	
South Bend	N4630-W12345/15	20	1938	USA	
Spokane	N4730-W11700/30	100	1898	USGS	See Mount Spokane
Spruce Mountain	N4745-W12400/15	50 & 100	1935	USA	
Stanwood	N4800-W12215/15	25	1940	USGS	SW¼ Mount Vernon
				USA	
Steamboat Mountain	N4600-W12130/30	100	1924-26	USGS	
Stehekin	N4800-W12030/30	100	1901-02	USGS	
Stilaguamish	N4800-W12130/30	100	1897-99	USGS	
Sultan	N4730-W12130/30	100	1919-21	USGS	
				State co-op.	

TOPOGRAPHIC QUADRANGLES OF WASHINGTON ARRANGED ALPHABETICALLY (Cont.)
Including tentative names of quadrangles not yet mapped as of September 30, 1946

Quadrangle Name	Map Index Numbers	C'ntour interval in feet	Date Mapped	Mapping Agency or Status	Remarks
Sumas	N4845-W12215/15	20	1906	USGS	
Svenson	N4600-W12330/15	20	1936	USA	1.0 percent in Washington
Tacoma	N4700-W12200/30	50	1894-95	USGS	See Lake Tapps and Tacoma South
Tacoma South	N4700-W12215/15	25	1941	USGS USA	SW¼ Tacoma 30′
Tenino	N4645-W12245/15	50	1942	USGS	NW¼ Chehalis
The Dalles	N4530-W12100/30	50	1929-30	USGS	66.6 percent in Washington unmapped
Toutle	N4615-W12230/15	100	1940	USA	
Umatilla	N4530-W11900/30	50	1907	USGS	13.8 percent in Washington
Van Zandt	N4845-W12200/15	50	1917-18	USGS USA State co-op.	
Walla Walla	N4600-W11800/30	50	1916, 19	USGS State co-op.	
Wallula	N4600-W11830/30	50	1915	USGS State co-op.	
Walville	N4630-W12315/15	20	1937	USA	
Washtucna	N4645-W11815/15	25	1923	USGS State co-op.	
Wellpinit	N4745-W11745/15	25	1941	USGS State co-op.	
Wenatchee	N4715-W12015/15	50	1911-13	USGS State co-op.	
Wheeler	N4700-W11900/15	25	1923	USGS State co-op.	
White Swan	N4600-W12030/30	50	1934	USGS	
Wickersham	N4830-W12200/15	50	1917-18	USGS USA State co-op.	
Wilbur	N4730-W11830/30			Unmapped	
Wildwood	N4615-W12300/15	100	1940	USA	
Willapa	N4630-W12330/15	20	1938	USA	
Wilson Creek	N4715-W11900/15				73.9 percent mapped by USBR
Winchester	N4700-W11930/15	25	1909	USGS State co-op.	
Winona	N4630-W11730/30			Unmapped	
Yacolt	N4545-W12215/15	20	1939	USA	
Yakima East	N4630-W12015/15	25	1936	USGS State co-op.	
Yelm	N4645-W12230/15	50	1942	USGS USA	NE¼ Chehalis
Zillah	N4600-W12000/30	50	1906	USGS	

TOPOGRAPHIC QUADRANGLES OF WASHINGTON ARRANGED BY LATITUDE AND LONGITUDE

Including tentative names of quadrangles not yet mapped as of September 30, 1946

INDEX NUMBER Coordinates, SE. Corner of Map		Minutes of Latitude and Longitude Covered by Map	Map Name
Latitude North	Longitude West		
N4518	W12139	Sp.	Mt. Hood and Vicinity
N4530	W11830	30	Pendleton
	W11900	30	Umatilla
	W11930	30	Blalock Island
	W12000	30	Arlington
	W12030	30	Goldendale
	W12100	30	The Dalles
	W12130	30	Hood River
	W12200	15	Bridal Veil
	W12215	15	Camas
	W12230	15	Portland
	W12245	15	Hillsboro
N4545	W12200	15	Lookout Mountain
	W12215	15	Yacolt
	W12230	15	La Center
	W12245	15	St. Helens
N4600	W11645	15	Limekiln Rapids
	W11700	15	Anatone
	W11715	15	Saddle Butte
	W11730	30	Pomeroy
	W11800	30	Walla Walla
	W11830	30	Wallula
	W11900	30	Pasco
	W11930	30	Prosser
	W12000	30	Zillah
	W12030	30	White Swan
	W12100	30	Mount Adams
	W12130	30	Steamboat Mountain
	W12200	30	Mount St. Helens
	W12230	15	Pigeon Springs
	W12245	15	Kalama
	W12300	15	Clatskanie
	W12315	15	Cathlamet
	W12330	15	Svenson
	W12345	15	Astoria
N4615	W11700	15	Asotin No. 1
	W11715	15	Peola
	W12230	15	Toutle
	W12245	15	Olequa
	W12300	15	Wildwood
	W12315	15	Skamokawa
	W12330	15	Brookfield
	W12345	15	Fort Columbia
	W12400	15	Cape Disappointment
N4630	W11700	30	Pullman
	W11730	30	Winona
	W11800	15	Riparia No. 4
	W11815	15	Riparia No. 3
	W11830	30	Connell
	W11900	15	Scooteney Lake
	W11915	15	Hanford
	W11930	15	Coyote Rapids
	W11945	15	Priest Rapids
	W12000	15	Black Rock Spring
	W12015	15	Yakima East
	W12030	30	Ellensburg
	W12100	30	Mount Aix
	W12130	30	Mount Rainier
	W12200	30	Eatonville
	W12230	30	Chehalis
	W12300	15	Meskill
	W12315	15	Walville
	W12330	15	Willapa
	W12345	15	South Bend
	W12400	15	Cape Shoalwater
N4644	W12130	Sp.	Mount Rainier National Park
N4645	W11800	15	Riparia No. 1
	W11815	15	Washtucna
	W11900	15	Othello
	W11915	15	Corfu
	W11930	15	Red Rock
	W11945	15	Beverly
	W12000	15	Boylston

TOPOGRAPHIC QUADRANGLES OF WASHINGTON ARRANGED BY LATITUDE AND LONGITUDE (Cont.)
Including tentative names of quadrangles not yet mapped as of September 30, 1946

INDEX NUMBER Coordinates, SE. Corner of Map		Minutes of Latitude and Longitude Covered by Map	Map Name
Latitude North	Longitude West		
	W12015	15	Badger Pocket
	W12215	15	Ohop Valley
	W12230	15	Yelm
	W12245	15	Tenino
	W12300	15	Gate
	W12315	15	Ford
	W12330	15	Montesano
	W12345	15	Aberdeen
	W12400	15	Grayland
N4652½	W12345	15	Hoquiam
	W12400	15	Ocosta
N4700	W11700	30	Oakesdale
	W11730	30	Rock Lake
	W11800	30	Ritzville
	W11830	15	Pacific Lake No. 4
	W11845	15	Schrag
	W11900	15	Wheeler
	W11915	15	Moses Lake
	W11930	15	Winchester
	W11945	15	Quincy
	W12000		Colockum Pass
	W12030	30	Mount Stuart
	W12100	30	Snoqualmie
	W12130	30	Cedar Lake
	W12200	30	Tacoma
	W12200	15	Lake Tapps
	W12215	15	Tacoma South
	W12230	15	Anderson Island
	W12245	15	Olympia
	W12300	15	Shelton
	W12315	15	Lake Nahwatzel
	W12330	15	Mobray
	W12345	15	Humptulips
	W12400	15	Moclips
N4715	W11830	15	Pacific Lake No. 1
	W11845	15	Pacific Lake No. 2
	W11900	15	Wilson Creek
	W11915	15	Bacon
	W11930	15	Ephrata
	W11945	15	Palisades
	W12000	15	Malaga
	W12015	15	Wenatchee
	W12230	15	Gig Harbor
	W12245	15	Allyn
	W12300	15	Potlatch
	W12315	15	Mohrweis
	W12330	15	Satsop
	W12345	15	Quinault Lake
	W12400	15	Raft River
	W12415	15	Cape Elizabeth
N4730	W11700	30	Spokane
	W11730	15	Medical Lake
	W11745	15	Reardan
	W11800	30	Davenport
	W11830	30	Wilbur
	W11900	30	Coulee City
		Sp.	Grand Coulee
	W11930	30	Jameson
	W12000	30	Chelan
	W12030	30	Chiwaukum
	W12100	30	Skykomish
	W12130	30	Sultan
	W12200	30	Snohomish
	W12215	15	Seattle
	W12230	15+	Port Orchard
	W12245	15	Point Misery
	W12300	30	Mount Constance
	W12330	15	Pierce
	W12345	15	Elk Park
	W12400	15	Queets
	W12415	15	Destruction Island
N4745	W11700	15	Mount Spokane
	W11730	15	Clayton
	W11745	15	Wellpinit

TOPOGRAPHIC QUADRANGLES OF WASHINGTON ARRANGED BY LATITUDE AND LONGITUDE (Cont.)
Including tentative names of quadrangles not yet mapped as of September 30, 1946

INDEX NUMBER Coordinates, SE. Corner of Map		Minutes of Latitude and Longitude Covered by Map	Map Name
Latitude North	Longitude West		
	W12200	15	Everett
	W12215	15	Edmonds
	W12230	15+	Port Gamble
	W12245	15	Quilcene
	W12315	15	Mount Angeles
	W12330	15	Mount Olympus
	W12345	15	Mount Tom
	W12400	15	Spruce Mountain
	W12415	15	Forks
	W12430	15	La Push
N4800	W11700	30	Newport
	W11730	30	Chewelah
	W11800	30	Bissell
	W11830	30	Keller
	W11900	30	Omak Lake
	W11930	30	Okanogan
	W12000	30	Methow
	W12030	30	Stehekin
	W12100	30	Glacier Peak
	W12130	30	Stilaguamish
	W12200	30	Mount Vernon
	W12200	15	Marysville
	W12215	15	Stanwood
	W12230	15	Coupeville
	W12245	15	Port Townsend
	W12300	15	Dungeness
	W12315	15	Port Angeles
	W12330	15	Port Crescent
	W12345	15	Lake Crescent
	W12400	15	Pysht
	W12415	15	Lake Pleasant
	W12430	15	Ozette Lake
N4815	W12200	15	Clear Lake
	W12215	15	Mount Vernon
	W12230	15	Deception Pass
	W12245	15	Richardson
	W12300	15	Kanaka Bay
	W12415	15	Clallam
	W12430	15	Cape Flattery
N4830	W11700	30	Metaline
	W11730	30	Colville
	W11800	30	Marcus
	W11830	30	Republic
	W11900	30	Osoyoos
	W11930	30	Chopaka
	W12000	30	Mazama
	W12030	30	Slate Pass
	W12100	30	Marblemount
	W12130	30	Mount Baker
	W12200	15	Wickersham
	W12215	15	Samish Lake
	W12230	15	Anacortes
	W12245	15+	Orcas Island
	W12300	15	Friday Harbor
N4845	W12200	15	Van Zandt
	W12215	15	Sumas
	W12230	15	Blaine
	W12250		Birch Bay
N4850	W12300		Point Roberts