TWELFTH BIENNIAL REPORT

OF THE

BUREAU OF MINES

OF THE

STATE OF COLORADO

T. R. HENAHEN, Commissioner

YEARS 1911 AND 1912

DENVER, COLORADO
THE SMITH-BROOKS PRINTING CO., STATE PRINTERS
1913

GETTING OUT THE ORE

Scene on the fifth level of the Seaton Mine, on Seaton Mountain near Idaho Springs, Colorado, one of the oldest silver mines in the state.

—Photo by L. McLean, Photographer, Idaho Springs.

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LOCATION OF DISTRICTS

DISTRICT No. 1—Denver, Jefferson, Boulder, Larimer, Jackson, Routt, Grand, Gilpin, and Clear Creek Counties; known and designated as the Georgetown District.

DISTRICT No. 2—El Paso, Teller, Pueblo, Las Animas, Huerfano, Custer, and Fremont Counties; known and designated as the Cripple Creek District.

DISTRICT No. 3—Lake, Summit, Chaffee, Park, Pitkin, Mesa, Delta, Eagle, Rio Blanco, and Garfield Counties; known and designated as the Leadville District.

DISTRICT No. 4—San Juan, Ouray, Hinsdale, Mineral, Rio Grande, Saguache, Costilla, Conejos, Archuleta, La Plata, Montezuma, Dolores, San Miguel, Montrose, and Gunnison Counties; known and designated as the San Juan District.

LETTER OF TRANSMITTAL

To His Excellency,
JOHN F. SHAFROTH,
Governor of Colorado.

Sir: As provided for in section 4268, Revised Statutes of 1908, relating to "Bureau of Mines—Mine Regulations," I have the honor of submitting to you herewith the twelfth biennial report of this department.

Respectfully yours,

T. R. HENAHEN,
Commissioner of Mines.

Denver, Colorado, December 15, 1912.

Introduction

The Commissioner believes that the primary purpose in creating this department was, and is, to carefully examine all metalliferous mines of the state, paying special attention to the ventilation and timbering for the protection of the men employed, for the express purpose of preventing accidents which occur in mines, mills, and metallurgical plants; to suggest remedies which may add to the safety and health of the miners of the state; and to reduce to a minimum the accidents and fatalities.

One of the principal duties of the Bureau of Mines is to give encouragement to the metal-mining industry of the state, and to keep a record of its advancement and future possibilities, with a view to setting before the world the place it occupies among the industries of Colorado.

The forty-one recognized metalliferous mining counties of the state are divided into four districts, with an inspector in each, who makes periodical visits to all the operating mines in his district, and makes such recommendations as he believes are just and proper for the health and safety of the miners and the protection of property. The law requires that the inspectors be practical mining men, and gives them power to enforce their recommendations.

REPORTS REQUIRED

Owners of mines, mills, smelters, and other metallurgical plants are required by law to submit immediate reports to this department of all accidents to workmen, giving the name of the injured person, the extent of his injuries, the cause of the accident, and such other details as will be of assistance to the Commissioner in preparing statistics, from which can be discovered the more frequent causes of accidents and the probable remedies. The mine inspector also visits the mine or plant, and makes a similar report of the accident from an impartial standpoint.

The owners of all mines, mills, smelters, and metallurgical plants are required by law to make annual report, on November 1 of each year, for the twelve months preceding, if they have operated at any time during that period. The report must show the name of the company owning the property, the company or person or persons operating it, the extent of the operations, number of men employed, and such other information as will enable the Commissioner to keep a complete record of all the operating mining properties in the state. The inspectors also make a report on all operating properties, and both reports are filed in the office of the Commissioner for reference.

ACKNOWLEDGMENTS

The thanks of this department are due to the four inspectors, who for the last two years have served the state conscientiously, and by their gentlemanly conduct and tact have been largely instrumental in obtaining many needed reforms without creating friction; and to the members of the office force for faithful and efficient services.

The department feels obligated to the mine-owners of the state for the considerate manner in which they have aided this department, not only to the extent required by law, but to that extent which denotes good-will.

The department feels thankful that its relations with the mine-owners and mine employes of the state during the last two years have been so cordial, and trusts that this condition will continue.

The Colorado Mining and Metallurgical Association, organized in December, 1911, at the suggestion of the Commissioner of Mines, is composed of three hundred active mining men of the state, and is a splendid example of the co-operation given us. We shall speak of this organization in detail in a special chapter.

A word of appreciation is due the splendid work done by Professor R. D. George, State Geologist, in the last two years, and his hearty co-operation with this department. Professor George has compiled a geological map of the state, which is of great value to men interested in mining. He also has analyzed many of the mineral springs of the state.

The United States Geological Survey has issued several important reports in the last two years on the mineral resources of Colorado, which, together with previous reports issued in former years, have settled many disputed questions. We have also received exchanges from many states, nations, and publishers, including newspapers, which were of valuable assistance to us.

The Colorado School of Mines is considered the best school of its kind in the United States, and is giving training yearly to young men who are going forth to solve the big problems of mineralogy and metallurgy.

The jurisdiction of the coal mines is under the State Coal Mine Inspector, who is in a separate department.

Only passing reference is made to other departments and institutions of the state, in order that readers of this report, not familiar with our institutions, may not be led to believe that this is the only department issuing literature relating to the mining industry. All the departments and institutions mentioned issue reports.

The thanks of the Bureau are due to the writers of special articles for this report, whose names appear above their papers.

The writers are authorities on the subjects discussed and are well known in the mining world.

FORESTRY POLICY DETRIMENTAL

It is to be regretted that the policy of the United States Bureau of Forestry is detrimental to the mining industry of the state. The regulations of the forestry service make it practically impossible for the prospector to seek new discoveries in the forest reserves, which cover a large part of the state. It is difficult to understand why areas above timber-line should be included in the forest reserves.

It is to be hoped that the forestry service will see the light and exclude from the forest reserves all lands which are not forests, and give to the prospector a better opportunity to locate the minerals within the forest reserves.

Future of Mining in Colorado

IMPORTANT INDUSTRY NEEDS MORE SUPPORT FROM STATE

As a citizen of Colorado, proud of the achievements and rapid advances of our great state along many lines of industry, I am pleased to note that agriculture, which has been fostered and stimulated by the mining industry, has advanced from the insignificant place it held a few years ago to the head of all the industries of the state in direct money return.

In all the Rocky Mountain states the miner has been the forerunner and mainstay of the farmer. This region of wealth fifty years ago was "a worthless desert," which even the sagacious Daniel Webster declared was quite uninhabitable.

Horace, Greeley would have made a reputation as a fool instead of a philosopher if he had advised the young farmer of 1858 to "go west and grow up with the country." But the discovery of gold was made, and the rush of the fortune-hunters peopled the hills, created towns, and opened a new empire.

The farmer came when he found a population here that would support him. His products were sold at handsome prices in the mining camps, and the two industries marched onward, hand in hand.

More than two-thirds of the agricultural area of this state is undeveloped, and this includes some of the richest land to be found on the globe. Without railroad facilities and near-by markets, the farmer is discouraged. This vast undeveloped area awaits the stimulating influence of the mining "strike."

In the last few years the federal and state governments, by the wide expenditure of large sums for experimental and development purposes, have revolutionized farming and have transformed the dreary drudgery of farm life into the scientific, interesting, and profitable industry that it is today. On the other hand, practically every advance made in mining has been through individual effort and at private expense.

The federal and state governments have solved the big problems for the farmer by teaching him how to manage his soil and fight the enemies of his crops. He has had great irrigation systems, such as the Uncompahgre project, built for his benefit at public expense.

MINING DESERVES ASSISTANCE

What little has been given the miner has been more than off set by the discouragements and obstacles placed in his way by senseless bureaucratic government.

I do not wish to be understood as criticising the large expenditures made by the nation and state for the farmers' benefit, for the results have demonstrated the great wisdom of this course; but I do maintain that mining has not received the consideration to which it is entitled.

I appeal to the legislature to be more just and generous with the miner, to whom this state owes more than it ever can repay. Every dollar spent for the benefit of the mining industry is an indirect benefit to the farmer, manufacturer, and merchant.

The history of civilized nations shows that their rise and fall have so frequently followed the rise and fall of mining as to lead to the conclusion that it is more than a coincidence. Civilization has not found it possible to survive without money, and the mines produce the metals from which money is manufactured. The products of the mines are essential to the comfort, convenience, and happiness of civilization. They are permanent, and are manufactured and remanufactured for ages, so that in indirect money return the products of Colorado's mines still hold a big lead over the products of any other industry in the state.

Colorado has scarcely touched its mineral resources. The wise expenditure of funds for the encouragement and development of this industry will result eventually in the pouring of more wealth into the lap of the state than all that has ever been produced heretofore, and will place the mining industry where it belongs—greatly in the lead of all other industries of Colorado.

COMPARISON OF APPROPRIATIONS

It is not my intention to enter objection to the appropriations for agriculture that have been made by the state legislature during the last dozen or more years. I believe, however, that the people of the state should known how niggardly the mining industry has been treated, and this showing can be made in no better way than by contrasting the relative amounts voted for agriculture and for mining.

The reports of the State Auditors show the following appropriations and expenditures made by the state in promoting these two great industries for the last ten years. The moneys spent on the School of Mines and on the Agricultural College are included in these figures:

	Agriculture	Mining
1901-02	$ 265,806	$127,803
1903-04	305,714	117,000
1905-06	340,358	138,816
1907-08	404,322	151,395
1909-10	389,658	247,160
Totals	$1,705,858	$782,174

At the present time the contributions of these two industries to the revenues of the state stand as $100 from agriculture to $60 from mining. (But only a few years ago the ratio was the opposite of the present.) The totals given above show that two and one-fifth times as much of the state revenue is spent in aid of agriculture as is spent in the development of the mining industry.

In other words, while the mines contribute to the state treasury $60 for each $100 from the farms, the mining industry receives state aid to the extent of only $42 for each $100 received by agriculture. The present appropriations to the School of Mines and to the Agricultural College are in about the same ratio as are the contributions of mining and agriculture to the state revenue, but the reports of the State Auditor show clearly that this has not always been the case. In fact, it is only within the last ten years that this approach to equality has existed. Deducting these appropriations from the totals given above, we find that during the last ten years the state aided these two industries as follows:

	Agriculture	Mining
1901-02	$101,956	.....
1903-04	116,976	$ 1,200
1905-06	124,557	.....
1907-08	121,473	7,053
1909-10	133,550	19,971
Totals	$598,512	$28,224

That is, after supporting the two schools, the state appropriated twenty-one times as much to aid agriculture as she did to aid mining.

Taking the years 1907-1908 as typical, we find that the agricultural interests were aided by such appropriations as follow:

The Dairy Commission (protects dairymen against competition of oleomargarine and like substitutes)	$ 5,400
Horticultural Board	6,800
State fair fund	12,000
State canal fund	35,000

and many others; while the only appropriation made in aid of the mining industry was one of $10,000 for the State Geological Survey.

It may be interesting to note that the appropriations to the Fish and Game Commissions for the ten years have been as follows:

1901-02	$ 52,779
1903-04	72,642
1905-06	94,710
1907-08	129,128
1909-10	61,200
Total	$410,459

This is almost exactly fifteen times as much as was given to mining, outside the appropriations to the School of Mines.

Colorado's total mineral production to the end of 1910 was $1,610,300,000. Since 1859 Colorado mines have produced $1,160,000,000 worth of metals, and $450,000,000 worth of coal, clay products, cement, stone and other non-metallic substances.

Official reports show that at least twenty-four states of the Union (exclusive of Colorado) are regularly giving substantial aid to their mining industries. In 1909 the average expenditure by these states for each $1,000,000 worth of mineral production (exclusive of the support of their mining schools) was $550. Colorado spent in the same year $189 for each $1,000,000 worth of mineral production—a trifle more than one-third the average of the other states.

METALLURGY MUST SOLVE PROBLEMS

It is more than twenty years since the state has enjoyed the stimulus of a bonanza camp, but it is a conservative statement that the industry has rather profited than otherwise from that fact. The hysteria of the boom-camp days has gone, the wild-cat has been chased to his lair, and the business of mining has become established as a legitimate industry, offering most substantial rewards to energy, initiative, and intelligent operation.

The Colorado miner has won an enduring place in the history of the West. Against every adverse circumstance he has risen triumphant. It was he who blazed the way into the impenetrable wilderness, opening new country and sending forth streams of wealth that attracted population to our valleys and plains.

When an unsympathetic government struck a blow at the very life of the state's mining industry, the men of the mines dug deeper into the ruins caused by the demonetization of silver and uncovered vast treasures of golden wealth. When these

bonanza deposits were exhausted, the problem of threatened depletion was attacked with characteristic energy. The indomitable spirit of the Colorado miner has never been seen to better advantage than in the manner in which production through lean years has been maintained at a high level.

Successful mining of later years means not only ore production, but includes also the work of the laboratory, the mill, and the reduction plant. Indeed, the hope of the future is bound up in the wizardry of chemistry. The prospector has done well his part. He has discovered inexhaustible deposits of ore, mountains of wealth. The miner has reduced his craft almost to the basis of an exact science, where the maximum of efficiency at a minimum of cost has been reached. It is now up to the metallurgist to unlock the treasures which are confined in the rebellious ores.

In proved mineral areas of Colorado are literally millions of tons of complex ores that will yield profits beyond the richest returns of boom-camp days when the secret of their separation and extraction of their values is revealed. The lead-zinc-iron sulphides of the San Juan and Montezuma districts, the zinc carbonates of Leadville, the low-grade tellurides of Cripple Creek, the medium-grade ores of Clear Creek and Gilpin, the extensive deposits of the rare uranium and vanadium of San Miguel and Montrose, and the radium-bearing carnotite ores of Dolores, San Miguel, Montrose, Mesa, and Rio Blanco Counties, offer the most attractive field in the world for application of the metallurgist's science.

San Francisco Fair Exhibit

VALUABLE COLLECTION MUST HAVE CAREFUL SUPERVISION

One of the most important duties that will be charged to the Commissioner of Mines during the present biennial period will be the transportation and arrangement of the state's mineral collection for display at the San Francisco exposition. In connection with that undertaking I desire to offer some suggestions and recommendations, based upon experience.

Colorado's mineral collection is one of the most valuable in the world. There are specimens in our cases that are not duplicated any place, and some that are priceless. A chapter on the museum is included in this report. There are, besides, several other collections in the state from which we might be able to borrow specimens.

In order that the exhibit which, I assume, the state is desirous of displaying at San Francisco, may be shown off to the best advantage, it is absolutely necessary that the collection be classified and catalogued. We must have our minerals classified as to their respective groups; and this classification is desired not only for exhibition purposes at San Francisco, but as well for their proper display in our own rooms in the State Capitol.

It is my belief that, with our rare specimens properly classified, and with our collection of rich ores augmented by selected specimens from the private collections, which I am confident we can borrow, we shall have for exhibition at San Francisco a collection unequaled—one that will appeal to the imagination of the lay visitor, and will be studied with interest by the scientific observer.

The transportation of the collection and responsibility for its safety are matters of vital importance. I wish to direct your attention to the fact that I am, by law, made custodian of the state's mineral collection and under heavy bond for faithful performance of that duty. Under the circumstances, I think that, when the time comes for the appointment of the exposition commission, there should be provided means whereby all the business of classifying, tearing down, packing, and transporting the collection be placed under my exclusive control, and the collection committed to my care during the time it is at the exposition.

Review of District No. 1

DRAINAGE CREATES WIDE RESUMPTION OF ECONOMICAL MINING

By W. H. PARENTEAU, Inspector

District No. 1 for 1911 and 1912 has had, in the main, a prosperous period. Many improvements have been made in mills and tunnels, and other improvements are contemplated or in the course of construction, promising a bright future for metalliferous mining. Taking into consideration the general depression in mining circles during the years just past, it is gratifying that the total output of the several counties in the district is in excess of former recent periods. Tunnels have opened up large bodies of ore at great depths, and drained many abandoned properties of accumulated water, making possible an early resumption of economical and profitable mining in many of the mines that have lain idle for years, with a corresponding increase of ore shipments naturally following.

Because of the methods of early-day mining, all the counties in this district contain rich dumps of ore awaiting facilities for profitable treatment by improved milling plants, that will successfully work out the reduction of ores heretofore looked upon as purely waste deposits. The addition of such facilities alone would give us a greater volume of business than in our most prosperous years, as these dumps, as a reserve, would furnish a steady tonnage necessary for economical and profitable management in milling.

Numerous properties throughout the district, that paid good profits so far as worked, and have been idle for years for various causes, have recently resumed operations. The economical system of mining, gravity transportation and drainage, and improved milling plants that have been erected recently, or are nearing completion, will add materially to the metal production of the district during the coming year.

GILPIN COUNTY

The Gilpin County district consists of true-fissure veins proven to a depth of 2,200 feet. The metals are gold, silver, copper, lead, zinc, uranium, and tungsten; the principal metal being gold. The ores are mostly iron sulphides and quartz, and are

free-milling and concentration of a fair value. The refractory ores in many of the mines are of a high value, and although seldom forming more than 20 per cent of the ore bodies, the average values of vein-filling are very materially increased thereby.

Gilpin County, the smallest mineral county in the state, is credited with a gold production of more than $160,000,000—an average of $3,000,000 a year. Since the completion of the Newhouse Tunnel, a number of the principal mines within the limits of Gilpin County are worked through the tunnel, and this production is included in the output of the Idaho Springs district in Clear Creek County. The total shipments of ore and concentrates from Gilpin County for the year 1911 were 2,004 carloads, or 76,745 tons; while the shipments for 1912 were 2,117 carloads, weighing 84,350 tons; an increase of about 7,000 tons. Thousands of tons of ore treated each year in the stamp mills and concentrating works of the county, ore transported through the Newhouse Tunnel, and ore from mines situate in the northern portion of the county and shipped via the "Moffat Railroad" are not included in the yearly figures. The average tonnage per car was twenty-five tons. The total valuation of the output for 1912 is $1,516,000—an increase of about 11 per cent over that of 1911. Gilpin County is one of the few counties in the state showing an increase in production over the previous year.

The Kansas-Burroughs group on Quartz Hill will start a general overhauling of its surface plant and underground workings, while the water is draining through the Newhouse Tunnel, which intersects this property at a depth of 1,700 feet. Adjoining properties on Quartz Hill are being drained at the same time, and, when fully drained, operations will be resumed on numerous properties that have been idle for years, because of the excessive cost of pumping.

The Fifty Gold Mines, comprising fifty patented claims, including the Gregory, Cook, Fiske, Bobtail, and other early claims, which has been idle for more than a year, is to be reopened within a short time. This is one of the largest and most famous properties in the state—the Gregory Lode was discovered in 1859—and has paid many millions during its fifty years of activity. Its present depth is 1,400 feet, and it is equipped with shaft buildings and a fine plant of machinery. Other equipment consists of an eighty-stamp, amalgamating mill, with a capacity of 400 tons per day. The ore is conveyed from the mine to the mill, a distance of one-quarter of a mile, by means of an electric tram, where it is automatically dumped and crushed by rock-breakers and fed into the bins below.

The Frontenac and Anduddell mines are located at the head of Willis Gulch, in Gilpin County, and are owned and operated by the Frontenac Consolidated Mines Company, of London, Eng-

land. This property is equipped with up-to-date machinery and conveniences, and is worked through a shaft 1,000 feet in depth. The total amount of development is over 17,000 feet. The ore bodies are of a low grade, but, owing to the large production and economical treatment of ores, the property pays a large annual dividend. About 5,000 tons of crude ore is produced monthly, which is treated at the company's new concentrating mill, situated one mile below Black Hawk, in the easterly portion of the county. Ores are hauled from the mine to the mill by the Gilpin Tramway, which has a gauge of twenty-four inches, a grade of 4 to 7 per cent, and twenty-one miles of track.

The Frontenac concentrating mill has been in operation two years, and during the time has treated a daily average of 150 tons of crude ore, concentrating four tons into one, with a saving of 78 per cent of assay values. The full capacity of the mill is estimated at 250 tons daily. The mill is run by electric power, the five motors having a total of 260 horse-power. The following data are taken from those furnished by the chief engineer of the company:

"Ores are delivered by Gilpin tram cars to a 250-ton storage bin. From this bin they are fed automatically by a shaking feeder to a large Blake crusher, size 13″ x 24″, with jaws opening sufficiently to receive the largest rocks usually coming from a mine. The crusher reduces the ore to two-inch size, and it is then conveyed by a bucket elevator up to a second storage bin of 250 tons' capacity; thence it is fed automatically to the first set of rolls, broken to one-half-inch size, elevated, and discharged into the screens. At the head of this elevator is an automatic sampler, which cuts out a sample of the mill feed at regular intervals.

"There are three screens in the series, with openings of approximately one-quarter, one-eighth, and one-sixteenth inch. Whatever portion of the feed is too coarse to pass the one-quarter-inch screen is delivered to the second set of rolls and elevated to the same screen. The entire feed is broken to one-quarter-inch size before concentration begins. The second screens take out all product between one-eighth and one-quarter-inch size, and deliver it to the coarse jig. All tailings from this coarse jig pass to the third set of rolls, and, after grinding, are elevated to the screen line above mentioned, so that the entire feed must pass through a one-eighth-inch screen before it passes on, or before any tailings are discarded. At the same time, any mineral that has been liberated by the preliminary crushing is taken out of the jig at once and has no opportunity to become ground to such fineness that it may float off the tables and be lost. After passing the second screen, the third, or one-sixteenth-inch screen, takes out whatever coarse feed there may

be between one-sixteenth and one-eighth-inch size, and delivers it to the fine jig, which removes all free mineral or clean concentrates, and passes on the reject or tailings to the tube mills, to be reground to thirty or forty mesh, and concentrated over again on the slime tables in the Penn mill building.

"The coarse product from the one-sixteenth-inch screen is jigged as just described. The fine stuff, which passes through the screen, is divided by a Richards classifier into different sizes, and each size is treated separately on the first series of seven card tables in the crushing department. Only clean concentrates and clean tailings are discharged from this set of tables. All mixed material, 'middlings,' or tailings which contain mineral are collected separately. The coarse stuff is passed to the tube mills for regrinding; the fines pass direct to the Penn mill or fine table department. Here they join the tube-mill discharge, and the whole is carefully classified again and retreated on the second series of ten concentrates—six Card and four Deister tables. The middlings or richer tailings from these ten tables pass on to a third set of three Card tables set lower, and from which the tailings are then discharged to the creek.

"All of the finest pulp, slime, dirty waste water, etc., from the different machines, is settled in a series of three eight-foot Callow tanks, and the thickened pulp is fed to a separate set of three slime tables especially designed for such material. The middlings from these three tables are retreated on a fourth machine, where any fine material, which may have escaped, has an additional chance on the final machine.

Summary

"There are four separate and independent treatments of the ore through the mill: first, on the jigs, the tailings from which are reground; secondly, they are reconcentrated on the coarse tables, tailings and middlings from these machines, as well as all tailings from the fine jigs, being reground in the tube mills; thirdly, they are retreated on the second set of tables; fourthly, middlings from these tables pass to their final treatment on the third set of tables."

The Topeka Mine, operated under the same management as the Frontenac-Andnddell group, is situated on the southeast slope of Alps Mountain, in the southerly portion of the county, and is owned and operated by the Topeka Consolidated Mining Company. The property is worked through a shaft 1,540 feet in depth, which dips to the north 45°. Over 6,000 feet of drifting has been done on this vein, and the ground between the upper levels was practically worked out during the early history of the mine. From the 700-foot level down the ore bodies are large and practically intact. About one-fourth of the ore from this mine is smelting, of a very high grade, while the balance is concentrating, which

is treated at the company's mill, known as the Iron City concentrator, situated at Black Hawk. The average monthly production—smelting and concentration—is 2,000 tons of crude ore. The Iron City concentrator is the only public concentrating works in the county, and, in addition to the ores from the Topeka Mine, the mill runs steadily to its full capacity of 2,000 tons per month, on custom ores, saving about 78 per cent of the assay values—a good saving over the old process of amalgamation alone.

The Pittsburgh group, at the foot of Nottaway Mountain, is owned and operated by the Cashier Gold Mining and Reduction Company. Nearly 8,000 feet of development work has been done on this property, and the main shaft is 1,050 feet in depth. It has an average monthly production of 100 tons, 85 per cent of which is smelting ore of a high grade. The surface equipment consists of a fine plant of machinery, run by electricity. The power is furnished by the Hydro-Electric Power Company of Georgetown, Colorado.

Other centrally located mines, as also those in the outside districts of the county, have been carrying on steady development work, and good ore bodies have been uncovered, but it is unnecessary to enumerate them in this report, although many of them are good producers of paying ore.

The U. P. R. mill, containing forty stamps, and situated in Central City, and the Polar Star mill, of forty stamps, in Black Hawk, are employed constantly on custom ore. Both mills are of the amalgamating type. The Hidden Treasure mill, in Black Hawk, is being converted into a concentrator for handling custom ores in the near future. During the past year many new properties have started up, new shaft-houses have been erected, and numerous plants of machinery installed—all in preparation for large and continuous operations during 1913.

CLEAR CREEK COUNTY

In the Clear Creek County district all the veins are true fissures. The greatest depth attained in this county is 1,700 feet, and veins are proven continuous to this depth. The metals are gold, silver, copper, lead, and zinc. Silver is the principal metal in that portion of the county which includes Silver Plume, while gold predominates in the Idaho Springs, Argentine, and Griffith districts. The ores are similar to those of Gilpin County, and have an average value of $20 a ton. The mineral productions for the year 1911 amounted to $1,131,000, and for 1912 the total is $1,191,000.

One of the best among the many large and producing mines of the Clear Creek County district is the Capital Prize group, situated at the base of Griffith Mountain, and within the cor-

porate limits of Georgetown. This group is owned and operated by the Capital Prize Mining and Tunnel Company, with principal office at Pittsburg, Pennsylvania. The property is operated through a tunnel 5,280 feet in length, and about 10,000 feet of development work has been done. The gross production of crude ore is 150,000 tons, of a good average grade in value. The average daily production of ore is 100 tons, of which 75 per cent is concentrating, which is treated in the company's concentrating mill, near the portal of the tunnel. The mill has a capacity of 100 tons a day, is equipped with two six-foot Chilian mills, two copper amalgamating plates, and one 500-ton capacity coarse ore bin, which feeds into a 9″x15″ Blake crusher, and then to a like-sized Sampson pulverizing crusher. From the latter an elevator carries the ore to the top of a 500-ton "fine" bin, from where it then goes to the Chilian mills, and thence to thirteen Card and Swain concentrating tables and two six-foot frue vanners. About 75 per cent of value of ore is saved by this process. An average of fifty men are employed in underground work.

The Blue Ridge group is located on the north slope of Capitol Mountain and about one mile south of North Clear Creek. It is owned and operated by the Blue Ridge Mines and Milling Company, with principal office at Lawson, Colorado. Work is carried on through a tunnel which intersects the Senator, Capitol, and Blue Ridge veins, belonging to the group. The main tunnel is 2,700 feet in length, and work has been confined principally to development; but hereafter the ore production will be on a larger scale, as the ore bodies uncovered are large and of good grade. A new concentrating mill of fifty tons' capacity has been recently completed near the portal of the tunnel, and treatment of the ore from the Senator vein, which gives good returns in silver, began December 1, 1912. The company contemplates building a new concentrating mill to take the place of their old-style mill on South Clear Creek, to treat the ore from the Blue Ridge vein, of which the principal values are gold. An aerial tram will also be built to convey ore from the mine to the mill, a distance of one mile.

The Hoosac Tunnel group is situate on Bellevue Mountain and about two miles above Idaho Springs. It is owned and operated by the Hoosac Transportation and Tunnel Company, with principal office at Denver, Colorado. This property is worked through a tunnel on the south side and near the base of Bellevue Mountain. A shaft was sunk many years ago on this property to a depth of 220 feet, and seventy-five feet distant from the portal of the tunnel. This shaft has been recently equipped with machinery for hoisting. The collar of the shaft is on a level with the crusher in the mill, and the ore coming from the tunnel and shaft is handled automatically. Less than two years ago a cross-cut, 500 feet long, was started at a distance of 1,200

feet from the portal of the tunnel, to intersect the Hoosac vein. This work has opened up a large body of ore of good grade, the smelting ore netting $45 per ton in carload lots. After twelve years of persistent work and large expenditures of money, this property has at last developed into one of the best-paying groups in the county. Among other improvements nearing completion by this company is a fifty-ton concentrating mill, which will be run by electricity.

The McClelland Tunnel and group of claims in Clear Creek County is a meritorious tunnel-mining proposition. The property consists of 109 patented mining claims, including millsites and placers, and twenty-nine unpatented lode claims, all situated in the Freeland or Trail Run, Banner, Montana, and Cascade mining districts, southwest of Idaho Springs. At about half a mile below the depot at Dumont is situated the portal of the McClelland Tunnel, which has been driven 7,150 feet. When completed, this tunnel will undercut the great Freeland Mine and adjoining claims, which have heretofore produced more than $5,000,000.

No work has been done on the project during the last two years, except that necessary as assessment work, to hold title to unpatented mining claims and to preserve the tunnel rights.

The McClelland Tunnel, when extended, will attain a depth of nearly one-half mile below the apex of the Freeland veins, and will develop an ore body that will require years to mine, and will furnish employment for hundreds of miners.

The intention is to continue the tunnel 1,100 feet, at which point a raise will be made of some 1,100 feet, which will connect with the bottom of the old Freeland mine workings. These workings are now filled with water (which was the great drawback to former operations), and the connection thus made will furnish drainage and ventilation, and the tunnel will afford a cheap and easy method of extracting and marketing the ore production. The tunnel mouth is on the main line of the railroad, where the smelting product can be loaded directly into cars; and there is ample ground for the erection of reduction works, and sufficient water for milling purposes.

The promoter of this enterprise is Mr. George E. McClelland, of Colorado, who has devoted the last dozen years in acquiring this group of properties and in driving the tunnel to its present length.

Many other mines, including the Oneida, New Era, and Little Mattie groups, are worked extensively, and are large and regular producers; but space does not permit further comment on the mines of this district.

The Hudson, Jackson, and Newton concentrating mills at Idaho Springs are steadily employed on custom ore. The fine,

large concentrating mill being constructed near the portal of the Newhouse Tunnel is nearing completion, and in a few months will start on the custom ores of this district.

BOULDER COUNTY

The total production of precious metals, including gold, silver, copper, lead, and tungsten, in the Boulder County district for 1911 was $800,162, and for 1912, $811,000. The increase for 1912 over 1911 is accounted for by the larger demand for tungsten and the better prices paid for this metal in the latter part of the year. Three-fourths of the output from this county results from tungsten mining alone. The average price of tungsten received, per unit of twenty pounds, during the last year was $7.50 for 60 per cent material.

The principal producer of tungsten is the Primos Mining and Milling Company, which operates three groups of mines. Other producing tungsten mines include a number of leasers on the Cold Spring, White Ranch, and a number of claims on the Roger's property.

The Red Signe Mine is operated by the owners. The latter property is situate in Boulder Canon. None of the small producers average less than 10 per cent material, and all pay good dividends to their owners.

The production of gold, silver, copper, and lead for 1912 shows an increase over both 1910 and 1911, partly due to better prices received for some of the metals.

One of the items not included in the figures given above is that of fluorspar, sold to the steel works at Pueblo, Colorado. About 3,000 tons, averaging $6 per ton, were sold during 1912. A large ledge on the summit of one of the mountains in the Jamestown district furnishes this output.

The Primos Mining and Milling Company operates the Congor group, one and one-half miles north of Nederland; the Lone Tree group, one mile north of the Congor; and the Oregon-Quaker group, which is five miles southeast of the Congor. The Congor group is operated through a shaft 450 feet in depth, and is equipped with a cage and good hoisting plant. The average monthly production of crude ore is 1,500 tons. The Lone Tree group is operated through a shaft 300 feet deep, part of the work carried on being confined to development, with an average monthly production of 400 tons of crude ore. The Oregon-Quaker group confines part of the work to development, and the monthly production averages 100 tons of crude ore.

All of the ore from the three properties is treated at the concentrating mill, owned by the same company, and situated at Lakewood, Colorado, which is about two miles from the Congor Mine. The mill has a capacity of 100 tons per day, and is

run by electric power. The mill equipment is as follows: ten quick-drop stamps; tube crusher for regrinding; eleven frue vanners; two Wilfley tables; and three sets of inclined canvas tables of twenty tables to each set (first set of tables twenty-four feet long, second set sixteen feet long, third set twelve feet long). Ten tons of crude ore are concentrated into one ton, the concentrates averaging $600 per ton, carrying principally tungsten values. The average saving is 90 per cent of assay values.

The United States Gold Corporation is operating the U. S. Gold and the Livingston groups, both groups situated on the southeast slope of Sugar Loaf Mountain. On the U. S. Gold group work is done through a shaft 230 feet deep on the Daisy vein—one of the U. S. Gold group—and a surface tunnel driven on the easterly portion of the Livingston vein. The average monthly production for both is 1,500 tons, with an average value of $23 per ton, running mainly in gold. Near the mines a cyanide mill of 150 tons capacity has been recently completed, for the treatment of ores produced from this company's mines. The values saved by this process average about 75 per cent of the assay value.

ROUTT COUNTY

Very little development work has been done in Routt County, rich in minerals, as all work has been confined to prospecting. Outside of the Hahns Peak district, no extensive work has been carried on during the last two years, owing to a lack of reduction works and the heavy cost of transportation to points where such facilities may be found.

During 1912 the mineral resources of Routt County have attracted increased attention, but the only property as yet upon which extensive work is done is the Royal Flush group, situated on the west slope of Hahns Peak and at an altitude of 9,500 feet. Two tunnels, 953 feet and 2,200 feet in length, respectively, have been driven, but all work is confined to the longer tunnel, which is driven its entire length through a conglomerate mass of quartz and porphyry. At a distance of 900 feet from the portal the Contact vein is intersected, and some drifting has been done on this vein, which is four and one-half feet wide. The vein matter is lead, zinc, iron sulphides, and black tale, with an average value of $35 per ton. Beyond the Contact vein a number of other veins, including a large porphyry dyke twenty feet in width and of low value, are intersected by the tunnel. This property is situated thirty-four miles northwest of Steamboat Springs, which is the nearest railroad station. The cost of hauling by wagon to Steamboat Springs, and thence to Denver via the "Moffat Railroad," is $18 per ton, which is prohibitive. The erection of an electric smelter is contemplated in the near future by the owners of the Royal Flush group, and the present production of 300 tons monthly is held until such time.

The total production for 1912 of gold, the only metal returned in Routt County, is $3,500. This is largely the result of placer mining. Previous to the year 1912 about $2,000,000 was taken from placers on the south side of Hahns Peak.

RECOMMENDATIONS

For the biennial term recommendations were issued to managers of various mines in the district, as follows:

Timbering shafts and tunnels, eight; repair ladders, four; provide additional exists for employes, ten; provide guard-rails around machinery, one; discontinue use of hoisting plant until placed in safe condition, one; regarding fire protection, two; regarding better ventilation, two; place fire doors near portal of tunnel, one; provide ladders in upraise, seven; partitioning shafts into two compartments, two; regarding sanitary conditions, two; regarding explosives, four; providing passage-ways around level stations, one.

Many verbal recommendations and suggestions were given upon other matters not enumerated above, and all working properties were supplied with the state code of signals, notices, and accident blanks. Managers in the district, in nearly all instances, have followed suggestions and recommendations promptly and have shown many courtesies to the inspector.

Review of District No. 2

DEEP DEVELOPMENT UNCOVERS RICH ORES IN TELLER COUNTY

By JAMES T. STEWART, Inspector

TELLER COUNTY

The output of the county, as gathered from the monthly reports of the mill managers, recently revised and corrected, gives a total for the year of 897,451 tons of gold-bearing ores, with a gross bullion value of $14,356,741.

Of this tonnage the local mills have handled, according to their respective reports, 350,453 tons of dump and low-grade mine ore, with an average value of $3.10 per ton and a gross bullion value of $1,086,188.

The several plants, together with their location and treatment, follow:

Portland Gold Mining Company, Battle Mountain: Process used, cyanide with added chemicals, so far secret. Tons treated, 173,079; average value, $3.04; gross value, $356,739.

Ajax Mill: Cyanide, with other chemicals; grinding to a 200-mesh, a modification of the Clancy process. Tons treated, 16,445; average value, $2.38; gross value, $55,527.

Wild Horse Mill, United Gold Mines Company, Bull Hill: Cyanide. Tons treated, 12,200; average value, $3.51; gross value, $42,860.

Kavanaugh Mill, Joe Dandy Mine, Raven Hill: Cyanide. Tons treated, 14,450; average value, $2.20; gross value, $33,060.

Gaylord Mill, Dante Mine, Bull Hill: Cyanide. Tons treated, 6,400; average value, $3.30; gross value, $21,180.

Blue Flag Mining and Milling Company Mill, Blue Flag Mine, Raven Hill: Cyanide. Tons treated, 4,700; average value, $4.15; gross value, $19,550.

Isabella Mines Company Mill, Bull Hill: Treating tailings of old mill dumps. Tons treated, 5,570; average value, $1.45; gross value, $8,325. This plant now treating coarse dump rock without crushing, securing the face values only.

Stratton's Independence Mill, Stratton's Independence Mine, Battle Mountain: Cyanide and concentration. Tons treated, not known; average value, $3 to $30.

The Valley mills treating the ore shipped from the district reported as follows:

Golden Cycle Mill, Colorado City: Cyanide. Tons treated, 381,450; average value, $20.09; gross value, $7,663,100.

Portland Gold Mining Company, Colorado City: Cyanide. Tons treated, 1,191,169; average value, $21.96; gross value, $2,117,518.

The accredited agent of the smelters at Pueblo and Denver, residing in Cripple Creek, reported the shipment and treatment of 46,379 tons of ore from this district, of the average value of $64.45 per ton and a gross bullion value of $2,989,935. This tonnage has not necessarily been treated at the Colorado plants referred to, but may have been shipped out of the state.

Other mills are in contemplation for 1913, notably by the El Paso Gold Mining Company, the Stratton Estate, the Mary McKinney Mining Company, the El Oro Gold Mining and Milling Company, and other corporations.

Deep Development

Deep development has been the order at practically all of the larger mines and chief producers of the gold district. This was made possible by the drainage of the entire district by the Roosevelt Tunnel of the Cripple Creek Drainage and Tunnel Company, hereinafter referred to.

The Portland No. 2 shaft of the Portland Gold Mining Company, on Battle Mountain, was drained by the tunnel, and the shaft sunk to a depth of 1,620 feet, and rich ore has been developed at the 1,600-foot level. A bonanza shoot, twenty-five feet wide, has been opened up for a distance of 350 feet to date, with ore in both ends of the drift. The ore contains a higher percentage of sulphide and richer gold content. The total output reported monthly has been 5,006 to 6,000 tons.

Golden Cycle, Bull Hill: The shaft on this big property was sunk to a depth of 1,650 feet, and here pumps are used to keep the 1,650-foot level free from water. The main Legal Tender vein has been opened up, and the ore found of high average value. Electric pumps have recently been installed at this property and are successfully draining both the Cycle and Vindicator properties, adjoining.

Vindicator: The main, or No. 1, shaft was sunk to the 1,600 foot point during the year, and mining operations are now being carried on at the 1,500-foot level, at handsome profit.

This company's Hull City and other shafts were operated during the year by lessees, and these leased shafts are producing about 1,000 tons monthly, while the company ships from 1,600 to 1,800 tons a month; the company ore averaging from $30 to $35 a ton, the lessees' ore about $20.

Cresson Gold Mining and Milling Company, Raven Hill: This mine, controlled by a close corporation, sank its shaft until water was reached at a depth of 1,300 feet. At the bottom level a huge ore body has been developed, and the mine is producing a higher grade of ore from recent development work than at any time in its previous history. The company is reputed to have paid half a million dollars in dividends during the past year.

El Paso Consolidated Gold Mining Company Mines, Beacon Hill: This property has produced heavier than at any time in its previous record. The main, or No. 1, shaft is connected up with the Deep Drainage Tunnel, and operations at the 1,000 foot, or tunnel, level have opened up strong and rich ore bodies. The Nichols shaft, on the north end of the estate, has been sunk to a depth of 915 feet and has been equipped with a powerful mine plant. The property is now producing approximately 3,500 tons a month, and with the Nichols shaft in full operation the output will be increased to 5,000 tons a month.

Mary McKinney, Raven Hill: Mine owned by the Mary McKinney Mining Company, and shaft sunk to a depth of 925 feet. New and rich ore bodies were opened up at the deeper levels, and since April the property has produced ore of the value of $300,000, and the company was brought back to the dividend-paying list.

Stratton's Independence, Battle Mountain: This mine, owned by a British corporation, made its largest output since the leasing system was introduced. The ore production reported to England for the fiscal year ending September, 1912, was $398,456, net.

Gold Dollar Consolidated Gold Mining Company, Beacon Hill: The main shaft on this property was sunk to the twelfth level—a depth of 1,000 feet. Ore bodies of great value were encountered and are now under development, and the company from its production paid handsome dividends to stockholders.

Granite Gold Mining Company, Battle Mountain: Properties of this company were operated both on company account and by lessees, and the 1,100-foot level was recovered by natural drainage through tunnel connections. The 1,100-foot level was recovered and the 1,200-foot level will shortly be accessible. Rich strikes were made at depth on the Dorothy and Gold Coin and Granite veins, and the company paid dividends.

Elkton Gold Mining and Milling Company, Raven Hill: The lower workings were drained and the main shaft sunk an additional 100 feet, to a depth of about 1,150 feet. The mine is shipping about 2,500 tons a month, with an average value of about $28, and dividends were paid quarterly.

The Strong Gold Mining Company, Battle Mountain: The lower levels drained made heavy production possible, and the ore-shoot at the 1,000-foot level proved rich. This mine has produced

in excess of one million dollars to each of its seven and one-half acres.

Other properties of the district on each of the several hills within the recognized producing area contributed liberally to the output.

Prospecting on the outside hills was confined and without profitable result to date.

The Dividend-Paying Corporations

The dividend-paying corporations, with amounts distributed, were as follows:

Acacia Gold Mining Co.	$ 14,389.89
Auraria Gold Mining Co. and owners, Forest Queen Mine.	35,000.00
Blue Bird Mining and Milling Co.	10,000.00
Cresson Consolidated Mining and Milling Co., close corporation (estimated)	500,000.00
Elkton Consolidated Mining and Milling Co.	112,500.00
El Paso Consolidated Gold Mining Co.	125,500.00
Golden Cycle Mining Co.	360,000.00
Granite Gold Mining Co.	16,500.00
Gold King Mining Co., close corporation	15,000.00
Gold Sovereign Mining and Tunnel Co.	5,000.00
Jerry Johnson Mining Co.	24,978.52
Little Bessie Gold Mining Co. (sale of property, company dissolved)	16,625.00
Maggie Gold Mining Co.	9,000.00
Mary McKinney Mining Co.	78,555.12
Portland Gold Mining Co.	240,000.00
Stratton's C. C. Mining and Development Co. (Stratton Estate)	25,000.00
Stratton's Independence, Ltd. (British corporation)	120,000.00
Strong Gold Mining Co., close corporation (estimated)	150,000.00
Vindicator Consolidated Gold Mining Co.	180,000.00
Gold Dollar Consolidated Gold Mining Co.	37,500.00

The profits of lessees during the year may be safely estimated at $450,000.

Drainage of District

The Roosevelt Deep Drainage Tunnel since November, 1910, has lowered the water level of the district 220 feet, as reported by Consulting Engineer T. R. Countryman, United States mineral surveyor. It is now flowing at the rate of 8,650 feet a minute, and is lowering the water level from eight to ten feet per month. The heaviest flow recorded was 17,000 gallons a minute.

A third tunnel is now projected, and plans have been prepared and submitted.

Woodland Park District

A number of locations were recorded during the year, and several very favorable prospects were exposed. But little substantial development obtains to date.

Mr. Beattie, of that place, is erecting a 100-ton acid plant—a new method.

Sixteen fatalities were reported during the year, and but two of these were from mine gases in a shallow shaft in Gold Hill. The drainage of the district was expected to cause an inflow, but, outside of periods of low barometer, no special increase has been noted. Due to modern appliances, the Conundrum Mine on Gold Hill, notorious for its foul gases, and the subject of a special report by the United States government authorities in 1904, was operated steadily the entire year without obstruction.

The government rescue appliances have been installed at the Portland Mine on Battle Mountain and the El Paso Mine on Beacon Hill, and a corps at each properly drilled in their use.

CUSTER COUNTY

In Custer County the famous old Bassick Mine is started up under new management. They are operating a small cyanide mill on a tailings' dump, and have three men at work in the mine. It is hoped that the old ore-shoot may be picked up.

The Whistle Mine, operated by the owner, Hugh H. Melrose, is shipping some high grade ore. There is much prospecting being done in that county, but very few shippers at the present time.

FREMONT COUNTY

The Gumaer Mine, located at Cotopaxi, Fremont County, is working about twenty men on development, and has developed a large ore-shoot, which gives promise of being a very large body of low-grade ore. Work has been suspended on the Copperfield group. Many very favorable copper prospects have been developed in Fremont County in the last year, but few shipping mines.

Review of District No. 3

LEADVILLE ENJOYS NEW PROSPERITY—ALL COUNTIES DOING WELL

By JOHN R. CURLEY, Inspector

LAKE COUNTY

Lake County has enjoyed a prosperous period during 1911 and 1912, due in great measure to the recent carbonate-of-zinc discoveries, which now total at least one-fifth of the output of the district. This new class of mineral has not only increased the tonnage, but has added to a large extent to the number of men employed underground. In the year 1910 there were employed in mines, smelters, and mills a total of 2,460 men, of whom 1,810 worked at mining, 575 worked in smelters, and seventy-five worked in mills. A recent enumeration shows that at the present time there are 2,130 men working at mining, 625 in smelters, and fifteen in mills and sampling works; a total of 2,770 in all the industries pertaining to the mining business. This is an increase of 310 men over the last biennial period, notwithstanding the fact that the American Zinc Extraction Company shut down its works, which formerly employed seventy-five men in the district.

The large shippers of the Leadville district are the Star Consolidated Mines Company, the Western Mining Company, and the Castle View Mine. From these properties comes the great bulk of the carbonate-of-zinc ores; also silver lead and manganiferous iron ores. The output from these three mines on Carbonate Hill will probably be in the vicinity of 600 tons of ore per day.

In California Gulch, the Yak Mining, Milling and Tunnel Company, the Iron Silver Mining Company, the Colonel Sellers Mining Company, and the A-Y and Minnie Mining Companies are large producers of lead, iron, and zinc-sulphide ores. These companies are all working full forces of men, and their combined shipments will average 20,000 tons of ore per month.

On Breece Hill and in Big Evans Gulch are situated the Ibex Mining Company, the New Monarch Mining Company, the Garbutt Leasing Company, the Luema Mining Company, and the Ethelma Mining Company, which are heavy shippers of gold and copper-bearing ores. The Ibex and Garbutt Mines

also produce considerable zinc sulphides. These mines, together with the large number of small leasing parties scattered over the district, undoubtedly make Lake County the largest shipper of crude ores in the state.

EAGLE COUNTY

Eagle County, although one of the smallest of the mining districts, has improved to a considerable extent during the years 1911 and 1912. The production of ore for 1912 exceeds that of the preceding year, the county showing an increase in the number of men engaged in mining over the year 1910. Mining operations are confined almost wholly to Battle Mountain, the properties in the Holy Cross district having suspended operations for two years.

The Eagle Mining and Milling Company, operating the Iron Mask group of mining claims, is the principal shipper in the district. The company has been very successful both in mining and milling operations, making a complete separation of the iron, zinc, and lead product of its ores. The mill is now being enlarged from a capacity of sixty tons per day to 120 tons, and with the great area of territory recently acquired, and the large amount of ore blocked out in reserve, the company will double its production during the present year.

The Success Mining and Leasing Company, operating the Bleak House and Pine Martin claims, has shipped a considerable tonnage also, as has the Champion Mine, of the Eagle Bird Mining Company, owned by the W. S. Cheeseman Estate, of Denver. Several small leasing parties of from three to four men make occasional shipments of ore, and while each individual shipment is small, the aggregate helps to increase the production of the district.

SUMMIT COUNTY

The Wellington Mines Company, in French Gulch, is the great producer of Summit County, the product consisting of silver-lead, iron, and zinc ores, which, by a successful milling process, enables the mine to market three products—iron, zinc, and lead. Recently the milling capacity has been enlarged by building a separate mill to handle the tailings from the main concentrating mill, which consists of iron and zinc. The latter process is by magnetic separation.

Other properties that are in successful operation in this vicinity are the Standard Mine, the Blue Flag, the Monte Christo, and the American Mining Company; these three properties being at the head of the Blue River. The closing-down of the Wilson Mine at Kokomo, with its 250-ton concentrating mill, last July, tended to decrease Summit County's production, but this will be

made up during the present year by the new discoveries made in Mayflower Gulch late this fall. Several of these prospects have already commenced shipping ore. Another drawback has been the closing-down of the New Pennsylvania mine and mill at Argentine, and the St. Johns mine and mill at Montezuma; both properties having suspended operations early in 1912. While the ores of both the Argentine and Montezuma districts seem to be almost inexhaustible in quantity, yet the low grade and refractory character of the mineral seem to preclude the possibility of mining it at a profit, until such time as modern metallurgy will devise a process by which the values may be separated at a lower cost than at the present time. Another hindrance to the development of these districts is the cost of transportation both for the product and for supplies, all loads being freighted by wagon from Keystone, on the Colorado & Southern Railroad, a distance of from ten to fourteen miles. The condition of the road is such that 4,000 pounds is a big load for a four-horse team.

PITKIN COUNTY

The Smuggler Mining and Leasing Company is the great producer of the Aspen district. During the past year a complete remodeling of the whole plant has taken place. Electricity has been substituted for steam power, both in hoisting material for the mill and in raising water from the mine. This change has materially reduced the cost of operating expenses and as the crude ore from this property is probably the lowest in value of any mined in the state, the saving of a few cents per ton in the cost of mining and milling may mean a profit or deficit on the books of the company. Considerable trouble has been experienced in subduing a fire that had started in the mine several years ago, and has been fed by the sulphur contained in the vein. A portion of the old workings where the fire occurred had been bulk-headed and cut off from the present operations in the mine, but the fire seems to course through the vein and breaks out in unexpected places. Dr. J. C. Roberts, of the Federal Bureau of Mines, has lately taken the matter in hand, and it is to be hoped that he can extinguish the fire.

On the Aspen and Durant Mines, on Aspen Mountain, considerable lime flux, carrying a few ounces of silver, is shipped to the smelters, and occasional shipments are made by leasers working some of the old properties in Tourtellote Park. There have also been some new finds of ore, both lead and zinc, on Italian Mountain, in the southwest portion of Pitkin County, that look favorable.

PARK COUNTY

The cessation of mining operations by the London Mining Company, on London Mountain, eighteen months ago, virtually

brought shipments from the Park County district to a standstill. This mine, which has been worked for years by the tunnel system, had exhausted the ore bodies above the present tunnel level, and the owners were compelled to go lower down the mountain and drive in deeper to reach the vein at a greater depth. The preliminary work for this undertaking has now been accomplished. A series of diamond drill holes has been driven downwards from the old tunnel to locate the ore bodies on their downward course, and the new tunnel started. When it reaches the desired distance, it will give 500 feet additional depth on the vein, and give stoping ground for many years. The London vein is one of the richest and greatest ore-shoots in Colorado, and for years gave an annual production of 15,000 tons of ore, that averaged $60 per ton in gold, besides small silver and copper values.

The Dolly Varden and Moose Mines, on Mount Bross, have worked during the past year small forces of men, and have made occasional shipments, the greatest part of the work being in the way of development.

The Chance-Hilltop Mining Company, in Horseshoe Gulch, formerly a large shipper of lead-zinc ores, last spring ran into a barren zone, and shipments were curtailed to a large extent. Recent developments this fall have discovered new ore bodies, and heavy shipments will undoubtedly be made during the coming summer. Owing to the high altitude in which the mine is situated, no ore is shipped during the winter months.

Several veins of silver-lead-bearing mineral have been discovered and opened up in the Tarryall district during the past year. The Oregon Mining Company, owned by the Simmons Hardware Company of St. Louis, has made an exceedingly fine showing, and last fall had a large quantity of good-grade ore broken and ready for market.

CHAFFEE COUNTY

The Mary Murphy Gold Mining Company is the largest mining operator in this county. The property is situated at Romley, a station on the Colorado & Southern Railroad, two miles above St. Elmo. The work thus far done is largely preparatory, and in the nature of development. A tunnel sufficiently large for a double track has been driven into the mountain, a distance of about 5,000 feet, and reaches the vein at a depth of 800 feet below the old workings that were operated a number of years ago. A large concentrating mill is about completed, and ready for operation, at the portal of the tunnel, and the company during the coming year will be ready to conduct mining operations on a large scale.

The Flora Belle Mining Company, operating near Hancock, has done a great amount of prospecting and development on its properties during the past season, with sufficient encouragement to

hope that, before the present year closes, the mine will be on the list of shippers.

In the Monarch district, the old Madonna Mine, that twenty-five years ago was one of the heaviest shippers of lead-silver ores, is now operated by a company known as the Monarch-Madonna Company. Operations were begun by driving a tunnel in new territory never worked under the old management. There was opened up in the contact between the Cambrian quartzite and the granite formation a large body of gold-bearing mineral, from which steady shipments have been made for the past year.

Another property adjoining the Madonna, and worked a year and a half ago, by a corporation known as the Monarch Mining Company, shipped several lots of ore in 1911, but has since suspended operations.

At Garfield, six miles from Monarch, the Ohio and Colorado Smelting Company employs about twenty-five men in taking out lime rock from a quarry, the product of which is used by the smelter for fluxing purposes.

GARFIELD COUNTY

Mining operations have been suspended in this locality for the past two years. In 1910, on Elk Creek, thirteen miles northwest of New Castle, a new district was opened, and considerable work done in the way of prospecting in the granite formation. A corporation, known as the Grey Eagle Consolidated Mining Company, drove a tunnel into the mountain on a fissure vein that outcropped on the side of the hill, and shipped several cars of gold-bearing ore that ran, with careful hand-sorting, $30 in gold to the ton; but, with the heavy cost of transportation to the railroad tracks at New Castle, it is doubtful if these properties could be made to pay under present conditions.

The mineral resources of Mesa, Rio Blanco, and Delta Counties have not been developed, although some carnotite ore is being mined in Rio Blanco and Mesa Counties.

Review of District No. 4

MINING IN ALL COUNTIES MAKES GOOD SHOWING FOR BIENNIAL PERIOD

By SAMUEL TREAIS, Inspector

SAN MIGUEL COUNTY

The mines in general are strong, permanent fissures, containing gold, silver, lead, and zinc values. The veins can be traced for long distances, and the ore bodies are proving themselves to be both continuous and rich.

The important mines which have brought this district into great prominence during the past few years are the Smuggler Union, Liberty Bell, Tom Boy, and many others too numerous to mention.

In the Ophir District considerable advance has been made, and it is surely, though slowly, pushing its way to the front, with a most encouraging outlook for the future. In brief, I wish to say of San Miguel County, with its modern and up-to-date mills, that mining and milling is conducted on a commercial basis, and that it has produced more gold, year in and year out, for the past thirty years, than any other known area of mining country in the state.

SAN JUAN COUNTY

This county presents topographical features and geological characteristics of great interest. Its resources are wonderful, and its richness is best understood when one learns that out of an area of 405 square miles, 100 square miles, or nearly one-quarter, have been located as lode claims.

The general character of the rock met with is eruptive; viz., trachyte, andesite, granites, schists, and gneiss. Metamorphic rocks also occur, tilted at a high angle. The larger part of this area is prolific in strong, well-defined fissure veins, which have been proven to extend to an unknown depth. Many of these veins, notably in the vicinity of Animas Forks and Eureka, are of great width, from 10 to 100 feet, and show large bodies of low-grade ores. Lead, zinc, and copper ores in the South Mineral, Ice Lake, Sultan Mountain, Bear Creek, Arasta Basin, Cunningham, Minnie and Maggie Gulches, Boulder Mountain, and

Gladstone district, all show well-defined fissures. The veins are as strong and persistent as they are in the Animas Forks and Eureka districts. Most of these veins carry high- and medium-grade gold, silver, lead, zinc, and some little copper values.

LA PLATA COUNTY

This county is located in the southwest corner of the state. It is principally covered by rocks of the Middle Cretaceous age. There is an area of several miles where the hornblendic trachyte comes through to the surface. Also, in the northeast corner of the county, metamorphic granite is the rock of the country, and on the edge of this are found beds belonging to both the Upper and Lower Carboniferous periods.

This county has, during the past two years, made leaps and bounds in progress, and is preparing for a more important place among the metalliferous counties of the state. During the past year a great deal of prospecting has been done in this county, with very promising results.

The amicable settlement, out of court, of the May Day and Idaho mines will go a long way in reviving the mining industry in this county the coming year.

GUNNISON COUNTY

While it is true that the mines of both gold and silver of this county have not realized the expectations raised by them, yet they have made considerable advance during the two years last past, and the mining industry has settled down to a legitimate basis.

In the Quartz Creek mining district there has been more activity in the past two years than for several years previous. The property of the Gold Links Mining and Milling Company is looked upon as the making of one of the big producing mines of Colorado. The Raymond Consolidated Mining Company, the Colorado Smelting and Mining Company, the Carter Mining Company, the Sandy Hook Mining Company, the Pandora Mining and Milling Company, and several other mining companies in operation, are looked upon as being heavy producers during the coming year.

In addition to the gold and silver mines in Gunnison County, there has been opened up in this county, during the past year, a graphite mine. When this property is thoroughly developed, it should make the best property of its kind, as the product is as pure as can be found anywhere.

SAGUACHE COUNTY

This county has increased in prosperity during the past two years, and the outlook for the future is better. Its mines are principally found in the eruptive and metamorphic rocks of the

range forming the Continental Divide. In the northern part of the county, on Kerber Creek, the principal mines are located, which are broad lodes carrying pay streaks from two to ten feet wide.

The Rawley Mine, in Rawley Gulch, is one of the most promising mines in the county. It is a strong, permanent vein, from eight to twelve feet in width, in which are found two ore-veins; one, a quartz, impregnated with gray copper and much stained by the carbonates of copper, and averaging about twenty ounces of silver per ton; the other, an argentiferous galena, with about twenty-five ounces of silver per ton and 40 per cent lead. The Rawley Tunnel is seven by eight feet, and 6,235 feet in length. It taps the main ledge at 1,200 feet below the surface. The ore at the 1,200-foot level has changed somewhat in character from that in the upper workings, the former being a very heavy iron sulphide, carrying practically no values, excepting silver and copper; the lead and zinc, prevalent above, having practically disappeared.

In the last few weeks the company has completed a crosscut drainage tunnel, and has cut the vein 600 feet below the surface workings. The manager is more than pleased with the showing of the vein at this point. The mountains and mineral region of this county are in a rich mineral belt, and, when the properties are more extensively developed, and with increased facilities, will yield handsome profits.

OURAY COUNTY

The progress made in the development of this part of the state has been very great, and probably no portion of the state has received greater attention. The mineral area of Ouray County is composed almost entirely of eruptive rocks. Porphyry, trachyte, basalt, quartzite, and granite are most frequently met with. Red Mountain contains some of the richest veins of the county, though the average grade of the ore is only medium. It occurs in immense bodies, which renders its extraction cheap and profitable.

We also find, in this district, large bodies of low-grade ores, which will be mined and milled at a good profit as soon as the metallurgist has solved the problem of extracting the values with a more economical process. There are thousands of tons of high- and medium-grade ores mined annually in the different mining districts in Ouray County.

The mines that made this district famous are the Virginius, the Terrible, Yankee Girl, Guston, National Bell, Old Lout, Wheel of Fortune, American Nettie, Camp Bird, Bachelor, Wedge, Atlas, Bright Diamond, and scores of others I might mention if space would permit.

HINSDALE COUNTY

Lake City is the shipping point. This county in 1912 shows a tonnage gain over 1911 equal to 388 per cent, and a value gain, based on higher quotations, of at least 400 per cent. This is the record gain of the year, traced directly to the introduction of modern concentration plants, such as the Hidden Treasure, Highland Mary, Yellow Medicine, and Pelican.

According to figures produced from the Rio Grande station agent, the amount of concentrate shipped in 1911 was 382 tons—about equal to 1,428 tons of crude ore. In 1912 the shipments reached 1,868 tons, or 7,472 tons of crude ore lifted from the several mines. On the active list are the Hidden Treasure, Highland Chief, Yellow Medicine, Pelican, Black Crook, Sun Flower, Excelsior, Sacramento, Hound, Golden Wonder, Czar, and Owl. Few of these did anything in 1911. The gain in concentrate shipments was 1,486 tons, and the increase in values arose from a total of $18,890 in 1911 to $93,890 in 1912.

Though the total output from the county is small, compared with that in other southwest Colorado counties, the outlook for the future is promising.

MINERAL COUNTY

Mineral County in 1912 made a gain in tonnage and values of 25 per cent over 1911. The district in 1911 produced 65,932 tons of raw ores, from which $179,196 in gold, $290,958 in silver, $312,656 in lead, $4,447 in copper, and $68,795 in zinc was extracted. The gain in value in 1912 over 1911, without allowing for the advance in silver, lead, copper, and spelter, was $214,011.

In September, 1911, the railroad charge on low-grade ore was reduced 25 per cent, and the smelter charge on such ores 50 cents, making the cost of transportation and treatment $4.75 per ton for this ore. This had an excellent effect in the fall months of 1911.

For 1912 the Creede shipments reached 40,915 tons, one-third of which was concentrate. The yield of raw ore in 1912 was 81,829 tons, and in 1911 65,932 tons.

DOLORES COUNTY

The principal and important mining region of this county is found in the neighborhood of Rico. The development of this section has been more or less retarded since 1893, until the latter part of 1911. Although the fine ranges of mountains show themselves rich in mineral wealth, their development is slow. Notwithstanding these drawbacks, the progress made in the last year is very cheering and points to a brighter future for 1913.

Most of the properties developed to any extent prove to be rather deposits than fissures, although in some cases fissures are

met with. The country rock or formation in which the mines are found consists largely of limestone and sandstones belonging to the Upper Carboniferous rocks, and breaking through these are frequently found dykes and masses of porphyry and other eruptive rocks, the most frequent being hornblendic trachyte. Most of the mines are contacts of the porphyry and lime, and generally carry as ore the carbonates of lead and copper, which are argentiferous. Sulphide, chloride, and bromide of silver and other silver minerals are present. Iron as oxide, sulphide, and carbonate are also frequent associates of the more valuable ore, while zinc and bismuth, in some combination, are also often met with in some of the mines.

In conclusion, I wish to say that the outlook is very promising in all of the counties of my district for a revival of the metal mining industry during 1913.

Carbonate of Zinc Booms Leadville

HEAVY TONNAGE FORCES RAILROAD TO INCREASE FACILITIES

By JOHN R. CURLEY
Inspector District No. 3

Two years ago mining in the vicinity of Carbonate Hill, in the Leadville district, was at a very low ebb. With the exception of the properties of the Western Mining Company and the leasing done on the Star Consolidated Mining Company's workings, the balance of the shafts in that neighborhood were virtually idle.

At present the tonnage from this locality exceeds that of any other in the district. Indeed, so enormous has been the increase that the Denver & Rio Grande Railroad has been compelled to broad-gauge its tracks to the mines on this hill, in order to handle the increased tonnage. The greatest portion of this increase comes from the Wolf Tone shaft of the Western Mining Company, which, since the discovery of enormous bodies of carbonate of zinc on the 750-foot level of the Maid of Erin, Brooklyn, and Clontarf claims, has been hoisting steadily from 400 to 450 tons of this class of mineral every twenty-four hours.

The discovery of zinc carbonates in the Leadville district marks this camp as one of the most wonderful in the history of mining. Other mining localities are noted for the production of some special metal; such as Cripple Creek for its gold production; Butte and Bisbee for their immense output of copper; and the Coeur d'Alenes for their vast deposits of lead-bearing mineral; but Leadville produces all the metals used in commerce, with the possible exception of cinnabar and tin ores.

A recent examination of the lately discovered zinc carbonates in the Maid of Erin, Brooklyn, Upper Waterloo, Morning and Evening Star, and Henrietta Mines shows a singular formation. Up to the year 1910 the material that contains this mineral was thrown over the dumps as waste, it being supposed to be without value.

PRACTICAL MINER DISCOVERS ZINC VALUES

Scientists and geologists for thirty years had access to these properties and were allowed to take what they pleased in the shape of the various formations for the purpose of mineral re

search, but it remained for the practical miner, with the assistance of the local assayers, to solve the problem.

To the practiced eye of the miner the rock looked "suspicious." Its heavy weight and general appearance gave indications of mineral contents; and it was often tried for gold, silver, lead, and iron, without any appreciable results as to values that would make it a commercial product, until someone thought of trying it for zinc, when it was found that the despised and unwelcome material ran high in zinc values.

These zinc ore bodies are generally found in the vicinity of the parting quartzite, which lies between the blue and white limestones, that being a part of the Leadville formation. Wherever the blue limestone is split by tongues of intrusive—or, as it is generally known, gray—porphyry, in the Maid of Erin, Upper Waterloo, or Evening Star Mines, the carbonates of zinc have been found to replace the blue limestone under the intrusive porphyry and above the parting quartzite.

Between the Morning Star Mine and the Lower Henrietta the conditions are altered. The zinc ore bodies are found to be under the parting quartzite and over the white limestone, having replaced the latter in many instances. This evidently is caused by a faulting, or benching, of the limestones and quartzites between the two properties, the Henrietta being on a much lower plane than its neighbors, the Waterloo and Maid of Erin. These changed conditions are undoubtedly caused by the action of water coursing along the fault disturbance, and depositing the mineral contents from the bench above at the point of least resistance—the broken dolomite, or white limestone, below the parting quartzite.

DEPOSITS OF UNIFORM VALUE

One of the most singular features of this remarkable deposit is its uniform value. With careful mining, so as to keep the product free from waste and the gangue of the hanging and foot walls, the vein will average 30 to 40 per cent zinc.

This great ore-shoot is practically opened for a distance of 1,800 feet from the Henrietta workings to a point east of the Maid of Erin shaft. Its width on a horizontal plane will average 250 feet, and the thickness from hanging to foot wall will be in the vicinity of thirty feet. It must not be considered that this area is all ore, the ore bodies conforming to the undulations of the limestone formation. Wherever the depressions in the limestone are deepest, there the zinc ore bodies are greatest, sometimes showing stopes of this mineral fifty feet in height, gradually thinning as the crest of the wave in the formation is reached, until often but a line of demarkation is left.

Fryer Hill, to the northwest of and adjoining Carbonate Hill, and Printer Boy Hill, a mile to the southeast, also produce

carbonate of zinc in large quantities. Although the deposits in these localities are irregular, and lack the continuity of the Carbonate Hill section, it would seem as if they were but detached portions of the great sheet of zinc ore that lies in the trough formed in the limestones between Fryer and Carbonate Hills.

Zinc sulphides are produced in large quantities from Iron and Breece Hills, and constitute the great bulk of the shipments of the Iron Silver Mining Company, the Ibex Mining Company, and the Yak Mining and Tunnel Company. The zinc sulphides are generally accompanied by sulphide of iron, which is separated from the zinc sulphide generally by hand-sorting. As the ore is hoisted from the mines, it is dumped on tables, where men separate the material, the shipping ore being thrown into chutes below the tables, and the waste material thrown into cars and run out to the waste dump.

INCREASING USES WILL MAINTAIN PRICES

There has been doubt expressed by some mine operators that zinc ores would hold the price that has prevailed during the past year. Yet, when we consider the many uses to which this mineral is applied, it seems as if the demand will continue for a long period.

Zinc—or spelter, as it is commercially known in trade circles—is used in the arts for a great variety of purposes. Electricity has helped increase the demand.

Rolled into sheets, it is employed in architecture for roofs of buildings, water-tanks, conduits, etc. Alloyed with copper, in varying proportions, it forms valuable compounds—brass and bronze; while its combination with other metals finds various uses in the arts. Iron dipped into the molten metal becomes coated with it, and is thereby protected against oxidizing agents. Large quantities of spelter are used in this operation, which is called galvanizing. The oxide of zinc, produced either from the metal or directly from the ore, forms a white pigment which is second in value only to white lead, and is extensively employed. A large quantity of zinc white is used by the rubber trade for admixture with the gum in the preparation of many articles. Most of the zinc produced in the world is used in these ways, but considerable quantities are consumed in galvanic batteries, in photo-engraving, in plate hung in boilers to prevent the formation of scale; for desilverizing lead bullion; for precipitating gold in the cyanide process; in the form of powder as a reducing agent in organic chemistry, and as a paint for iron; and in the preparation of numerous salts, of which the most important are the chloride, employed as a preservative of wood, and the sulphate, employed in medicine, in dyeing, in the manufacture of glue, and in the preparation of a zinc-barium white known as lithophone.

MARKET CONTROLLED BY ST. LOUIS

Carbonate-of-zinc ores from the Leadville district, shipped to the furnaces in Oklahoma and southern Kansas, where the fuel used in reduction is from the natural gas wells of those localities, gives the prices the miner receives for his product, as follows:

The values of zinc carbonates are governed by the price of spelter in the St. Louis markets, the standard being 35 per cent of zinc to the ton of ore. Thus, a ton of 35 per cent zinc ore nets at Leadville on the railroad cars $15.60 per ton, clear of transportation and treatment charges. For each unit of twenty pounds above 35 per cent the shipper receives an advance of $1 per unit above the fixed price, and for each unit of twenty pounds below the standard of 35 per cent, $1 per unit is deducted.

A still further variation in price is made when spelter advances or declines in value in the market from a fixed figure. An advance of 1 cent in the price of spelter gives the miner an advance of 5 cents, or a decline of 1 cent deducts 5 cents from the established rate of $15.60 per ton of 35 per cent zinc ores.

On zinc sulphides the standard is 25 per cent zinc to the ton of ore, with a fixed price of $7.50 per ton. For each unit above the standard, 42 cents per unit is added, and for each unit below, the same figure is deducted. This product is generally accompanied by a small proportion of lead and silver, the average being in the vicinity of 5 per cent lead and five ounces in silver; for which is paid 25 cents per unit for the lead, and 30 cents per ounce for the silver values.

Shipments above 40 per cent of carbonate of zinc will command a higher price in proportion than the figures given above, but it is seldom that ore of a higher grade than 40 per cent is found and shipped in carload lots.

ORES SHOULD BE REDUCED IN COLORADO

Relative to the reduction of zinc ores in Colorado, to compete with the natural-gas furnaces of Oklahoma and southern Kansas, it might be presumed that the treatment of the ores, which includes transportation, might be lessened by the difference in freight rates; but this would rest solely with the reduction works.

Could the coal fields of Colorado now owned and controlled by the state be reduced to gas at a low cost, and utilized in the treatment of the low-grade carbonate-of-zinc ores in the Leadville district, it is within the range of possibility that ores down to, and as low as, 10 per cent could be worked with profit. If legislation is to be enacted for the betterment of the mining industry, the subject of utilizing the vast coal resources of the state to the reduction of our low-grade zinc ores might be looked into with

profit. This would give employment to hundreds of our own citizens, and would put an end to the shipping to neighboring states of 400,000 tons of zinc ores annually from the Leadville district.

In the ordinary course of events, natural gas in the fields of Kansas and Oklahoma will be exhausted some day. Even before it is wholly consumed, its use in treatment of zinc ores will begin to assume an expense gradually up to the point where it will be more costly than coal. Until the arrival of that time Colorado will have to depend on her own resources for the treatment of these low-grade zinc ores.

Carnotite a Supply of Radium

By PROFESSOR A. W. FORSTALL, S. J.
Chair of Chemistry, Sacred Heart College, Denver

LOCATION AND COMPOSITION

The mineral called carnotite is to be found exclusively, as far as we know, in western Colorado, and to some extent in Utah. The principal fields explored in Colorado are in San Miguel, Montrose, and Mesa Counties, in the La Plata and McElmo formations.

In spite of the very valuable work of Poulot, Friedel, Cumenge, and Hillebrand, the problem of the chemical composition of carnotite is yet to be solved. The difficulty is twofold: on the one hand, a deficiency appears invariably in the most accurate analyses, and the yellow substance called carnotite apparently contains elements which present chemical methods fail to reveal; on the other, the elements found in carnotite are such, and in such proportions, that it has been impossible to ascribe with certainty to the mineral those which belong to it, and to exclude the others, so as to establish molecular ratios giving rise to a chemical formula.*

All that can be said at present is that carnotite is probably a mixture of minerals; i. e., uranyl-potassium-vanadate, with silicates of vanadium in the trivalent state.

RADIUM CONTENTS

Various rumors—of European origin, we think, and well calculated to discourage carnotite-owners—have circulated of late in our state. According to some, carnotite did not contain radium. According to most of them, it did contain it, but European experts declared that its extraction was impossible. These rumors are absolutely unwarranted. Carnotite is radio-active. As far back as 1904 Rutherford demonstrated that the respective radio-activities of the pitchblende of Joachimsthal and the Colorado carnotite are as follows:

Pitchblende of Joachimsthal—saturation current	7.0×10^{-11} amp.
Carnotite of Colorado—saturation current	6.2×10^{-11} amp.

It is evident from this that carnotite is radio-active. In fact, it is not much inferior to its rival. The figures show that

*Cf. U. S. Geol. Survey, Bull. 262.

if the radio-activity of pitchblende be represented by unity, that of carnotite is represented by 0.88. However, this is not quite conclusive. The reason is simple. All radiferous substances are radio-active, but some radio-active substances do not owe their radio-activity to radium. Hence we will show now that carnotite does contain radium.

Recently (1911) this very question was further investigated in Paris, at the laboratory of Mme. Curie, under her supervision, by one of her distinguished students.* The figures arrived at, after three careful analyses conducted independently, are as follows:

Analysis	Ore	Locality	Weight (Grm.)	Ur. Met. (%)	Weight Rad. Met. (Grm.)
1	Carn.	Colo.	100	16	0.00000375
2	Carn.	Colo.	100	16	0.00000378
3	Carn.	Colo.	100	16	0.00000380

Incidentally it may be interesting to the reader to glance at the results of three similar analyses of pitchblende of Joachimsthal, conducted by the same chemist. The two sets of analyses are exactly on the same basis:

Analysis	Ore	Locality	Weight (Grm.)	Ur. Met. (%)	Weight Rad. Met. (Grm.)
1	Pitchbl.	Joach.	100	46	0.00001460
2	Pitchbl.	Joach.	100	46	0.00001490
3	Pitchbl.	Joach.	100	46	0.00001480

Hence the carnotite used in the first analysis contained 3.75 milligrams of metallic radium per 100 kilograms. This is the same as 34 milligrams of metallic radium per ton of 2,000 pounds avoirdupois nearly. Out of these, 58 milligrams of radium bromide can be manufactured, the price of which, to the best of my knowledge, is $100 per milligram, making the value of a ton of the material in question $5,800.

These figures are significant in view of the fact that the data were procured in the laboratory of Mme. S. Curie and were published most likely with her tacit approval. Of course, carnotite-owners are not prepared to place on the market many tons of the material containing 16 per cent metallic uranium, but Colorado has a large tonnage of carnotite ores containing 3 per cent U_3O_8; that is, 60 pounds avoirdupois of this oxide, or 50 pounds avoirdupois of metallic uranium, to the ton. This is

*Cf. Miss Ellen Gleditsch, "Rapport entre l'Uranium et le Radium," Radium, 1911, Vol. VIII

worth $905 a ton, as far as the radium salts alone are concerned. The uranium and vanadium product can also be saved.

As to the second set of analyses, we do not wish to disguise the fact that this particular pitchblende contained nearly four times as much radium as the carnotite. However, let us not forget that the pitchblende contained 46 per cent metallic uranium, whereas the carnotite contained only 16 per cent of the metal. To make the comparison a fair one, let us see what the radium of the pitchblende would amount to on the supposition that the ore contained only 16 per cent metallic uranium. We find this would be 0.00000520 gram metallic radium, against 0.00000375 gram for the carnotite.* The difference is not enormous. This means that, weight for weight, and the contents of metallic uranium being the same, if the value of this pitchblende as a radium-bearing mineral is represented by unity, that of the carnotite in question is represented by 0.72; a result altogether of the same order as that derived from the data of the electrometer, though not quite so favorable.

RADIUM EXTRACTION

Carefully collected data, furnished not by theory, but by actual experiments in the laboratory, go to prove that radium salts can be extracted from carnotite more easily and more economically than from pitchblende.

The last-mentioned mineral is very refractory. Carnotite is very easily soluble. Seldom can pitchblende be separated from radium without fusion with alkaline carbonates—a process as cumbersome as it is expensive. No such fusion is necessary with carnotite. Pitchblende generally contains very heavy sulphides, while carnotite is completely free from them. If pitchblende is attacked with chlorhydric acid, the decomposition is imperfect. If nitric acid is resorted to, the sulphides are converted into sulphates of the alkaline earth metals, with the result that both residue and solution must be treated for the extraction of radium. From this moment on, the work and expense are doubled. When the time factor is ample, carnotite dissolves completely in a cold dilute mixture of water and chlorhydric acid. Tests made in Denver check those conducted in Paris, and prove that the residue after careful washings is practically non-radio-active.† The price of chlorhydric acid is $3.00 the carboy of 120 pounds, whereas that of nitric acid is $8.40 the carboy of 140 pounds.

In case the ore be attacked with chlorhydric acid and radium separated by repeated additions of barium chloride, and precipitation by sulphuric acid or a sulphate, we wish to mention the fact that relatively little barium chloride need be

*Using data of Analysis No. 2 for the pitchblende and those of Analysis No. 1 for the carnotite.

†Le Radium, Vol. 8, 1911, p. 260.

added to the one already contained in the ore and present as chloride in the solution. Very commonly ores are met with which contain little less than 1 per cent of barium oxide. This would mean already about 27 pounds of the chemical needed in one ton of ore, provided the barium compound be available; i. e., soluble in chlorhydric acid. We are not positive that this is always the case, for barium may at times enter into the composition of the ore as heavy spar, in which case it would be of no value, so far as the production of barium chloride is concerned. What we wish to emphasize is that in many ores this barium is available. To our knowledge, in two cases out of four a Denver chemist has prepared radium salts without any addition whatever of barium chloride to the one already contained in the ore. In the other two cases it is probable that the barium was also available, since the ore came from the same property, but it was thought of too late. We met with ores of the "Yellow Boy" claim which contained more than 3 per cent of barium oxide.

Other processes are applicable. The ore can very well be treated at the start with a mixture of water, sulphuric and nitric acid. If this be done, the sulphates are formed at once and remain in the residue, while the solution can be treated for the uranium and vanadium product. In this case the ore seems to dissolve more quickly and more perfectly, but the method has its drawbacks as well as certain advantages.

At any rate, the following points ought to be noted carefully, inasmuch as they seem to be borne out by facts:

1. Carnotite contains radium, and probably other radio-active elements well worth the attention of mining men.

2. Investigations, made in Paris and confirmed in Denver, go to prove that radium salts can be extracted more economically from carnotite than from pitchblende.

3. The production of highly radio-active radium salts is a very technical process, requiring the supervision of men of high scientific attainments. It is very doubtful whether at present such men could be induced to come from Europe to settle in Colorado. Neither is it evident that these could be secured in our own country. At any rate, this enterprise would be very difficult, and certainly a hazardous venture.

4. On the contrary, judging from laboratory experiments—which are always good indications, if not always conclusive—it seems quite feasible to market carnotite ores in the shape of two distinct products containing all the values:

Sulphates: These will consist of the sulphates of barium, calcium, lead, with radium sulphate.

Uranium and vanadium oxides, with numerous impurities.

Thus the problem of transportation would be practically solved. The preparation of these two products is simple. However, it must be distinctly borne in mind that the process is exclusively a chemical one. Hence the problem of equipment of a plant must of necessity be a delicate one, and also a novel one in Colorado.

DEMAND FOR RADIUM SALTS

This demand today is enormous. Though there is a large number of minerals containing radium, yet, as far as we know, there are but two occurring in sufficient quantities to constitute a supply. These are pitchblende and carnotite. Even these represent but a very moderate reserve; while the organizations now anxious to invest in radium are numerous and their orders very important. Two years ago Dr. Smith, of Johns Hopkins University, Baltimore, placed an order for $100,000 worth of radium salts, and declared that he would buy twice as much if it could be had.

France has now a Radium Institute and a Radium Bank, besides numerous private laboratories in which radio-active researches are being conducted. England is determined not to stay in the rear, and has now its Radium Institute, and hospitals well organized. Germany and Russia follow and are very close. Recently Austria bought up the famous mines of pitchblende of Joachimsthal, and their exploitation has been made a government monopoly. This is full of significance. If we are well informed, New York City and Chicago are planning to organize institutions similar to those of Europe. Hence radium is in demand for research work.

Parallel and simultaneous with this movement is the one started by the medical profession. A few years ago eminent European doctors laid down the foundations of a new science, radiumtherapy.* The works of these men have been translated into all modern languages. It was our good fortune to peruse several of them, and, judging from the wonders described, there is little doubt that the future of this new science is a bright one. Its advocates do not claim that the mysterious element will ever be a universal panacea, but they conscientiously relate the facts, and we cannot doubt their word. Hence radium salts will be needed by the medical profession.

*For instance, cf. Radiumtherapy, by Drs. Wickham and Degrais. (Funk & Wagnalls, New York.)

Carnotite

Some twelve years ago carnotite ores were discovered in the western part of Montrose County; later came the discovery of carnotite ore in Rio Blanco County. Carnotite ore is mined in the following-named districts: McIntyre, San Miguel County; Bull Canon, Paradox Valley, Long's Park, Club Ranch, Hydraulic, Roc Creek, all in Montrose County; and Gateway, in Mesa County.

In 1911 Montrose County produced 1515½ tons of crude uranium and vanadium ores, which had a valuation of $303,100. In 1912 the output from this county was 1,092½ tons, with a valuation of $245,812.50. Practically all of this ore was shipped to foreign markets for treatment, the largest part of it being exported to Liverpool, England, where it is concentrated. The concentrates are then shipped to other countries, and radium is extracted.

Roscoelite

Following the discovery of carnotite ores came the discovery of roscoelite ore in San Miguel County. These ores are mined and milled on a commercial basis at present, at Newmire, Colorado, by the Primos Chemical Company. This ore is made to yield, in the form of vanadic acid, at least 1 per cent metallic vanadium. The output for 1911 was valued at $517,500, and in 1912, 666½ tons, valued at $666,500. Roscoelite ores contain no values other than vanadium.

Radium

Radium is worth $80 a milligram. There are 1,000 milligrams to the gram, or 30,000 milligrams to the ounce. This would make radium worth $2,400,000 per ounce.

So far as can be ascertained, there has been less than three-quarters of an ounce of radium produced. One of Europe's most famous scientists made the statement, some years ago, that it was his opinion that there was not one ounce of radium on this planet. This statement was made before Colorado carnotite mines began shipping their product to the European markets. It has been conceded among scientific men that in the future scientists will have to look to Colorado for their carnotite ore from which radium is extracted.

Radium is manufactured into three products: first, sulphate of radium; second, bromide of radium; third, chloride of radium. I have been informed that the best radium authorities in the world say that Colorado carnotite ore, such as is produced in the Counties of Montrose, Rio Blanco, San Miguel, Dolores, and Mesa, is the most easily treated in existence. A 5 per cent Colorado carnotite ore can be treated more cheaply than some of the high-grade pitchblende ores of other sections of the world.

The Colorado carnotite ores are found in the sandstone, while in other countries their ores are found in a different and a harder formation, which makes up the difference in the cost of the treatment in favor of our low-grade ores.

Montrose County has produced 95 per cent of the carnotite ores found in this state up to date. Some of the largest operators in this county are doing only enough development work to hold their claims at present. Two of these companies have had their chemists working out a metallurgical process for the treatment of their ores, and I have been informed that what tests have been made by them in an experimental way have proven satisfactory to the owners of the properties.

When the process has been worked out for treating this ore successfully, there is every reason to believe that the output from this state of its uranium ores will amount to millions of dollars annually. For this reason there is no other country known that has the same amount of territory to draw from. This mineral zone is from three to five miles in width, and about one hundred miles in length. I do not mean by this, that this section of country is all productive. It is like that of any other mineral zone—you will find section after section that is productive, and vice versa.

Tungsten in Boulder County

RICH DEPOSITS OF RARE MINERAL BRING FAME AND WEALTH TO STATE

The discovery of tungsten in Colorado can be traced to the intelligence and energy of the old-time prospector—the genus that gave birth and wonderful growth to the state. For years the so-called "black iron" which occurred as float in the eastern part of the Grand Island mining district, Boulder County, had been passed by as worthless. In 1900 Sam P. Conger, a veteran prospector, recognized its true value and began systematic mining of the black metal.

Following Conger, there came the Great Western Exploration and Reduction Company, the Wolf Tongue Mining Company, the Primos Chemical Company of Primos, Pennsylvania, and the Colorado Tungsten Corporation of Pittsburg. These companies almost immediately began active prosecution of mining and development of Boulder County's tungsten deposits. Capital was invested in construction of mills for economical treatment of the ores for maximum extraction of values. The scientific methods now in practice have demonstrated that Boulder County can, for many years to come, supply the demand for the entire country.

With the assurance of a stable supply, steel manufacturers have been able to increase wonderfully the efficiency of their product. It has been proved, in the case of machine tools, that four or five times the work may be had from them when alloyed with tungsten as from ordinary carbon steel tools. The effect of this conservation is almost incalculable. It means that lathes and planers can be speeded up to give a daily output four or five times their former capacity, resulting in an increase of millions of dollars annually to the wealth of the country.

During the year just closed the industry has enjoyed greater prosperity from a rising market, a sharp advance being made in the last months of the year. If the present favorable condition of the market continues, there is every reason to expect an increase in production which will add to the growth and prosperity of Boulder and Colorado.

OCCURRENCE

Tungsten is obtained from ores known as hubnerite, a tungstate of manganese; wolframite, a tungstate of manganese and

iron; ferberite, a tungstate of iron; and scheelite, a tungstate of calcium. The Boulder County ore is classed as ferberite, except in the vicinity of Ward, where it occurs in the form of hubnerite.

The Boulder County deposits of ferberite are noted for their almost complete absence of other minerals commonly associated with tungsten ores in other parts of the world. On the outer borders of the producing district, which now comprises a tract about four miles wide and nine miles long, particularly on the north, pyrite, and occasionally a rare crystal of galena, are found. At Magnolia on the south and Sunshine on the north, gold and tellurides are associated in some instances, and at Wheelman a parallel vein of gold telluride is found on the tungsten properties of the Red Signe Company. At Crisman, in the Logan, free gold is sometimes found with the ferberite. The hubnerite, near Ward, is associated more or less with pyrite, but altogether the Boulder ores are remarkably free of impurities or any mineral that detracts from the value.

The ore occurs in considerable quantities, carrying as high as 60 per cent of tungsten trioxide; in rare instances selected specimens contain as high as 70 per cent. The average ore, below which it is seldom profitable to mine, runs about 10 per cent, though a much lower grade is treated at the mills. Below 35 per cent the ore is concentrated and shipped with the higher grades to the eastern refineries, where it is converted into metal or ferro-tungsten.

Much of the production in the past has been from shallow workings, but this is gradually giving way to deeper mining and modern mine methods. The Conger mine has a shaft approximately 700 feet deep, with no apparent decrease in values or extent of ore bodies.

The following extracts are from "Mineral Resources," published by the United States Geological Survey:

"The tungsten minerals used as ores are hubnerite, a tungstate of manganese; wolframite, a tungstate of manganese and iron; ferberite, a tungstate of iron; and scheelite, a tungstate of calcium. The first three minerals grade into each other, and wolframite is a good class name to use for the three until the particular species may be determined. In general, hubnerite has a semi-translucent appearance, which approaches transparency in certain specimens. Wolframite shows little or no translucency and is nearly black. Ferberite is black and opaque, and shows a tendency to form small crystals with chisel-shaped terminations. As the iron content increases in tungsten minerals, the streak becomes progressively darker, from light yellow in some dull, and quartz has a more splintery, glassy fracture.

"Scheelite is calcium tungstate, a combination of lime and tungsten trioxide. In appearance it varies from an almost glassy

white to a dull brown or yellow, and is occasionally of a slight greenish tinge. It is always of a stony appearance, some specimens resembling coarse marble in structure. In places it shows its crystal form, which is tetragonal. It has a specific gravity of 6, or about twice that of limestone or quartz, and its weight at once attracts attention. It is somewhat softer than limestone and is easily scratched with a knife. The only other minerals which are to be confused with it are barite, which is softer and not so heavy, having a specific gravity of 4 to 4.5, and quartz, which has a comparatively low specific gravity (2.65) and cannot be scratched with a knife. Scheelite has an almost greasy, lustrous appearance when broken; the appearance of barite is often dull, and quartz has a more splintery, glassy fracture.

"The tungsten minerals, like tin ore, generally occur in veins cutting igneous rocks containing much silica, such as granite and granodiorite. Sometimes the veins penetrate rocks lying adjacent to the igneous rocks. Apparent exceptions to this rule are found, as, for instance, in the Victorio district, four miles south of Gage, New Mexico, where hubnerite and some scheelite occur with pyrite and lead minerals in a vein cutting limestone; and at Nome, Alaska, where scheelite is found in the fold placers in a region of schists, several miles from the nearest granite outcrop. However, in general, search for tungsten may be expected to be most successful in districts of granite rocks."

TESTS FOR TUNGSTEN

A simple test, sufficient for all ordinary purposes, to determine the presence of tungsten in ore, may be made by powdering a small quantity of the ore, placing it in a test-tube with about twice the quantity of muriatic acid, and boiling it for about ten minutes over a spirit lamp or candle. If tungsten is present, the solution, while cooling, turns a beautiful blue or purple. The process is facilitated by dropping in, while cooling, a small piece of tinfoil or zinc.

With zinc the solution first turns blue, then wine-colored, and later brown. When the reduction takes place very quickly, the blue color of the solution may not be seen at all, the first color to appear being a reddish lilac, quickly turning to brown.

USES OF TUNGSTEN

Much speculation and many wild claims are made regarding the various uses for tungsten, and while it is undoubtedly true that in the manufacture of certain kinds of steels, as well as for other purposes, the secret use of tungsten is employed, there can be no disputing the fact that the most important use of the metal, calling for its use on a large scale, is an alloy for high-speed tool steel. The introduction of tungsten into steel gives it the property of holding its temper at a much higher temperature than

high-carbon steels. A lathe tool or bit of tungsten steel enables the machine to be speeded up until the chips leave the machine so hot that they turn blue, thereby increasing the output from four to five times the capacity of the machines using carbon steel. Six to 20 per cent of tungsten is ordinarily used in lathe tools. In saws 1½ to 3½ per cent is used by some makers. In hack saws a much larger percentage of tungsten is used.

According to the United States Geological Survey, "the advent of tungsten steel tools has compelled the redesigning and rebuilding of metal-cutting lathes and machines, as on a conservative estimate lathes equipped with such tools can be made to cut four times as fast as they can with carbon-steel tools, which means that four times as much work can be done by each lathe with the same attendant labor. It is probable that the saving thus effected in the United States alone amounts to hundreds of millions of dollars per year."

The value of tungsten steel in machine-shop practice is indicated in a personal communication to Frank L. Hess, chief of the division of rare minerals of the Geological Survey, in which Mr. Elwood Haynes, president of the Haynes Automobile Company, states that his company would be compelled to add $200 to the selling price of each automobile produced, should the firm have to use carbon-steel tools in place of tungsten-steel, which they now employ.

During the past two years wonderful improvements have been made in the manufacture of tungsten incandescent electric lamps, and the defects that in many instances prevented the use of the earlier lamp have been remedied, and the carbon filament has been almost entirely superseded by the tungsten element. The General Electric Company has recently developed the drawing of tungsten into fine wire, which is about as strong as steel. The toughening of the filament has not only made practicable the use of lamps of larger candle-power, but has brought the tungsten lamp in use wherever electric lighting is used. Thousands of filaments can be made from a pound of tungsten, so that the market for tungsten ores for this use is comparatively small.

Dr. W. R. Whitney, chief of the research laboratory of the General Electric Company, in a paper before the Massachusetts Institute of Technology, speaking of the use of tungsten in electric lamps, said: "On the assumption that the present rate of lamp consumption is equivalent to about eighty million 25-watt tungsten lamps per year, and on the basis of 1¼ watts per candle-power as against 3.1 of the earlier lamps and of charge for power of 10 cents per kilowatt hour, we get as a result a saving of $240,000,000 per year, or two-thirds million per day. Naturally this is a saving which is distributed among producers, consumers, and others, but illustrates very well the possibilities of tungsten."

While it is often stated that tungsten is used in armor plate, its use, if employed at all, is a secret and not acknowledged by any government or manufacturer. Experiments with tungsten steel were made for this government several years ago, but the result was not satisfactory. In "Mineral Resources of the United States," Geological Survey of 1909, it is stated: "The writer has been informed by the Ordnance Bureau of the Navy Department that tungsten is not now, and, so far as known to that bureau, never has been used in the manufacture of armor plate in this country, and it is not known to have been so used in other countries, though it has probably been used in experimental armor plates. One of the greatest essentials of armor plate is its ability to resist shock, and this property is not imparted to steel by tungsten. Most armor plate depends for its shock-resisting properties upon the addition of nickel and chromium to the steel from which it is made, and upon special treatment."

Since the above was issued, manufacturers have discovered that, in combination with other alloys, tungsten can be used to advantage in the manufacture of a steel possessing ductility to a large degree, and there is reason to believe that the German government has recently made discoveries whereby its use is made, to some extent at least, in armor plate.

In the big guns used by the government it is claimed that the heat-resisting qualities of tungsten impart to the steel an ability to withstand the erosion of the burning powder and the friction of the projectile passing along the bore, thereby increasing the life of the gun several fold. A representative of the Firth Sterling Steel Company, which manufactures most of the larger projectiles used by the United States government, states that tungsten is not used in projectiles.

Tungsten is used in the manufacture of small crucibles for use in the electric furnace. Large quantities of sodium tungstate are used in the manufacture of fireproof cloth for curtains, draperies, etc., and as a mordant in dyeing. Other tungsten salts are used in weighting silks. Sodium tungstate has almost precisely the same rate of expansion for moderate temperatures as platinum, and is sometimes used in the laboratory in place of this metal.

Calcium tungstate is used as a screen to make X-rays visible. Tungstate salts are also used in glass-making, and in making gold and violet bronze powder. It is used for propeller blades, when alloyed with aluminum and copper. Because of its lightness and strength, an alloy of aluminum and tungsten is said to be used in automobile construction. Lead tungstate is substituted for white lead as a pigment in paints. It is used in coloring glass, in the manufacture of stained paper, and in glazing porcelain.

THE METAL AND ITS METALLURGY

The following paragraphs are quoted from "Colorado Geological Survey," by R. D. George, State Geologist:

"**The Metal**—There is still a notable lack of agreement among chemists regarding the properties of tungsten. Metallic tungsten is generally produced in the form of a black or grayish-black powder. The fused metal is slightly darker than metallic zinc, and is distinctly lustrous. It is brittle and non-ductile (some say ductile and malleable), but may be welded, filed, and forged. Sulphuric and hydrochloric acids attack it slowly, nitric more vigorously, and a mixture of nitric and hydrofluoric acids readily dissolves it.

"**Metallurgy of Tungsten**—The following three examples be regarded as representing the methods of obtaining tungsten from its ores:

"1. The ore is ground to pass an eight- or ten-mesh sieve, and is brought to a cherry-red heat and fused with sodium carbonate (soda ash). The sodium tungstate thus formed is dissolved in boiling water, filtered from the solid impurities, and treated with hot hydrochloric acid (or nitric), in earthen vessels. This precipitates tungstic acid. The liquid is drawn off, and the tungstic acid is washed to remove sodium salts, and is then converted into tungstic oxide by drying. The dry oxide is mixed with pure carbon and placed in crucibles and heated to a very high temperature in a gas furnace. The carbon and the oxygen of the ore unite and pass off, leaving a black or gray-black metallic powder, which usually contains a small amount of carbon.

"2. The tungstic oxide is produced by the same method, but the reduction with carbon is effected in an electric furnace. This method is said to produce a metal quite low in carbon.

"3. The pulverized ore is mixed with pure carbon or placed in carbon-lined crucibles, and reduced in an electric furnace. The impurities, chiefly iron and manganese, and the oxygen unite with the carbon, and metallic tungsten is left.

"**Uses of Tungsten**—Pure metallic tungsten is but little used in finished industrial products. But, alloyed with other metals, and in various chemical compounds, the use of tungsten has recently become important. Many of its physical and chemical properties have been known for decades, but until recently the supply of tungsten ore was so uncertain and irregular that there has been little inducement to develop industries dependent upon a supply of tungsten. The discovery of the Australian deposits and those of the United States has given manufacturers reasonable assurance that an increasing demand would be met.

"The certainty of a supply of ore encouraged a more thorough study of the metal and its possible uses. And the development

of the gas and electric furnaces for metallurgical purposes made the production of metallic tungsten much less expensive. As a result, the demand for tungsten has increased very rapidly, and the metal has taken its place as a necessary factor in a number of important industries.

"Tungsten is employed chiefly in the following forms:

"The metal is used: (1) for the making of alloys with the various metals, such as iron, aluminum, nickel, copper, titanium, tin, and others; a small amount of tungsten is mixed with the magnetite in the electrode of the 'magnetite arc' lamp; (2) for filaments in the tungsten incandescent lamp, and it has been tried as an electrode in arc lamps.

"It is interesting to note that two or more of the large manufacturers of incandescent lamps specify that Boulder County tungsten must be used in the filaments. Most of the foreign tungsten deposits are associated with, or contain, minerals carrying one or more of the following elements: sulphur, phosphorus, tin, arsenic, and antimony; all of which render the metallurgy more complex, and make the production of a pure metallic tungsten more difficult. Even a small trace of sulphur, phosphorus, tin, or arsenic is said to be very detrimental to the filament, and it is very reasonable to suppose that sulphur and phosphorus are as objectionable in ferro-tungsten and tungsten steel as they are in ordinary steel. Probably the only foreign tungsten deposits which compare in purity with the Boulder County ores are those of Saxony and Bohemia.

"Tungstic oxide has but few direct commercial uses. Certain metallurgical processes for the production of metallic tungsten, ferro-tungsten, tungsten steel, and other alloys may be said to start with the tungstic oxide, while in others, such as the fusion-lixiviation method, its separation from the sodium tungstate is one of the steps in the process. It is the essential part of certain mordants used in dyeing textile materials and fabrics. It is also used in paper-staining and printing. But in both these uses a tungstate (usually the sodium paratungstate) is used as a source of the oxide, and it is probable that tungstic acid, rather than the oxide, is the form in which tungsten takes part in the reactions. Sodium and barium tungstates are used in glass-coloring and pottery glazing. The colors obtained include various shades of yellow and blue.

"The tungstates are the chief ores of the metal, and are therefore the primary source of tungsten in whatever form it may be used in the industries. The insolubility (in water) limits the direct use of the natural tungstates except as sources of the metal and its commercial compounds. Tungsten forms soluble tungstates with sodium and potassium. Those of sodium are by far the most important, and are made by fusing powdered wolframite, hubnerite, or ferberite with sodium carbonate. It is used

as a mordant in dyeing and calico-printing, and for rendering vegetable fibers and fabrics uninflammable. Sodium tungstate and other tungsten compounds characterized by rich color tones are used in the manufacture of stained papers. Tungsten salts are also used for weighting silk fabrics.

"The partial decomposition of the sodium and potassium tungstates yields a series of tungsten bronzes of very beautiful colors and high lusters. A fusion of potassium tungstate and tin yields 'bronze powder.' These tungsten bronzes and bronze powder are much used for decorating. Lead tungstate was sometimes substituted for white lead as a pigment.

"**Alloys of Tungsten**—Tungsten forms useful alloys with many metals. It unites in almost any proportions with iron and steel.

"Platinoid contains copper, zinc, nickel, and a small percentage of tungsten. Its high electrical resistance does not decrease with heat. 'Wolfram-aluminum' is a very useful alloy, which may be rolled, spun, and woven. It is used for military appliances. A light and very strong alloy of tungsten and aluminum, called partinium, is used in automobile manufacture. An alloy of tungsten, aluminum, and copper, having great tensile strength and elasticity, is used for propeller blades. Alloys of tungsten, with copper and iron; iron, copper, and aluminum; iron, titanium, and carbon; iron, columbium, and tantalum, are available.

"Carbides of tungsten and chromium are extremely hard, and resist acids well.

"**Iron and Steel Alloys**—The alloys of tungsten with iron and steel are by far the most important. Those with iron are known as ferro-tungsten and ferro-alloys. Their chief use is in the manufacture of tungsten steels. Those with steel are known as tungsten steel, wolfram steel, high-speed steel.

"**Ferro-tungsten**—The ferro-tungstens commonly carry from 30 to 85 per cent of tungsten. They are sometimes classed, according to the percentages of carbon and tungsten, into: (a) high carbon and medium tungsten; (b) high carbon and high tungsten; (c) low carbon and high tungsten.

"**Tungsten Steel**—The effect of tungsten as a steel-hardening metal was known as early as 1855, but it was not until Robert Mushet, an English iron master, placed his 'special steels' on the market, a few years later, that any commercial use was made of the knowledge. The Mushet steels contained tungsten in varying percentages from 6.4 up to 10. They were known as self-hardening, or air-hardening, or high-speed steels. It was later discovered that tools made of the Mushet steel, reheated to a yellow heat, and cooled in a current of air, possessed greater hardness and greater cutting efficiency. The Mushet steels contained less

tungsten and more manganese than the average high-speed steel of today. The special qualities given to steel by the addition of tungsten depend upon a nice balancing between the carbon (manganese) and tungsten. Several contain chromium also. With 3 per cent of tungsten and 0.9 per cent carbon, the tenacity of the steel reaches its maximum, and its ductility is not materially decreased. As the percentage of tungsten rises from 9 to 16, the steel becomes very hard and brittle, but its efficiency in cutting tools is greatly increased. Beyond 16 per cent of tungsten, the steel becomes softer and tougher, and the cutting efficiency decreases.

"In an iron-working machine, when a cutter made of hard carbon steel develops a temperature, through friction, of about 500° F., it begins to lose its temper. This fact limits the speed at which the machine may be run. The tungsten steel-cutters do not begin to soften until a temperature of 1,000° F. to 1,200° F. is passed. The tools are completely restored by reheating to a very high temperature and cooling in an air blast. They are, therefore, not strictly self-hardening. It is also found that the higher the temperature used in reheating, the higher may be the temperature developed by friction before the tool will soften.

"**The Uses of Tungsten Steel**—1. The tougher grades are being used for armor plate, and the harder for heavy projectiles. Edge tools and various other kinds are being made of tungsten steel.

"2. The harder grades are used for cutters for steel- and iron-working machinery.

"3. Car springs of high carrying power are made of the more elastic grades. Tungsten steel has also been used with excellent results for railway frogs and rails, in places where the wear is very heavy.

"4. Tungsten steel will retain a high degree of magnetism for a long period, and is therefore used for 'permanent magnets,' such as compass needles, and calibrating instruments.

"5. Sounding plates and wires for musical instruments, made of tungsten steel, give a more powerful response.

"6. It is reported that heavy guns, car wheels, and the wearing parts of heavy machinery are being made of tungsten steel.

"7. An alloy containing 35 per cent tungsten and 65 per cent iron is used for shells for lead bullets to increase their penetrating power."

UNITED STATES TUNGSTEN PRODUCTION*

The production of ore in the United States has been recorded only since 1900; before that time it was insignificant. As ob

*From U. S. Geological Survey

tained from the United States Geological Survey, the output of concentrated tungsten ores in the United States in short tons was as follows:

Year	Boulder Co.	U. S.	Value	Year	Boulder Co.	U. S.	Value
1900	40	46	$ 11,040	1906	786	928	$348,867
1901	65	179	27,720	1907	1,146	1,640	890,048
1902	166	184	34,040	1908	584	671	229,955
1903	243	292	43,639	1909	993	1,619	614,370
1904	375	740	184,000	1910	1,221	1,821	832,992
1905	642	803	268,676	1911	740	1,125	472,500

Since 1906 the United States Geological Survey has, so far as possible, based its figures on production on the output of ore reduced to an equivalent of a product carrying 60 per cent tungsten trioxide, which is the ordinary commercial basis in the United States.

WORLD'S TUNGSTEN PRODUCTION

Country	1905	1906	1907	1908	1909	1910
United States	803	928	1,640	671	1 619	1,821
Africa	.....	9	211	40	16	.....
Asia	.....	151	99	83	106	147
Australia	1,940	1,387	1,378	833	1,200	1,789
East Indies	.....	.....	5	25	23	33
Austria	65	63	50	44	43	54
England	193	304	361	261	421	307
France	28	20	67	124	.....	.....
German Empire	42	57	68	46	106	105
Italy	36	28	18	.....	.....	.....
Portugal	320	629	702	684	609	1,132
Spain	413	222	303	249	.....	.....
New Zealand	64	121	153	87	78	187
Argentina	.....	326	507	548	900	1,061
Bolivia	75	75	500	187	168	232
Brazil	.....	.....	.....	16	.....	.....
Nova Scotia	.....	.....	.....	.....	.....	83

BOULDER COUNTY PRODUCTION, 1911-1912

	Tons	Per Cent Product	Price
1911	740‡	60	$6.00
1912	700	60	7.50

The "unit" scale has been adopted in placing the value on tungsten ore—or a price based on a unit of twenty pounds of tungsten per ton. The price per ton, therefore, is the per unit price multiplied by the percentage of tungsten content. Taking the price at $6, a ton of 60 per cent ore should be worth $360, while a ton of 50 per cent ore at the same price per unit would bring only $300.

According to the United States Geological Survey, this country has produced, since 1900, $3,797,347 in tungsten ores, of which Boulder County, in round numbers, contributed $2,950,000.

San Bernardino County, California, is the only other point in the United States where tungsten is produced in any considerable quantity, the ore there being in the form of scheelite.

There were imported into the United States during the year 1910, according to the United States Geological Survey, 852 tons of tungsten ore, valued at $344,979, and 528 tons of tungsten and ferro-tungsten, valued at $678,534. There were 94 tons exported, valued at $47,940.

The melting point of tungsten is exceedingly high, being about 3,080 degrees, and, when reduced to a metal, is obtained as a fine gray powder. When used in steel, it is introduced in this form or as ferro-tungsten, the latter being an alloy of iron and tungsten containing from 40 to 80 per cent of tungsten.

List of local ore-dealers:

The Primos Mining & Milling Company, Lakewood, Colorado.
The Wolf Tongue Mining Company, Nederland, Colorado.
Eugene Stevens, Boulder, Colorado.

‡A statement issued by this department, showing production of minerals by counties in 1911, gave the Boulder output as 1,200 tons, but later checking shows it should have been 740 tons.

Gold Dredging

By HERMAN J. REILING

Gold-dredging has, in fact, reached the dignity of an industry. During a comparatively short time it has gone ahead with rapid strides, until now it has reached a state of perfection that has lifted dredging for gold from an experimental basis to the plane of sound business.

The underlying reason for the general success of gold-dredging is that, by the use of sound judgment, the value of the property can be ascertained to a practical certainty before any money is spent, other than that for prospecting the ground. Dredging ground must lie practically flat, and the values must be disseminated over a wide area, free from boulders. The bed-rock must be such that it can be dug by the dredge. The depth and the character of the bed-rock can be determined during the time prospecting is done, and if the ground shows an average value of 20 cents per cubic yard, the property has been proved.

The dredge of the present day is the endless-chain elevator type. An endless chain of buckets is carried on rollers resting on a steel ladder. The lower end of the ladder is suspended by cables, which pass over sheaves to a drum on a winch, so that the ladder may be raised or lowered to feed the buckets. The power to drive the buckets is supplied at the upper tumbler.

Water under pressure is forced from spray pipes over the screens onto the traveling gravel. Gold-bearing material passes through the screens into a distributor, which feeds this material and water to tables provided with riffles. The coarse material passes from the screen to a conveyor, which carries this thirty to forty feet behind the dredge and stacks it twenty to thirty feet high.

There are three distinct functions which a dredge must perform:

1. Dig large quantities of gravel.
2. Screen and wash the gravel the buckets can dig.
3. Save the gold.

An ordinary six-foot bucket dredge can dig from 70,000 to 80,000 cubic yards per month.

These dredges can be run by steam or electricity. Most of them at the present time are run by electricity. The actual average power used on a 70,000-yard machine is about 150 horsepower.

The wear on the buckets of a dredge has been very great, until the manganese bucket came into use, which has practically eliminated the cost of keeping the buckets in repair.

A successful dredge must be kept running as near twenty-four hours a day as possible; for when a dredge stops, the producing part of the plant stops, while the expenses continue. Good judgment in the management of a dredge will minimize the time lost.

The cost of handling ground per yard is about as follows:

	Cents
Labor	2.00
Power	2.00
Dredge supplies	.34
Taxes and insurance	.18
Maintenance and repairs	1.20
Sundries	.43
Heat	.15
Total	6.30

It is is useless to predict what the future has in store for gold-dredging, so rapidly has the industry developed within the last few years. Ground is being handled today that four years ago was placed out of the possibility of dredges.

The greatest field for gold-dredging is in California. But Alaska is fast overtaking California. In Colorado we have three large dredges which are operating successfully, all situated in Summit County.

Colden Cycle Mill—Colorado City

By JOHN TAIT MILLIKEN
Consulting Engineer of the Golden Cycle Mining Company

The Golden Cycle Mill, situated near West Colorado Springs, was originally planned to treat the ores of the Golden Cycle Mine and the other properties controlled by the Golden Cycle Mining Company; but ere the original plans were carried out, the field for a thoroughly equipped and up-to-date milling plant, employing the cyanide process, for the handling of custom ores originating in the Cripple Creek district, was so attractive and inviting that a cyanide plant, having a capacity of 1,000 tons per day, was constructed. This plant has recently been enlarged to 1,150 tons per day, and is today handling over 80 per cent of the output of Cripple Creek.

By reason of this milling enterprise, the shippers of the Cripple Creek district are enjoying the best facilities, and are accorded the lowest treatment charges on their ores, of any in the world.

The Golden Cycle Mill lays no claim to any secret process or mysterious mechanical devices, its efficiency arising from the intelligent application of well-known mechanical devices, coupled with good metallurgical talent, and enthusiastic and skillful employes.

The process employed is the one generally applied to such ores as are afforded by such districts as Cripple Creek; namely, gold ores in which the gold or silver is associated with small amounts of tellurium and iron pyrite, and not infrequently arsenopyrite. The process is one of roasting the ores, followed by straight cyanide treatment. The general method of procedure is as follows:

The ore is bought from the miner, the value of its gold content being ascertained by causing the entire lot to pass through the sampler or sampling works situated at the mill. The entire operation is automatically conducted, from the minute the lot starts through the machinery until it is delivered to the department where the final sample—or "pulp," as it is generally called—is delivered to the owner of the ore, or his agent, as the case may be.

The entire sampling operation is based on well-established laws pertaining to the art, and are capable of mathematical demonstration; and the degree of accuracy that can be attained in

any properly designed and well-conducted sampling works today is truly amazing.

On the final agreement on the value of the ore between the shipper and the mill, the ore is purchased outright, the shipper receiving cash for the full amount, less a certain amount deducted as a treatment charge by the mill.

The sampling works can receive and accurately valuate from 45,000 to 50,000 tons per month.

All ores, after sampling, are conveyed, by means of belt conveyors, to one of three large bins, commonly called bedding floors. Here the different lots, as they come from the sampler, are uniformly distributed. This mixing, by automatic means, continues until a mixture or bed of some 2,500 to 3,500 tons is obtained, the size of the product varying from pieces having a maximum diameter of one and one-half inches to the very finest sand.

The object in thus mixing the ore is to obtain as nearly as possible a product uniform in gold and sulphur content. Such a mixture greatly facilitates, and tends to maintain, plant equilibrium as the treatment of the ore progresses.

The ore is removed from these bedding or mixing bins, by means of belt conveyors, to bins provided directly above the ball mills, six in number, which receive the ore through automatic feeders from the bins.

The ore is here ground the second time, until it will all pass an opening one-eighth of an inch square. The capacity of the ball mills is 1,250 tons per day.

The ore is now in the proper condition for the roasters, and is delivered from the ball mills, by means of a belt conveyor, to steel bins directly above the roasters, of which there are nine (the Edwards duplex type), each having a daily capacity of 125 tons when the sulphur content in the ore does not exceed 1¾ per cent. The ore is roasted until the sulphur content will not exceed 7-100 of 1 per cent, the tellurium being burned out early in the roasting process.

The gold is now practically all in a free state and ready for the cyanide treatment.

The fuel employed is a typical Colorado lignite, and, when properly burned, makes a most excellent fuel for ore-roasting purposes. The temperature in the furnaces ranges from 500° F., the temperature of the escaping gases, to 1,300° F., the maximum attained near the discharge end.

The ore is automatically cooled on surface coolers. The coolers are simply the furnaces extended, with the arch or top removed. The roasted ore is again conveyed, by means of belt conveyors, to bins directly above the Chilian mills, and here the cyanide treatment begins.

The ore is fed to seven six-foot Chilian mills by means of a stream of cyanide solution, and here ground, in the cyanide solution, until all passes through a screen having openings about one-fiftieth of an inch square.

The product discharged from the Chilian mills is caused to flow over blanket tables, upon which the coarse particles of gold produced in the roasting process are recovered, and subsequently reduced to amalgam form by pan amalgamation. The product discharging from the blanket tables is classified by suitable means into two products; one called the sand, or that portion which, when placed in the leaching vats, will admit of the cyanide solution being readily passed through it, thus dissolving the gold. This percolation continues for about five days, after which clear water is passed through the vat, thus removing the cyanide solution containing small amounts of gold. After the sand has thus been thoroughly washed, the residue is then discharged by means of hydraulic pressure, applied with a hose. The other portion of the product classified is called the slime, by reason of its extremely fine state of division, all of which will pass a screen having 40,000 openings to the square inch. This product, by reason of its fine state, possesses the property of holding on to, as it were, the gold in solution, or the gold that has been dissolved by the cyanide solution, and until recent years has been the means of causing terrific losses in milling, and many failures. Today the early troubles attending the treatment of this product have been overcome most efficiently, and many ores are reduced entirely to slime, as a better recovery is effected thereby. This slime trouble, as stated above, has been completely overcome through the development of the vacuum-filter and the slime-filter processes. It is by the use of the former that all the slimes produced in the Golden Cycle Mill are successfully handled.

As is well known, the cyanide of potassium dissolves the gold. The next step in the process is to again reduce the gold to solid state, and in such form as will be readily accepted by the United States mints. This is accomplished at the Golden Cycle Mill by means of metallic zinc, in the form of shavings resembling excelsior. The zinc shavings are placed in suitable boxes—usually a large steel box divided into a number of compartments. The cyanide solution, containing the gold in solution, is caused to flow through the boxes containing the zinc, which converts the gold back to the metallic state. The gold-zinc product at certain intervals is removed, placed in suitable vessels, and the zinc dissolved and washed away. The residue, containing the gold, is thoroughly washed free of zinc sulphates and melted into bars.

Liberty Bell Mill—Telluride

By W. H. STAVER
Superintendent of the Mill

The ore is crushed at the mine, in two 11″x18″ Blake crushers, to three-inch size—about the minimum opening at which crushers can be set on account of the sticky nature of the ore. It is delivered to the mill and distributed in the mill bins by tramway. The mill contains eighty 850-pound stamps with concrete battery blocks. The ore is stamped to twelve or fourteen mesh in a two-pound cyanide solution, and amalgamated on eight-foot plain copper plates.

The pulp is then classified in four Richards three-spigot vortex classifiers and six six-foot settling cones, and concentrated on eighteen Wilfley tables. Coarse table tailings and middlings are reground in two 5′x22′ Abbé tire-type tube mills, reamalgamated on copper plates, and reconcentrated on ten Deister No. 3 slime tables. All table tailings and cone overflows are then combined to one pulp in nine 33′x10′ Dorr thickeners. The thickened pulp is agitated in six seventeen-foot Hendryx agitators, operated continuously in series. The agitator tailing pulp is filtered in a Moore vacuum-filter plant, the tailings being discharged to waste, and the filtrate clarified through an extra set of filter leaves and precipitated on zinc shavings. Barren solution from the zinc boxes and the Dorr thickener overflows are returned to the mill.

Retorted amalgam and acid-treated cyanide precipitate are melted to bullion and shipped to the Denver mint. Concentrates are at present shipped to the Durango smelter. A plant is under construction for the local treatment of the concentrates by fine grinding and cyanidation.

The mill treats approximately 480 tons of ore per day.

Portland Mill—Victor

By THOMAS B. CROWE
Mill Superintendent of the Portland Gold Mining Company

The Victor plant of the Portland Gold Mining Company was built for the treatment of the ore from the Portland Mine which would not withstand the high cost of freight and treatment when shipped to the Portland plant at Colorado Springs.

The ore is brought to the mill in five-ton electric cars, and dumped into a cylindrical steel bin above the crushing plant. From this bin it is fed by an apron conveyor to a 15x30 Blake crusher, which reduces the ore to about three-inch size. It then passes to a thirty-six-inch, style B, Symons disc crusher, which machine reduces it to one and one-half inches; thence to a set of 20x48 rolls, which makes a product all of which will pass a one-inch ring. A belt conveyor takes this one-inch product to the main mill building, where, after passing through a Vezin sampler, it is distributed into four steel storage bins. These four bins discharge by plunger feeders to four six-foot Akron Chilian mills. At this point a weak cyanide solution is introduced, the mills discharging a pulp through a thirty-mesh screen, which flows and is distributed to thirty-six Wilfley tables. The concentrate from these tables is finished on six Wilfley finishing tables; the high grade, high in iron concentrate, going to the smelter; the low grade, high in silica concentrate, after sliming in a tube mill, being mixed with the regular mill slimes.

The tailing from the thirty-six Wilfleys runs to four Akins classifiers, where it is divided into sands and slimes.

The sands go to a continuous wash system (Akins classifiers), from where, after being washed free of soluble gold, they are hauled to dump.

The slimes are pumped to thickening cones, where, after thickening, they are reconcentrated on Card tables. The concentrates from the Cards join the concentrates from thirty-six Wilfleys. The tailing from the Cards runs to Dorr and Akins thickeners, the thick pulp from the same going to air agitators and thence to Portland filters, whence, after being washed free of soluble gold, it is hauled to dump.

The effluent solution from the Portland filters joins the clear overflow from the thickeners and goes to the zinc-dust precipitating plant.

The mill has a capacity of 500 tons per day, and is unique in that it uses only about 1,000,000 gallons of water per month, the tailings being hauled and stacked on the dump in a fairly dry condition.

Wellington Mill—Breckenridge

By R. M. HENDERSON
Manager of the Wellington Mines Company

The Wellington Mines Company, of Breckenridge, Summit County, is using crusher and rolls in a wet mill, grinding to three-eighths of an inch, followed by jigs and tables. The better grade of middlings and tailings is reground on the rolls and re-treated. The lead-zinc-iron middling is sent to the magnetic mill, dried, crushed to about fourteen-mesh, roasted, and passed over magnetic machines to remove the iron. The remaining lead-zinc product is treated on a table to separate the lead and zinc.

Our ore assays approximately 7 per cent lead, 18 per cent zinc, 16.5 per cent iron, and 25 per cent insoluble.

The recovery is about 85 per cent of lead in a 45 per cent lead product, and 80 per cent of the zinc in a 43 per cent zinc product.

The iron is at present worthless and is discarded.

Eagle Mill

By C. H. HANNINGTON
Manager of the Eagle Mining and Milling Company

The Eagle Mining and Milling Company, of Gilman, Eagle County, is treating a double sulphide of zinc-iron, carrying about as follows: .03 to .05 per cent gold, 2 per cent silver, 1 to 5 per cent lead, 17 per cent zinc, 30 per cent iron, 26 per cent sulphur, and 2 per cent Sio_2.

In milling the ore is crushed with jaw crushers and rolls to sixteen-mesh, roasted to magnetize the iron, and removed with Cleveland-Knowles and Ball-Norton machines. The tailings, or zinc, lead, and silica over end of machine, are sized and passed over Card tables, thus producing the lead and zinc shipping products. At present the mill is treating seventy-five tons per day, putting three and one-half tons into one, and making a little better than 70 per cent saving of zinc.

Stratton's Independence Mill

By PHILIP ARGALL

Until the discovery of Cripple Creek in 1891, calaverite was considered little more than a cabinet curiosity, though tellurides of gold and silver had been successfully mined in Transylvania, Hungary, and in Boulder County, Colorado, for many years. Cripple Creek was the first great deposit of gold telluride ever discovered; Kalgoorlie, West Australia, was the second; and none other has since been found.

Though gold was discovered in Kalgoorlie in 1892, it was not until four years later that tellurides were recognized, and six years before the treatment of sulpho-tellurides became a live issue in that field. In Cripple Creek the situation was entirely different, since calaverite and sylvanite were almost immediately recognized, and the treatment of the sulpho-tellurides was investigated as early as 1893. Roasting as a preparation of these ores for cyanidation was conducted as early as 1895 (no doubt the first application of roasting to cyanidation) at the works of the Metallic Extraction Company, at Florence, Colorado, where in 1896 about 3,000 tons per month of roasted ore were cyanided direct.

In experimenting with Cripple Creek ores toward the close of 1893, the writer tried removing the sulpho-tellurides by simple concentration, and in the following year published the advantages to be derived by removing the tellurides in this way before subjecting the pulp to cyanidation. The state of the arts of concentration and cyanidation at that early date did not justify the application of concentrating-cyaniding methods to the higher grades of tellurides of the early nineties, but thirteen years later, when called upon by the directors of Stratton's Independence, Limited, to advise them with regard to the treatment of $3 to $4 sulpho-telluride ores, these old tests formed the starting-point in the elaboration of the milling methods put into successful operation with the starting of Stratton's Independence Mill in March, 1908.

DUMP PROVES VALUABLE

In mining and shipping some $20,000,000 worth of gold ore from the Independence Mine, about 1,000,000 tons of refuse had been sorted out and had gone to form the huge dump. It was generally assumed that this mountain of waste would average

between $4 and $5 per ton, and it was with the idea of recovering some of the potential $4,000,000 represented by this dump that the directors of Stratton's Independence authorized the building of a mill. After the most careful experiments and a minute working out of details, the writer advised the directors that a mill of 10,000 tons' capacity per month could treat the dump for $1.52 per ton, including 10 cents per ton for mining the dump, and guaranteeing an extraction of 70 per cent of the contained value. The fact that 300,000 tons of this dump since milled have shown a total value of but $3 per ton has in no way affected the returns promised, as the fiscal year just passed showed an extraction of 73.63 per cent of the contained value, at a cost of $1.503269 per ton—mining, milling, and treating concentrate included.

Upon my advice, a mill of 5,000 tons per month was planned and erected, was tested thoroughly, and was later increased to 10,000 tons—its present capacity. The methods used are, in brief:

(a) Crushing and concentrating the ore in cyanide solution, in order that the cyanide could begin dissolving gold from the moment that the fine crushing begins.

(b) Removing the rebellious sulpho-tellurides as completely as possible, by a careful concentration process conducted alike on sand and slime.

(c) Leaching the sand in ordinary tanks, to effect a further extraction, and to wash out the remaining traces of cyanide.

(d) Treating the slime by air agitation and bromo-cyanide, or other oxidizers, as and when required. (A long and thorough series of working scale tests soon convinced us that bromo-cyanide was the best solvent in our case, though somewhat erratic in its action, and always requiring the most careful chemical application.)

The application of these methods, as shown in the present mill operations, is as follows:

Dump Mining.—The dump is mined by means of an electric shovel, equipped with a dipper of one cubic yard's capacity, which mines the ore and loads it into cars of four tons' capacity. These cars are hauled up an incline from the dump to the breaker plant by means of an electric hoist, the cars automatically discharging onto the breaker. The cost of this department, as shown for the past year, is as follows:

99,372 tons; cost, $9,490.22, or $0.095502 per ton.

Dump Breaker Plant.—The ore discharges directly upon a Gates gyratory breaker, size 7½ D, which reduces it to pass a four-inch ring and delivers the broken product to a grizzly. Here the fines are removed, while the coarse passes onto a picking belt, where worthless red granite and old steel of various sorts—such

as drills, car wheels, hammer heads, and track spikes—are removed, and the selected material passes on to a Gates gyratory breaker, size 5K, where it is broken to pass a one-and-one-half-inch ring. The discharge from the small breaker, together with the fines from the grizzly, is then sent to the crude-ore storage bin.

From the crude-ore bin, as needed, ore is drawn through two sets of 16″x36″ rolls, which reduce the ore to approximately three-eighths inch, and it is then delivered to the Chilian mill bins.

Mine Breaker Plant.—In addition to the above, another breaker is installed at the shaft, to take care of the low-grade ore that is won in the course of development work, or that may be sorted out from the ore-house waste. This plant is equipped with 5K Gates breaker, 16″x36″ rolls, and screens, the finished product being sent direct to the Chilian mill bins, averaging three-eighths inch in size.

The cost of operating these two breaker plants for the fiscal year was:

112391 tons; cost, $19,030.26, or $0.169402 per ton.

Fine Crushing.—This plant consists of four Akron Chilian mills of six feet diameter, three of which easily give the required 10,000 tons per month, while the fourth is held in reserve until needed to replace one of the others. These mills, with 0.046 foot screen aperture at thirty-three revolutions per minute, give a fairly steady output of 120 tons each in twenty-four hours. Rolled steel tires and dies are used, of the Midvale brand, and the average consumption of steel figures 0.62 pound per ton of ore crushed. The power consumed per mill varies from fifty to fifty-five horsepower, depending upon the feed and the condition of the mill.

Tellurides are friable, and while the fine is richer than the coarse, in most cases, yet the ores of Cripple Creek afford the greatest contrast in this respect. From the lumps that will pass through a two-inch grizzly to the dust caught in the rafters of the mill, the finer pieces and particles are invariably the richer. Advantage was taken of this fact, and extensive experiments conducted to determine the best method of crushing and the most economical size of reduction.

The ore of Stratton's Independence appears at first glance to consist of a rather sparse scattering of sulphides in phonolite and phonolitic breccia. On closer examination, it is found that the gold occurs chiefly as films along fracture planes, or in cavities, or in small veinlets. The sulphide in the body of the rock is invariably low-grade, and occasionally worthless. To crush the rock fine enough to liberate all the sulphides was out of the question on account of the cost, the dressing loss in concentrating slime, and the low-grade product obtained from the concentrators. Experiments were made with rolls, stamps, pans, and

Chilian mills; the latter giving the best results. Then followed experiments with size-crushing on a full working scale, made through screens varying from 0.02 to 0.10 inch aperture. The best average results were obtained around 0.046 screen aperture, which, on $3.25 ore, gives us a sand tailing averaging, after concentration, about 80 cents per ton, and a slime running about $2 per ton after concentration; both products being subjected to further cyanide treatment.

The guide chosen, after months of experimenting, is not to allow the sand tailing from the table to exceed $1 per ton. When this limit is approached, a finer screen is used on the mills. Comparatively coarse crushing, and eliminating 40 to 50 per cent of the ore as sand, with as poor a tailing as we can obtain from the slime, is one of the nice points in our practice not generally seen, or, at least, understood by either the casual observer or the critic. Here the physical character of the ore is utilized to obtain:

(1) A coarse sand, from which a high-grade concentrate and an almost worthless tailing are obtained in one operation.

(2) An enriched slime, from which a high-grade concentrate can also be obtained, leaving but 50 to 60 per cent of the original ore for special treatment, such as air agitation, oxidizing chemicals, and filtration.

Concentrating.—The discharge from the Chilian mills is run to two Ovoca classifiers, where the sand is separated from the slime. The sand passes to a distributor, which feeds twenty Card concentrating tables, or any less number, as the distributor is automatic and so arranged that any table being plugged off the pulp immediately arranges itself to suit the smaller number of tables. The slime passes to thickeners, the thickened slime from these to a similar distributor, which supplies the thirteen Deister slime tables and the four vanners, or any less number. From Card and Deister tables alike there are obtained a four-to-five ounce first-grade concentrate, running 8 to 10 per cent silica and 35 to 43 per cent iron, and a middling product, which is returned to a 14′x5′ tube mill, ground and reconcentrated, giving a two-ounce product, with 14 per cent silica and 30 per cent iron. The Card table sand tailing usually assays .04 ounce, while the Deister and vanner slime tailing averages .10 ounce. Both sand and slime tailing is pumped from the concentrator building to the cyanide building by four-inch centrifugal pumps, while the concentrate is collected, drained, and shipped to the smelters. The cost of fine crushing and concentrating for the year was:

112,391 tons; cost, $55,503.66, or $0.4938444 per ton.

Cyanidation.—After concentration, the various tailing products are pumped to the cyanide plant and again passed through Ovoca classifiers, to be separated into clean sand and slime. These classifiers give a sand practically free from slime and carrying

from 15 to 25 per cent moisture, as desired. They consequently perform a double service—slime separation and sand de-watering. To the clean sand at the head of the classifiers is added as much barren solution as will pass through the tanks during filling, the mixture of sand and barren solution being conveyed to the desired tank by means of a reciprocating conveyor. Leaching thus continues throughout the filling process, and is continued until the value is extracted, when, after water washes, the sand is sluiced to the tailing ponds.

The slime is collected in four cone-bottomed steel collecting tanks, and charges of thickened slime are drawn from these every twelve hours to a similar-shaped treatment tank, fitted with a pneumatic agitator. The air lift tube ends about ten feet below the surface of the charge, where a small reverse cone disposes of the ascending stream. In this way the upper portion of the charge is kept in brisk agitation by a surprisingly small amount of air. Sand, if present, sinks and is deflected toward the side of the vat by the lower cone. Rapidly settling to the suction of the lift, it passes up again, and in this way is kept in active agitation. In the pneumatic type of agitator, where the air lift discharges above the surface of the charge, the compressed air escapes into the atmosphere before it is fully expanded; while in the method here described the expanding air is dispersed and keeps the whole charge, above the reverse cone, in brisk agitation, instead of that small portion of the charge within the central tube, as in the old style of pneumatic agitator. The slime is worked in charges of about eighty tons, agitated in cyanide solution of varying strength, and, as required, given a final treatment with bromo-cyanogen.

The solutions are precipitated on zinc shaving, the dried precipitate being ground to impalpable powder in a special tube mill, and sold to the refineries.

The clear solution overflowing from the slime settlers in this department returns to the Chilian mills, flows over the tables, and returns to this department with more slime, thus forming a closed circuit. Sufficient solution is withdrawn and precipitated from this circulation each day to keep the gold content down to less than a dollar per ton.

Conclusion.—The points to be especially noted in this brief description are the following:

(a) This is the first mill anywhere in the world to successfully treat $3 sulpho telluride ores.

(b) Concentration in cyanide solution.

(c) The closed circuit; i. e., the solution is constantly in circulation from the Chilian mills, over the tables, through the tanks, over the zinc boxes, and back to the Chilian mills.

(d) The use of bromo-cyanogen on the most rebellious ores.

MILLING COSTS

			Per Ton
Coarse crushing	$ 19,030.26	or	$0.169402
Fine crushing and concentrating	55,503.66	or	0.493844
Cyaniding and special chemicals	54,686.80	or	0.486576
Miscellaneous expense	13,617.59	or	0.121163
Total milling cost	$142,847.31	or	$1.270985
Mining dump ore	19,039.26	or	0.095502
Treating concentrate	15,373.12	or	0.136782
Total cost for 112,391 tons	$177,259.69	or	$1.503269

Delayed for a time through financial reasons, the mill started work in April, 1909, and has been in continuous and successful operation from the first, and is earning more than 15 per cent per annum on the capital of the company. The costs of the process undoubtedly set a record for the treatment of low-grade rebellious ores, especially for those of the Cripple Creek district, where the lowest open rate previous to this time—at custom plants—had been $4 per ton.

There are no secrets, the method being simply a combination of already well-known processes adapted to meet the conditions, and the methods so worked out in this mill have since become the standard method in use in the successful sulpho-telluride mills of the district.

Argo Mill—Idaho Springs

By ARTHUR H. ROLLER

We sample all ore shipped us, and pay cash for it on a stated schedule.

This ore, after sampling, is bedded in storage bins, from which it is fed to the stamps and stamped in cyanide solution. From the stamps the pulp passes over amalgamated plates, then through electrified amalgam traps, classified, and the sands tabled on Card concentrating tables. Iron, copper, and lead concentrates are kept separate, going to Dorr classifiers to de-water, and are sold to the smelter.

The sands from the above tables are washed and dried in Dorr classifiers and sent to waste. The middlings from the tables are reconcentrated and ground in the tube mill, thickened in Dorr thickeners, and sent to agitators.

The slimes from the first classification are thickened in Dorr thickeners and go to the agitators.

We are using continuous agitation through Parral and Dorr agitators, from which the pulp goes to four Dorr thickeners, operated on a continuous decantation scheme.

The clear overflow from several of the Dorr thickeners throughout the mill goes to clarifying filter tanks, and then to the zinc boxes for precipitation. An electric current through a lead cell is used in the zinc boxes as an oxidizing agent. The precipitates from the zinc boxes are dried and sold to the Omaha smelter.

The bullion from the amalgam plates is sold to the Denver Mint.

Smuggler Mill—Telluride

At the Smuggler Leasing Company the method in vogue is wet concentration, the ore being crushed; then through rolls, over jigs; then to Wilfley style tables and frue vanners. The recovery on silver is in the neighborhood of 65 or 70 per cent. and on the lead from 85 to 90 per cent; the ore being a straight silver and lead product.

The Experimental Ore Dressing and Metallurgical Plant of the Colorado School of Mines

By PROFESSOR VICTOR C. ALDERSON
President Colorado School of Mines

The practical conservation of the vast mineral resources of the State of Colorado has received a marked impetus recently in the establishment of an Experimental Ore Dressing and Metallurgical Plant at the Colorado School of Mines at Golden. The question of economic handling of the immense tonnage of low- and medium-grade ores has been discussed at various commercial and technical clubs for years, and while these influences have been of undoubted value in stimulating interest and activity, it is evident that other aid is necessary. In the wasteful, long-established smelting industry, and in the more advanced milling and concentration lines, problems present themselves, the solution of which vitally affects the future of the mining industry in this state.

The economic and profitable concentration and extraction of the rare metals—such as molybdenum, tungsten, uranium, and vanadium—from their ores, will add materially to the production of this state. The concentration of the tungsten ores of Boulder County, at the same time recovering the gold and silver, is one problem; the low-grade ores of famous Clear Creek and Gilpin Counties, another; Leadville presents the problem of treating immense deposits of low-grade zinc carbonate; Cripple Creek, of sulpho-tellurides; the San Juan, of complex zinc, iron, lead, and copper sulphides. In the southwestern part of the state are extensive deposits of radium, uranium, and vanadium. The problem confronting the mining industry is a metallurgical one. Local treatment, to avoid the prevailing high freight rates, greater technical skill, more care regarding details of operation, and increased business efficiency are the points to be taken into account.

The experimental plant at Golden should be of inestimable value in the solution of these problems, not only to the mine operator and the engineer, but indirectly through the facilities given the instructing corps in research work and the better training given the students.

THE BUILDING

The building of the experimental plant is situated on the bank of Clear Creek, a few blocks from the campus of the school. The slope of the bank is in itself sufficient to carry off water with considerable solid matter in suspension. The building is 98 feet by 141 feet 8 inches on the ground floor. The frame work is of structural steel, resting on concrete foundations which have been carried down to a substantial bed of gravel. The walls consist of two and one-half inches of cement mortar, reinforced by "hy rib," and are of natural cement color. The roof is of elaterite, resting on a two-inch sheathing of matched Oregon fir. The ground floor is concreted throughout, and is divided into three sections of different elevations. Above the ground floor, but covering only a part of the area, are two suspended floors of reinforced concrete, supported by steel framework. The building is well lighted and is ventilated by an easily operated monitor ventilator.

All machinery and apparatus requiring power is operated by alternating current motors, supplied with current from the School of Mines power-house. For the generation of the current required, a producer-gas-power-generator unit of 80-K.W. capacity has been installed in the power-house. This unit is of Westinghouse design throughout and consists of a bituminous suction gas-producer, a vertical three-cylinder gas engine, and a direct-connected, alternating-current generator.

The producer has a number of noteworthy features. The principal one, and the one which contributes so largely to its success, consists of the two distinct fire zones. This feature makes it possible to operate successfully on very low-grade fuel, and eliminates the difficulties usually arising from the tar and hydrocarbons given off and deposited during the process of gas-making. Ordinary Colorado lignite coal is used. From this is produced a cool, clean gas with a heat value of from 115 to 130 B.T.U. per cubic foot. To eliminate the loss of power on account of a reduced intake pressure, a motor-driven, positive-pressure type of exhauster is used. This draws the gas from the producer and delivers it to the engine at a pressure corresponding to about four inches of water.

The engine is of the standard Westinghouse vertical three-cylinder type, single acting, and using a four-stroke cycle. The cylinders are 15 by 14 inches (stroke). At a speed of 257 revolutions per minute, the engine operating on the producer gas, delivers 118 brake horse-power. Compressed air is used for starting, and both engine and producer can be started readily, even though having stood idle for several days.

Direct-connected to the engine through a flanged coupling is an 80-K.W., 2,300 volt, three-phase, sixty-cycle generator. The current is transmitted at this voltage to the experimental plant,

where it is stepped down to the working voltage of 440. The installation is such that the 80-K.W. machine can be operated in parallel with a steam turbine in the power-house. In case of an emergency all power can be supplied from the turbine alone.

A concrete-lined well, 5 feet in diameter and 25 feet deep, has been sunk near the bank of Clear Creek. A 4 by 6-foot tunnel, 120 feet long, extends from the bottom of the well to a stratum of gravel under the bed of the creek. The well and tunnel have a storage capacity of 20,000 gallons. The pumping outfit consists of an automatic, motor-driven, submerged-type, two-stage centrifugal pump. This has a capacity of 100 gallons per minute against 50 pounds' pressure, pumping into pressure storage tanks of 2,500 gallons' capacity. An ample supply of clear water is thus assured for all operations.

SECTIONS

The plant, when fully equipped, will consist of four sections or units—sampling, concentration, cyanidation, and a fourth devoted to roasting and special apparatus, such as magnetic and electrostatic separators, dry tables, and flotation schemes. For general equipment the plant will contain a Curtis air compressor, a two-stage centrifugal pump, three large water supply tanks operating under air pressure, two motor-operated platform elevators, giving control over all the floors, a Ruggles-Coles dryer, ore bins, track scales, turn tables, and ore cars.

The sampling section will contain the following equipment: one Vezin sampler, one Brunton sampler, a portable feed hopper, one set of 12 by 20-inch Traylor rolls, one 2 by 6-inch Sturtevant roll jaw crusher, with accessories for finishing the sample, such as laboratory crusher and pulverizers, bucking board and riffles. In addition to this, a complete gasoline assay furnace outfit will be installed.

The concentrating unit will contain one 7 by 10-inch Blake crusher, one Samson crusher, one 2D Gates gyratory crusher, one set of 14 by 30-inch P. & M. M. rolls, one set of 12 by 24-inch P. & M. M. rolls, one set of triplex rolls, one 3½-foot Huntington mill and one 3½-foot Akron Chilian mill for regrinding, one Richards pulsator jig, one Harz jig of one compartment, one Harz jig of five compartments, one standard Card table, one No. 6 Wilfley table, one Wilfley slimer of latest design, one Johnston vanner, one Traylor vanner, one Richards pulsator classifier, one three-compartment classifier, two Callow cones, grizzlies, impact and revolving screens, sampling devices, and the necessary sand pumps, elevators, and concentrate driers. In addition, the concentrator will contain a battery of five 850-pound gravity stamps, equipped with amalgamating plates, Pierce amalgamator, and clean-up pans. A special feature of this unit will be the installation of small-sized apparatus for the handling of small ore lots;

i. e., a Callow miniature ore-testing plant, a quarter-size Wilfley table, and a quarter-size Card table. Through this arrangement, ore lots of any size whatever may be tested efficiently.

The cyanide section will contain one 3-foot tube mill, one 3½ by 10-foot Pachuca tank, one Paterson agitator, a Dorr classifier, a Dorr thickener, thickening cones, a Butters filter, one six-compartment zinc box, one lead-lined acid tank, one filter press for zinc slime, solution storage tanks, and a small pebble mill. This department will also be provided with small-scale apparatus in the shape of agitators and precipitating devices.

In the fourth section provision will be made for the installation of special machinery, whereby its efficiency may be tested and comparison made with standard apparatus; for testing by roasting and magnetic or electrostatic separation, by dry tabling, and by such new processes and apparatus as may from time to time come before the metallurgical and mining public.

THE IMPORTANCE OF PRELIMINARY TREATMENT

The proper preliminary mechanical preparation of an ore is one of the most important metallurgical problems with which we have to deal. So many factors enter into its consideration that it becomes a very complex question. The nature of the ore, the state of aggregation of the constituents, the commercial conditions for disposal of products, and other factors have their influence.

If the ore, like the copper sulphide of Butte, is in a state of coarse aggregation, then coarse crushing with concentration beginning at the maximum size—in this case about two inches in diameter—is used for the double purpose of keeping the production of slime at a minimum and also producing as large a quantity of coarse concentrate for the blast furnace as practicable. In general, it is a safe rule to reduce ore only to the requisite fineness to secure satisfactory results and to avoid slime—the bane of the concentration man.

In cyanidation it may be necessary to reduce only to three-fourths inch diameter in order to secure a practically complete extraction, as was done in the early Mercur practice; on the other hand, it may be necessary to bring all the material to a practically impalpable powder, as in the case of the all-slime treatment of silver ores. Each case presents a problem of its own, the successful solution of which means much in the subsequent treatment of the ore. In order to carry on this preliminary treatment at a minimum expense, small-size equipment is installed. For a preliminary investigation on small apparatus, a mine-owner may send fifty pounds. On this small amount, work may be done in any one of a variety of ways, the results of which will point to more extended work, possibly on a carload lot. By this means a mine-owner may, at a minimum cost, and with the maximum

amount of investigation, learn what process is best adapted to his ore and what kind of a mill to erect. This will appeal especially to the small mine-owner, for it puts him on an equality with the large corporation. The wealthy mine-owner can employ the best talent because he has the money to pay for it. But the School of Mines plant will be available to everyone.

FLEXIBILITY

A special feature, carefully considered in building the plant, is its flexibility. The installation of launders, conveyors, and elevators is so arranged that any combination or variety of tests may be made. Ore may be taken from one part of the plant to any other for comparing the effect and value of different screens, classifiers, or concentrators working upon the same material and under similar conditions. This is an important feature, because it will enable a wide range of work to be done. If there is any solution whatever to the problem of the reduction of rebellious ores, it certainly can be discovered by means of the facilities of this plant.

SELF-SALTING

The utmost pains have been taken to avoid self-salting. This precaution is especially necessary when successive tests follow each other closely. To avoid this danger, all launders are designed to be easily flushed, compressed air is installed for cleaning, and all obstructions to the free passage of ore are removed.

EDUCATIONAL FEATURES

Although the location of the Colorado School of Mines is an ideal one, and it is possible to see practical ore-dressing and metallurgical plants at any time, this fact does not make the need of an experimental plant at the school any less imperative. The school takes advantage of its location by requiring numerous carefully conducted inspection trips, in which students, in squads of small numbers, are required to make detailed studies of processes in operation, and to hand in reports of such studies. By a series of outlines, each devoted to some particular practice, care is taken that no detail of importance is overlooked. This method produces excellent results, is carried out as fully as possible, is of immense value, and is a very important part of the curriculum. Visits of inspection, however, are necessarily limited in time, and admit of only a cursory study of operations. Furthermore, it is difficult, if not impossible, to study the mechanism of a machine while it is in motion. What is needed is a plant with type machines which can be studied under all conditions, and which can be adjusted so as to answer the requirements of experimental work.

The fact remains that the best result these inspection trips can accomplish is to bring about the knowledge of the particular practice, good or bad, at the plant visited, without the opportunity of learning how or why the practice produces the results obtained. In the study of concentration, for example, breakers are run at a certain speed, with jaws at some fixed distance and with the feed regular or irregular. What should be done is to show how a variation in one or more of these conditions affects the result. This cannot be done without an experimental plant, for no manager would be willing to have the regular course of operations disturbed in order to afford an object-lesson to a group of students. In like manner, the size of feed to rolls, the diameter, the distance between rolls, the spring pressure, and the manner of feeding are all important factors in securing quality and quantity of product. With commercial requirements to be considered, as is necessary in the usual plant, it is impossible for a student to learn experimentally the relative influence of these various factors.

It is very desirable to determine the relative capacity and efficiency of various screens; for instance, trommels and impact screens, and especially new types recently introduced; for rarely does an individual plant employ both. For some reason, one form or the other is adopted, and the possibility for the only proper comparison of value—that wherein both machines are working on the same material—is never afforded. As soon as a plant is in successful operation, the routine involving the rate of feed, the proportion of water, speed and stroke of machines, is established, and unless some radical change is decided upon in the practice, these conditions are unvaried.

In the apparently simple process of gold-milling the practice is so varied that, unless it is possible, by means of an adjustable battery, to compare the different methods, students can form no true idea of the influence of these variations. It would be possible, in an experimental plant, to investigate every important detail of construction, to see how variations of all kinds affect the economy of operation, to appreciate the effects of various losses, and to determine their influence in operations on a commercial scale.

Perhaps the educational advantages which result from the possession of an experimental plant are nowhere more evident than in the improvement made possible in the thesis work of the seniors. Thesis subjects are now very limited in range; most of them may be grouped under one of two heads—the treatment of a specific ore, or a report on a mine. The former cannot be treated properly under existing conditions. The study of the amount and character of the work done by the various ore-dressing machines is not possible at present, because no plant will permit the attachment of measuring devices which absorb useful

power of direct cash value. So, too, a comparison of plate amalgamation with amalgamation by the Pierce device becomes impossible, because we cannot compare the work of the methods on the same ore under similar conditions. An experimental plant like the one at the Colorado School of Mines, therefore, serves the purpose of a laboratory in a most practical and useful way.

RESEARCH FEATURES

Besides supplying the students of the school with a superb laboratory, and thereby increasing the efficiency of their studies, the plant can be used as a research laboratory by the faculty and the alumni of the school. Problems of ore treatment applicable to ores of wide occurrence—problems which affect not only a single mine, but a whole district—will be investigated, and the results published.

The facilities of the plant also will be available to experts who desire to make investigations of their own. In addition to all this, floor space has been reserved for testing new devices. An inventor who wishes to perfect his invention can have all the facilities of power, water, floor space, ore supply, and expert assistance at his command at a slight expense, and will not be obliged to incur the heavy cost of equipping a plant for his one invention. The plant, then, will serve not only the needs of the school in an educational way, but will be a means of acquiring much information of great value to the mining industry.

COMMERCIAL TESTING

Commercial testing will be done in one of two ways:

(a) When ore is sent to be tested the work will be done by the manager, assisted by the corps of assistants connected with the plant. The manager will make a report to the consignor and be responsible for the accuracy of the results. In no case, however, will such report state that the ore comes from any particular mine or locality, unless a member of the corps goes to the mine and takes the samples.

(b) Ore may be sent to the plant for testing, and the owner may designate some expert who will have charge of the test and make a report only to the owner. In this case the expert in charge will be allowed the assistance of the manager and the regular corps at the plant. All the facilities of the plant will be at the disposal of the expert, and he will be responsible for the accuracy of the results.

The second method, it is thought, will be most satisfactory to the mine-owner and is, therefore, recommended. Facilities for

the transportation of ore are afforded by the Colorado & Southern Railway and the Denver & Inter-Mountain Railroad Company.

APPROPRIATIONS

Two appropriations have been made for the erection, equipment, and operation of the plant: $75,000 by the Seventeenth General Assembly and $50,000 by the Eighteenth General Assembly. The first has been expended in full, and the second as yet only in part.

THE PERSONNEL

Inasmuch as this plant differs in size, plan, and scope from other commercial or educational plants now in existence, the drawing of the plans was a long and tedious operation. First, the faculty proposed, in a general way, their ideas to the consulting engineer, Frank E. Shepard, president of the Denver Engineering Works Company. He, assisted by Philo D. Grommon, a graduate of the school of the class of 1907, worked on the details in collaboration with Professors Traphagen and Haldane, of the school.

Then, when nearly completed, the plans were submitted to two prominent engineers of Denver, D. W. Brunton and Philip Argall. Reduced copies of the plans were then sent to a large number of engineers in different parts of the country for suggestions and criticisms. Finally, a prize of $50 was offered to the graduate of the Colorado School of Mines who should offer the best suggestion for their improvement. This prize was awarded to Wallace A. Stephens, of the class of 1898.

The plant is organized as a department of the school, with F. W. Traphagen as director, and William G. Haldane as manager in immediate and active charge of tests. Practical millmen and skilled mechanicians will be employed as the need for them becomes apparent. In no case will inexperienced students be allowed to carry on commercial tests. Such work will be done only by the regular experienced corps connected with the plant.

An advisory committee, consisting of the following men, also has been appointed: D. W. Brunton, Denver, mining engineer; Philip Argall, Denver, manager Stratton's Independence; John Tait Milliken, Colorado Springs, consulting engineer; Thomas B. Crowe, Victor, superintendent New Portland Mill; Walter G. Swart, Denver, western representative American Zinc Ore Separating Company.

CONCLUSION

The possession of this plant enables the school to enter that broad field of usefulness that lies outside the distinct educational

work of educating mining engineers. In every industry there are many problems, too large for the individual operator, which naturally can be solved best by the state or federal government. The government surveys the coast lines, maps the shoals, erects the lighthouses, prepares tables which show high and low water at all points on the coast; but, after supplying all this information, the government leaves the captain to manage his own ship.

The German government keeps a fostering eye upon all its industries. If any particular industry requires free raw material, the needed legislation is passed; if it should have a protective tariff until it can stand alone, such protection is enacted into a law; if a technical school is needed in which to train skilled workers, the government sees that such a school is established; if low freight or steamer rates are needed, the reductions are made; if better banking facilities are required, they are provided. And yet, when all this is done by the government, the individual operator must manage his own business.

Parallel with these illustrations is the work of the Experimental Ore-Dressing and Metallurgical Plant of the Colorado School of Mines. By means of this plant, knowledge of great theoretical and practical value to the ore-dressing and metallurgical industries will be obtained and exhaustive tests will be made to indicate the character of the mill that should be erected to treat any particular ore successfully; but the operator must still build and manage his own treatment plant.

Electric Pumping Plant, Smuggler Mine, at Aspen, Colorado

By CHARLES E. ANDERSON, Manager

In the year 1907 variable-speed electric motors were perfected to guarantee continuous operation, thus enabling the Smuggler Mining Company to conclude the reduction of mine drainage expense by the substitution of electric pumps in place of the existing compound steam pumps, which had been in operation for a period of eighteen years. As centrifugal turbine and triplex electric pumps had been in operation in the district with varying success, one 7″x12″ quintuplex pump, under a head of 550 feet, was installed in the Argentum Juniata Mine by the Smuggler Mining Company, to drain one of the Smuggler water channels, and to prove by comparison and actual practice the most suitable pumps for future draining of the whole district.

By actual measurement of the 351 square feet sump of the first pump thus installed, the efficiency of the pump at forty-nine strokes was 97 per cent, and the motor efficiency 90 per cent; or a combined efficiency of 87.3 per cent. As the motor and pump were under perfect regulation under varying quantities of gritty flow, the quintuplex type, after a trial of two years, was finally adopted. The valves in that first pump do not, after five years of continuous service, show any appreciable wear, thus proving the continuous-flow system of pump most durable for mine pumping.

The present equipment in the Free Silver shaft of the Smuggler Leasing Company in addition to the above-mentioned pump, comprises four 7″x12″ vertical quintuplex pumps, each connected with two 125-H.P., 400-600-R.P.M., 550-volt, direct-current, shunt-wound commutating pole motors. In addition, one auxiliary pump of the above dimensions is at the present time under construction, thus making at completion five pumps in one station, with a combined capacity of 3,000 gallons of water per minute, under a head of 1,150 feet. The cost of pumping has been reduced to 50 per cent of the former expense by means of steam pumps, besides the relief of all imaginary annoyances connected with attention of steam pumps.

Electric Pumping Plant, Golden Cycle Mine, Victor, Colorado

By JOHN TAIT MILLIKEN

As the Roosevelt Drainage Tunnel has not as yet afforded the mining properties of the Vindicator and Golden Cycle Mining Companies any relief, and until such time as this tunnel is extended to the vicinity of these shafts, and drainage thereby effected, it was concluded by the aforesaid companies, in order more economically and efficiently to handle the present water situation, to install pumps, electrically driven, as by this means a great reduction in pumping expense could be accomplished over the former means.

The Vindicator and Golden Cycle Companies thereupon entered into a joint pumping agreement for the installation and operation of these pumps. The pumps were installed in the Golden Cycle shaft, and operated by them under the conditions provided in the agreement.

The equipment comprises the following:

Two specially designed triplex horizontal double-acting power pumps, outside-packed double plunger, pot-valve pattern, each capable of delivering 300 gallons per minute, against a total head of 1,650 feet.

Diameter of plungers	4½	inches
Length of stroke	12	inches
Speed of pump	65	R.P.M.

Two specially designed induction motors, commonly described as Type I, 6-12, 175, 87½-H.P., 600 and 300 R.P.M., 2,200-volt, Form K, 3-phase, 30 cycles. Each pump is direct-connected to one of the above motors by means of a flexible coupling and herringbone gear. The motors are supplied with current through a three-phase varnished cambric cable, enclosed in a lead conduit 1,850 feet long.

The pumps are situated on the 1,650-foot level, are in successful operation, and discharging 320 gallons per minute each, against a total head of 1,550 feet.

The efficiency of the installation is remarkable, as evidenced by the following figures, taken from the final tests for efficiency:

Head	1,550	Feet
Full speed	600	R.P.M.
Gallons per minute	310	
Kilowatts input	108	
Horse-power	144.7	
Over-all efficiency	83.8%	
Motor efficiency	90.0%	
Pump efficiency	93.0%	

Head	1,500	Feet
Half speed	300	R.P.M.
Gallons per minute	160	
Kilowatts input	52.8	
Horse-power	70.7	
Over-all efficiency	85.5%	
Motor efficiency	91.0%	
Pump efficiency	95.0%	

By reason of the two speeds obtainable from the motors, it is possible to pump at the following rates: 150, 300, 450, and 600 gallons per minute. The advantage of this will be readily appreciated by those familiar with the troubles attending the handling of mine water. It appears that the cost of handling water in these mines, by means of this installation, will be about one-third of that by the former means—viz., steam pumps—and can be accomplished with only a fraction of the many annoyances attending any large steam-pump installation for the handling of large volumes of mine water.

Water Power in Mining

By harnessing the waters of the mountain streams, large companies now are generating electricity and furnishing it to the miners of the state at a cost much below the price heretofore paid for coal.

The Shoshone plant of the Central Colorado Power Company supplies power and light to the Red Cliff, Leadville, Breckenridge, and Boulder districts. The company has an auxiliary hydro-electrical plant at Idaho Springs, which supplies the mines and mills with power.

The Cripple Creek district receives a large part of its power from the Colorado Electric Power Company of Canon City.

The Northern Colorado Power Company and the Canon City Company operate their plants with coal.

The Telluride Power Company and the Animas Power Company supply power to mines, mills, and towns in the San Juan district.

The use of electrical power is destined to occupy a much larger field in the mining industry of Colorado.

State Leader in Iron and Steel

BIGGEST PLANT WEST OF CHICAGO LOCATED AT PUEBLO

While Colorado has scarcely begun to assume that position which, on account of its great natural resources, it should occupy in the manufacturing world, it is already one of the leading states of the nation in the manufacture of iron and steel.

Nature has blessed Colorado with an inexhaustible supply of coal of the most desirable kind for steel and other manufactories. Its mountain streams are capable of producing unlimited power and sufficient water for all manufacturing purposes. One need not look far into the future to the day when the manufacturing output of the state will rival that of Pennsylvania or Indiana.

Although there are several smaller iron and steel factories in Colorado, the Colorado Fuel and Iron Company is the principal producer, and a report of its output practically covers the entire field.

The plant of the Colorado Fuel and Iron Company covers an area of 700 acres at Minnequa, Colorado, a suburb of Pueblo. It operates six blast furnaces and twelve open-hearth furnaces, besides rolling mills, nail mills, spike mills, bolt and nut mills, cooper shops, and other accessories of a large steel works.

The plant produces a diversity of products, but the manufacture of rails, spikes, bolts, angle bars, and tie plates for railroads is in point of tonnage the chief branch of the industry. The nail mill is a large institution, in which is manufactured every class of that product, including cement-coated nails, which are in special demand for the sealing of fruit boxes.

The wire mill also is a complete institution, in which all kinds of wire are manufactured, including barbed, telephone, poultry netting, and woven wire for fencing.

Merchant bars are manufactured for the reinforcement of concrete and for the general trade.

The cooper shop is a large factory in itself, which furnishes kegs for the spikes, bolts, and nuts produced at the plant. It has an output of 60,000 to 80,000 kegs a month.

The plant, in brief, produces all classes of steel-mill products, except structural and sheet steel.

MARKETS AND SOURCES OF SUPPLIES

The Colorado Fuel and Iron Company supplies more steel used in all the states west of the Missouri River than any other company.

The company operates its own coal mines, which are by far the most extensive in the state. Forty per cent of the output of the company's coal mines is consumed at the Pueblo works. The plant also is the market for a large part of the surplus slack produced by the other coal-mining companies in southern Colorado. The plant consumed 550,000 tons of coal in 1911, and 600,000 tons in 1912, besides 625,000 tons of coke in 1911, and 642,000 tons in 1912. It also used 430,000 tons of limestone in 1911, and 460,000 tons in 1912, all of which was produced at its own quarries in Chaffee and Pueblo Counties.

The company mined and used 676,693 gross tons of iron ore in 1911, and 689,808 gross tons in 1912. Of this amount, 14,075 gross tons in 1911 and 5,543 gross tons in 1912 were mined in Colorado, the balance having come from New Mexico and Wyoming.

Unlike coal, which, when used once, is worthless, all metals, including iron, have a permanent economic value. The steel products of yesterday are the scrap of today and become the steel products of tomorrow. The mineral mines thus add permanent wealth to civilization.

The Colorado Fuel and Iron Company is a large consumer of scrap iron and steel, it being the market for the greater part gathered west of the Missouri River. The scrap is used in the open-hearth furnaces and makes a superior raw material.

OTHER STATES BUY $27,000,000 WORTH OF PRODUCT

The total value of the steel products manufactured at the Pueblo works last year was $15,140,000. The products of 1911 and 1912 combined approximate $30,000,000, of which 90 per cent was shipped out of the state, and for which $27,000,000 of foreign cash was returned to Colorado, to be distributed as wages and for the purchase of material and supplies in Colorado. The company buys all material in Colorado when available, and deposits its money in Colorado banks, so that the state is directly benefited by its gross income.

There are more than 4,000 men employed in the Pueblo works, and the pay-roll amounts to $3,500,000 annually; but if we include the men employed in the mines and quarries producing raw material for this plant exclusively, and coal and coke, 40 per cent of which is used in this plant, the number of employes in the industry is 12,000 to 15,000, and the annual pay-roll $10,000,000.

The Pueblo steel plant represents an investment of $26,000,000, which is independent of the mines and of a further investment of $6,000,000 in a railroad for the hauling of ore to the commercial railways and for the transporting of material within the plant. There are ninety miles of railroad track inside the Pueblo works.

The Pueblo plant is situated in an ideal location for steel manufacture, being midway between the iron mines of Colorado, New Mexico, and Wyoming, and at the door of the great Trinidad coal fields, which contain an inexhaustible supply of the finest grade of coking coal needed in the furnaces. The plant also is convenient to the limestone quarries of Pueblo and Chaffee Counties, the products of which are an indispensable requisite of the industry.

The company has established a sociological department for the benefit of its employes in the mills and mines. The workmen and their families are given instruction at the expense of the company, on the theory that this makes for greater efficiency. Young men employed in the works are given opportunity to attend night school, where they are taught not only the rudiments of general education, but such technical information as will fit them to advance to higher positions. The wives and daughters of the workmen are taught social science.

The Minnequa hospital, which is owned by the company and is located near the plant, is claimed by the company to be the finest in the West, if not in the nation, and its service is not excelled. Every man employed by the company contributes $1 a month toward the support of the hospital, and for medical services in the camps for himself and his family. He is entitled to hospital services as required. If not too ill, he is treated by a physician at the plant or camp.

COLORADO FUEL AND IRON COMPANY STATISTICS

	1911		1912	
Iron ore mined	676,693.09	gr. tons	689,808.36	gr. tons
Finished steel produced	450,000	net tons	480,000	net tons
Limestone consumed	430,000	net tons	460,000	net tons
Coal consumed	550,000	net tons	600,000	net tons
Coke consumed	625,000	net tons	642,000	net tons
Steel rails produced	280,000	net tons	320,000	net tons

Graphite

A large body of amorphous graphite was discovered several years ago in Chaffee County, midway between Salida and Turret, and was being mined by the Federal Graphite Company, which ceased operations in 1911. This company had sunk two incline shafts and had driven a tunnel 125 feet below the mouths of the inclines, from which the graphite was reached by a raise.

The graphite in this mine is in white to gray crystalline limestone, buff-colored quartzite, and dark-gray to purplish quartzitic schist.

The graphite bed varies from three to four feet in thickness, where already exposed. Geologists consider this bed of graphite as having originally been coal and highly carbonaceous shale, interbedded with sedimentary rocks.

The company operated a mill in Denver. The product was used for paint pigment, stove polish, lubricants, and foundry facings. A large quantity of the material was of sufficient quality for use in the manufacture of pencils.

Another graphite mine was opened last year in Gunnison County, and a fine quality of the material discovered. The owners of the property are enthusiastic and are proceeding with the development of the property, which they believe will be one of the best in the world.

The Cement Quarries and Industry

COLORADO PRODUCT DRIVES COMPETITORS FROM LOCAL MARKETS

The growth of the manufacture of cement has been phenomenal.

Until recent times the only cement used was either partially burned gypsum or lime, which was a very inferior product.

"Natural cement"—or "Roman cement," as it was called in England—came into general use about a hundred years ago. It was made by burning, in a vertical lime-kiln, lime-rock having 20 to 50 per cent of clay matter. The clay gave it the property of setting under water. Artificial, or accurately mixed, cement —called "Portland," because it was of the color of English Portland building-stone—came into general use in England and Germany about fifty years ago. Its manufacture in this country was exceedingly small until the last thirty years. We then made, in the entire country, about 200 barrels per day. The cost was ten times what it is now, and the quality was irregular and inferior; yet the need of it was so great that its production increased more rapidly than that of any other staple article.

The local business in Colorado has been not only moderately successful, but successful from the start. No cement was produced here a few years ago. The capacity of the plants in Colorado is now two million barrels a year, or four times the demand in the state, and double that of all territory to which competition freight rates can be obtained.

THE COLORADO CEMENT QUARRIES AND PLANTS

Few of our citizens realize the quality and extent of the local plants in Fremont County. The largest steam shovels handle hundreds of yards per hour. Electric railroad trains drop the great rocks into the mammoth maws of the largest crushers. Immense rolls, automatic scales that can handle ten yards at a time, blending bins, lines of ball and tube mills that take thousands of horse-power to drive, are used. Burning at a white heat in immense revolving cylinders produces a new artificial stone of an exact and absolutely uniform chemical and physical composition, which, when ground, produces a grade of cement that has held the market and driven every other brand from this entire section of the country. In fact, the well-known

manufacturers of the East, who once were thought by many unequaled, have withdrawn entirely from this field.

The superiority of quarry, machinery, organization, and management has placed the local companies so far ahead of their competitors that the foreign cements are now almost never seen in this section.

The machinery and process by which Colorado won the great fight against plants estimated worth $30,000,000, and having free gas and oil, may be of interest.

THE QUARRIES

The quarries are in the Niobrara limestone and shale. Both lie above and near the plants, the shale on top. They are open quarries, with very little cover to move. The horizontal strata are easily shattered by small charges of dynamite in holes made by electric-driven, Colorado-made drills. The yard-and-one-half dippers of the steam shovels load eight-ton cars every three minutes. Trainloads, hauled by ten-ton electric locomotives, are dumped continuously into the gyratory crushers which, with the aid of heavy rolls, reduce the stone to about two inches, in which form it is weighed, mixed, and stored in a large series of blending bins. Drawn from these through automatic proportioning apparatus, it is carried by broad rubber belts to the dryers, Fuller, Kominuter, and tube mills, which reduce it all to practically 10,000-mesh fine to the square inch.

Rotary cylinder kilns, eight and nine feet in diameter and more than 120 feet long, burn the fine rock powder at 3,000 degrees of heat, melting and chemically combining the accurately proportioned silica, alumina, iron, and lime into a new material —a tri-calcium silicate and aluminate and calcium meta ferrate, called "cement clinker."

This is exceedingly hard, and is stored, when possible, to facilitate grinding, which is also done in ball and tube mills to such a fineness that 80 per cent will pass a sieve having 40,000 meshes to the square inch. To this product is added a small per cent of gypsum to regulate the rapidity of setting, and the cement is carried to great bins in storehouses capable of holding several hundred thousands of barrels.

POWDERED COAL PLANT

The cement is burned by the explosion of coal dried and ground to an impalpable powder, and blown into the kiln by apparatus that regulates the exact quantity and pressure.

The preparing, storing, and handling of the powdered coal require a large and very expensive plant.

POWER PLANT

The automatic coal-handling and stoking apparatus supplying the 500-H. P. boilers and the cross compound, direct-connected and low-pressure turbine engines are the acme of economical power-producing systems.

The United States Portland Cement Company buys its electrical power from the Arkansas Valley Railway Light and Power Company, which has plants at Canon City, Skagway, and Pueblo.

LABORATORY

The watching of the chemical and physical changes in the quarry, and the determining and regulating of the actual proportions of the silica, alumina, lime, iron, sulphur, etc., in the raw mixtures, to bring an exact chemical product, is a matter of the greatest importance, vital to the quality of the result, and where there must be absolutely no inaccuracy, no variation, no guesswork, no rule of thumb.

For this the Colorado companies have provided a large corps of experts, housed in a large and special building; and have provided so many checks on each man's and department's work that it is almost impossible for an error to be made in the final product.

The cement, as soon as ground, is tested in every manner by a separate corps of men; also, when each bin is filled and as each car is shipped. Large samples and a full record are kept of every test.

The result is the adoption and use of Colorado cement by all of the large consumers, who test every car they get, and by the cities and federal government, for all their work in this section.

Their tests, made by their own experts, show the Colorado cement wonderfully uniform and unsurpassed in soundness, regularity, and strength.

About 400 men are employed by the two plants, with a pay-roll of about $400,000 a year. All of this money is paid out at the plants and kept at home. Both companies have made it a universal practice to buy all material possible in Colorado or from Colorado manufacturers.

The outlook for 1913 is very encouraging, and both companies believe that business will be materially improved during the year.

The United States Company is planning the building of some additional storage bins during the early part of the year.

OUTPUT

	1911	1912
Colorado Portland Cement Co.....	550,000 bbls.	515,000 bbls.
United States Portland Cement Co..	210,000 bbls.	180,000 bbls.
Total	760,000 bbls.	695,000 bbls.

Average price, $1.20 a barrel, f. o. b. plant.

Clays

The principal clays mined in Colorado are those used for the manufacture of brick, stoneware, and fire clay. The product is liberally distributed over the state, so that nearly every city of importance has its local plant for the manufacture of brick.

Sewer-pipe, fire-clay, lining, and drain-tile manufacture is limited practically to two firms—the Denver Sewer Pipe and Clay Company, of Denver, and the Standard Fire Brick Company, of Pueblo—the two largest clay plants in the state. These concerns also manufacture brick.

Pottery is manufactured by companies located in Denver, Colorado Springs, and Golden, and their products are among the best produced in the United States. One Denver company is a large producer of crucibles and brick for accompanying foundations, which are shipped to all the mining districts of the world.

Most of the clay manufactured in Denver is mined at Golden and transported by railroad to the plant, but there are several brick kilns in the city located near local beds of clay.

Colorado brick is in large demand in other states. One Denver firm supplies two of the big trunk lines entering that city with most of the brick used by them west of the Missouri River. The Colorado plants produce the finest grades of building-brick of all shades of color, and as Colorado is noted for its preference for brick in building, as against wood, the local markets are strong. Vitrified brick of the finest quality for paving purposes also is manufactured in large quantities.

Sewer pipe, fire-clay lining, and drain tile manufactured in Colorado find a ready market in New Mexico, Wyoming, Montana, South Dakota, Nebraska, and Kansas.

There are 3,100 men employed in the clay industry in Colorado, including the workmen in the mines and plants. The total output of the state in clay products is upwards of $5,000,000 annually.

The Denver Sewer Pipe and Clay Company alone employs 300 men and has an annual output of $500,000. It has forty-four kilns. This is the largest plant in the state.

KAOLIN

While prospectors have been endeavoring to find kaolin to meet the demand for this product in the manufacture of pottery, cement, and high grade fire-clay products, Routt County comes to

the front with two seams of kaolin that are as free of iron and other impurities as nature has produced in any country.

The finest deposit is at the mouth of Trout Creek where it merges into the Yampa River, locally known as Saddle Mountain. The seam of kaolin is five and one-half feet thick and underlies the sandstone ledge just above the lower series of the Routt County coal measure. A chemical analysis made a few years ago by Professor Ohly shows this kaolin to be very high grade. He gave the proportions of lime to unite with it to make a fine Portland cement.

About twenty feet under this seam is a good seam of Welsh clay that has some promise in the manufacture of fire-clay brick.

The second deposit of kaolin in this northwest part of the state is in Moffat County, west of Craig, and will be very near the main line of the Moffat Road when built to Salt Lake.

Gypsum

The United States continues to import gypsum, although it is distributed plentifully over this country, in sufficient quantity to supply the world, if properly developed. Colorado contains rich deposits of this mineral, but development practically is in its infancy. Only those deposits which are near railroads are being utilized at present, and of these there are several, which now are making large outputs. An increase in transportation facilities will assist in developing the more inaccessible deposits which now are lying idle.

There are frequent occurrences of gypsum along the eastern foothills of the Rocky Mountains from the northern to the southern boundary of the state. Custer County contains an important deposit, and large bodies have been discovered near Morrison, Loveland, Oakdale, and Colorado City, where quarries have been worked. The principal beds, however, are located in Eagle, Pueblo, Delta, and Montrose Counties. The beds in Montrose and Delta Counties are continuous, and are more frequently referred to as the Uncompahgre deposit.

The Eagle County beds are convenient to the Denver & Rio Grande and the Colorado Midland Railroads. The beds range from eighty to 800 feet in depth, and the color is of an ashy gray where it has weathered, and of lighter color where covered.

John G. Fairchild, of the United States Geological Survey, made the following analysis of the Eagle County gypsum beds in 1911. The numbers at the top of the table indicate the location of the product analyzed as designated beneath the table:

	1	2	3	4	5	6
SiO_2	0.24	Trace	16.55	3.90	4.38	0.05
$Fe_2O_3 + Al_2O_3$	.18	Trace	2.81 10.42	2.29	1.86	.13
CaO	32.60	40.61	27.80	34.56	30.74	32.94
SO_3	43.80	56.82	6.24	32.61	40.40	44.23
H_2O	19.62	1.87	3.40	14.54	18.62	20.30
Organic matter	1.11	.46	6±	2.99	.75	.25

1. One-half mile south of Gypsum.
2. Two and one-half miles east of Gypsum, nearly anhydrite.
3. Cottonwood Creek, eight miles west—southwest of Gypsum.
4. Eight miles north of Gypsum.
5. Eagle, Colorado.
6. Ruedi, Colorado.

Considerable gypsum in Eagle County is manufactured into plaster of Paris and white coat, both of the best quality. The

plants now in operation are able to remove the material with a minimum of cost. Coal for power is obtained from the mines at Cardiff.

The beds cover a large part of the county along the Grand and Eagle Rivers and Gypsum Creek.

The Uncompahgre beds are located in the Grand Canon of the Gunnison, the most accessible being along the west side of the river. The east side of the river also contains rich beds, but for the present they are inaccessible and will await future development. The deposit is 110 to 150 feet thick, and extends twenty miles along the Gunnison River.

The Pueblo County gypsum beds are massive. They are mostly a mottle-gray and white. A granular or earthy gypsum also is obtained near Greenhorn station, and is extensively used in the county.

Precious Stones

Colorado is one of the leading states of the Union in the production of precious stones, although its resources have scarcely been touched. Mining for precious stones is conducted principally in Fremont County, but beds have been discovered in various localities scattered widely over the state.

J. D. Endicott, of Canon City, is the owner of several large claims which produce amethyst, beryl, agates, and other stones. At a claim located by Mr. Endicott at Garden Park, a few miles north of Canon City, agate of bright red, yellow, and gray color is being produced. This agate is in demand for watch charms, and is beautiful when highly polished. Agates also are obtained from Curio Hill, a few miles southeast of Canon City. These agates contain blood-red spots; one specimen is known as St. Stephen stone. The agates produced are in large demand for tourist trade as souvenirs of Colorado, and are extensively sold as well throughout the country, because of their beauty as ornaments in various kinds of jewelry.

Amethyst is found in Fremont County, twelve miles northwest of Canon City, adjoining Twelve Mile Park. Three shafts have been sunk, and the property appears to have a good future as a producer. The amethyst is in a vein which varies from several inches to three feet in thickness and occurs in streaks. The gem is very attractive for scarf pins, cuff buttons, and necklace stones.

Beryl, topaz, phenacite, and aquamarine are found in the Mount Antero district, in Chaffee County, but the location is not properly accessible for extensive mining. The seasons are short, and the elevation so high that it is possible to work only a few months in the year. Beryl is the most frequently found in this property. The beryls are a clear light blue, to pale and deep aquamarine green.

Amazon stones are found in the Pike's Peak district, near Manitou. Amazon stones, topaz, and phenacite are produced in the Crystal Park and Crystal Peak region. Some of the amazon stone is of a deep, rich green and blue-green color and is excellent for gems.

Garnets are liberally distributed in Colorado. There are two claims near Canon City, near Grape Creek. The garnets are in crystals, some of which are three inches in diameter. Garnets and topaz also are obtained from Ruby Mountain, near Nathrop, in Chaffee County, but the development has not been extensive. Chalk Mountain, near Fremont Pass, contains garnet,

some beautiful specimens of which have been obtained. Other specimens have been obtained near Westcliffe, in Custer County.

Rose quartz is found distributed over several districts in Colorado, but most abundantly in Fremont County. The rose quartz outcrops 150 feet north and south on the canon at Texas Creek, a mile west of the junction of Echo Canon and East Gulch. Some of the rose quartz is of the proper color for gem purposes, and some large blocks are used for ornamental purposes.

The Mineral Springs of Colorado

DUPLICATES OF FAMOUS WATERS OF WORLD ALL FOUND IN COLORADO

By THOMAS TONGE

Colorado is as yet too young, and her people have hitherto been too busy in developing her mining, agricultural, and manufacturing resources, to have realized what an immense source of wealth she possesses in her mineral springs, by which to attract annually increasing numbers of health- and pleasure-seekers from other states and countries, with all the resulting influx of outside money put into Colorado circulation.

Until recently only about sixty of such mineral springs had been analyzed, and some of the sixty have not yet been improved.

In much older Europe, centuries of technical investigation and medical experience have reduced the correct and beneficial use of mineral springs to a science. As a result, there are scores of towns in Europe either entirely or largely dependent for their very existence on the visitors to the local mineral springs, of which the following are a few instances:

The town of Aix-les-Bains, in Savoy, has a population of 4,500, and its local mineral springs (used for bathing since the time of the Romans) are so beneficial for certain ailments that 25,000 strangers visit the town annually. As shown by analysis, there is a group of similar springs in Colorado, but as yet undeveloped.

The mineral springs at Cauterets (population, 1,560), in the Pyrenees, have over 20,000 visitors annually. There are similar springs in Colorado, but unequipped with similar accommodations.

Wiesbaden, in Hesse-Nassau, is the oldest and most famous of the German watering places. It has 60,000 visitors annually and has been called "a city of lodging-houses." Colorado has similar springs, as yet practically unutilized.

Vichy, in France (population, 1,400), is called "The Queen of the Thermal Watering Places," and is visited by 40,000 people annually. There are similar springs in Colorado.

When it is remembered that each of the visitors to the European resorts stays, on an average, about six weeks, some idea can be formed of the vast sums annually spent in the European watering places. Many of such visitors are Americans, mostly from the eastern states.

COLORADO MINERAL SPRINGS COMPARED WITH THOSE OF EUROPE

Years ago the writer collected all the data then available, and, with the assistance of an eminent European scientist of international reputation, compared the analyses of the mineral springs of Colorado with the analyses of the best and most celebrated European mineral springs. The result of such comparison may be briefly stated as follows:

While Colorado has the usual proportion of mineral springs which do not rise above mediocrity, there are others of exceptional merit and value.

There is one spring in Colorado which has no counterpart in Europe, and (it is professionally stated), the waters of which it would pay to bottle and ship to Europe as a specific for certain complaints.

There are several springs in Colorado which in some respects are superior to any springs in Europe.

The waters of one or two springs in Europe are imported to Colorado as a sovereign remedy for certain serious ailments. Colorado has mineral springs of the same kind, but neither the owners of such springs nor the general Colorado public appear to know it, or it would not be necessary to send to Europe for similar water.

The upwards of sixty mineral springs in Colorado investigated years ago by the writer comprise representatives of every class of mineral springs found in Europe.

VALUABLE WORK BY THE STATE GEOLOGICAL SURVEY

Professor R. D. George, State Geologist, under date December 18, 1912, informed the writer as follows:

Recently the State Geological Survey has analyzed samples of the waters of 203 mineral springs of the state, about fifty of which springs had been previously analyzed. The calculation of the mineral contents (a long and tedious task) is not yet completed. Until it is completed, no final classification of the waters can be made. All present indications, however, are that:

(1) Practically every one of the recognized twelve classes of mineral waters is represented in Colorado.

(2) A surprising number of the springs contain lithia (a most valuable ingredient for some ailments) in traces and in appreciable amounts.

(3) Many of the celebrated mineral waters of Europe and of the eastern part of the United States can be duplicated in Colorado.

CAPITAL NEEDED

What has been done at Manitou, Glenwood Springs, etc., can be effectively repeated at a number of places in Colorado, and at less expense in the first instance. It cannot be done all at once, which is all the more reason why steps should be taken and continued from year to year.

If within the next ten years, say $10,000,000 was judiciously expended in (1) securing the best expert medical opinion as to the curative value of the various Colorado mineral waters; (2) developing and equipping the most meritorious of the numerous mineral springs, by building up-to-date bathing, drinking, hotel, etc., accommodations, making good roads, bridle-paths, etc., planting trees, and generally beautifying and making attractive the surroundings, the returns would be highly satisfactory for the investors, the local communities in question, and the state at large.

There is no better opening today in the state for the judicious investment of capital than the well-directed development and equipment, on up-to-date lines, of some of the meritorious mineral springs reached by railroad.

There are hundreds of thousands of Americans in the eastern, middle and southern states who would visit the mineral-spring health and pleasure resorts of Colorado instead of those of Europe, if more of the embryo watering places of Colorado presented the same accommodations and attractions as the European resorts.

T. T.

A complete study of the mineral springs of Colorado has been made in the last two years by Professor R. D. George, State Geologist, who has had a field party out for two seasons measuring the flow, temperature, and gases given off, and analyzing the gases at the springs. The party then took samples of the water in sealed containers, which were analyzed later at the laboratory of the State Geologist at the Colorado State University.

Analyses were made of 200 mineral springs, but the calculations of salt contents, dissolved gases, etc., have not been completed.

Professor George expects to issue a bulletin about September 1, 1913, giving the results of his analyses in detail.

Oil

There are two oil fields in Colorado which are actively producing in large quantities. These are the Boulder and the Florence fields; the Florence field being considerably the larger. There has been considerable prospecting for oil in the state. Wells have been sunk in Routt and Rio Blanco Counties, where a good grade of oil was obtained.

Considerable prospecting for oil was done in the San Luis Valley field in 1911, but this appears to have been discontinued last year. Strong flows of gas have been discovered at De Beque, but no commercial oil in paying quantities. Prospecting for oil has been done also in Montezuma, Jackson, and Mesa Counties. A good grade of petroleum has been found in Jackson County, but the quality is undetermined.

According to the geological formation of the state, experts declare, oil should be found in ten to twelve districts.

The well records for the two producing districts for the biennial period are as follows:

Name of District	Wells Producing Jan. 1, 1911	Wells Drilled in 1911	Wells Dry in 1911	Wells Oil or Gas 1911	Abandoned 1911	Wells Producing Dec. 31, 1911
Florence	55	15	11	4	5	54
Boulder	25	16	9	7	9	23
	Jan. 1, 1912	1912	1912	1912	1912	Dec. 31, 1912
Florence	54	21	13	8	6	56
Boulder	23	.....	.....	.....	3	20

The production in barrels and value of the crude oil in these two districts are as follows:

	Bbls. 1911	Value 1911
Florence	210,094	$178,579.90
Boulder	36,961	46,188.75
	Bbls. 1912	Value 1912
Florence	201,195	$171,015.75
Boulder	13,377	16,721.25

Oils	Boulder Gallons 1911	Florence Gallons 1911	Total Gallons 1911
Illuminating	522,814	2,202,083	2,724,897
Gasoline	293,084	226,622	519,915
Fuel	183,655	2,745,622	2,929,277
Gas		400,000	400,000
Engine		563,769	563,769
Black		564,198	564,198
Mineral seal		127,172	127,172
Smudge		583,070	583,070
Paraffine wax		1,000,000 lbs.	1,000,000 lbs.
	1912	1912	1912
Gasoline and naphtha	184,235	219,285	403,520
Illuminating	234,764	2,334,275	2,569,039
Fuel	111,299	2,401,420	2,512,719
Gas	22,372	360,101	382,473
Smudge		614,838	614,838
Engine		634,118	634,118
Black		654,718	654,718
Mineral seal		146,778	146,778
Auto		23,405	23,405
Paraffine wax		1,131,840 lbs.	1,131,840 lbs.
Residuum	5,775		5,775 gals.

The total approximate value of all the above products for 1911 at the refinery was $401,002, and for 1912, $375,809.18.

Natural Gas

Frequent explorations for natural gas have been made in Colorado, and experts maintain that a large part of the state is underlain with this product, but the developments have not been extensive. There is a large well in the Boulder field, the product of which is being used for domestic purposes in the city of Boulder. A compressor for the extraction of gasoline from the natural gas of this field is in operation.

Building-Stone

Colorado contains enough building-stone to satisfy the nation for many years to come. The Rocky Mountains, as their name implies, are composed principally of rocks of every character. Quarrying is not conducted as extensively as in the more thickly populated eastern states, and there are thousands of square miles of stone land which remains in its virgin wild state, awaiting a demand which will come with an increase in population.

The marble of Gunnison County has become famous for its beauty and texture, and the Colorado-Yule Marble Company is shipping large quantities of its product to eastern states.

The most beautiful buildings in Colorado, including the State Capitol, the Denver Public Library, and the new Post Office, are built entirely of Colorado stones. Colorado-Yule marble also was used in the Cuyahoga County court-house at Cleveland, in the court-house at Youngstown, and in hundreds of buildings east and west of Colorado.

Granite of a beautiful grade and shade of color is being quarried in Gunnison County. The State Capitol building of Colorado was built of this stone. Granite also is quarried at Platte Canon, Salida, Silver Plume, Cotopaxi, Arkins, and several other places.

Sandstones of superior quality are being quarried in the St. Vrain country, at Fort Collins, Howard, and Morrison, and along Turkey Creek and Texas Creek.

Lava rock is quarried at Del Norte and Castle Rock, and is extensively used in building and for paving.

SALIDA GRANITE

Salida granite, the finest dark granite on the market today for monumental purposes, is being quarried exclusively by the Salida Granite Company, of Salida, Colorado. This company has a large manufacturing plant located in Salida, where they do an exclusive monumental business. During the past year this company was reorganized and is now building an addition to its plant which will double the production. The sales last year were greatly increased and the demand for Salida granite for monumental purposes is rapidly growing in the West. They are now shipping into nineteen western states and expect to enter the eastern fields during the present year.

Salida granite takes a brilliant polish and will retain this high gloss after being subjected for years to the influence of the

weather. It will not rust, as there is a very small percentage of iron in it. It shows a beautiful contrast when lettered or traced, which is permanent, the polish being black and the lettering white. It is very dense, weighing 176 pounds to the cubic foot, and has an absorption of .27 per cent. Tests have shown it to be the best fire-resisting stone known today.

The quarries are located in the Whitehorn country, ten miles from Salida, and their entire output is hauled by wagons to the finishing plant in Salida. After this industry has been thoroughly developed and a large market created, it is the intention to provide for a railroad into the quarry, which will reduce the costs considerably and make it possible to handle the business on a larger scale.

Following is a report made by the University of Colorado on samples of Salida granite:

Compressive strength	25,550 lbs. to sq. inch
Modulus of rupture	4,345 lbs. to sq. inch
Proper specific gravity	2.83
Ratio of absorption	.27%
Porosity	.76%
Weight per cubic foot	175.6
Coefficient of wear	14.54
Modulus of elasticity	1,103,200 lbs. to sq. inch

Labor Troubles

While it is no part of the prescribed duties of the Commissioner of Mines to intervene in labor troubles or in disputes between miners and operators, I have not hesitated to proffer offers of mediation in cases where I believed the interests of the state and of both parties might be subserved by arbitration. I have acted on the theory that industrial peace is at all times the most potent factor in industrial development.

One case in particular, I think, merits attention. A strike involving 140 men had been in progress twenty-five days, with no prospect of settlement, when I decided to use my best efforts to bring about an understanding between the employers and employes. I succeeded in arranging a meeting, which resulted in an agreement satisfactory to both sides, and the men went back to work.

With this exception, there were no serious contentions between employers and employes in the metalliferous mining industry of Colorado for the last eight years.

Colorado Mining and Metallurgical Association

In the fall of 1911 the Commissioner of Mines and the State Treasurer, Roady Kenehan, who is a practical miner, decided to encourage the mining men of the state to organize, for the purpose of securing some of the reforms needed in the industry, and especially to voice their opinions in favor of metallurgical plants conducted by the government on the lines of the agricultural experiment stations established for the benefit of the farmer.

We sought to obtain assistance for the poor miner who has a good property, but the ores of which are rebellious. We believed it unfair to expect the poor miner to solve his own problems, because he has not the means.

On the other hand, the expenditure of a few thousand dollars by the government for the establishment of experimental plants, in charge of experts, would solve the problems of the poor miner and revolutionize the mining industry.

As each district, and frequently individual mines, have their individual problems, one plant would not be sufficient, but several would have to be established at various points in the state.

We issued a call to the mining men of the state, and we were more than pleased with the response. Three hundred mining men from every part of the state attended the first meeting, which was held in the chamber of the House of Representatives in the State Capitol building, December 28, 1911.

The meeting was lively, enthusiastic, and interesting. It was probably the first time in the history of the state that so many mining men had come together from various sections to exchange ideas.

Immediately there was a demand for a permanent organization, and to this end the members arranged for a second meeting, which was held, at the same place, on January 13, 1912. Roady Kenehan was elected president of the organization, which took the name of the Colorado Mining and Metallurgical Association. Captain James Smith, mining editor of the *Rocky Mountain News* was elected secretary, and John I. Tierney, assistant secretary.

It was decided that the association should not dabble in the technical, but that all discussions be practical talks, understandable by the practical mining man.

Governor John F. Shafroth delivered a splendid address on "Conservation," in which he pointed out the fallacy of the federal government's policy with regard to the administration of the forest reserves. State Geologist R. D. George read a paper denouncing the niggardly policy of the state government toward the mining interests, which was ordered printed for distribution throughout the state. Dr. Victor C. Alderson, of the Colorado School of Mines, read a paper on the objects of the metallurgical plant at that institution.

At the close of the meeting the association adopted resolutions endorsing the resolution introduced in the state Senate by Senator John T. Joyce, urging Congress to make appropriation for experimental plants for the solving of the low-grade-ore problems.

The several speakers denounced the policy of the federal government in its administration of the forest reserves, and recommended that the rules of the forestry department be amended so that they will not retard the mining development of the state.

A resolution was adopted, requesting the president to appoint a committee to "ascertain to what extent, if at all, does the policy of administration adopted by the National Forestry Bureau retard the progress of mining in Colorado." President Kenehan appointed on that committee: Henry I. Seemann, Denver; P. C. McCarthy, Hinsdale; S. G. Adams, Routt County; John Annear, Boulder; John W. Old, Clear Creek County. The committee was instructed to report at the next meeting.

It is planned to have another meeting next summer, and to hold regular meetings every six months thereafter. We believe every mine-owner in the state should affiliate, because the combined strength of the men engaged in this industry will be felt at Washington and at the State Capitol.

Mineral Museum and Library

COLLECTION AT CAPITOL FAMOUS WORLD PRIZE WINNER; EXHIBIT LARGE

In variety, beauty, and value of specimens, the mineral museum of Colorado, in the custody of the Bureau of Mines, is one of the most complete in the world. The exhibit rooms comprise an area of a half-acre, every available foot of which is taken up with cases containing specimens of ores, rocks, gems, and crystals, 95 per cent of which were obtained in this state. Separate cases for nearly all the mineral counties of the state are on exhibition, in which are contained specimens of ores and crystals obtained in these counties. Besides, there are many cases devoted to the particular minerals, in which are exhibited choice specimens from many portions of the state.

Specimens of unusual value are enclosed in separate cases, where they can be shown to best advantage. Besides the ores, there are specimens of clays, marble, granite, and other building-stones, oils, and the various products classed as minerals. The museum also contains specimens of manufactured products of clay, and an assortment of the coals mined in this state.

Dr. John Elsner, a pioneer physician of Colorado, devoted more than thirty years in the collecting of valuable mineral specimens for a private collection from all parts of the globe. This became one of the most valuable private collections in the world. Some of the specimens cannot be duplicated, and the great museums of Europe are anxious to obtain them at fancy prices; but Dr. Elsner desired that the entire collection become the heritage of the state of Colorado, and he agreed to sell it for $15,000. The legislature consented to the purchase, and this valuable collection now is owned by the state and is on exhibition in the museum.

Dr. Elsner traveled thousands of miles in search of specimens, and in the course of his wanderings visited all the great mineral collections of the world, with a view to learning the rarer species and then searching for them. He paid $1,000 for single specimens, and bought others cheaply which now are priceless.

The mineral museum of Colorado has become famous throughout the world through the premiums won at the greatest world expositions. The exhibit was first entered in competition at the World's Columbian Exposition at Chicago in 1893.

MUSEUM EXPANDS

The museum since then has been much enlarged, and the reader can readily imagine that a great deal more could now be added to the high praise given by the international judges at Chicago. In fact, at every international exposition where it has been entered in competition, beginning with the Chicago World's Fair, it has been a winner.

In awarding a medal for specific merit, the board of international judges of the World's Columbian Commission says of the Colorado mineral collection:

"It illustrates in a clear way the resources of an important mineral-bearing district. It gives important technical information and has great educational value. It is exceedingly well arranged from technical and artistic points of view. It illustrates, by means of this extensive and beautiful collective display, all the more important building-stones in the state, partly as rough specimens and partly worked in order to show how these rocks can be used. For representative exhibits of mineral points, natural cement, fire clay and brick, plastic clays and pottery, kaolin, gypsum, asphaltum, smaller samples and large displays from all the leading coal mines in the states [award is made]. For very extensive, systematic collections of gold, silver, lead, copper, and iron ores from all the important mining districts in the state, and finally metallurgical products and by-products illustrating the processes and stages in reduction of ores, as well as large exhibits of the reduced metals. The exhibit is illustrated by a general geological map of the state, very interesting maps showing land and sea areas at different geological periods, and handsome photographs of mining camps and other interesting parts of the state. One of the principal features of the exhibit is the very careful labeling, each label giving information as to scientific and common name, locality, metallurgical process used, and exhibitor, and, in cases where it is necessary, analysis and assays, value per ton of ore, and statistical data which make it possible to the intelligent visitor to make a study of the mineral resources of the state without any explanation. This exhibit is an ornament to the mining building."

The World's Columbian Exposition also awarded a medal for "specific merit" for a collective exhibit of gold, silver, and lead ores.

OTHER MEDALS

Medals were awarded also by the following large expositions:

Lewis and Clark Centennial, Portland, 1905: Gold medal for general installation and collective exhibit; silver medal for col-

lective exhibit of varieties of ores, etc.; silver medal for painting of mine scenes; gold medal for collective mineral exhibit and excellence of installation.

Trans-Mississippi and International Exposition, Omaha, 1898: Gold medal for collective display of minerals and ores, and excellence of installation.

Louisiana Purchase Exposition, St. Louis, 1904: Grand prize for collective mineral exhibit; gold medal for exhibit of rocks and minerals; silver medal for uranium and vanadium.

South Carolina Interstate and West Indian Exposition, Charleston, S. C., 1901-1902: Gold medal for gems and minerals.

The mineral exhibit is visited daily by hundreds of people—mostly tourists interested in the mineral resources of the state. Most of the specimens are plainly labeled, so that they are interesting to the layman as well as the scientist.

Along the walls of the museum are hung paintings and photographs of many of the important mines and mining towns of Colorado.

LIBRARY

The Bureau of Mines exchanges literature with all the leading mining centers of the world, and its library contains reports, maps, and statistics relating to the mineral resources of all the American states and of many foreign countries. All the government reports relating to mining also are received, and from time to time the Bureau purchases standard reference books relating to mining.

Accidents

FALLING ROCK MOST FREQUENT CAUSE; OPERATORS TRY TO PREVENT

It will be noticed from the statistical report on accidents, printed in another part of this report, that there is little improvement in the record of casualties collected by the Bureau since its establishment. Mine accidents are apparently of the class that is listed as "unavoidable." Legislation prescribing rules and regulations for the operation of metalliferous mines has done much to lessen the number of accidents. Operators generally give full co-operation to the Bureau of Mines in our efforts to compel enforcement of all laws making for the safety and health of employes. From the nature of the work, however, accidents, which no amount of caution can anticipate, are bound to happen. Falling rock is the most common cause of serious and fatal accidents, and even in the most carefully policed mines, where every precaution of sounding, testing, and timbering is observed, there is a discouraging frequency of such occurrences.

This condition teaches that eternal vigilance is the price of safety. After all that enforcement of health and safety statutes can do, there still remains the human equation to be reckoned with. Therefore, all connected with the Bureau continually, in season and out of season, urge upon operators and men alike the practice of unremitting care in the operation of the mining properties of the state.

In another part of this report will be found directions for resuscitation of persons overcome by electricity. These first aids are recommended, having been successfully tried out on many occasions.

ACCIDENTS

CAUSE OF ACCIDENT

ABOVE GROUND	1911		1912	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Machinery accidents	3	11		2
Mill accidents		19	1	22
Smelter accidents*				183
Overwinding cage or bucket		1		
Falling from gallows frame or staging		2		2
Gravity tram	1	1	2	1
Tramming, coupling or dumping cars		11		4
Handling loose rock or ore				2
Falls while carrying tools or material				
Snowslide				
Getting on or off cage or bucket at surface				
Falls in chute or bin or caught with running ore		1		
Falling into uncovered prospect hole				
Operating hydraulic machine				
Injured by windlass				2
Miscellaneous	1	5		7
Electricity	1	1	2	
TOTAL	6	52	5	225

SHAFT ACCIDENTS	1911		1912	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Getting on or off cage or bucket in motion at station		1	1	
Falls from bucket or cage while being hoisted or lowered	1	1	2	
Caught in shaft while being hoisted or lowered	1		3	2
Falls from ladder	1			
Material falling from level or side of shaft				
Struck by descending cage or bucket			2	
Pushing car into open shaft, going down with same		1	1	
Falls of rock or earth in shaft				1
Falling down shaft from level				2
Material falling from overloaded bucket				3
Cable breaking detached, letting cage down shaft	1	2	2	2
Miscellaneous		7		1
TOTAL	4	12	11	11

*Prior to 1912 smelters did not report accidents to this department.

ACCIDENTS—Concluded

UNDERGROUND ACCIDENTS	1911		1912	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Falls of rock	14	85	16	90
Falls of timber while timbering		3		7
Falls from ladder			1	3
Falls from staging while working	2	5	1	10
Falls in chute, winze, upraise or manway	3	10	1	4
Caught in chute with running ore	1	2		4
Injured by tram car	2	19	1	26
Struck by flying rock or steel from hammer or pick		2		5
Struck with hammer, pick or tools		3		4
Injured handling loose rock or ore	1	4		5
Falls while carrying tools or material in mine				1
Suffocation, burning shaft-house or tunnel building				
Suffocation, bad air or powder smoke	5	1	5	2
Operating machine drill		7		5
Miscellaneous	3	15	1	20
Electricity	1	1	1	
TOTAL	32	157	27	186

EXPLOSIVES	1911		1912	
	Fatal	Non-Fatal	Fatal	Non-Fatal
Thawing powder over candle, in stove, hot water or sand				
Picking out missed shot		1		4
Drilled into hole that missed fire	1	7		5
Blast exploded while loading			1	
Remaining too long after lighting fuse		1	1	
Returned before blast exploded				1
Struck unexploded powder or caps with pick or shovel while cleaning away muck		3		
Hit with flying rock from blast, not being in place of safety		2		
Explosion, cause unknown		2	2	1
Miscellaneous		10		2
TOTAL	1	26	4	13
GRAND TOTAL	43	247	47	435

SUMMARY OF ACCIDENTS 1902-1912, INCLUSIVE

	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Number of men engaged in mining, milling and smelting	35,118	32,267	35,376	34,287	34,790	33,014	32,720	20,302	19,568	21,809	23,004
Number of non-fatal accidents	561	494	539	486	436	300	313	347	274	247	435*
Number of fatal accidents	82	67	101	109	82	77	64	51	51	43	47
Number of non-fatal accidents above ground	106	109	105	103	72	43	45	80	79	52	225*
Number of fatal accidents above ground	13	6	13	11	12	17	5	11	6	6	5
Number of non-fatal accidents under ground	455	385	434	383	364	257	230	267	195	195	210
Number of fatal accidents under ground	69	61	88	98	70	60	48	40	45	37	42
Proportion non-fatal accidents per 1,000 men employed	15.97	15.31	15.24	14.14	12.53	9.08	9.56	17.09	14.00	11.33	18.91
Proportion of fatal accidents per 1,000 men employed	2.30	2.08	2.86	3.18	2.37	2.33	1.95	2.50	2.60	1.97	2.04
Per cent non-fatal accidents per 1,000 men above ground	7.55	8.45	7.42	7.49	5.17	3.29	3.50	10.20	10.30	6.58	28.84
Per cent fatal accidents per 1,000 men above ground	.92	.47	.92	.80	.86	1.30	.38	1.40	.70	.759	.641
Per cent non-fatal accidents per 1,000 men under ground	21.59	19.88	20.45	18.65	17.44	12.86	11.59	21.41	16.32	14.03	13.81
Per cent of fatal accidents per 1,000 men under ground	3.27	3.15	4.15	4.77	3.35	3.00	2.41	3.21	3.76	2.66	2.76

*Smelters did not report accidents to this department until 1912.

NUMBER ENGAGED IN MINING, MILLING, AND SMELTING

COUNTY	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Arapahoe	1,615	1,382	.....	.....	.....	.....	.....	.....	.....	.....	.....
Archuleta	18	7	10	4	6	12	8	10	14	12	13
Boulder	1,556	1,310	1,087	975	1,042	1,076	1,050	823	746	423	522
Chaffee	725	470	680	742	615	820	780	576	532	390	423
Clear Creek	2,010	1,748	1,936	1,860	1,985	2,036	2,050	938	854	843	861
Conejos	18	20	15	6	4	7	8	6	8	14	18
Costilla	35	30	32	10	14	12	14	7	9	15	19
Custer	350	566	625	647	521	464	480	216	187	163	197
Delta	5	10	12	8	6	9	11	8	7	.....	.....
Denver	.....	.....	1,175	1,210	1,175	1,060	1,042	914	873	455	475
Dolores	352	325	378	418	396	337	365	125	95	93	158
Douglas	7	5	7	3	7	14	12	8	7	35	44
Eagle	305	240	265	340	376	384	350	182	153	112	215
El Paso	830	792	742	518	785	797	940	942	928	935	918
Fremont	725	630	768	610	630	563	586	220	45	70	105
Garfield	15	12	20	10	15	20	18	12	10	12	16
Gilpin	2,322	1,985	1,860	1,990	1,837	1,971	1,940	876	741	888	876
Grand	75	90	100	36	28	116	145	38	46	55	80
Gunnison	630	537	687	590	672	642	630	374	498	270	215
Hinsdale	580	332	420	432	395	408	370	187	162	98	114
Huerfano	35	10	12	8	12	11	10	.....	.....	37	68
Jefferson	85	52	115	185	76	76	84	63	58	65	67

NUMBER ENGAGED IN MINING, MILLING, AND SMELTING—Concluded

COUNTY	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912
Lake	5,772	6,300	6,380	6,425	6,911	5,906	5,836	2,630	2,160	2,555	2,770
La Plata	475	525	784	792	642	640	625	427	630	390	264
Larimer	45	82	85	77	96	126	108	10	14	18	21
Mineral	920	918	1,010	873	964	872	866	618	526	215	232
Montezuma	152	110	132	80	75	76	64			141	168
Mesa	65	35	146	168	210	140	162			60	85
Montezuma	143	190	185	170	148	135	125	78	106	109	113
Ouray	1,609	1,465	1,586	1,626	1,510	1,468	1,430	867	752	684	687
Pueblo	1,485	1,500	1,945	1,744	1,867	1,832	1,684	1,620	1,684	5,822*	5,850*
Park	406	420	635	690	682	586	570	482	476	153	74
Pitkin	1,355	900	1,252	1,035	1,108	980	916	628	538	206	387
Rio Blanco	25	12	10	11	15	12	14	15	18	15	24
Rio Grande	145	110	131	120	94	74	86	22	27	68	87
Routt	135	200	233	190	217	186	232	116	132	85	110
Saguache	310	280	385	375	348	274	295	137	119	108	101
San Juan	1,595	1,647	1,860	1,740	1,836	1,890	1,756	872	743	705	851
San Miguel	1,625	1,250	1,190	1,233	1,320	1,640	1,460	1,084	1,142	1,333	1,237
Summit	623	570	814	860	851	580	615	310	485	342	511
Teller	5,940	5,200	5,667	5,480	5,196	4,762	4,983	3,861	3,743	3,815	4,028
TOTAL	35,118	32,267	35,376	34,287	34,790	33,014	32,720	20,302	19,568	21,809	23,004

*Includes employees of C. F. & I. Co. plant and two smelters.

EMPLOYES ABOVE AND UNDER GROUND

	1904	1905	1906	1907	1908	1909	1910	1911	1912
Number of men engaged above ground	14,150	13,754	13,916	13,041	12,854	7,840	7,626	7,905	7,801
Number of men engaged under ground	21,226	20,533	20,874	19,973	19,866	12,462	11,942	13,904	15,203
Total number engaged in mining milling and smelting	35,376	34,287	34,790	33,014	32,720	20,302	19,568	21,809	23,004

Safety Recommendations

DURING THE FISCAL YEARS OF 1911 AND 1912 THE FOLLOWING ORDERS WERE ISSUED BY THE DEPARTMENT.

	1911	1912
Regarding timbers	29	16
Regarding explosives	72	24
Regulating amount of powder kept in storage	15	6
Use of steel or iron tamping bar	4	5
Removing old timbers from mine	12	8
Regarding employment of hoisting engineer	5	7
Regarding indicator on hoisting machinery	17	14
Posting uniform code of signals	30	26
Regarding fire protection	2	3
Timbering shafts, stopes, raises and securing same	14	9
Partitioning shafts or divide into compartments	1	2
Placing ladders in shaft, with stations as law provides	16	7
Provide or repair ladders in upraise or winzes-manway	5	3
Provide tunnel or adit with connection to surface with suitable ladders, as provided by law	1	3
Provide chain ladders in shaft or incline when sinking	2	
Provide shaft collar with cover, bonnet or doors	1	
Equip cage with safety clutches or repair same	7	2
Make passageway around working shaft	3	1
Provide guard rails at shaft stations	9	8
Cover winzes or mill holes, or surround with guard rails	3	5
Leave pillar ground standing on side of shaft	1	
Cover or fence abandoned mine shafts or pits	4	2
Notice of number of men permitted to ride upon cage, skip or bucket	5	
Repair cable, or replace cable, or test cable	2	3
Repair machinery	2	
Place fire doors near mouth of tunnel and in shafts	18	5
Regarding sanitary conditions	4	2
Provide chairs or overwinding device	2	3
Miscellaneous	9	6
Electricity, electric wire, etc	2	3

Instructions for Resuscitation from Electric Shock

(Recommended by a commission representing the American Medical Association, the National Electric Light Association, and the American Institute of Electrical Engineers. Issued and copyrighted by the National Electric Light Association, Engineering Societies Building, New York.)

TREATMENT FOR ELECTRIC SHOCK

An accidental electric shock usually does not kill at once, but may only stun the victim and for a while stop his breathing.

The shock is not likely to be immediately fatal, because:

(*a*) The conductors may make only a brief and imperfect contact with the body.

(*b*) The skin, unless it is wet, offers high resistance to the current.

Hope of restoring the victim lies in prompt and continued use of artificial respiration. The reasons for this statement are:

(*a*) The body continuously depends on an exchange of air as shown by the fact that we must breathe in and out about fifteen times a minute.

(*b*) If the body is not thus repeatedly supplied with air, suffocation occurs.

(*c*) Persons whose breathing has been stopped by electric shock have been reported restored after artificial respiration has been continued for approximately two hours.

The Schafer, or "prone pressure," method of artificial respiration, slightly modified, is illustrated and described in the following resuscitation rules. The advantages of this method are:

(*a*) Easy performance; little muscular exertion is required.

(*b*) Larger ventilation of the lungs than by the supine method.

(*c*) Simplicity; the operator makes no complex motions and readily learns the method on first trial.

(*d*) No trouble from the tongue falling back into the air passage.

(*c*) No risk of injury to the liver or ribs, if the method is executed with proper care.

Aid can be rendered best by one who has studied the rules and has learned them by practice on a volunteer subject.

METHOD OF RESUSCITATION

Follow these Instructions Even if Victim Appears Dead

I. Break the Circuit Immediately

1. With a single quick motion separate the victim from the live conductor. In so doing, avoid receiving a shock yourself. Many have, by their carelessness, received injury in trying to disconnect victims of shock from live conductors.

OBSERVE THE FOLLOWING PRECAUTIONS

(*a*) Use a dry coat, a dry rope, a dry stick or board, or any other *dry non-conductor* to move either the victim or the wire, so as to break the electrical contact. Beware of using metal or any moist material. The victim's loose clothing, if dry, may be used to pull him away; do not touch the soles or heels of his shoes while he remains in contact—the nails are dangerous.

(*b*) If the body must be touched by your hands, be sure to cover them with rubber gloves, mackintosh, rubber sheeting, or dry cloth; or stand on a dry board or on some other dry insulating surface. If possible, use only *one* hand.

If the victim is conducting the current to ground, and is convulsively clutching the live conductor, it may be easier to shut off the current by lifting him than by leaving him on the ground and trying to break his grasp.

2. Open the nearest switch, if that is the quickest way to break the circuit.

3. If necessary to cut a live wire, use an ax or a hatchet with a dry wooden handle, or properly insulated pliers.

II. Send for the Nearest Doctor

This should be done without a moment's delay, as soon as the accident occurs, and while the victim is being removed from the conductor.

The doctors entered on the opposite page are recommended:

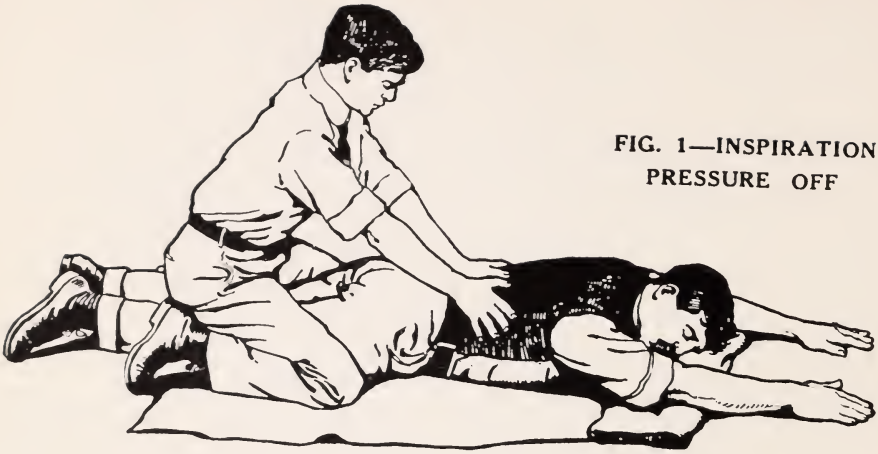

FIG. 1—INSPIRATION;
PRESSURE OFF

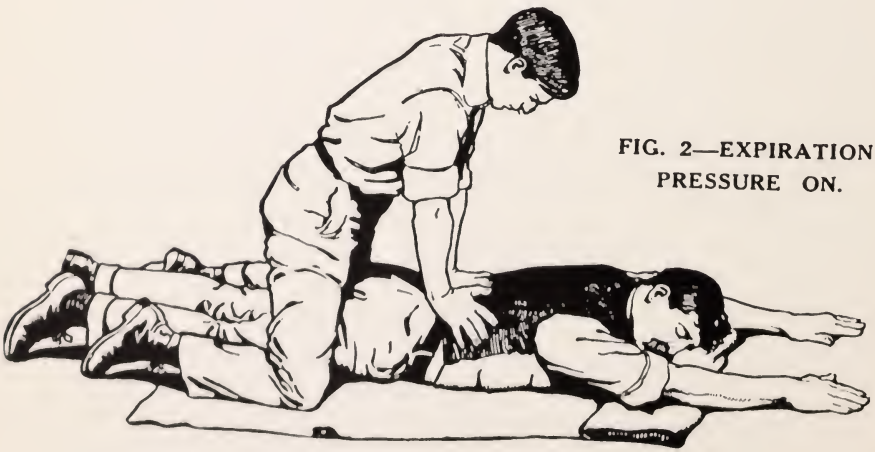

FIG. 2—EXPIRATION;
PRESSURE ON.

Name .....
Address .....
Telephone Call .....

Name .....
Address .....
Telephone Call .....

Name .....
Address .....
Telephone Call .....

Name .....
Address .....
Telephone Call .....

III. Attend Instantly to Victim's Breathing

1. As soon as the victim is clear of the live conductor, quickly feel with your finger in his mouth and throat, and remove any foreign body (tobacco, false teeth, etc.). *Then begin artificial respiration at once.* Do not stop to loosen the patient's clothing; *every moment of delay is serious.*

2. Lay the subject on his belly, with arms extended as straight forward as possible, and with the face to one side, so that the nose and mouth are free for breathing (see Figure 1). Let an assistant draw forward the subject's tongue.

If possible, avoid so laying the subject that any burned places are pressed upon.

Do not permit bystanders to crowd about and shut off fresh air.

3. Kneel, straddling the subject's thighs and facing his head; rest the palms of your hands on the loins (on the muscles of the small of the back), with thumbs nearly touching each other, and with fingers spread over the lowest ribs (see Figure 1).

4. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the subject (see Figure 2). This operation, which should take from two to three seconds, *must not be violent*—internal organs may be injured. The lower part of the chest and also the abdomen are thus compressed, and air is forced out of the lungs.

5. Now *immediately* swing backward so as to remove the pressure, but leave your hands in place, thus returning to the position shown in Figure 1. Through their elasticity, the chest walls expand, and the lungs are thus supplied with fresh air.

6. After two seconds swing forward again. Thus repeat deliberately twelve to fifteen times a minute the double movement of compression and release—a complete respiration in four or five seconds. If a watch or a clock is not visible, follow the natural rate of your own deep breathing—swinging forward with each expiration, and backward with each inspiration.

While this is being done, an assistant should loosen any tight clothing about the subject's neck, chest, or waist.

7. Continue artificial respiration (if necessary, two hours or longer), *without interruption*, until natural breathing is restored or until a physician arrives. Even after natural breathing begins, carefully watch that it continues. If it stops, start artificial respiration again.

During the period of operation, keep the subject warm by applying a proper covering and by laying beside his body bottles or rubber bags filled with *warm* (not hot) water. The attention to keeping the subject warm should be given by an assistant or assistants.

8. *Do not give any liquids whatever by mouth until the subject is fully conscious.*

First Care of Burns

When natural respiration has been restored, burns, if serious, should be attended to until a doctor comes.

A raw or blistered surface should be protected from the air.

If clothing sticks, do not peel it off—cut around it. The adherent cloth, or a dressing of cotton or other soft material applied to the burned surface, should be saturated with picric acid (0.5 per cent). If this it not at hand, use a solution of baking-soda (one teaspoonful to a pint of water), or the wound may be coated with a paste of flour and water. Or it may be protected with a heavy oil, such as machine oil, transformer oil, vaseline, linseed, carron or olive oil. Cover the dressing with cotton, gauze, lint, clean waste, clean handkerchiefs, or other soft cloth, held lightly in place by a bandage.

The same coverings should be lightly bandaged over a dry, charred burn, but without wetting the burned region or applying oil to it.

Do not open blisters.

"Don'ts" for the Operators, Mine Managers, Superintendent, Miners, and Engineers

FOR OPERATORS AND MINE MANAGERS

Don't forget that the mine inspector is an officer of the law.

Don't omit to report all accidents.

Don't forget that two places of egress are required at all mines.

Don't say that you are ignorant of the mining law.

Don't fail to provide sufficient timbers at your mine for timbering.

Don't fail to protect the lives of all of your employes.

Don't fail to make annual report on your property to the Bureau of Mines on November 1 of each year for the twelve months preceding.

FOR MINE SUPERINTENDENTS

Don't let your signaling device get out of order.

Don't allow men to ride on the cage when safety catches are out of order.

Don't fail to provide sufficient hand rails or rings on the cage.

Don't let a day pass without having safety catches tested.

Don't fail to have hoisting rope tested before men are lowered into the mine.

Don't omit to do whatever is necessary for the safety of your employes.

Don't allow material to be hoisted while men are on the cage.

Don't fail to scrap for your rights and those of the company you are working for.

Don't forget to have your powder thawed outside of your shaft-house and have a building for this purpose.

Don't drive cross-cuts or drifts on a grade of over four and one-half inches to the hundred feet. By driving on this grade, it will take the same power to haul the empty car back that it takes to haul the loaded car out.

Don't forget to leave a solid block of ground not less than twenty-five feet on either side of your working shaft.

Don't let your temper get hot enough to be incandescent.

Don't fail to give proper credit for work well done, or dim the glory of another.

Don't forget that kind words to your employes cost you nothing.

Don't forget to have a kind word for the miner who is seeking employment.

FOR MINERS

Don't forget that "liberty" consists in the power of doing that which is permitted by law.

Don't fail to understand the difference between self-reliance and self-sufficiency.

Don't drill into missed holes.

Don't forget to use wooden tamping bars.

Don't fail to have your working place sufficiently timbered.

Don't forget your fellow-miners at the time of danger.

Don't fail to protect the company's property.

Don't fail to comply with the rules of the company and the instructions of the mine superintendent.

FOR HOISTING ENGINEERS

Don't forget that the men on the cage have no control over their own fate, and they depend upon your skill and attention while being hoisted and lowered into the mine.

Don't let your signal device get out of order.

Don't fail to have a good brake on the hoisting drum.

Don't neglect your cable fastenings.

Don't forget the code of signals.

Don't start the engine until you get the correct signal.

Don't fail to keep hoisting ropes in good condition.

Don't get excited when you have an accident. Keep cool.

Don't forget the lawful speed at which men should be hoisted or lowered into the mine.

Don't talk to anyone while you are operating the engine.

Code of Signals

The following is a certified copy of the state code of bell signals for all metalliferous mines operating in the state of Colorado, from Level No. 1 to Level No. 30, inclusive; by order of T. R. Henahen, Commissioner of Mines:

1-1	Bells	1st	Level
1-2	Bells	2nd	Level
1-3	Bells	3rd	Level
1-4	Bells	4th	Level
1-5	Bells	5th	Level
2-1	Bells	6th	Level
2-2	Bells	7th	Level
2-3	Bells	8th	Level
2-4	Bells	9th	Level
2-5	Bells	10th	Level
4-1	Bells	11th	Level
4-2	Bells	12th	Level
4-3	Bells	13th	Level
4-4	Bells	14th	Level
4-5	Bells	15th	Level
5-1	Bells	16th	Level
5-2	Bells	17th	Level
5-3	Bells	18th	Level
5-4	Bells	19th	Level
5-5	Bells	20th	Level
6-1	Bells	21st	Level
6-2	Bells	22nd	Level
6-3	Bells	23rd	Level
6-4	Bells	24th	Level
6-5	Bells	25th	Level
8-1	Bells	26th	Level
8-2	Bells	27th	Level
8-3	Bells	28th	Level
8-4	Bells	29th	Level
8-5	Bells	30th	Level

Appointments

Thomas R. Henahen was appointed Commissioner of Mines, for a term of four years, beginning May 10, 1911.

W. H. Parenteau was reappointed mine inspector for District No. 1, for a term of two years, beginning June 17, 1911.

James T. Stewart was reappointed mine inspector for District No. 2, for a term of two years, beginning June 7, 1911.

John R. Curley was reappointed mine inspector for District No. 3, for a term of two years, beginning June 17, 1911.

Samuel Treais was appointed mine inspector for District No. 4, for a term of two years, beginning August 15, 1911.

John I. Tierney was appointed chief clerk and assistant curator, for a term of four years, beginning June 17, 1911.

John M. O'Connell was appointed chief clerk and assistant curator on December 14, 1912, to fill the unexpired term of John I. Tierney, resigned.

Mrs. A. M. Nickerson was reappointed clerk and stenographer, for a term of four years, beginning June 7, 1911.

Financial Statement of the Bureau of Mines, 1911-1912

RECEIPTS

Appropriated by the Eighteenth General Assembly for this department.

Salaries	$24,400.00	
Traveling expenses	8,000.00	
Incidental fund	1,000.00	
		$33,400.00
Fees collected		9.50
		$33,409.50

DISBURSEMENTS

	Salary	Expense	Incidental	Total
Commissioner	$ 5,000.00	$ 1,599.75		
Inspector District No. 1	3,000.00	1,658.70		
Inspector District No. 2	3,000.00	1,422.45		
Inspector District No. 3	3,000.00	1,540.45		
Inspector District No. 4	1,939.48	899.85		
Clerk and assistant curator	3,000.00			
Stenographer	2,000.00			
Incidental			$954.15	
	$20,939.48	$ 7,121.20	$954.15	$29,014.83
Balance	$ 3,460.52	$ 878.80	$ 45.85	$ 4,385.17
*Fees remitted to State Treasurer				9.50
Total balance				$ 4,394.67

*The only fees collected by this department are those for the making of certified copies of records on file.

Conservation

PRESENT POLICY RETARDS DEVELOPMENT OF MINERAL RESOURCES

The administration of the national forest reserves has been the cause of considerable complaint from mining men, on the grounds that the policy pursued is detrimental to the interests of the prospector for minerals, and retards the development of the mineral resources of the country. I believe the complaints in general are well founded, notwithstanding the denial of the Department of the Interior and the officials of the Forestry Service. It is the contention of the federal government that it desires to aid in the development of the natural resources of Colorado and other western states, but that this must not be done at the expense of the great forests which cover the Rocky Mountains. The government contends that it makes liberal provision for the prospector who honestly desires to locate a valid mineral claim in the forest reserve, but rules are laid down to establish the validity of a claim which are unjust and unreasonable.

So far as I can ascertain, no officer of the Interior Department, while in the employ of the government, has ever discovered a mine. On the other hand, some of the greatest mines in the history of the world were declared by experts to be worthless, but the dogged determination of a practical miner, whose scent of a vein is derived from experience, kept at his work (when he had no government red-tape to restrain him), until he had demonstrated the great value of his discovery.

I might cite, as instances, the Cripple Creek district, one of the greatest gold-producing areas in the whole world, of which experts, after extended examination and deliberate study, declared the deposits were not extensive and would soon be exhausted. It is a matter of history that not until ten paying mines had been developed would any of the experts, who visited the Cripple Creek district, go on record as saying that the district would ever be a great producer.

When Marcus Daly was developing the Anaconda, Neversweat, and St. Lawrence mines, which made him and his associates multi-millionaires, and placed his name at the head of the list of the greatest mining men the world has produced, the experts who visited his camps were unanimous in their opinions that none of these mines would be productive.

The output from the Cripple Creek district and the Daly mines was sufficient to make a big increase in the mineral supply of the world; yet we should not have heard of them today, if the determined miner had been compelled to listen to the commands of those who would advise him.

Shall we say that a forest ranger, who may or may not be a mining man, and, as a matter of fact, in most cases knows nothing of mining, should be competent to judge whether a prospector has located a valid claim? Does it not look more reasonable that the prospector, willing to devote his time and hard labor to the development of a prospect, in which there is no reward for him unless he strikes mineral, be allowed to take the chance, instead of being told off-hand by a forest ranger that he has not located a mineral vein? Is not the prospector who tramps the hills month after month, year after year, in search of a mine, to be encouraged, at least to the extent that, when he finds what he thinks is the object of his search, he be permitted to prove to his own satisfaction that he was mistaken?

The world needs all the minerals that can be produced, and since there is no means of producing them unless the prospector first discovers them, it is an outrage to retard him in his work. There are in the forest reserves of Colorado approximately thirteen million acres, all of which are practically closed to most prospectors, because under present conditions they fear the red-tape methods of the Forestry Service. There are 1,814,800 acres in the forest reserves above timber-line, on the mountain-tops, where no trees grow or can grow. Although some of the richest mines in Colorado are located above timber-line, the Forestry Service continues to maintain this vast area in the forest reserves, when it is of no practical value for forestation purposes. The acreage above timber-line in the various forest reserves is as follows:

	Acres
Arapahoe	130,000
Battlement	1,300
Cochetopa	180,000
Colorado	120,000
Durango	56,000
Gunnison	60,000
Holy Cross	51,000
Leadville	385,000
Montezuma	50,000
Pike	107,500
Rio Grande	186,500
Routt	27,500
San Isabel	80,000

	Acres
San Juan	80,000
Sopris	115,000
Uncompahgre	100,000
White River	75,000
	1,814,800

I believe that 65 per cent of the land above timber-line is mineral land, and I can see no reason for placing and keeping it in the forest reserve, other than trying to collect royalties on any ores that might be produced.

I believe that prospectors and mining men making mineral locations on land, where good timber is available, should be permitted to use all the timber necessary for the mine and buildings connected with it, but under no consideration should they be allowed to sell the timber for commercial purposes.

Locators of mining claims should be permitted to locate mill sites for milling purposes. Ninety-five per cent of our metalliferous mines must erect mills for the treatment of medium-grade ores that are taken from these mines. For this cause I can see no reason why the locator of mining claims should not be permitted to locate mill sites for milling purposes without being compelled to show that there is a vein on said mill site.

I believe that, when an owner of any mineral location has complied with the federal laws and makes application for a patent, should any question arise as to the validity of said claim, the Secretary of the Interior should call upon the Commissioner of Mines of the state in which the land is situated to determine whether the claim is valid.

I submitted these suggestions to Walter L. Fisher, Secretary of the Interior, in a letter dated August 3, 1911. I received no direct reply from him, but my letter was answered by the Denver office of the bureau, in which the customary statement, that the prospector is not hindered in his work, was made.

Field for Manufacturing

COLORADO SHACKLES OWN HANDS TO HELP MAKE OTHER STATES PROSPEROUS

Only a few years ago the waters from the great watershed of Colorado coursed their ways to the Gulf of Mexico and the Pacific Ocean, and the state from which they derived their source received no benefit. Then came the farmer and irrigation. Today these waters are converting thousands of square miles into the finest agricultural country in the world, after which they pass on, to be taken up again and used by other states.

There are other streams, however, which have their origin here, and which have been flowing out of the state for fifty years, and scarcely any attempt has been made to utilize them. I refer to constant streams of minerals, which flow from the mines of Colorado every year and go to the eastern states and to Europe, to give employment to thousands of people in manufacturing industries which should be located in Colorado.

It must seem strange, even to the casual observer, that all this wealth is being taken from Colorado to make other states thrifty and populous, while we of Colorado are crying for an increased population.

There can be no doubt that Colorado is possessed of all the qualifications of a manufacturing state. It is in the center of an important region. It contains enough coal of the finest quality to supply factories for hundreds of years. Its mountain streams can be harnessed and made to furnish power and light for 10,000,000 population and 10,000 factories. The raw material lies at the feet of the manufacturer, and its variety is so great that there is scarcely any important manufacturing industry which should not prosper in this state.

Think of the millions of dollars of gold that have been mined in this state, and how little of it has been used at home! It is shipped in a bullion, composed of silver, lead, copper, and other metals, to the refinery in New Jersey. Being mixed with so much alloy and bulky, it is of no great value as shipped, and therefore the freight rates are low.

When the various metals are extracted, the gold and silver and copper are used at the mints and in the commercial arts. The lead also is used in commerce. But none of these metals finds its way back to Colorado until the hands of the eastern artisan have converted it into a useful article, and Colorado must pay the freight going, express returning, and the cost of manufacture.

REFINERY NEEDED HERE

Why should not the refinery be located in this state? Then would the worker in precious metals be induced to come here, where he could buy his raw material cheaper. His little factory, giving employment to a few men and women, multiplied by hundreds of similar shops, would create an important industry in the manufacture of gold articles alone. The silversmith should be induced to come here to manufacture the thousand and one articles of silver which one sees daily in our stores and our homes.

The silver manufacturer would pave the way for the cutlery manufacturer, who would find a ready supply of iron ores.

If the lead were refined in Colorado, it would provide for the shot, sheet-lead, plumbing-supply, and white-lead factories.

We have the finest quality of sand for the manufacture of glass, so that the bottle manufacturer and the plateglass maker should find a good field. The copper, gold, and other metals needed in glass manufacture are at hand. This should pave the way for the stained-glass maker, who would find lead in abundance for the manufacture of windows.

Colorado possesses an immense supply of zinc, which is not being utilized in this state, but which, combined with copper and iron can be used in galvanized-iron industries, in the manufacture of electrical appliances, and in the hundreds of other arts.

We have the sulphur which is the basis of acids used in most of the arts.

With all the asphaltum within easy reach in Colorado, there is no reason why the state should not support a waterproof-painting works. In addition to the asphaltum, we have barytes used in the manufacture of paints, the lead for white lead, and plenty of pigments. The barytes also are used in the manufacture of hydrogen peroxide, but not in Colorado.

The state contains immense beds of cement, which are being utilized; but there is room for more capital.

Colorado has plenty of fluorspar, which is useful in smelting. It has an abundance of gypsum for the manufacture of plaster of Paris, manganese to purify iron, mica for insulation and fireproof packing, vanadium for steel-hardening, petroleum, and potash, which enters into the manufacture of glass and from which potassium cyanide is made. In short, the state has all the principal minerals of the world.

EUROPEANS AMAZED

Europeans visiting Colorado are amazed at the extent of our mineral resources, and declare that if a tenth part of them were in France or Germany or Austria, those nations would be immensely wealthy and all the people prosperous.

What is the matter with Colorado? Since we possess the location, raw material, coal, power, water, why cannot we manufacture, instead of sending our raw products to the East?

I think the answer is—freight rates. If the railroads were more liberal in giving fair rates to encourage manufacturing in this state, Colorado would jump into first place in this nation as a manufacturing center, its population would increase by millions, and in a few years the western railroads would be reaping the benefit of the wise policy of building up their own territory.

The railroads are in business to make money for their stockholders and they cannot be blamed if they demand such rates as will give them a return on their money; but greater returns are made on handling a large volume of business at low rates than a small volume at high rates.

We have touched only briefly upon the possibilities of manufacturing in Colorado, but the reader can readily understand that this state is supplying the material which is giving employment to tens of thousands of people in the East and in Europe, while our people seek employment.

While agriculture does not come under the province of this department, it might be well to cite a few examples from that industry to make our point clear.

Thousands of tons of fruit rotted in the fields of the western slope last year, because there were no canneries there to preserve it. This state is shipping cattle on the hoof to the eastern markets, when it should be slaughtering it here and sending the meat to the East. Then we could keep the hides here, and convert them into shoes and other leather articles, giving further employment to the thousands. The same is true of the sheep industry.

In fact, Colorado is giving away its heritage for a mess of pottage. It behooves the citizens of this state to see to it that conditions are brought which will encourage the manufacturing industry. Our towns and cities should encourage the manufacturer by making it easy for him to get a start. He should be given land free for his factory as a gift of the community; he should not be burdened with taxes until he has attained a sound financial footing. The people should assist him in obtaining fair rates from the railroads, so that he will not be burdened with competition from the East. Then would Colorado become a great, prosperous state.

TRADE VERSUS MONEY

Often a business man will tell you that money is the life of business. This is not true. Although it would prove very inconvenient, we could get along without money in business.

Business is created by an exchange or trade of commodities. If our mines sold their ores to Colorado manufacturers, and the manufacturers sold their product to the miners and the farmers, we could build up a heavy, healthy trade. Instead, we sell our raw products to the East and buy back the same product at a higher price, giving the East the benefit of the trade. Of what use are the millions upon millions in the Denver mint and in the vaults of our banks? I would rather see one prize bull or stallion imported into Colorado than a million dollars cash to be loaned out at interest. I would rather that a small manufacturer with $1,000 capital came to this state to manufacture its raw products, than that a retired billionaire of Wall Street took up his residence here and lived an idle life.

With an eye to the future, Austria forbids the shipment of radium-bearing ores from that country, because the Austrian government is wise enough to see that the nation cannot afford to surrender this precious metal to other countries. Yet the largest field of carnotite ores in the world is found in Colorado, and every pound of the ore mined in this state is shipped out of it. The carnotite ores of Colorado are destined to be exhausted, when this state will realize the folly of having parted with this precious treasure.

Think of the possibilities of Colorado as an automobile manufacturing center, if we were to encourage the use of vanadium, tungsten, and molybdenum at home! The automobile manufacturer has found that nothing equals tungsten for hardening the steel parts of automobiles. Manufacturers of tools also employ tungsten to a large extent, making it possible for Colorado to encourage both of these industries.

Production of Precious Metals to December 31, 1912

Colorado's total production of precious metals, including gold, silver, lead, copper, zinc, tungsten, uranium, and vanadium, from the earliest history of the state (1859) to December 31, 1912, so far as can be checked, reached the magnificent total of $1,232,971,559. But I am quite sure that millions of dollars of ores, not included in this total, have been shipped out of the state of which no record was kept. In the sixties and early seventies tons and tons of high-grade gold and silver ores were shipped to Swansea, Wales, for treatment. I believe no accurate record was kept of these shipments. It is safe to assume that records are wanting of other large shipments.

The total output given here does not agree with that given in the tables to be found in this volume following this article, but these tables did not include tungsten, uranium, and vanadium. The earlier tables did not include zinc. Allowance also must be made for the gold and silver ore shipments of which no record was kept. It is difficult, however, to make an accurate check of the mineral output, and I have no doubt that at the time these tables were prepared, every effort was made to have them as nearly correct as possible.

We are basing our statement of a total production of $1,232,971,559 upon reports of the United States Geological Survey and other reliable sources. For the output of 1911 and 1912 we have checked the reports of the various smelters, in this and other states, handling Colorado ores; the United States Mint, and other ore-buyers, and we believe the totals given are as nearly correct as it is possible to make them.

The output of coal, clays, precious stones, and many other mineral resources is not included in these tables.

The production of gold, silver, lead, copper, and zinc combined in 1912 was greater than in any year since 1907. Notwithstanding improved methods of treatment, which now make it possible to handle profitably such ores as in previous years were left untouched, the production of gold in 1912 was less than in any year since 1896. On the other hand, the production of silver, lead, and zinc has increased in the last few years, adding to the total wealth of mineral production to such extent that in 1912 there was produced $4,301,414.61 more in gold, silver, lead, copper, and zinc combined than in 1911.

There was also an increase in 1911 over 1910, but theretofore there had been a steady decrease since 1905. This is an

indication of the revival in mining which set in in 1911, became more vigorous in 1912, and promises to continue. The price of silver in 1912 was greater than it had been since 1907. There was a large advance last year in the price of copper, when it reached its highest market value since 1907.

One of the noticeable features in the totals is that the production of gold in Teller County had decreased greatly from 1908 to 1911, but showed an increase in 1912.

THE BUREAU OF MINES OF THE STATE OF COLORADO

PRECIOUS METAL PRODUCTION BY COUNTIES FOR THE YEAR 1900.

COLORADO	GOLD		SILVER		LEAD		COPPER		TOTAL
Name of County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	
Arapahoe	12	$ 248 04							$ 248 04
Archuleta	7	144 69	30	$ 18.43					163.12
Baca	5	103 35	102	62.64			8,900	$ 1,470 28	1,636 27
Boulder	29,367	607,015.89	90,327	55,469.80	76,076	$ 3,598.39	20,371	3,365.29	669,449 37
Chaffee	8,354	172,677.18	125,330	76,965.15	833,462	39,422.75	753,677	124,507 44	413,572 52
Clear Creek	22,518	465,447.06	1,358,143	834,035.62	4,994,263	236,228.64	244,092	40,324.00	1,576,035.32
Conejos	137	2,831.79	1,014	622.70	2,200	104.06	4,527	747.86	4,306 41
Costilla	100	2,067 00	314	192.83			107	17.68	2,277 51
Custer	1,008	20,835 36	82,605	50,727.73	709,349	33,552 22	2,301	380.13	105,495 44
Delta	47	971 49	97	59 57					1,031 06
Dolores	2,425	50,124 75	159,318	97,837 18	210,380	9,950.97	36,009	5,948.69	163,861 59
Douglas	3	62 01	24	14.74					76 75
Eagle	5,012	103,598 04	234,674	144,113.30	3,679,828	174,055.86	359,054	59,315.72	481,082.92
El Paso	95	1,963 65							1,963.65
Fremont	402	8,309 34	2,199	1,350.40	8,282	391.74	6,725	1,110.97	11,162 45
Gilpin	80,092	1,655,501 64	236,400	145,173.24	735,773	34,802.06	799,478	132,073.77	1,967,550.71
Grand	182	3,761 94	21	12 90					3,774 84
Garfield	25	516 75	13	7 98					524 73
Gunnison	4,057	83,858 19	146,746	90,116 72	1,583,320	74,891 04	42,790	7,068 90	255,934 85

Hinsdale	2,732	56,470.44	155,485	95,483.34	9,377,062	443,535.03	29,180	4,820.54	600,309.35
Huerfano	6	124.02	20	12.28	.....	.....	.....	.....	136.30
Jefferson	34	702.78	51	31.32	.....	.....	.....	.....	734.10
Lake	122,376	2,529,511.92	6,967,279	4,278,606.03	62,599,654	2,960,963.63	2,728,553	450,756.96	10,219,838.54
La Plata	726	15,006.42	7,084	4,350.28	14,500	685.85	350	57.82	20,100.37
Larimer	79	1,632.93	126	77.38	.....	.....	13,806	2,280.75	3,991.06
Las Animas	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mineral	10,130	209,387.10	2,280,038	1,400,171.34	14,951,956	707,227.52	2,614	431.83	2,317,217.79
Montrose	79	1,632.93	19,652	12,068.29	.....	.....	32,026	5,290.70	18,991.92
Mesa	6	124.02	311	313.80	.....	.....	2,150	355.18	793 00
Montezuma	480	9,921.60	103	63.25	.....	.....	.....	.....	9,984 85
Ouray	69,565	1,437,908.55	1,985,267	1,219,152.46	9,478,657	448,340.48	352,368	58,211.19	3,163,612 68
Park	5,639	116,558.13	43,138	26,491.05	682,107	32,263.66	15,000	2,478.00	177,790 84
Pitkin	651	13,456.17	4,119,116	2,529,549.14	27,452,260	1,298,491.90	6,082	1,004.75	3,842,501.96
Pueblo	12	248.04	9	5.53	.....	.....	.....	.....	253.57
Rio Grande	5,207	107,628.69	3,075	1,888.36	26,260	1,242.10	8,599	1,420.55	112,179 70
Routt	159	3,286.53	477	292.93	.....	.....	5,765	952.38	4,531.84
Saguache	386	7,978.62	15,793	9,698.48	316,061	14,949.69	16,129	2,664.50	35,291.29
Jan Suan	36,633	757,204.11	681,317	418,396.77	17,579,177	831,495.07	1,972,087	325,788.77	2,332,884.72
San Miguel	88,406	1,827,352.02	1,136,692	698,042.56	3,353,425	158,617.00	311.045	51,384.63	2,735,396.21
Summit	16,361	338,181.87	403,330	247,684.95	5,610,710	265,386.58	53,030	8,760.56	840,013 96
Teller	877,972	18,147,681.24	80,792	49,614.37	.....	.....	134	22.14	18,197,317.75
TOTAL	1,391,287	$28,762,036.29	20,336,712	$12,488,774.84	164,274,762	$7,770,196.24	7,826,949	$1,293,011.98	$50,314,019 35

NOTE—In the above table the calculation is on the average market price of the metal for the year.

THE BUREAU OF MINES OF THE STATE OF COLORADO

PRECIOUS METAL PRODUCTION BY COUNTIES FOR THE YEAR 1901.

COLORADO	GOLD		SILVER		LEAD		COPPER		TOTAL
Name of County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	
Arapahoe	16	$ 330.72							$ 330.72
Archuleta	6	124.02	18	$ 10.61					134.63
Baca	4	82.68	80	47.16			590	$ 97.67	227.51
Boulder	37,460	774,298.20	113,782	67,074.49	191,987	$ 8,320.72	22,186	3,672.89	853,366.30
Chaffee	7,677	158,683.59	76,286	44,970.60	209,768	9,091.35	576,251	95,398.35	308,143.89
Clear Creek	26,172	540,975.24	1,271,227	749,388.32	3,890,216	168,601.96	374,534	62,004.10	1,520,969.62
Conejos	57	1,178.19	102	60.13	1,200	52.01	210	34.77	1,325.10
Costilla	47	971.49	153	90.19			235	38.90	1,100.58
Custer	538	11,120.46	50,394	29,707.26	400,481	17,356.85	40,528	6,709.41	64,893.98
Delta	25	516.75	10	5.90					522.65
Dolores	1,079	22,302.93	111,632	65,807.06	367,057	15,908.25	13,106	2,169.70	106,187.94
Douglas	5	103.35	10	5.89					109.24
Eagle	4 711	97 376.37	175,181	103,269.20	2,775,291	120,281.11	157,914	26,142.66	347,069.34
El Paso	78	1,612.26	15	8.84					1,621.10
Fremont	312	6,449.04	933	550.00	33,945	1,471.18	15,907	2,633.40	11,103.62
Gilpin	79,292	1,638,965.64	271,638	160,130.60	670,018	29,038.58	731,194	121,049.17	1,949,183.99
Garfield	17	351.39	13	7.66					359.05
Grand	50	1,033.50	30	17.68					1,051.18
Gunnison	4,037	83,444.79	93,243	54,966.75	656,631	28,458.39	53,396	8,839.71	175,709.64

Hinsdale	3,684	76,148.28	152,122	89,675.92	7,588,675	328,893.17	12,532	2,074.67	496,792.04
Huerfano	4	82.68	10	5.90					88.58
Jefferson	15	310.05	20	11.80					321.85
Lake	85,928	1,776,131.76	6,830,084	4,026,334.51	56,359,708	2,442,629.94	1,930,556	319,603.55	8,564,699.56
La Plata	1,316	27,201.72	5,528	3,258.76	6,197	268.58	132	21.85	30,750.91
Larimer	45	930.15	73	43.03			18,140	3,003.08	3,976.26
Mineral	4,974	102,812.58	1,816,023	1,070,545.56	10,519,895	455,932.25	1,007	166.71	1,629,457.10
Montrose	75	1,550.25	101,359	59,751.13			55,944	9,261.52	70,562.90
Mesa	99	2,046.33	155	91.37			7,795	1,290.46	3,428.16
Montezuma	175	3,617.25	60	35.37					3,652.62
Ouray	74,810	1,546,322.70	1,633,725	963,080.89	7,904,724	342,590.74	652,937	108,093.72	2,960,088.05
Park	4,660	96,322.20	69,175	40,778.66	421,955	18,287.53	9,657	1,598.72	156,987.11
Pitkin	227	4,692.09	3,532,863	2,082,622.74	32,749,511	1,419,363.81	50,786	8,407.62	3,515,086.26
Pueblo	8	165.36	52	30.65			210	34.77	230.78
Rio Grande	1,593	32,927.31	6,926	4,082.88	677	29.34	65,603	10,860.58	47,900 11
Routt	215	4,444.05	239	140.89	2,193	95.04	500	82.77	4,762 75
Saguache	3,869	79,972.23	20,507	12,088.88	235,750	10,217.40	15,253	2,525.13	104,803.64
San Juan	46,588	962,973.96	784,218	462,296.51	15,473,187	670,607.92	2,740,042	453,613.95	2,549,492 34
San Miguel	99,152	2,049,471.84	916,245	540,126.43	3,309,517	143,434.47	308,322	51,042 72	2,784,075 46
Summit	16,387	338,719.29	368,887	217,458.89	4,342,437	188,201.22	17,062	2,824.62	747,204 02
Teller	833,705	17,232,682.35	89,545	52,786.78					17,285,469.13
TOTAL	1,339,112	$27,679,445 04	18,492,563	$10,901,365 89	148,111,020	$6,419,131 61	7,872,529	$1,303,297 17	$46,303,239 71

NOTE—In the above table the calculation is on the average market price of the metals for the year. Gold, 20.67. Silver, .5895. Lead, .04334. Copper, .16555.

THE BUREAU OF MINES OF THE STATE OF COLORADO

PRECIOUS METAL PRODUCTION BY COUNTIES FOR THE YEAR 1902.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Arapahoe	11	$ 227 37									$ 227 37
Archuleta	4	82 68	10	$ 5 22							87.90
Baca	5	103 35	59	30 77			1,929	$ 229 30			363 42
Boulder	26 062	538,701 54	82,710	43,141 54	13,493	$ 549 03	11,090	1,318 27			583,710 38
Chaffee	20.199	417,513 33	114.155	59,543 25	456,889	18,590 81	173,538	20,628 46	220,500	$ 10,672 20	526,948 05
Clear Creek	45.016	930,480 72	1.279,050	667,152 48	3,282,270	133,555 57	473,754	56,315 14	317,705	15,376 92	1,802,889 83
Conejos	61	1.260 87	81	42 25			78	9 27			1,312 39
Costilla	57	1,178 19	205	106 93							1,285 12
Custer	1.147	23,708.49	28,189	14.703 38	94,662	3,851 80	32,945	3,916.17	40,500	1,960 20	48,140 04
Delta	20	413 40	12	6 26							419 66
Dolores	2,296	47,458.32	121,311	63,275 82	388,806	15,820.52	15,054	1,789 47	248,680	12,036 11	140,380 24
Douglas	3	62 01	10	5 22							67 23
Eagle	1,546	31,955 82	45,336	23,647 26	832,846	33,888 50	150,134	17,846 43			107,338 01
El Paso	35	523 45									723 45
Fremont	357	7.379 19	515	268 62	2.836	115 40	22,300	2,650 80	22,825	1,104 73	11,518 74
Gilpin	75,038	1.551,035 46	303,638	158,377 58	497,366	20.237 82	765,516	90,996 89			1,820,647 75
Garfield	8	165 36	5	2 61							167 97
Grand	63	1,302 21	24	12 52							1,314 73
Gunnison	5,009	103,536 03	123,138	64,228 78	728,935	29,660 37	28,686	3,409 90	131,975	6,387 59	207,222 67

Hinsdale	4,758	98,347.86	117,177	61,119.52	6,213,763	252,838.02	8,314	988.29	319,000	15,439.60	428,733.29
Huerfano	41	847.47	260	135.62							983.09
Jefferson	25	516.75	3	1.56			2,978	353.99			872.30
Lake	58,245	1,203,924.15	5,641,857	2,942,792.61	39,450,178	1,605,227.74	2,611,167	310,389.42	47,637,490	2,305,654.52	8,367,988.44
La Plata	6,030	124,640.10	7,387	3,853.06	2,156	87.73	3,143	373.61			128,954.50
Larimer	39	806.13	49	25.56			24,888	2,958.44			3,790.13
Mineral	5,459	112,837.53	1,923,973	1,003,544.32	9,291,358	378,065.36			2,047,555	99,101.66	1,593,548.87
Montrose	288	5,952 96	3,149	1,642.52	64	2.60	2,505	297.77			7,895.85
Mesa	26	537.42	32	16.69			15,000	1,783.05			2,337.16
Montezuma	123	2,542.41	29	15.13							2,557.54
Ouray	117,113	2,420,725.71	789,855	411,988.37	4,262,063	173,423.34	526,541	62,589.95			3,068,727.35
Park	6,892	142,457.64	49,968	26,063.31	261,046	10,621.96	8,113	964.39			180,107.30
Pitkin	237	4,898.79	3,063,450	1,597,895.52	24,973,816	1,016,184.57	10,654	1,266.44			2,620,245.32
Rio Grande	690	14,262.30	3,171	1,653.99	166	6.75	1,260	149.78			16,072.82
Routt	733	15,151.11	136	70.93							15,222.04
Saguache	243	5,022.81	10,486	5,469.50	454,995	18,513.75	13,669	1,624.83	267,100	12,927.64	43,558.53
San Juan	73,741	1,524,226.47	838,102	437,154.00	7,699,883	313,308.24	3,012,283	358,070 08			2,632,758 79
San Miguel	97,129	2,007,656.43	1,056,640	551,143.42	4,296,849	174,838.79	454,790	54,060.89			2,787,699.53
Summit	11,736	242,583.12	274,571	143,310.12	3,092,387	125,829.22	93,609	11,127.30	1,329,180	64,332.31	587,182 07
Teller	819,153	16,931,892.51	62,780	32,746.05	6,547	266.40					16,964,904 96
TOTAL	1,379,638	$28,517,117.46	15,941,703	$8,315,192 29	106,303,374	$4,325,484.29	8,463,938	$1,006,108 31	52,582,510	$2,544,993.48	$44,708,895 83

NOTE—In the above table the calculation is on the average market price of the metals for the year.

THE BUREAU OF MINES OF THE STATE OF COLORADO

PRECIOUS METAL PRODUCTION BY COUNTIES FOR THE YEAR 1903.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Arapahoe	8	$ 165 36									$ 165.36
Archuleta	3	62.01	6	$ 3 21							65.22
Boulder	20,879	431,568.93	61,833	33,049.74	115,100	$ 4,876.79	6,154	$ 814.48			470,309.94
Chaffee	8,192	169,328.64	129,900	69,431.55	249,308	10,563.18	79,581	10,532.55	3,000	$ 162.00	260,017.92
Clear Creek	22,838	472,061.46	851,638	455,224.56	3,451,849	146,254.84	289,876	38,365.09	656,000	35,424.00	1,147,329.95
Conejos	59	1,219.53	46	24 59							1,244.12
Costilla	48	992 16	179	95.68							1,087.84
Custer	4,006	82,804.02	160,175	85,613.54	387,301	16,409.92	52,242	6,914.23			191,741.71
Delta	12	248 04	8	4 28							252 32
Dolores	2,093	43,262.31	103,096	55,104.81	143,417	6,076 58	147,588	19,533.27			123,976.97
Douglas	2	41.34	2	1 07							42 41
Eagle	776	16,039.92	27,054	14,460.36	677,730	28,715 42	32,863	4,349.42			63,565.12
Fremont	307	6,345.69	223	119.19	2,091	88.60	20,777	2,749.84			9,303.32
Garfield	5	103.35	3	1.60							104.95
Gilpin	65,125	1,346,113.08	375 238	200,564.71	945,975	40,080.96	611,988	80,996.61			1,667,755.36
Grand	69	1,426.23	12	6 41							1,432.64
Gunnison	2,348	48,533.16	65,447	34,981.42	127,661	5,409.00	15,000	1,985.25	55,600	3,002.40	93,911.23
Hinsdale	799	16,515.33	33,139	17,712.80	459,462	19,467.40	11,263	1,490.66	106,000	5,724.00	60,910.19
Jefferson	12	248.04	5	2 67			218	28 85			279.56

Lake	64,827	1,339,974.09	4,973,033	2,658,086.14	36,353,239	1,540,286.74	2,556,583	338,363.76	76,566,000	4,134,564.00	10,011,274.73
La Plata	6,807	140,700.69	7,627	4,076.63	3,017	127.83	810	107.20			145,012.35
Larimer	79	1,632.93	10	5.35			56,700	7,504.24			9,142.52
Mineral	8,658	178,960.86	1,608,788	859,879.19	8,600,646	364,409.37	133	17.60	2,634,000	142,236.00	1,545,521.02
Montrose	136	2,811.12	2,061	1,101.60			10,920	1,445.26			5,357.98
Mesa	17	351.39	8	4.28							355.67
Montezuma	224	4,630.08	89	47.57							4,677.65
Ouray	105,056	2,171,507.52	417,343	223,069.63	3,350,569	141,963.61	380,409	50,347.13			2,586,888.09
Park	6,593	136,277.31	52,128	27,862.42	802,489	34,001.48	5,895	780.20			198,921.39
Pitkin	230	4,754.10	2,569,862	1,373,591.24	33,269,852	1,409,643.63	11,683	1,546.25			2,789,535.22
Rio Grande	626	12,939.42	3,410	1,822.63			5,098	674.72			15,436.77
Routt	1,008	20,835.36	117	62.54							20,897.90
Saguache	143	2,955.81	22,424	11,985.63	376,711	15,961.25	67,410	8,921.71	44,600	2,408.40	42,232.80
San Juan	82,758	1,710,607.86	781,358	417,635.85	6,969,093	295,280.47	2,939,018	388,979.03			2,812,503.21
San Miguel	56,933	1,176,805.11	737,028	393,941.47	3,704,201	156,947.00	466,264	61,710.04			1,789,403.62
Summit	10,753	222,264.51	220,543	117,880.23	1,523,703	64,559.30	41,447	5,485.51	550,800	29,743.20	439,932.75
Teller	572,824	11,840,272.08	41,605	22,237.87							11,862,509.95
TOTAL	1,045,252	$21,605,358.84	13,245,483	$7,079,710.66	101,513,414	$4,301,123.35	7,807,920	$1,033,642.90	80,616,000	$4,353,264.00	$38,373,099.75

NOTE—In the above table the calculation is on the average market price of the metals for the year.

THE BUREAU OF MINES OF THE STATE OF COLORADO

PRECIOUS METAL PRODUCTION BY COUNTIES FOR THE YEAR 1904.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Arapahoe	12	$ 248.04									$ 248.04
Archuleta	6	124.02	10	$ 5.72							1,829.74
Boulder	19,912	411,581.04	57,424	32,858.01	62,111	$ 2,670.77	26,115	$ 3,348.73			450,458.55
Chaffee	3,113	64,345.71	69,045	39,507.55	652,238	28,046.23	263,239	33,755.14	294,440	$ 15,016.44	180,671.07
Clear Creek	30,799	636,615.33	873,949	500,073.62	3,913,976	170,364.97	401,180	51,443.31	906,705	46,214.95	1,404,739.18
Conejos	40	826.80	52	29.75							856.55
Costilla	42	668.14	151	86.40							954.54
Custer	2,586	53,452.62	87,373	49,994.83	126,593	5,443.50	15,068	1,932.17			110,823.12
Delta	17	351.39	9	5.15							356.54
Dolores	2,602	53,783.34	108,301	61,969.83	181,229	7,792.85	25,392	3,256.02	18,196	928.00	127,730.04
Douglas	14	289.38	5	2.86							292.24
Eagle	1,455	30,074.85	27,348	15,648.53	375,207	16,133.90	32,409	4,155.81			66,013.08
El Paso	15	310.05									310.05
Fremont	226	4,671.42	208	119.02	1,071	46.05	1,024	131.31			4,967.80
Gilpin	67,918	1,403,865.06	318,406	182,191.91	859,293	36,949.60	638,945	81,931.92			1,704,938.49
Garfield	25	516.75	14	8.01							524.76
Grand	31	640.77	13	13.16			1,114	142.85			796.78
Gunnison	1,259	26,023.53	115,153	65,890.55	200,462	8,619.87	16,233	2,081.56	20,010	1,020.50	103,636.02
Hinsdale	509	10,521.03	46,585	26,655.94	1,041,222	44,772.55	13,187	1,690.97	59,089	3,013.54	86,654.03

Jefferson	17	351.39	12	6.87			538	68.99			427.25
Lake	57,419	1,186,850.73	5,085,151	2,909,723.40	47,180,865	2,028,777.20	3,734,593	478,886.86	58,254,353	2,970,972.00	9,575,210.19
La Plata	6,164	127,409.88	31,033	17,757.08	2,177	93.61	1,473	188.88			145,449.45
Larimer	57	1,178.19	11	6.29			23,028	2,952.88			4,137.36
Mineral	10,782	222,863.94	1,664,633	952,503.00	13,346,436	573,896.75	1,337	171.44	4,402.697	224,537.55	1,973,972.68
Montrose	72	1,488.24	1,067	610.54			7,476	958.65			3,057.43
Mesa	12	248.04	9	5.15							253.19
Montezuma	135	2,790.45	53	30.33							2,820.78
Ouray	104,367	2,157,265.89	294,028	168,242.82	2,044,525	87,914.58	420,191	53,881.09	4,332	220.93	2,467,525.31
Park	9,433	194,980.11	50,013	28,617.44	757,703	32,581.23	5,920	759.12			256,937.90
Pitkin	113	2,335.71	2,129,618	1,218,567.42	18,882,901	811,964.74	9,862	1,264.60	593,661	30,276 71	2,064,409 18
Rio Grande	194	4,009.98	2,281	1,305.19			650	83.35			5,398.52
Routt	1,172	24,225.24	181	103.57							24,328.81
Saguache	267	5,518.89	60,506	34,621.53	699,312	30,070.42	48,722	6,247.62	15,585	794.83	77,253.29
San Juan	67,569	1,396,651.23	1,042,044	596,257.58	9,288,643	399,411.65	3,467,124	444,589.31	317,254	16,179 95	2,853,089.72
San Miguel	74,072	1,531,068.24	667,710	382,063.66	5,704,708	245,302.44	239,520	30,713.65			2,189,147.99
Summit	10,069	208,126.23	180,554	103,313.00	2,178,182	93,661.82	7,510	963.00	89,913	4,585 56	410,649.61
Teller	699,397	14,456,535.99	47,817	27,360.89			63	8.08			14,483,904 96
TOTAL	1,171,892	$24,223,007 64	12,960,777	$7,416,156 60	107,546,854	$4,624,514.73	9,401.913	$1,205,607 31	64,976,235	$3,313,787.97	$40,783,074 25

NOTE—In the above table the calculation is on the average market price of the metals for the year. The zinc is figured on actual spelter recovered.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES THE MINERAL PRODUCTIONS OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1905.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Arapahoe	22	$ 454 74									$ 454 74
Archuleta	4	82 68	15	$ 9 05							91 73
Boulder	17,191	355,337 97	98,252	59,295 08	18,236	$ 857 09	14,106	$ 2,199 13			417,689 27
Chaffee	1,915	39,583 05	96,822	58,432 08	994,133	46,724 25	869,507	135,556 14	849,963	$ 49,977 82	330,273 34
Clear Creek	27,092	572,393 64	739,985	446,580 95	3,262,540	153,339 38	355,740	55,459 87	1,102,301	64,815 30	1,292,589 14
Conejos	21	434 07	25	15 09							449 16
Costilla	34	702 78	15	9 05			44	6 86			718 69
Custer	424	8,764 08	2,619	1,580 57	3,391	159 38	862	134 39			10,638 42
Delta	12	284 04	15	9 05							257 09
Dolores	2,275	47,024 25	88,374	53,333 71	564,256	26,520 03	71,122	11,087 92	556,266	32,708 44	170,674 35
Douglas	24	496 08	6	3 62							499 70
Eagle	2,155	44,543 85	67,695	40,853 93	349,850	16,422 95	65,179	10,161 40	605,612	35,609 99	147,612 12
El Paso											
Fremont	1,947	40,244 49	53,868	32,509 34	30,373	1,427 53	635	99 00	97,639	5,741 17	80,021 53
Gilpin	72,466	1,497,872 22	337,536	203,702 98	819,592	38,520 82	638,597	99,557 27	33,090	1,945 69	1,841,598 98
Garfield	21	434 07	1	60							434 67
Grand	101	2,087 67	26	15 69							2,103 36
Gunnison	1,313	27,139 71	88,307	53,293 27	184,481	8,670 61	36,997	5,767 83	17,905	1,052 81	95,924 23
Hinsdale	740	15,295 80	61,262	36,971 62	891,888	41 918 74	24,532	3,824 54	235,178	13,828 47	111,839 17

Huerfano	13	268.71	617	372.36							641.07
Jefferson	770	15,915.90	95	57.33							15,973.23
Lake	56,839	1,174,862.13	4,494,967	2,712,712.58	52,848,413	2,483,875.41	4,486,117	699,385.64	70,238,634	4,130,031.68	11,200,867.44
La Plata	12,096	250,024.32	88,085	53,159.30	610	28.67	425	66.26			303,278.55
Larimer	50	1,033.50	35	21 12			4,336	675.98			1,730.60
Las Animas											
Mineral	10,498	216,993.66	1,193,442	720,242.25	11,880,797	558,397.46	107	16.68	2,515,628	147,918.93	1,643,568.98
Montrose	54	1,116.18	395	238.38			2,440	380.40			1,734.96
Mesa	25	516.75	11	6.64							523.39
Montezuma	100	2,067.00									2,067.00
Ouray	115,742	2,392,387.14	758,107	457,517.57	5,348,264	251,368.41	524,199	81,722.62	102,812	6,045.35	3,189,041.09
Park	15,889	328,425.63	42,647	25,737.46	560,417	26,339.60	38,374	5,982.50			386,485.19
Pitkin	205	4,237.35	2,384,542	1,439,071.10	21,975,972	1,032,870.68	127,094	19,813.95	3,854,339	226,635.13	2,722,628.21
Rio Grande	196	4,051.32	1,055	636.69			123	19.18			4,707.19
Routt	486	10.045.62	133	80.27							10,125.89
Saguache	189	3,906.63	66,337	40,034.38	131,132	6,163.20	2,988	465.83	2,917	171.52	50,741.56
San Juan	40,035	727,523.45	739,363	446,205.57	6,445,583	302,942.40	2,274,106	354,533.13	163,845	9,634.09	1,940,838.64
San Miguel	91,013	1,881,238.71	1,174,900	709,052.15	7,100,640	333,730.08	272,513	42,484.78	17.214	1,012 18	2,967,517.90
Summit	8,149	168,439.83	194,843	117,587.75	2,275,344	106,941.17	44,033	6,864.74	805,601	47,369.34	447,202 83
Teller	756,737	15,641,753.79	56,951	34,369.93	26,996	1,268.81					15,677,392 53
TOTAL	1,237,443	$25,577,946.81	12,831,348	$7,743,718.51	115,712,908	$5,438,506.67	9,854,176	$1,536,266.04	81.198,944	$4,774,497.91	$45,070,935.94

NOTE—In the above table the calculation is on the average market price of the metals for the year. The zinc is figured on actual spelter recovered.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES THE MINERAL PRODUCTIONS OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1906.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Arapahoe	12	$ 248.04									$ 248.04
Archuleta	5	103.35	10	$ 6.68							110.03
Boulder	12,290	254,034.30	51,028	34,082.11	59,738	$ 3,194.19	22,656	$ 4,367.62			295,678.22
Chaffee	2,753	56,904.51	66,473	44,397.98	791,075	42,298.78	743,310	143,295.30	623,955	$ 38,672.73	325,569.30
Clear Creek	22,183	458,522.61	610,699	407,891.97	2,877,077	153,837.31	272,411	52,515.39	1,733,477	107,440.90	1,180,208.18
Conejos	17	351.39	20	13.36							364.75
Costilla	38	785.46	34	22.71			83	16.00			824.17
Custer	795	16,432.65	76,266	50,938.82	120,389	6,437.20	10,975	2,115.76	971	60.18	75,984.61
Delta	15	310.05	13	8.68							318.73
Dolores	1,001	20,690.67	46,709	31,197.41	643,336	34,399.18	204,041	39,335.02	883,533	54,761.38	180,383.66
Douglas	21	434.07	4	2.67							436.74
Eagle	2,167	44,791.89	83,059	55,475.94	407,203	21,773.14	45,610	8,792.70	1,426,029	88,385.28	219,218.95
El Paso											
Fremont	254	5,250.18	153	102.19	200	10.69	365	70.36			5,433.42
Garfield	13	268.71	3	2.00							270.71
Gilpin	57,353	1,185,486.51	241,491	161,294.25	474,254	25,358.36	681,151	131,312.29	46,000	2,851.08	1,506,302.49
Grand	30	620.10	210	140.26							760.36
Gunnison	4,001	82,700.67	91,625	61,197.25	245,421	13,122.66	14,357	2,767.74	158,198	9,805.11	169,593.43
Hinsdale	1,051	21,724.17	72,177	48,207.74	883,315	47,230.85	55,487	10,696.78	38,387	2,379.23	130,238.77

Huerfano	23	475.41	56	37.40			37	7.13			519.94
Jefferson	15	310.05	30	20.04							330.09
Lake	51,063	1,055,472.21	4,487,251	2,997,079.82	47,836,328	2,557,808.46	4,028,497	776,613.65	70,198,462	4,350,900.67	11,737,874.81
La Plata	14,908	308,148.36	121.912	81,426.24	1,763	94.27	188	36.24			389,705.11
Larimer	5	103.35	10	6.68							110.03
Las Animas											
Mineral	8.522	176,149.74	1,254,058	837,597.88	14,886,356	795,973.46			2,892,061	179,249.94	1,988,971 02
Montrose	15	310.05	12	8.01							318 06
Mesa	103	2,129.01	697	465.53			6,000	1,156.68			3,751 22
Montezuma	34	702.78	10	6.68							709 46
Ouray	47,627	984,450.09	912,099	609,200.04	5,721,599	305,933.90	662,111	127,641.76	54,883	3,401.65	2,030,627.44
Park	19,810	409,472.70	66,376	44,333.19	628,289	33,594.61	76,234	14,696.39			502,096.89
Pitkin	316	6,531.72	2,160,736	1,443,177.18	17,562,565	939,070.35	285,346	55,009.00	3,276,711	203,090.55	2,646,878.80
Rio Grande	420	8,681.40	1,293	863.61			1,432	276.06			9,821 07
Routt	333	6,833.11	175	116.88							6,999 99
Saguache	149	3,079.83	17,286	11,545.49	181,878	9,725.02	18,530	3,572.24	74,302	4,605.24	32,527 82
San Juan	40,363	834.303.21	688,894	460,119.19	4,139,588	221,343.77	2,094,066	403,694.04	718,192	44,513.54	1,963,973.75
San Miguel	122,965	2,541,686.55	1,476,977	986,487.71	7,039,046	376,377.79	319,692	61,630.22			3,966,182 27
Summit	8,208	169,659.36	130,093	86,890.42	1,482,060	79,245.75	22,740	4,383.82	3,363,740	208,484 61	548.663.96
Teller	673,949	13,930,525.83	67,943	45,379.82	3,060	163.62					13,976,069 27
TOTAL	1,092,827	$22,588,734.09	12,725,882	$8,499,743.83	105,984,540	$5,666,993.36	9,565,319	$1,844,002 19	85,488,901	$5,298,602 09	$43,898,075 56

NOTE—In the above table the calculation is on the average market price of the minerals for the year.
Gold, 20.67; silver, .66791; lead, .05347; copper, .19278; zinc, .06198. The zinc is figured on actual spelter recovered.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES THE MINERAL PRODUCTIONS OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1907.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Boulder	8,944	$ 184,872 48	24,888	$ 16,276 74	36,286	$ 1,937 67	21,026	$ 4,205 20	.....	.....	$ 207,292 09
Chaffee	2,694	55,685 00	34,098	22,300 10	469,452	25,068.74	345,933	69,186.60	2,407,730	$ 149,399 64	321,640 08
Clear Creek	21,558	445,603 88	571,896	374,019 98	3,663,719	193,642.59	172,568	34,513.60	2,771,960	172,027 83	1,219,807.88
Custer	351	7,255 17	20,828	13,621.50	48,127	2,569.98	7,776	1,555.20	.....	.....	25,001.85
Dolores	589	12,174 63	40,369	26,401 34	44,403	2,371.12	102,389	20,477.80	.....	.....	61,424.89
Douglas	3	62 00	.....	.....	.....	.....	.....	.....	.....	.....	62.00
Eagle	1,506	31,129 02	68,167	44,581 22	346,644	18,510 80	88,319	17,663.80	429,198	26,631 73	138,516 57
Fremont	2	41 34	97	63.44	.....	.....	10	2.00	.....	.....	106 78
Gilpin	51,308	1,060,536.35	269,184	176,046 34	442,671	23,638.63	715,790	143,158.00	.....	.....	1,403,379.32
Gunnison	2,519	52,067.72	48,971	32,027.03	94,913	5,068.35	12,653	2,530.60	38,224	2,371.79	94,065.49
Hinsdale	396	8,285.33	46,292	30,274 96	939,855	50,188.26	131,712	26,342.40	....	.....	115,090.95
Lake	53,982	1,115,807 44	4,604,480	3,011,330.56	34,064,162	1,819,026.25	5,366,759	1,073,351.80	67,247,381	4,172,700.00	11,192,216.05
La Plata	19,470	402,444 89	217,319	141,344 22	444	23.70	708	141.60	.....	.....	543,954.41
Larimer	6	124 02	.....	.....	.....	.....	7,988	1,597.60	.....	.....	1,721.62
Mineral	6,909	142,802 51	1,246,961	815,512 49	12,980,288	693,147.38	12,711	2,542.20	2,691,216	166,989.95	1,820,994.58
Montrose	16	330.72	165	107 90	.....	.....	11,222	2,244 40	.....	.....	2,683.02
Montezuma	23	475 41	116	75 86	.....	.....	.....	.....	.....	.....	551.27
Ouray	118,497	2,449,332 98	352,614	230,609.55	3,606,699	192,597.72	908,675	181,735 00	.....	.....	3,054,275.25
Park	25,057	517,930 25	126,287	82,591 68	1,052,113	56,182.83	115,363	23,072 60	..	.....	679,777 36

Pitkin	803	16,598.00	1,693,477	1,107,533.95	13,914,993	743,059.42	234,493	46,898.60	4,688,693	290,933.40	2,205,023.37
Rio Grande	314	6,490.38	6,393	4,181.00	330	17.62					10,689.00
Routt	154	3,183.18	26	17.00							3,200.18
Saguache	122	2,521.74	13,829	9,044.11	480.150	25,640.01	12,928	2,585.60			39,791.46
San Juan	50,190	1,037,427.30	1,033,539	675,934.50	12,425,828	663,539.21	2,572,764	514,552.80	1,772,764	110,000.00	3,001,453.81
San Miguel	119,240	2,454,787.82	1,490,770	974,963.58	6,499,957	347,097.70	381,437	76,287.40			3,853,136.50
Summit	4,038	83,465.45	96,806	63,311.12	1,788,247	95,492.38	32,173	6,434.60	2,970,991	184,350.00	433,053.55
Teller	501,707	10,370,283.68	51,630	33,766.00	87,954	4,696.74	894	178.80			10,408,925.22
TOTAL	990,398	$20,471,526.66	12,059,202	$7,886,736.17	92,987,235	$4,965,517.10	11,256,291	$2,251,258.20	85,018,157	$5,275,376.64	$40,847,834.55

NOTE—In the above table the calculation is on the average market price of the minerals for the year.
Gold, 20.67; silver, .654; lead, .0534; copper, .20; zinc, .06205. The zinc is figured on actual spelter recovered.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES THE MINERAL PRODUCTIONS OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1908.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Boulder	8,391 874	$ 173,480 03	29,270 03	$ 15,466 28	115,131	$ 4,847 01	12,518	$ 1,627 34			$ 195,420 66
Chaffee	1,659 514	34,302 15	19,301 06	10,198 68	416,312	17,526 73	303,170	39,412 10	754,860	$ 34,572 58	136,012 24
Clear Creek	26,135 627	540,223 41	529,436 77	279,754 38	2,410,253	101,471 65	197,588	25,686 44	3,714,309	170,115 35	1,117,251 23
Custer	1,690 060	34,933 54	62,574 65	33,064 44	72,637	3,058 01	320	41 61			71,097 60
Dolores	1,751 114	36,195 52	160,240 92	84,671 29	995,705	41,919 18	39,556	5,142 28	754,860	34,572 58	202,500 85
Douglas	6 501	134 37									134 37
Eagle	1,200 090	24,805 86	30,461 09	16,095 63	215,237	9,061 47	3,885	505 05			50,468 01
Fremont	11 636	240 51	3 00	1 58							242 09
Gilpin	53,163 718	1,098,894 05	264,193 75	139,599 97	573,631	24,149 86	631,381	82,079 53	810,850	37,136 93	1,381,860 34
Gunnison	2,056 040	42,498 34	11,841 03	6,256 80	246,843	10,392 09	3,646	473 59	694,956	31,828 98	91,449 80
Hinsdale	56 142	1,160 45	14,348 98	7,582 00	164,499	6,925 40	147,921	6,774 78			22,442 63
Lake	67,383 351	1,392,813 86	3,215,994 42	1,699,331 45	14,338,832	603,664 82	5,334,682	693,508 66	23,400,600	1,071,750 22	5,461,069 01
La Plata	5,124 343	105,920 16	72,817 89	38,476 97	748	31 49	458	59 54			144,488 16
Mineral	6,170 735	127,549 09	830,950 78	439,074 39	8,238,025	346,820 85	41	5 33	1,657,323	75,905 39	989,355 04
Montezuma	4 250	87 84	7 25	3 83							91 67
Ouray	96,945 575	2,003,865 03	408,469 28	215,835 16	3,033,352	127,699 90	1,189,587	154,646 31			2,502,046 40
Park	20,214 155	417,826 58	28,540 39	15,080 73	554,120	23,328 45	46,577	6,055 01	1,883,835	86,279 64	548,570 41
Pitkin			1,023,808 93	540,980 63	7,437,550	313,120 85	22,474	2,921 62	1,887,150	86,431 47	943,454 57
Rio Grande	11 857	245 08	1,407 05	743 48							988 56

Routt	130.121	2,689.60	22.00	11.62							2,701.22
Saguache	36.172	747.67	2,750.84	1,453.54	76,420	3,217.28	3,102	403.26			5,821.75
San Juan	47,375.009	979,241.43	941,553.01	497,516.61	10,266,101	432,202.85	2,133,323	277,331.99	15,610	714.93	2,187,007.81
San Miguel	119,718.856	2,474,588.75	1,651,687.52	872,751.68	7,135,863	300,419.83	562,888	73,175.44	1,154,392	52,871.15	3,773,806.85
Summit	8,284.227	171,234.97	64,074.74	33,857.09	1,407,610	59,260.38	10,763	1,399.19	2,542,010	116,424.05	382,175.68
Teller	630,474.957	13,031,917.35	52,270.44	27,619.70	13,129	552.73	219	28.47			13,061,118.25
TOTAL	1,097,995.924	$22,695,575.75	9,416,025.82	$4,975,428.05	57,711,898	$2,429,670.91	10,644,099	$1,383,732.87	39,270,815	$1,798,603.33	$33,283,010.91

NOTE—In the above table the calculation is on the average market price of the minerals for the year.
Gold, 20.67; silver, .5284; lead, .0421; copper, .13; zinc, .0458. The zinc figured on actual spelter recovered.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES THE MINERAL PRODUCTIONS OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1909.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Boulder	7,829.636	$ 161,838.58	49,362.50	$ 25,621.68	412,538	$ 17,627.75	11,499	$ 1,391.38	.....	.....	$ 206,479.39
Chaffee	1,464.559	30,272.43	34,617.68	17,828.10	531,808	22,724.15	560,579	67,830.06	1,292,189	$ 71,070.40	209,825.14
Clear Creek	23,423.435	484,162.40	457,671.50	235,700.82	2,990,034	127,764.15	237,762	28,769.20	757,680	41,672.40	918,068.97
Custer	617.296	12,759.50	14,594.95	7,516.40	41,718	1,782.61	577	69.81	89,600	4,928.00	27,056.32
Dolores	1,127.951	23,314.75	107,381.41	55,301.42	463,360	18,799.37	30,449	3,684.32	686,200	37,741.00	138,840.86
Eagle	2,642.587	54,622.27	123,875.51	63,595.88	147,770	6,314.21	221,169	26,761.45	458,380	25,210.90	176,504.71
Fremont	23.757	491.05	313.27	161.33	6,906	294.09	926	112.40	.....	.....	1,058.87
Gilpin	45,708.737	944,799.60	214,084.64	110,253.59	663,337	28,344.00	499,560	60,446.76	.....	.....	1,143,843.95
Grand	45.620	942.96	3,596.77	1,852.34	.....	.....	.....	.....	.....	.....	2,795.30
Gunnison	5,218.039	107,860.86	30,454.66	15,684.15	419,723	17,934.75	4,762	576.20	525,000	28,875.00	170,930.96
Hinsdale	264.184	5,460.68	73,825.88	38,020.32	100,692	4,302.57	544,663	65,904.22	.....	.....	113,687.79
Lake	67,465.398	1,394,509.78	3,340,589.84	1,720,403.76	14,122,282	603,445.10	5,031,576	608,820.70	28,020,259	1,541,114.24	5,868,293.58
La Plata	6,160.845	127,344.86	74,871.70	38,558.92	2,980	127.33	392	47.43	.....	.....	166,078.54
Mineral	5,440.185	112,448.62	911,222.47	469,279.57	9,052,061	386,794.56	14,346	1,735.86	1,926,338	105,948.59	1,076,207.20
Ouray	145,686.412	3,011,338.14	341,904.90	176,081.02	2,708,369	115,728.60	805,608	97,478.56	21,358	1,174.69	3,401,801.01
Park	26,889.970	555,815.68	101,900.42	52,478.71	2,234,181	95,466.55	49,646	6,007.16	585,949	32,227.20	741,995.30
Pitkin	64.328	1,329.66	653,237.06	336,417.08	12,630,028	539,681.10	21,708	2,626.66	717,851	39,481.80	919,536.30
Rio Grande	.....	.....	654.35	336.98	245	10.46	.....	.....	.....	.....	347.44
Routt	90.284	1,866.17	20.81	10.71	.....	.....	.....	.....	.....	.....	1,876.88

Saguache	12.586	260.15	2,864.71	1,475.32	102,226	4,368.11	3,266	395.18			6,498.76
San Juan	34,076.241	706,355.90	848,669.42	437,064.75	9,841,112	420,510.71	1,566,524	189,549.40	1,345,927	74,025.98	1,827,506.74
San Miguel	112,222.111	2,319,631.03	1,361,966.54	701,412.76	4,909,422	209,779.60	478,437	57,891.88	1,005,376	55,295.68	3,344,010.95
Summit	20,461.175	422,932.48	97,160.85	50,037.83	3,303,134	141,142.91	3,833	463.80	4,296,000	236,280.00	850,857.02
Teller	554,727.943	11,466,226.58	63,203.70	32,549.90	36,720	1,569.04	668	80.82			11,500,426.34
Total	1,061,663.279	$21,946,684.13	8,908,045.54	$4,587,643.34	64,720,646 Boulder Co	$2,765,511.72 unty's producti	10,087,950 on of tungste	$1,220,641.95 n for 1909	41,728,107	$2,295,045.88	$32,815,527.32 396,000.00
											$33,211,527.32

Note—In the above table the calculation is on the average market price of the minerals for the year.
Gold, 20.67; silver, .515; lead, .04273; copper, .121; zinc, .055. The zinc figured on actual spelter recovered.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES THE MINERAL PRODUCTIONS OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1910.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Boulder	6,430 075	$ 132,909 65	44,161 82	$ 23,613 32	51,373	$ 2,306 64	21,851	$ 2,759 78			$ 161,589 39
Chaffee	3,524 866	72,858 98	170,768 69	91,310 02	1,026,297	46,080 74	185,314	23,405 16	1,254,637	$ 67,624 93	301,279 83
Clear Creek	23,552 950	486,839 48	457,976 45	244,880 00	2,457,290	110,332 32	607,543	76,732 68	1,910,432	102,972 28	1,021,756 76
Costilla	112 151	2,318 16	9 27	4 96							2,323 12
Custer	442 150	9,139 24	7,268 74	3,886 60	15,712	705 47	4,242	535 76			14,267 07
Delta	3 439	71 08									144 96
Dolores	741 599	15,328 85	87,777 09	46,934 41	198,648	8,919 29	14,025	1,771 36	52,813	2,846 62	75,800 53
Douglas	4 005	82 78									82 78
Eagle	1,416 322	29,275 38	89,538 68	47,876 33	395,895	17,775 68	211,119	26,664 33	1,340,370	71,245 94	192,837 66
Garfield	175 346	3,624 40	304 25	162 68			499	63 02			3,850 10
Gilpin	28,637 398	591,935 02	143,732 57	76,853 80	570,845	25,630 94	518,631	65,503 10			759,922 86
Gunnison	11,482 855	237,350 61	45,074 69	24,101 44	566,694	25,444 56	22,306	2,817 25	357,394	19,263 54	308,977 40
Hinsdale	289 745	5,989 03	55,642 98	29,752 30	248,756	11,169 14	460,961	58,219 37			105,129 84
Lake	57,215 569	1,182,645 81	3,045,312 37	1,628,328 52	12,728,195	571,495 96	3,749,724	473,589 76	41,757,155	2,250,710 71	6,106,770 76
La Plata	18,953 330	391,765 23	142,167 34	76,016 88	373	12 26	152	19 20			467,813 57
Mineral	5,634 123	116,457 32	769,442 38	411,420 84	8,131,421	365,100 80	25,520	3,223 18	3,129,157	168,661 56	1,064,863 70
Montezuma	422 241	8,727 72	214 57	114 75			217	27 41			8,869 86
Ouray	107,007 180	2,211,838 41	417,980 04	223,493 93	4,043,070	181,533 84	654,295	82,637 46			2,699,503 64
	12,838 681	265,375 54	116,939 80	62,527 71	2,051,812	92,126 36	86,254	10,893 88	940,760	50,706 96	481,630 45

Pitkin	31.436	649.78	472,597.05	252,697.64	13,407,805	602,010 44	24,426	3,085.00			858,442 86
Rio Grande	63.188	1,306.10	61.19	32.72	246	11 04	89	11.24			1.361 10
Routt	254.096	5,252 16	35.64	19.06							5.271 22
Saguache	52.263	1,080 28	6,296.83	3,366.92	193,823	8,702 65	7,429	938.28			14.088 13
San Juan	33,447 194	691,353 50	756,234.87	404,358.78	10.887,752	488,860.06	1,146,134	144,756.72	5,161,542	278.207.11	2,007,536 17
San Miguel	120,716.816	2,495,216.58	1,156,663.27	618,467.85	7.431,312	323,665.91	538,158	67,969.36	1,762,879	95.019.18	3,600.338 88
Summit	18,078.218	373,676.77	172,857.71	92,427.02	6,154,629	276,342.84	25,426	3,211.30	4,808,508	259,178.58	1,004,836 51
Teller	530,453.204	10,964,467.73	56,269.42	30,087.26	3,421	153.60					10,994,708 59
Total	981,980.440	$20,297,535.69	8,215,327.71	$4,392,735.72	70,565,369	$3,158,380.54	8,304,312 Boulder Coun	$1,048,834.60 ty's production	62,475,647 of tungsten	$3.366,437 41 for 1910	$32 263.923 74 736,700 C0
											$33.000.623 74

Note.—In the above table the calculations are made on the average price of the mineral for the year,
Gold, 20.67; silver, .5347; lead, .0449; copper, .1263; zinc, .0539. The zinc figured on actual spelter recovered.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES THE MINERAL PRODUCTION OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1911.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Boulder	7,888 312	$ 163,051 40	47,926 78	$ 25,546.40	151,501	$ 6,764.53	38,275	$ 4,676.81	.....	.....	$ 200.039 14
Chaffee	3.186 483	65,864 60	94,072.39	50,143.41	1,016,511	45,387.21	106,112	12,965.83	630,794	$ 35,374.93	209,735.98
Clear Creek	26,933 131	556,707 83	474,760.75	253,061.73	3,910,660	174,610.97	728,250	88,984.87	1,587,134	89,006.47	1,162,371.87
Costilla	1,081 736	22,359 49	96.62	51.50	.....	.....	.....	.....	.....	.....	22,410.99
Custer	74 549	1,540 93	11,716.42	6,245.20	17,601	785.88	1,899	232.04	.....	.....	8,804.05
Dolores	361 584	7,473.94	49,862.24	26,578.06	502,688	22,445.02	1,774	216.77	618,047	34,660.08	91.373.87
Douglas	1.700	35.13	.....	.....	.....	.....	.....	.....	.....	.....	35.13
Eagle	2,001.301	41,366.89	113,965.43	60,746.99	820,342	36,628.27	94,726	11,574.57	7,432,000	416,786.56	567,103.28
Fremont	8 601	177.78	1,345.12	716.99	19,918	889.34	17,047	2,082.97	25,359	1,422.13	5,289.21
Gilpin	38,106.510	787,661.58	318,947.56	170,008.62	1,401,595	62,581.22	1,361,022	166,303.28	.....	.....	1,186 554.70
Gunnison	6.650.238	137,460.42	25,024.64	13,338.88	413,054	18,442.86	10,946	1,337.49	454,501	25,488.42	196,068.07
Hinsdale	185 252	3,829.16	7,754.70	4,133.49	118,719	5,300.80	26,365	3,221.54	42,870	2,404.15	18,889 14
Lake	56,149.600	1,160,612.25	3,067,463.12	1,635,049.87	16,237,749	725,015.49	4,787,587	584,995.25	74,150,404	4,158,354.66	8,264,027 52
La Plata	13,896.973	287,250.43	68,266.06	36,387.88	1,516	67.69	89,933	10,988.92	.....	.....	334,694.92
Mineral	8,706.304	179,959.30	545,856.04	290,957.64	7,002,372	312,655.91	36,395	4,447.11	1,226,725	68,794 74	856,814.70
Montezuma	.....	.....	4.50	2.40	.....	.....	223	27.25	.....	.....	29.65
Ouray	93,602 831	1,934.770 50	484,608 02	258,310.59	4,002,798	178,724.92	668,414	81,673.50	.....	.....	2,453,479.51
Park	2,843 588	58,776.96	69,255.97	36,915.51	923,080	41,215.52	25,831	3,156.29	974,000	54,621.92	194,686.20
Pitkin	18 439	381 12	438,701 37	233,840 99	10,179,982	454,536.20	40,700	4,973.13	.....	.....	693,731.44

Rio Grande.....	.649	13.41	1,558.93	830.96	1,689	75.41	79	9.65	.....	.....	929.43
Saguache.....	20.274	419.06	2,437.01	1,299.00	48,003	2,143.34	4,963	606.42	.....	.....	4,467.82
San Juan.....	15,633.716	323,148.91	296,207.43	157,887.45	6,280,287	280,414.82	473,987	57,916.47	2,047,722	114,836.25	934,203.90
San Miguel.....	118,759.546	2,454,759.84	995,741.55	530,760.12	6,668,744	297,759.42	831,007	101,540.74	2,752,883	154,381.68	3,539,201.80
Summit.....	13,555.729	280,196.92	181,364.70	96,672.83	5.788,878	258,473.40	34,103	4,167.05	9,630,096	540,055.78	1,179,565.98
Teller.....	511,606.863	10,574,913.85	59,899.52	31,928.24	10,712	478.29	307	37.51	.....	.....	10.607,357.89
TOTAL.....	921,273.909	$19,042,731.70	7,356,836.87	$3,921,414.75	65,518,399	$2,925,396.51	9,379,945	$1,146,135.46	101,572.535	$5,696,187.77	$32,731,866.19
					Boulder Coun	ty's production	of tungsten	for 1911—740	tons at $600.	.....	444,000.00
					Gilpin Count	y's production o	f uranium fo	r 1911—20 tons	.....	.....	5,000.00
					San Miguel C	ounty's produc	tion of vanad	ium for 1911...	.....	.....	547,500.00
					Montrose Cou	nty's productio	n of uranium	and vanadium	for 1911—1,5	15½ tons.....	303,100.00
											$34.031.466.19

NOTE.—In above table the calculations are made on the average price of the mineral for the year.
Gold, 20.67; silver, .53303; lead, .04465; copper, .12219; zinc, .05606. The zinc figured on actual spelter recovered.

THE BUREAU OF MINES OF THE STATE OF COLORADO

SHOWING BY COUNTIES THE MINERAL PRODUCTION OF COLORADO FOR THE YEAR ENDING DECEMBER 31, 1912.

COLORADO	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
Name of County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Boulder	4,907.897	$ 101,446.23	54,722.20	$ 33,290.25	313,159	$ 14,001.33	33,525	$ 5,453.18			$ 154,190.99
Chaffee	5,010.318	103,563.27	99,304.51	60,411.89	980,174	43,823.58	137,752	22,406.74	255,750	$ 17,388.44	247,593.92
Clear Creek	25,021.702	517,198.58	437,539.21	266,176.98	4,846,816	216,701.14	590,550	96,058.86	1,564,003	106,336.57	1,202,472.13
Custer	644.412	13,320.00	21,470.40	13,061.52	10,372	463.73	2,175	353.79			27,199.04
Dolores	441.233	9,120.29	82,569.44	50,231.12	501,833	22,436.95	680,985	110,769.02	768,252	52,233.45	244,790.83
Eagle	2,352.963	48,635.75	164,748.76	100,224.91	1,240,842	55,478.05	176,937	28,780.57	5,337,630	362,905.46	596,024.74
Fremont	319.455	6,603.13	2,024.04	1,231.82	25,481	1,139.26	14,862	2,417.45			11,391.16
Gilpin	42,302.636	874,395.49	334,312.46	203,378.99	1,551,192	69,353.79	1,427,989	232,276.69			1,379,404.96
Gunnison	6,012.898	124,286.60	23,786.78	14,470.69	298,381	13,340.61	8,425	1,370.41	435,652	29,619.98	183,088.29
Hinsdale	312.060	6,450.28	33,639.55	20,464.62	1,222,197	54,644.43	57,009	9,273.08	14,034	954.17	91,786.58
Jefferson	5.238	108.27	.59	.36							108.63
La Plata	6,485.563	134,056.58	49,325.05	30,006.89	9,293	415.49	6,360	1,034.52			165,513.48
Lake	54,789.935	1,132,507.96	2,979,490.06	1,812,572.78	24,736,738	1,105,979.57	2,835,799	461,271.07	99,387,563	6,757,360.41	11,269,691.79
Montezuma	1.022	21.12	10.88	6.62			86	13.99			41.73
Mineral	4,403.844	91,027.46	716,127.07	435,655.90	5,267,925	235,528.93	68,543	11,149.20	327,116	22,240.62	795,602.11
Mesa	430	8.89	257.46	156.63	20	.89	7,287	1,185.30			1,351.71
Moffat	117.054	2,419.51	5.26	3.20							2,422.71
Montrose	37.037	765.55	8.63	5.25							770.80
Ouray	53,028.409	1,096,097.21	566,170.24	344,429.67	3,062,018	136,902.82	527,558	85,812.58	44,435	3,021.14	1,666,263.42

Pitkin	11.195	231.40	529,035.18	321,838.55	8,390,842	375,154.55	29,443	4,789.20	465,154	31,625.82	733,639.52
Park	3,318.355	68,590.40	28,834.06	17,541.20	170,389	7,618.09	13,615	2.214.62	62,156	4,225.99	100,190.30
Rio Grande	22.058	455.94	102.47	62.34	564	25.22	6	.98			544.48
Routt	.148	3.06	28.14	17.12			5,968	970 75			990.93
San Juan	25,205.157	520,990.60	720,394.22	438,251.82	8,904,586	398,124.04	1,323,073	215,211.06	2,370,118	161,144.32	1,733,721.84
San Miguel	116,112.771	2,400,050.98	1,178,660.84	717,038.32	7,588,242	339,270.30	884,309	143,841.71	3,704,379	251,860.73	3,852,062.04
Saguache	184.009	3,803.47	19,209.59	11,686.15	504.275	22,546.14	32,118	5,224.31	600,630	40,836.83	84,096.90
Summit	20,480.628	423,334.58	150,040.51	91,277.14	3,697,660	165,322.38	20,577	3,347.05	11,029,119	749,869.80	1,433,150.95
Teller	532.756.878	11,012.084 66	66,521.77	40,468.52	54,380	2,431.33	1,170	190.31			11,055,174.82
Grand Total	904,285.305	$18,691,577.26	8,258,339.37	$5,023.960.75	73,377,379	$3,280,702.62	8,886,121	$1,445,416.44	126,365,991	$8,591,623.73	$37,033,280.80
					Boulder Coun	ty's production	of tungsten f	or 1912—700 to	ns at $750		525,000.00
					San Miguel C	ounty's produc	tion of vanad	ium for 1912—	666½ tons		666,500.00
					Montrose Cou	nty's productio	n of uranium	and vanadium	for 1912—1,	092½ tons	245,812.50
											$38,470,593.30

Note—In the above table the calculations are based on the average price of the mineral for the year.
Gold, 20.67; silver, .060835; lead, .04471; copper, .016266; zinc, .06799.

PRODUCTION OF

PRECIOUS METAL

To December 31, 1912

THE BUREAU OF MINES OF THE STATE OF COLORADO

PRECIOUS METAL PRODUCTION OF COLORADO TO DECEMBER 31, 1912.

YEAR	GOLD		SILVER		LEAD		COPPER		ZINC		TOTAL
	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	Pounds	Value	
Previous to 1870	1,316,550	$27,213,081 00	250,000	$ 330,000 00			200,000	$ 40,000.00			$ 27,583,081 00
1870	145,864	3,015,000 00	500,000	660,000.00			97,088	20,000.00			3,695,000 00
1871	175,808	3,633,951 00	779,590	1,029 058 00			90,909	30,000 00			4,693,009 00
1872	128,034	2,646,463 00	1,524,207	2,015,001 00	80,000	$ 5,000.00	155,172	45,000.00			4,711,464 00
1873	88,788	1,835,248 00	1,683,370	2,185,014 00	112,000	7,078.40	28,172	65,000.00			4,092,340.40
1874	99,932	2,065,595 00	2,415,435	3,086,926 00	624,000	37,502.40	400,876	90,197.00			5,280,220.40
1875	112,291	2,321,055 00	2,306,253	2,873,591 00	1,636,000	95,706.00	428,571	90,000 00			5,380,352 00
1876	131,897	2,726,311 00	2,552,125	2,950,256 00	1,334,000	81,774 20	376,244	70,000 00			5,828,341 20
1877	145,138	3,000,000 00	3,480,548	4,180,138 00	1,794,000	98,490 60	504,283	93,796 64			7,372,425 24
1878	162,864	3,366,404 00	4,172,744	4,807,001 00	13,338,000	481,501 80	539,393	89,000 00			8,743,906 80
1879	156,023	3,225,000 00	9,049,424	10,162,503 00	47,348,000	1,960,207 20	766,082	131,000 00			15,478,710 20
1880	154,814	3,200,000 00	13,148,735	15,055,302 00	71,348,000	3,595,939.20	915,422	184,000 00			22,035,241 20
1881	159,652	3,300,000 00	13,272,488	15,104,092 00	81,094,000	3,900,621.40	889,503	161,000 00			22,465,713 40
1882	162,554	3,360,000 00	12,707,866	14,436,136 00	110,000,000	5,401,000.00	1,494,000	276,390 00			23,473,526 00
1883	198,355	4,100,000 00	13,434,915	14,912,756 00	141,114,000	6,096,124 80	1,153,000	182,750 50			25,291,631 30
1884	205,612	4,250,000 00	12,375,280	13,984,066 00	126,330,000	4,724,742 00	2,013,000	278,800 50			23,237,608 50
1885	203,193	4,200,000 00	12,220,589	13,014,927 00	111,000,000	4,345,000 00	1,146,000	127,435 20			21,687,362 20
1886	215,288	4,450,000 00	12,375,280	12,313,404 00	118,000,000	5,463,400 00	409,000	44,990 00			22,271,794 00
1887	193,517	4,000,000 00	11,600,826	11,345,608 00	126,000,000	5,670,000 00	2,012,000	226,350 00			21,241,958 00

1888	181,809	3,758,000.00	14,695,645	13,813,906.00	131,000,000	5,790,200.00	1,621,000	270,058.60	.....	.....	23,632,164.60
1889	187,898	3,833,859.00	18,375,519	17,199,486.00	138,000,000	5,423,400.00	3,100,000	426,250.00	.....	.....	26,932,995.00
1890	200,774	4,150,000.00	18,800,425	19,665,245.00	109,000,000	4,883,200.00	6,000,000	945,000.00	.....	.....	29,643,445.00
1891	222,545	4,600,000.00	21,160,480	20,906,554.00	128,000,000	5,568,000.00	7,000,000	883,400.00	.....	.....	31,957,954.00
1892	256,410	5,300,000.00	26,350,000	23,082,600.00	123,000,000	5,030,700.00	7,250,000	837,375.00	.....	.....	34,250,675.00
1893	364,151	7,527,000.00	25,838,600	20,205,785.00	84,396,000	3,147,970.80	7,121,157	765,535.13	.....	.....	31,646,290.93
1894	462,009	9,549,731.00	23,236,025	14,638,696.00	97,264,000	3,200,000.00	6,528,214	624,097.26	.....	.....	28,012,524.26
1895	656,021	13,559,954.00	17,891,626	11,683,232.00	91,477,214	2,954,714.00	6,125,000	659,050.00	.....	.....	28,856,950.00
1896	738,618	15,267,234.00	21,547,743	14,458,536.00	82,018,000	2,321,109.30	7,539,245	820,269.86	.....	.....	32,867,149.26
1897	947,249	19,579,637.00	21,278,202	12,692,448.00	80,799,778	2,731,032.49	9,151,592	960,917.13	.....	.....	35,964,034.62
1898	1,138,584	23,534,531.28	23,502,601	13,690,265.15	113,417,168	4,117,043.24	10,870,869	1,304,504.28	.....	.....	42,646,343.95
1899	1,282,471	26,508,675.57	23,114,688	13,771,731.10	138,048,446	6,170,765.53	7,357,245	1,295,610.85	.....	.....	47,746,783.05
1900	1,391,487	28,762,036.29	20,336,712	12,488,774.84	164,274,762	7,770,196.24	7,826,949	1,293,011.98	.....	.....	50,314,019.35
1901	1,339,112	27,679,445.04	18,492,563	10,901,365.89	148,111,020	6,419,131.61	7,872,529	1,303,297.17	.....	.....	46,303,239.71
1902	1,379,638	28,517,117.46	15,941,703	8,315,192.29	106,303,374	4,325,484.29	8,463,938	1,006,108.31	52,582,510	2,544,993.48	44,708,895.83
1903	1,045,252	21,605,358.84	13,245,483	7,079,710.66	101,513,414	4,301,123.35	7,809,920	1,033,642.90	80,616,000	4,353,264.00	38,373,099.75
1904	1,171,892	24,223,007.64	12,960,777	7,416,156.60	107,546,854	4,624,514.73	9,401,913	1,205,607.31	64,976,235	3,313,787.97	40,783,074.25
1905	1,237,443	25,577,946.81	12,831,348	7,743,718.51	115,712,908	5,438,506.67	9,854,176	1,536,266.04	81,198,941	4,774,497.91	45,070,935.94
1906	1,092,827	22,588,734.09	12,725,882	8,499,734.83	105,984,540	5,666,993.36	9,565,319	1,844,002.19	85,488,901	5,298,602.09	43,898,075.56
1907	990,398	20,471,526.66	12,059,202	7,886,736.17	92,987,235	4,965,517.10	11,256,291	2,251,258.20	85,018,157	5,275,376.64	40,847,834.55
1908	1,097,995	22,695,575.75	9,416,025	4,975,428.05	57,711,898	2,429,670.91	10,644,099	1,383,732.87	39,270,815	1,798,603.33	33,283,010.91
1909	1,061,663	21,946,684.13	8,908,045	4,587,643.34	64,720,646	2,765,511.72	10,087,950	1,220,641.95	41,728,107	2,295,045.88	33,211,527.32
1910	981,980	20,297,535.69	8,215,327	4,392,735.72	70,565,369	3,158,380.54	8,304,312	1,048,834.60	62,475,647	3,366,437.41	32,263,923.74
1911	921,274	19,042,731.70	7,356,837	3,921,414.75	65,518,399	2,925,396.51	9,379,945	1,146,135.46	101,572,535	5,696,187.77	32,731,866.19
1912	904,285	18,691,577.26	8,258,339	5,023,960.75	73,377,379	3,280,702.62	8,886,121	1,445,416.44	126,365,991	8,591,623.73	37,033,280.80
TOTAL	25,409,959	$525,226,307.21	546,389,412	$433,486,844.00	3,541,900,404	$151,373,353.11	212,636,499	$29,755,733.37	821,293,839	$47,308,420.21	$1,187,543,778.41

NOTE.—In the above table the calculations are made on the average price of the mineral for the year.

Average Market Value of Metals per Annum

YEAR	Gold per Ounce	Silver per Ounce	Lead per Pound	Copper per Pound	Zinc per Pound
Previous to 1870	$20.67	$1.32	.....	$0 20	.....
1870	20.67	1.32	.....	.206	.....
1871	20.67	1.32	.....	.33	.....
1872	20.67	1.322	$0.0625	.29	.....
1873	20.67	1.298	.0632	.232	.....
1874	20.67	1.278	.0601	.225	.....
1875	20.67	1.246	.0585	.21	.....
1876	20.67	1.156	.0613	.186	.....
1877	20.67	1.201	.0549	.186	.....
1878	20.67	1.152	.0361	.165	.....
1879	20.67	1.123	.0414	.171	.....
1880	20.67	1.145	.0504	.201	.....
1881	20.67	1.138	.0481	.181	.....
1882	20.67	1.136	.0491	.185	.....
1883	20.67	1.11	.0432	.1585	.....
1884	20.67	1.13	.0374	.1385	.....
1885	20.67	1.065	.0395	.1112	.....
1886	20.67	.995	.0463	.11	.....
1887	20.67	.978	.0450	.1125	.....
1888	20.67	.94	.0442	.1666	.....
1889	20.67	.936	.0393	.1375	.....
1890	20.67	1.046	.0448	.1575	.....
1891	20.67	.988	.0435	.1262	.....
1892	20.67	.876	.0409	.1155	.....
1893	20.67	.782	.0373	.1075	.....
1894	20.67	.63	.0329	.0956	.....
1895	20.67	.653	.0323	.1076	.....
1896	20.67	.671	.0283	.1088	.....
1897	20.67	.5965	.0338	.105	.....
1898	20.67	.5825	.0363	.12	.....
1899	20.67	.5958	.0447	.1761	.....
1900	20.67	.6141	.0473	.1652	.....
1901	20.67	.5895	.04334	.16555	.....
1902	20.67	.5216	.01069	.11887	.0484
1903	20.67	.5345	.04237	.13235	.054
1904	20.67	.5722	.043	.12823	.051
1905	20.67	.6035	.047	.1559	.0588
1906	20.67	.66791	.05347	.09278	.06198

AVERAGE MARKET VALUE OF METALS PER ANNUM—CONCLUDED

YEAR	Gold per Ounce	Silver per Ounce	Lead per Pound	Copper per Pound	Zinc per Pound
1907	$20.67	$0.654	$0.0534	$0.20	$0.06205
1908	20.67	.5284	0421	.13	.0458
1909	20.67	.515	.04273	.121	.055
1910	20.67	.5347	.0449	.1263	.0539
1911	20.67	.53303	.04465	.12219	.05608
1912	20.67	.60835	.04471	.16266	.06799

Mining Laws and Regulations Relating to Lode and Placer Claims

RULES AND REGULATIONS OF THE UNITED STATES SURVEYOR GENERAL'S OFFICE AND UNITED STATES LAND OFFICE

FEES AND PAYMENTS FOR PATENTING

For lode claim	$30.00
For placer claim	35.00
For millsite	30.00
For millsite included in one survey with a lode claim	20.00
For each lode claim within and included in the survey of a placer claim	20.00
For several lode locations included in one survey, the first location named	30.00
All other locations named, each	25.00
For several placer locations included in one survey, the first location named	35.00
All other locations included, each	30.00
For affidavit of $500 expenditure of improvements after approval of survey	5.00

PUBLIC LAND FILINGS

All valuable mineral deposits in lands belonging to the United States, both surveyed and unsurveyed, are hereby declared to be free and open to exploration and purchase, and the lands in which they are found, to occupation and purchase by citizens of the United States, and those who have declared their intention to become such, under regulations prescribed by law, and according to the local customs or rules of miners in the several mining districts, so far as the same are applicable and not inconsistent with the laws of the United States. (Rev. Stat. U. S., Sec. 2319.)

LODE CLAIMS

No location of a mining claim shall be made until the discovery of the vein or lode within the limits of the claim located.

The length of any lode claim may be equal to, but not exceed, 1,500 feet along the vein. The width of lode claims shall be 150 feet on each side of the center of the vein or crevice.

The discoverer of a lode shall, within three months from the date of discovery, record his claim in the office of the recorder of the county in which such lode is situated, by a location certificate.

Before filing such location certificate the discoverer shall locate his claim: (1) By sinking a discovery shaft upon the lode to the depth of at least ten feet from the lowest part of the rim of such shaft at the surface, or deeper if necessary to show a well-defined crevice. (2) By posting at the point of discovery on the surface a plain sign or notice, containing the name of the lode, the name of the locator and the date of discovery. (3) The discoverer shall have sixty days from the time of uncovering or disclosing a lode to sink a discovery shaft thereon.

On each claim located, and until a patent has been issued therefor, not less than $100.00 worth of labor shall be performed or improvements made during each year. The period within which the work required to be done annually on all unpatented mineral claims shall commence on the first day of January succeeding the date of location of such claim.

Marking boundaries—posts, piles of stones.—Such surface boundaries shall be marked by six substantial posts hewed or marked on the side or sides which are in toward the claim, and sunk in the ground, to-wit: one at each corner and one at the center of each side line. Where it is practically impossible on account of bed-rock to sink such posts, they may be placed in a pile of stones, and where in marking the surface boundaries of a claim any one or more of such posts shall fall by right upon precipitous ground, where the proper placing of it is impracticable or dangerous to life or limb, it shall be legal and valid to place any such post at the nearest practicable point, suitably marked, to designate the proper place.

Open cut, cross-cut, tunnel, adit, to hold lode.—Any open cut, cross-cut or tunnel which shall cut a lode at a depth of ten feet below the surface, shall hold such lode, the same as if a discovery shaft were sunk thereon, or an adit of at least ten feet in along the lode from the point where the lode may be in any manner discovered, shall be equivalent to a discovery shaft.

Sixty days to sink discovery shaft.—The discoverer shall have sixty days from the time of uncovering or disclosing a lode to sink a discovery shaft thereon.

What location includes; extralateral rights.—The location or location certificate of any lode claim shall be construed to include all surface ground within the surface lines thereof, and all lodes and ledges throughout their entire depth, the top or apex of which lies inside of such lines extended downward, vertically, with such parts of all lodes or ledges as continue by dip beyond the side lines of the claim, but shall not include any portion of such lodes or ledges beyond the end lines of the claim, or the end lines continued, whether by dip or otherwise, or beyond the side lines in any other manner than by the dip of the lode.

PLACERS

All placer mining claims shall conform as near as practicable with the United States system of public land surveys, and no such location shall include more than twenty acres for each individual claimant.

Claims usually called "placers," including all forms of deposits, excepting veins of quartz or other rock in place, shall be subject to entry and patent under like circumstances and conditions, and upon similar proceedings, as provided for vein or lode claims.

Location certificate; recording; manner of locating.—The discoverer of a placer claim shall, within thirty days from the date of discovery, record his claim in the office of the recorder of the county in which said claim is situated, by a location certificate, which shall contain: first, the name of the claim, designating it as a placer claim; second, the name of the locator; third, the date of location; fourth, the number of acres or feet claimed; and, fifth, a description of the claim, by such reference to natural objects or permanent monuments as shall identify the claim. Before filing such location certificate the discoverer shall locate his claim, first, by posting upon such claim a plain sign or notice, containing the name of the claim, the name of the locator, the date of discovery, and the number of acres or feet claimed; second, by marking the surface boundaries with substantial posts, and sunk into the ground, to-wit, one at each angle of the claim.

Size of claims.—Legal subdivisions of forty acres may be subdivided into ten-acre tracts; and two or more persons or associations of persons, having contiguous claims of any size, although such claims may be less than ten acres each, may make joint entry thereof; but no location of a placer claim made after the ninth day of July, eighteen hundred and seventy, shall exceed one hundred and sixty acres for any one person or association of persons, which location shall conform to the United States surveys; and nothing in this section contained shall defeat or impair any bona fide pre-emption or homestead claim upon agricultural lands, or authorize the sale of the improvements of any bona fide settler to any purchaser.

Twenty acres to one locator.—Where placer claims are upon surveyed lands, and conform to legal subdivisions, no further survey or plat shall be required, and all placer mining claims located after the tenth day of May, eighteen hundred and seventy-two, shall conform as near as practicable with the United States system of public land surveys and rectangular subdivisions of such surveys, and no such location shall include more than twenty acres for each individual claimant; but where placer claims cannot be conformed to legal subdivisions, survey and plat shall be made as on unsurveyed lands; and where, by the

segregation of mineral land in any legal subdivision, a quantity of agricultural land less than forty acres remains, said fractional portion of agricultural land may be entered by any party qualified by law for homestead or pre-emption purposes.

Claim intersected by lode.—Where the same person, association or corporation is in possession of a placer claim, and also a vein or lode included within the boundaries thereof, application shall be made for a patent for the placer claim, with the statement that it includes such vein or lode, and in such case a patent shall issue for the placer claim, subject to the provisions of this chapter, including such vein or lode, upon the payment of five dollars per acre for such vein or lode claim, and twenty-five feet of surface on each side thereof. The remainder of the placer claim, or any placer claim not embracing any vein or lode claim, shall be paid for at the rate of two dollars and fifty cents per acre, together with all costs of proceedings; and where a vein or lode, such as is described in section 2320, is known to exist within the boundaries of a placer claim, an application for a patent for such placer claim which does not include an application for the vein or lode claim shall be construed as a conclusive declaration that the claimant of the placer claim has no right of possession of the vein or lode claim; but where the existence of a vein or lode in a placer claim is not known, a patent for the placer claim shall convey all valuable mineral and other deposits within the boundaries thereof.

Location and location certificate.—The discoverer of a placer claim shall, within thirty days from the date of discovery, record his claim in the office of the recorder of the county in which said claim is situated, by a Location Certificate which shall contain: first, the name of the claim, designating it as a placer claim; second, the name of the locator; third, the date of location; fourth, the number of acres or feet claimed; and, fifth, a description of the claim by such reference to natural objects or permanent monuments as shall identify the claim.

Before filing such location certificate, the discoverer shall locate his claim: first, by posting upon such claim a plain sign or notice, containing the name of the claim, the name of the locator, the date of discovery, and the number of acres or feet claimed; second, by marking the surface boundaries with substantial posts, and sunk in the ground, to wit, one at each angle of the claim. (1879.)

Annual labor.—On each placer claim of one hundred and sixty acres or more, heretofore or hereafter located, and until a patent has been issued therefor, not less than one hundred dollars' worth of labor shall be performed or improvements made by the first day of August, 1879, and by the first day of August of each year thereafter. On all placer claims containing less than one hundred and sixty acres the expenditure during each

year shall be such proportion of one hundred dollars as the number of acres bears to one hundred and sixty. On all placer claims containing less than twenty acres the expenditures during each year shall not be less than twelve dollars; but when two or more claims lie contiguous, and are owned by the same person, the expenditure hereby required for each claim may be made on any one claim, and upon a failure to comply with these conditions, the claim or claims upon which such failure occurred shall be open to relocation, in the same manner as if no location of the same had ever been made; provided, that the original locators, their heirs, assigns or legal representatives, have not resumed work upon the claim after failure and before such location; provided the aforesaid expenditures may be made in building or repairing ditches to conduct water upon such ground, or in making other mining improvements necessary for the working of such claim.

Upon the failure of any one of several co-owners to contribute his proportion of the expenditures required hereby, the co-owners who have performed the labor, or made the improvements, may at the expiration of the year, to wit, the first of August, 1879, for the locations heretofore made, and one year from the date of locations hereafter made, give such delinquent co-owner personal notice in writing, or, if he be a non-resident of the State, a notice by publication in the newspaper published nearest the claim for at least once a week for ninety days, and mailing him a copy of such newspaper if his address be known, and if at the expiration of ninety days after such notice in writing, or after the first publication of such notice, such delinquent should fail or refuse to contribute his proportion of the expenditure required by this section, his interest in the claim shall become the property of his co-owners who have made the required expenditures. (1879.)

TUNNELS

Any person or persons engaged in working a tunnel, within the provisions of this chapter, shall be entitled to 250 feet each way from said tunnel, on each lode so discovered; provided, they do not interfere with any vested rights. If it shall appear that claims have been staked off and recorded prior to the record of said tunnel, on the line thereof, so that the required number of feet cannot be taken near said tunnel, they may be taken upon any part thereof where the same may be found vacant; and persons working said tunnel shall have the right of way through all lodes which may lie in its course.

Where a tunnel is run for the development of a vein or lode, or for the discovery of mines, the owners of such tunnel shall have the right of possession of all veins or lodes within 3,000 feet from the face of such tunnel on the line thereof not

previously known to exist, discovered in such tunnel, to the same extent as if discovered from the surface; and locations on the line of such tunnel of veins or lodes not appearing on the surface made by other parties after the commencement of the tunnel, and while the same is being prosecuted with reasonable diligence, shall be invalid; but failure to prosecute the work on the tunnel for six months shall be considered as an abandonment of the right to all undiscovered veins on the line of such tunnel.

Where a person or company has or may run a tunnel for the purpose of developing a lode or lodes owned by said persons or company, the money so expended on said tunnel shall be taken and considered as expended on said lode or lodes, and such person or company shall not be required to perform work on the surface of said lode or lodes in order to hold the same.

AFFIDAVIT OF ANNUAL LABOR—EFFECT OF FILING

Within six months after any time set or annual period allowed for the performance of labor or making improvements upon any lode claim or placer claim, the person on whose behalf such outlay was made, or some person for him, may make and record in the office of the recorder of the county wherein such claim is situate, an affidavit in substance as follows:

State of Colorado, ... County, ss.

Before me, the subscriber, personally appeared ..... who, being duly sworn, saith that at least ..... dollars' worth of work or improvements were performed or made upon (here describe claim or part of claim), situate in ..... mining district, County of ....., State of Colorado, between the ..... day of ..... A. D. ....., and the ..... day of ..... A. D. ..... Such expenditure was made by or at the expense of ....., owners of said claim, for the purpose of complying with the law, and holding said claim.

Jurat: (Signature) .....

And such affidavit, when so recorded, shall be prima facie evidence of the performance of such labor or the making of such improvements; Provided, That all affidavits of labor or improvements upon placer claims heretofore filed and recorded within the period prescribed in this section, or within the period prescribed in section twenty-four hundred and ten of the General Statutes, which shall contain in substance the requirements of the affidavit prescribed by this section or said section twenty-four hundred and ten, shall be prima facie evidence of the performance of such labor or the making of such improvements;

and the original thereof, or a certified copy of the record of the same, shall be received as evidence accordingly by the courts of this state, and this class of evidence shall be receivable, where relevant or material, in all causes, whether now pending or hereafter brought.

RE-LOCATION BY OWNER—CONDITIONS

If at any time the locator of any mining claim heretofore or hereafter located, or his assigns, shall apprehend that his original certificate was defective, erroneous, or that the requirements of the law had not been complied with before filing, or shall be desirous of changing his surface boundaries, or of taking in any part of an overlapping claim which has been abandoned, or in case the original certificate was made prior to the passage of this law, and he shall be desirous of securing the benefits of this act, such locator, or his assigns, may file an additional certificate, subject to the provisions of this act; Provided, That such re-location does not interfere with the existing rights of others at the time of such re-location, and no such re-location or other record thereof shall preclude the claimant or claimants from proving any such title or titles as he or they may have held under previous location.

RE-LOCATION OF ABANDONED LODES

The re-location of abandoned lode claims shall be by sinking a new discovery shaft and fixing new boundaries in the same manner as if it were the location of a new claim; or the re-locator may sink the original discovery shaft ten feet deeper than it was at the time of the abandonment, and erect new or adopt the old boundaries, renewing the posts if removed or destroyed. In either case a new location stake shall be erected. In any case, whether the whole or part of an abandoned claim is taken, location certificate may state that the whole or any part of the new location is located as abandoned property.

PATENT

A patent for any land claimed and located for valuable deposits may be obtained in the following manner: Any person, association or corporation having claimed and located a piece of land for such purposes, may file in the proper land office an application for a patent, together with a plat and field notes of the claim or claims in common, made by or under the direction of the United States Surveyor-General, and shall thereupon be entitled to a patent for the land in the manner following: The register of the land office, upon the filing of such application, shall publish a notice that such application has been made, for the period of sixty days, in a newspaper to be by him

designated as published nearest to such claim; and he shall also post such notice in his office for the same period. The claimant shall file with the register a certificate of the United States Surveyor-General that $500.00 worth of labor has been expended or improvements made upon the claim. At the expiration of the sixty days of publication, the applicant is entitled to a patent, upon the payment to the proper officer of $5.00 per acre.

Altitude of Cities and Towns in Colorado

Name	Feet	Name	Feet
Alamosa	7,536	Las Animas	3,884
Alma	10,238	Leadville	10,190
Anaconda	9,453	Littleton	5,358
Antonito	7,876	Longmont	4,911
Aspen	7,943	Loveland	4,986
Berthoud	4,962	Lyons	5,319
Black Hawk	8,015	Mancos	6,996
Boulder	5,350	Manitou Springs	6,307
Breckenridge	9,534	Manzanola	4,249
Buena Vista	7,958	Meeker	6,182
Canon City	5,332	Monte Vista	7,653
Central City	8,516	Montrose	5,801
Colorado City	6,077	New Castle	5,552
Colorado Springs	5,878	Ouray	7,710
Como	9,785	Pagosa Springs	7,095
Creede	8,850	Palmer Lake	7,224
Cripple Creek	9,591	Pitkin	9,190
Del Norte	7,868	Pueblo	4,675
Delta	4,970	Red Cliff	8,598
Denver	5,184	Rico	8,725
Dillon	8,849	Ridgway	6,993
Dolores	6,945	Robinson	10,857
Durango	6,508	Rocky Ford	4,176
Fairplay	9,896	Saguache	7,745
Florence	5,187	Salida	7,038
Fort Collins	4,984	San Luis	7,946
Georgetown	8,507	Silver Plume	9,189
Glenwood Springs	5,747	Silverton	9,288
Golden	5,693	Starkville	6,337
Grand Junction	4,573	Steamboat Springs	6,781
Greeley	4,652	Sterling	3,932
Gunnison	7,673	Telluride	8,744
Idaho Springs	7,556	Trinidad	5,985
Lafayette	5,094	Victor	9,728
La Junta	4,052	Walsenburg	6,187
Lamar	3,610	Wray	3,531
Lake City	8,675	Yuma	4,117

Elevation of Mountain Peaks and Passes in Colorado

Name	Feet
Agency Knob	12,274
Alpine Tunnel	11,606
Anchor Mountain	12,092
Antelope Pass	8,050
Antero, Mount	14,245
Arapahoe Peak	13,520
Argentine Pass	13,286
Arkansas, Mount	13,807
Augusta Mountain	12,615
Avery Peak	12,659
Axtell Mountain	12,012
Bald Mountain, Boulder Co.	11,493
Bald Mountain, Larimer Co.	11,270
Bald Mountain, Summit Co.	13,974
Bald Mt., San Miguel Co.	11,700
Baldy, Mount	12,809
Banded Peak	12,860
Battlement Mesa, Mean	12,000
Basalt Peak	11,906
Bear Mountain	12,950
Beckwith Mountain	12,371
Belle View	12,673
Bellven	12,350
Beson Peak	12,426
Blackhawk	12,677
Blackhead	12,514
Blaine, Mount	14,249
Blanca Peak	14,390
Boreas	11,480
Boulder Pass	11,670
Boulder Peak	12,417
Breckenridge Pass	11,503
Buckeye Peak	12,873
Buckskin Mountain	14,296
Buffalo Peak	12,541
Calico Peak	12,056
Cameron Cone	10,685
Canby, Mount	13,466
Capitol Mountain	13,997
Carbon Mountain	12,000
Cascade	11,707
Castle Peak	14,259
Cement Mountain	12,212
Chama Peak	12,248
Cheyenne	9,497
Chicago Lake	11,500
Chief Mountain	11,710
Clark's Peak	13,167
Cochetopa Dome	10,000
Conejos Mountain	13,183
Corral Peak	11,533
Crested Butte	12,172
Crestone Peak	14,233
Culebra Peak	14,069
Cunningham Pass	12,090
Daly, Mount	13,193
Del Norte	13,084
Double Top Mountain	12,192
Eagle Peak	12,105
East Cement Mountain	12,047
East Spanish Peak	12,708
Elbert	14,421
Elk Mountain	12,718
Engineer Mountain	13,190
Elliott Mountain	12,337
Emmons, Mount	12,414
Eolus, Mount	14,079
Ethel Peak	11,976
Evans, Mount	14,321
Farnum Peak	11,400

ELEVATION OF MOUNTAIN PEAKS AND PASSES IN COLORADO.—Continued

Name	Feet
Flora, Mount	12,878
Freeman Peak	11,627
Fremont Pass	11,320
Frustum Mountain	13,893
Galena Mountain	13,290
Garfield, Mount	13,065
Georgia Pass	11,476
Gibson Peak	13,729
Gilpin Peak	13,682
Glacier Peak	12,654
Golden Peak	9,650
Gothic Mountain	12,646
Grand Mesa	10,000
Grayback Peak	12,387
Gray Head Summit	10,994
Gray's Peak	14,341
Greenhorn Mountain	12,334
Green Mountain	10,530
Griffith Mountain	11,427
Grizzly Peak, San Juan	13,748
Grizzly Peak, Pitkin	13,956
Gunnison, Mount	12,688
Guyot Mountain	13,565
Hagerman	11,495
Hague	13,832
Hamilton, Mount	13,800
Hancock Pass	12,263
Handie's Peak	14,008
Hanby Peak	10,906
Harvard, Mount	14,375
Hayden Divide	9,182
Hayden Pass	10,780
Helmet Peak	11,976
Hermosa, Mount	12,564
Hesperus Peak	13,225
Holy Cross, Mount of	14,170
Homestake Peak	13,227
Hoosier Pass	10,309

Name	Feet
Horsefly Peak	10,504
Horseshoe Mountain	13,912
Humboldt Peak	14,044
Hunchback Mountain	13,133
Hunt's Peak	12,446
Hurricane Peak	13,565
Iron Mountain	10,405
Jacque Peak	13,215
James Peak	13,283
Johnny Bull Mountain	12,018
Jones Mountain	13,851
Jupiter Peak	13,830
Kendall, Mount	13,480
Kenosha Cone, East	12,350
Kenosha Cone, West	12,340
Keyes, Mount	13,750
Kit Carson Peak	14,100
Lake Creek Pass	12,226
Lamborn, Mount	11,337
La Plata Peak	14,342
La Veta Peak	11,000
Leavenworth Mountain	10,390
Leviathan Peak	13,52[illegible]
Leon Peak	10,954
Lilie Mountain	11,433
Lincoln, Mount	14,297
Little Lone Cone	12,001
Lizard Head	13,156
Lone Cone	12,761
Long's Peak	14,271
Lookout Peak	13,674
Lost Park Mountain	11,800
Loveland Pass	11,876
McClellan, Mount	13,423
McMillan Peak	12,800
Macomb Peak	13,154
Marcellina, Mount	11,34[illegible]
Marmot Peak	11,8[illegible]

ELEVATION OF MOUNTAIN PEAKS AND PASSES IN COLORADO.—Continued

Name	Feet	Name	Feet
Maroon Peak	14,126	Pisgah, Mount	10,322
Marshall Pass	10,846	Plateau Peak	12,030
Marvine, Mount	12,045	Pole Creek Mountain	13,400
Massive, Mount	14,424	Poncha Pass	9,049
Matterhorn Peak	13,589	Pope's Nose	12,274
Mears Peak	13,008	Potosi Peak	13,763
Mesa Peak	12,581	Powell, Mount	13,398
Mesquite Pass	13,308	Princeton, Mount	14,196
Mineral Creek Pass	11,098	Prospect Mountain	12,618
Mineral Point	12,541	Ptarmigan Hill	12,174
Monitor Peak	13,703	Ptarmigan Peak	13,746
Mosca Pass	9,713	Purgatory Peak	13,749
Mosquito Peak	13,794	Pyramid Peak	13,885
Muddy Creek Pass	8,772	Quandry Peak	14,266
Nebo, Mount	13,192	Rabbit's Ears Mountains	10,719
North Italian Mountain	13,225	Ragged Mountain	12,481
North Main	10,973	Ralston Butte	10,593
North Sheep Mountain	12,439	Raspberry Mountain	10,500
Ohio Peak	12,251	Raton Pass	7,893
Ohio Pass	10,033	Red Cloud Peak	14,050
Old Baldy	14,176	Red Mountain	13,333
Ormus Mountain	12,185	Republican Mountain	13,393
Oso, Mount	13,640	Rhyolite Mountain	10,775
Ouray, Mount	13,956	Richmond Mountain	12,543
Owen, Mount	13,102	Rio Grande Pyramid	13,773
Pagoda Peak	11,257	Rito Alto	12,989
Pagosa Peak	12,674	Rolling Mountain	13,694
Park Cone	12,021	Rosa, Mount	11,427
Parrott Peak	11,876	Rosalie, Mount	13,575
Parry Peak	13,133	Round Mountain, Elk	10,881
Pass Mountain	11,200	Round Mountain, San Juan	13,422
Pearl Mountain	13,484	Rowtner, Mount	13,750
Pearl Pass	12,715	Ruby Peak	12,749
Peeler Peak	12,219	Saddle Mountain	10,815
Pigeon Peak	13,961	San Bernardo Mountain	11,845
Pike's Peak	14,107	San Francisco Pass	8,560
Pike's Peak Timberline	11,720	Sangre de Cristo Pass	9,459
Pilot Knob	13,750	San Luis Peak	14,100

ELEVATION OF MOUNTAIN PEAKS AND PASSES IN COLORADO.—Continued

Name	Feet
Schuylkill Mountain	12,188
Searight Mountain	11,333
Sharano Peak	14,239
Sheep Mountain, Chaffee Co.	12,447
Sheep Mountain, Elk Mts.	13,180
Sheep Mtn., Huerfano Co.	10,600
Sheep Mountain, Summit Co.	12,380
Sheridan Mountain, Park Co.	14,038
Sheridan Mtn., San Juan Co.	12,785
Sherman Mountain	14,048
Signal Butte	9,300
Silex, Mount	13,687
Silver Hill	13,880
Silver Heels, Mount	13,835
Simpson, Mount	14,055
Slate Peak	12,989
Sneffels, Mount	14,158
Snowmass Mountain	13,970
Sockrider Peak	12,315
Sopris, Mount	12,823
South River Peak	13,160
Spanish Peaks	13,620, 12,708
Squaw Mountain, Teller Co.	10,376
Squaw Mtn., Front Range	13,093
Star Peak	13,562
Stewart Peak	14,032
Stoll Mountain	10,915
Stony Mountain	12,677
Storm King	13,742
Stormy Peak	11,748
Storm Ridge	11,859
Sultan Mountain	13,336
Summit Peak	13,323
Sunlight Mountain	14,053
Sunshine Mountain	12,945
Tarryall Pass	12,456
Tarryall Peak	11,300
Taylor Peak	13,419
Telescope Mountain	12,231
Ten Mile Peak	12,800
Teocalli Mountain	13,229
Tetons Mountain	14,198
Tilton Mountain	12,633
Tomichi Dome	11,384
Torrey Peak	14,336
Tower Mountain	13,444
Trachyle Mountain	10,876
Treasury Mountain	13,200
Trinchera Mountain	13,516.
Trinity Peaks	13,752 13,801 13,745
Troublesome Peak	11,500
Trout Creek Pass	9,346
Turret Peak	13,819
Twilight Peak	13,153
Twin Cones	12,400
Twin Sisters	13,438
Uncompahgre Peak	14,289
Union Mountain	12,336
Ute Peak	11,968
Vasquez Peak	12,658
Velie Peak	13,456
Venado Peak	12,800
Vermillion Peak	13,870
Vestal Peak	13,846
Veta Pass	9,373
Virginia Peak	10,350
Vulcan Crest	13,971
Wasatch Mountain	13,551
Weminuche Pass	10,622
West Elk Peak	12,920
Weston Pass	12,109
West Spanish Peak	13,623
Wetterhorn	14,092
Wheatstone Mountain	12,548

ELEVATION OF MOUNTAIN PEAKS AND PASSES IN COLORADO.—Concluded

Name	Feet	Name	Feet
White Dome	13,607	Wilson, Mount	14,250
White Face Peak	11,494	Windom Mountain	14,084
Whitehead Peak	10,817	Wood Mountain	13,640
Whitehouse Mountain	13,496	Yale, Mount	14,187
White Rock Mountain	13,522	Yampa Peak	8,022
Wild Horse Peak	13,271	Yellow Jacket Pass	7,493
Wilkinson, Mount	11,687	Yellow Peak	13,618
Williams Peak	11,413	Zenobia Peak	9,297
Willow Creek Pass	9,683	Zirkel, Mount	12,126

Elevation of Parks and Lakes

Name	Feet	Name	Feet
Allen Park	8,513	Manitou Park	8,464
Bergen Park	7,543	Middle Park (Mean)	7,500
Big Lake (San Luis Valley)	7,478	North Park (Mean)	8,500
Brennan Lake	10,325	San Cristoval Lake	9,000
Buffalo Springs (South Park)	8,901	San Luis Valley (Mean)	7,500
Chicago Lake	11,500	San Luis Lake	7,592
Columbine Lake	8,788	San Miguel Lake	9,720
Crater Lake	8,877	Sheridan Lake	4,065
Crane Park	10,102	South Park	8,000 to 10,000
Crystal Park	9,317	Trout Lake	9,700
Eagle Park	9,212	Twin Lakes	9,012
Elk Park	8,868	Twin Sister Lake	13,438
Grand Lake	8,153	Union Park	9,655
Hughes Lake	7,453	Weiserhorn Lake	5,238
Jerome Park	8,290	White River Plateau,	11,000 to 12,000
Lake Moraine	10,268		

Population of Colorado

FROM 1860 TO 1910, BY DECADES

CENSUS YEARS	POPULATION	INCREASE	
		Number	Per Cent
1860	34,277	...	....
1870	39,864	5,587	16.2
1880	194,327	154,463	387.4
1890	413,249	218,922	112.1
1900	539,700	126,451	30.9
1910	799,024	259,324	48.1

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