



BUREAU OF MINES

ARRY A LEE ADMINISTRA



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REPORT OF THE STATE BUREAU OF MINES DENVER, U. S. A.

HARRY A. LEE, COMMISSIONER

COLORADO



FOR THE YEARS 1901-2

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HISTORY OF PRECIOUS METAL MINING

(Note.—The limitation of official reports to 300 pages by the last legislative assembly was unknown until a quite recent date. This required a hasty condensation of original notes of nearly four pages into one, the exclusion of topics that should be entered into, the elimination of detail description of typical mines and mills in each county, together with more extended notes upon all subjects now necessarily generalized. The Bureau of Mines should be granted in its reports sufficient latitude to avoid this curtailing and glittering generalities, which are not only unsatisfactory, but from the technical standpoint subject to misconstruction.—H. A. L.)

The history of precious metal mining may be summarized as progress, resulting from knowledge gained by experience and pushed to successful issue by cool judgment, nerve and ability.

The fiscal period of 1901-1902 finds Colorado still leading, in precious metal production, all other states and territories of the Union. That it will continue to maintain this position, is a reasonable expectation, in view of the superior advantages gained from the many and varied progressive methods adopted in the past two years. While the future of the industry can not be accurately foretold, we must note the fact that the optimistic utterances of the past, assuring a greater future, have been more than realized. Also that there still exists within the borders of the state large mineralized areas wholly unexplored or barely scratched by the pick of the prospector.

Colorado's transition from the leading silver to the leading gold producing state in the Union was not attained without effort, nor in a day. Neither was it attained without discouragement and loss in those sections where silver ores predominated and operators had large capital invested. The demand for gold, emphasized by the general financial depression of 1893, and the resulting effects of legislation unfavorable to silver production, brought about a cataclysm in the mining industry wholly unlooked for or anticipated. The way Colorado met this condition, with a quick and absolute change of her main commodity, proves without question, and for all time, the wonderful resourcefulness of the commonwealth, as well as that of the mining operators. ment the ore shoot itself varies in grade at different horizons or different depths.

The mining industry of to-day is conducted on a much larger scale than in the past, and a rich strike in an individual mine attracts less attention from the general public. Mining plants are now being constructed with a view of reaping profit from the usually larger and more persistent low grade ore bodies, rather than the more erratic high grade ore shoots found therein. High grade ore is not objectionable, and, when encountered, adds materially to the revenue of the mine, but it is not absolutely essential to success in the same degree that it was in the past. In short, the future of the Colorado mining industry is more promising than ever before.

At no period in the history of the state has there been so much inquiry for mining property as during the two years 1901-1902. One of the most salient features during this time has been the large amount of well-invested capital. Many transfers, some of great magnitude, have been made, new enterprises, new companies, reorganization and consolidation have been common to all sections of the state. Such conditions, existing at a time when there is no unusual excitement or boom shows the solid character of the industry. It indicates that the steady and regular annual production, together with the regular dividends announced by mining companies, is not only attracting attention, but investigation. Finally, that investigation, carefully conducted, results in investment.

There is probably no better index to mining prosperity than the demand for mechanical equipment and improved machinery. During the past two years the mining machinery manufacturers and mine supply houses of the state universally report their inability to keep pace with orders received. Engine and mill builders, and the producers of all manner of mine equipment, have found it necessary to crowd operations to the fullest extent possible, and, even then, have been unable to meet the constant and apparently increasing demand. True, this demand is not entirely from Colorado operators. Much of the machinery of Colorado manufacture and design goes to other states, or, in fact, to all parts of the globe; but the local demand is constantly increasing, indicating not only material advance, but operation on a more extended scale. It is not reasonable to expect that all properties equipped with mechanical appliances will develop into large paying mines. The percentage of successes, however, will doubtless prove as great or greater than in the past. We should bear in mind that misdirected effort is not confined to the mining industry alone, and failure is common to all pursuits. Neither is it probable that all the mills and reduction works now constructing will realize the hope of those who thus express the courage of their conviction by erection of these costly plants.

The problems that enter into mining and metallurgy are still in an experimental stage. The success achieved in the past ten or fifteen years is marked and, in part, satisfies the present demand. The processes now in vogue which make valuable products heretofore valueless record a great advance in metallurgical science, but it only indicates to those who have studied mining in all its varied branches the marvelous improvements that may be looked for in the fu-The success achieved in concentration and reduction ture. of ores, recognized as far from perfect, acts as an incentive to more strenuous and extended investigation. The best mechanical, chemical and electrical talent in the country is at work upon the problems involved in a more perfect extraction and cheaper method for reduction of ores. We may, therefore, reasonably expect that the waste dumps and mill tailings accumulating below the various mine and mill plants will prove valuable assets to the next generation, if not to this.

Almost every section of the state shows a renewed and vigorous impetus to aggressive enterprise in mining. The underlying causes responsible for this improved condition are: First—Confidence in the existence of large precious metal deposits. Second—Their attraction for the genius and physical energy of man to overcome the obstacles interposed by nature, and reap financial gain. Third—A growing belief that mining is a profitable industry when accorded the same care and business methods granted other industrial pursuits.

When conducted on a thorough business basis, mining is demonstrated by statistics to be one of the most productive and remunerative enterprises, differing from others only in its possibilities. In mining it is possible, and is offtimes recorded, that, with small outlay of capital, labor and time, fortunate owners are raised from comparative poverty to wealth. This is true of no other industrial pursuit, and is likewise the exception in mining. As a general rule, the time and capital required to make a mine is comparable to like equations in the erection and equipment of a manufacturing establishment expected to yield large returns upon Lack of conception of the magnitude of the investment. mining enterprise entered into is one of the main causes of failure. Numerically, the failures far exceed the successes, but the mercantile reports show that nine-tenths of all men who engage in business pursuits sooner or later make failures. Mistakes in judgment are common in all lines, but are no more apt to occur in mining than in any other pursuit, if the same care and investigation is given. Improper investigation and departure from business principles cause many failures. In common with all pursuits, a little knowledge of mining and mining methods is dangerous to follow, and knowledge conserved by experience should alone be employed to advise acceptance or rejection of mining enterprises.

The actual condition of mining in the various districts throughout the state is not subject to generalization, and is, therefore, localized in the sections following, which are assigned to individual counties alphabetically arranged.

COLORADO BY COUNTIES.

The following chapters are intended to in part supply the demand for general information regarding special districts. To supply a ready reference book that will give a general idea of the geology, topography, vein formation, ore deposition, location and commercial importance of the various counties; the past record as evidenced by precious metal production and probable further importance as shown by development. Each chapter is therefore intended, as far as space permits, to be a complete summary in itself. A number of the various sections being comparable in many ways, repetition is unavoidable. It is not expected, however, that those desiring information of the San Juan region will read all the chapters that precede by reason of alphabetical rank, but will turn to the desired chapter at once. A report designed to be read in totum would require a different arrangement from the following.

ARAPAHOE COUNTY.

The first mining camp established in Colorado, inhabited by the white man, was within the present boundaries of Arapahoe county. While not strictly a mining county, and while gold mining receives but little attention, the same placer bars and placer gold exist at present as in 1858. Nearly all the stream beds in the western end of the county may yet be made to yield gold in small quantity, and each year the total gold production of the state includes a few ' thousand dollars' worth from this section.

The county was organized when territorial organization began, in 1861. Its early history is associated with the thrilling incidents of border life, conflicts with the red man and the stirring events of the Civil War. It was first to establish law and order upon the western border of the Great Plains country, and quite early in its history gained a commercial supremacy over other sections since maintained. As at present constituted it embraces an area of 4,800 square miles, rectangular in form and extending from the west boundary line of Kansas, thirty miles wide, westward 160 miles, the western boundary being near the foothills that skirt the front range of the Rocky Mountain system.

The city of Denver is the seat of government for the county, likewise for the state. Its location is on a comparatively level plateau one mile above sea level. From a small mining camp of a few hundred souls it has grown within fifty years to a first-class city of nearly two hundred thousand people. Its rapid development is due in part to its advantageous location for a leading commercial center, but more especially to its energetic and broad-minded citizens, who have always recognized the fact that whatever advanced the material welfare of any section of the commonwealth, likewise advanced that of Denver.

Denver is the recognized financial center of the state. Its apparent advantages as a distributing point have attracted all the leading railroads and made it a prominent railway center. In addition to the trunk lines from the east, local lines reach nearly all sections of the state and afford easy means of ingress and egress. A new railroad from Denver to Salt Lake, via Grand, Routt and Rio Blanco counties, embracing the northwest corner of the state, is now under construction. This section, owing to topography and without railway facilities, is naturally tributary to our sister state, Wyoming. With transportation facilities it will materially contribute to Colorado's welfare, and especially that of Arapahoe county.

The railroad companies have through the advantages of transportation, judicious and prolific advertising, done as much to hasten development of Colorado as any other factor.

Prior to 1870 little was really known of the actual resources and less thought was given to the natural advantages this section offered for a great commercial center. The alluring search for gold was the primary cause of settlement and few if any expected or deemed it necessary to remain on the border and submit to the attendant hardship and privations

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longer than a few seasons at most, in order to reap the desired golden reward. The completion of the first railroad to Denver during the year 1870 produced a marked change in sentiment. Its completion gave rise to thoughts of stability heretofore not generally entertained, and this section was then first seriously considered as a place of permanent abode. The natural advantages and possibilities were carefully studied, and the decisions reached are evidenced by the cities, towns, villages, railroads and manufacturing establishments of the present time.

ARCHULETA COUNTY.

This is one of the south-central border counties of the state, with an area of about 1,100 square miles. It is bounded on the east by Conejos county, from which it was segregated by legislative enactment, approved April 14, 1885. The eastern boundary line is the Continental divide, formed by the San Juan mountains, locally known as the Conejos range. On the south it borders on New Mexico, on the west on La Plata county and on the north Hinsdale and Mineral counties.

The principal drainage is through the Rio San Juan, which flows in a southerly direction through the central part of the county. The main tributaries are the Navajo, caring for the waters in the southwest part, and the Rio Piedra, those of the western portion of the county.

Topography.—The county as a whole is a hilly one, composed of numerous mesas and ridges of sedimentary rock, intersected with equally numerous valleys locally widening into parks. The hills and mesas are timbered with some of the finest timber in the state, principally white pine, yellow pine, red and white spruce. These trees often attain a thickness of three feet or more, and run up for fifty or sixty feet, a straight column without a branch. The fineness of the timber has attracted saw mills into the district, and one of the finest and best equipped lumbering establishments in the state is at the little town of Edith. This company owns a line of railroad through the lumbering districts of the county. When a section of timber country is used up, the rails are taken up and laid down in another section. The valleys and parks between the hills contain flourishing farms and stock ranches.

The peaks of the adjacent Conejos range average from 12,000 to 13,500 feet. The average altitude of the valleys and parks is between 7,000 and 8,000 feet. The mesas may rise 500 feet above this.

Geology.—The topography is largely due to the geology, hill and valley being outlined by the relative degrees of hardness and softness of the rocks. Apart from the volcanic rocks, those appearing near the surface almost entirely belong to the Cretaceous system, from the Dakota quartzites below to the Montana vellow sandstones above, with a few intervening outcrops of the Niobrara limestones. The remaining sedimentary rocks constituting the valleys and parks are all Cretaceous shales of the Colorado and Montana groups. The Montana sandstones being harder than the shales, characterize the tops of the mesas, especially where they are protected by a cap of basaltic lava. The Dakota-Cretaceous quartzite, from its extreme hardness, appears in ridges or anticlinal rolls as near as Pagosa Springs. The Niobrara limestone only locally occurs in low ridges containing marine fossil shells.

Volcanic Rocks.—As might be expected from its near contiguity to the adjacent eruptive "Conejos range," volcanic rocks are not wanting. In the area, these appear prominently in narrow basaltic dikes, apparently traversing the middle of the county from north to south, or northeast to southwest. Another small system appears to cross these diagonally and locally from northwest to southeast. These dikes, though along a certain zone, are quite numerous, and are rarely more than a yard or two in width. They appear to follow certain cleavage lines in the sedimentary rocks, and to conform to them without materially displacing or faulting the rocks up through which they come. Overflow, doubtless from the dikes, form a protecting cap of some of the table lands, such as Cerro del Navajo or, Navajo peak. near the town of Edith, and no doubt a large portion of the country in the vicinity of these dikes was originally overflown with basaltic lava. These caps have been mostly washed away, leaving only the eroded dikes to show the source whence the lava came.

In the vicinity of the eastern boundary of the county, the Conejos range, numerous large intrusions of volcanic rocks occur, of the same andesitic lava and andesitic breccias and conglomerates which compose the main mass of the San Juan mountains.

Structural Fcatures.—In a region of pliable strata bordering so closely upon a great eruptive range one would natural expect disturbances. These consist of faults, usually near to and running parallel to the trend of the Conejos range, where the disturbance was most violent, and further away, where it was less strong, of great anticlinal and synclinal folds in the more or less pliable strata. These folds preserve a rough parallelism to one another, and by careful mapping their course and continuity might be definitely determined. There are at least two very prominent folds, or anticlines, one along the Navajo river, known as the Chromo anticline; another, further north along the San Juan river, known locally as the San Juan anticline. Between these are doubtless many minor folds.

The principal fault of the region appears to run parallel for many miles with and close to the Conejos range north and south. This fault appears to have brought up from below, and into juxtaposition with more recent strata, older strata of a variegated hue belonging either to the the Jura-Trias or the Upper Carboniferous. No fundamental granite has been observed in the county.

Evidence of a certain amount of fissuring and disturbance is shown in the occurrence of the dikes and right through the center of the Chromo anticline is a zone of hot or tepid springs, which, at intervals, can be traced to the great Pagosa springs as a culmination. These springs doubtless ascended through lines of fault, and seem to occur near the axis of the principal anticline, or just where the anticlinal arch would be apt to break and fault.

Pagosa Springs.—This town is the county seat of Archuleta county, and is located north of the center, on the San Juan river. The surroundings are picturesque, being lofty mountain peaks, grassy slopes and large belts of timber. The town is now accessible by the completion of the Rio Grande & Northern Railroad from Pagosa Junction, thirty miles distant. This line is practically a branch of the Denver & Rio Grande railway system, and connects with east and west bound trains running between Durango and Alamosa, or trains of the "Around the Circle" route so extensively advertised by the Rio Grande company.

Mineral Springs.—The Pagosa hot springs are on the northern bank of the San Juan river, adjoining the town bearing the same name. Prior to the advent of the white man these springs were known among the Indians as the "Great Medicine Waters," or "Healing Waters," and their possession jealously guarded. During late years, their healing powers have proven a Mecca for many, and especially the miners of Archuleta and adjoining counties. The list of visitors is annually increasing. With railroad facilities, good climate and beautiful surroundings, Pagosa springs must ere long gain the celebrity to which their medicinal qualities undoubtedly entitle them. The main spring basin is fifty by seventy-five feet in size, and presents the appearance of an immense seething caldron. The temperature of the water is 148 degrees Fahrenheit. The outlet from this pool evidences the probability of the springs being justly entitled to the claim of the "largest hot spring in the world." Accurate measurements were not made, but the stream flowing was approximately ten feet wide by thirty inches deep. The natural flow was comparatively slow near outlet. The claim is made that this pool has been sounded to a depth of over 800 feet. Other springs occur at various places along the axis of anticlinal fold noted under "Geology." These springs are not improved as they doubtless will be in the near future. The town affords good hotel accommodations, and the springs have bath houses. Analytically, the water compares favorably with the famous Carlsbad springs, and Pagosa Springs is destined to become a celebrated resort.

The following analysis by Dr. Oscar Loew:

Constituents.	No. 1.	No. 2.	No. 3.	No. 4.
Sodium carbonate	4.70	3.33		
Calcium carbonate	59,00	59.50	54.51	58.73
Magnesium carbonate	4.85	3.92	3.68	3.59
Lithium carbonate	0.71	Trace	Trace	Trace
Sodium sulphate	221.66	220.20	223.92	224.59
Potassium sulphate	7.13	6.98	6.63	7.10
Sodium chloride	29.25	29.36	31.21	29,81
Silica	5.70	5.21	5.53	3.82
Organic matter	Trace	Trace	Trace	Trace
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Total parts in 100.000	333.00	328.50	325.18	327.64

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Mines.—The precious metal mines of the county are practically an undeveloped resource. Each year the eastern portion, or, in other words, the western slope of the Conejos range, is the scene of more or less prospecting and desultory mining. A large portion of this territory has, until within a few years, been closed to prospectors. It is known as the Tierra Amarilla grant. The northern portion of this grant, embracing some sixty thousand acres, is owned by The Banded Peak Land and Mining Company. Willard Teller, president; E. B. Morgan, secretary, Denver, Colo. This company has formulated a set of mining rules and regulations for those desiring to prospect or mine that are liberal and insure good title to property. The regulations, in the main, conform to state laws governing mining operations.

The andesitic rocks of the Conejos range are similar to those in the better developed mining districts of the "San Juan" section. The ore deposits that have attracted the most attention are found in the large "porphyry" dikes, or near the edges of the intrusive sheets. The ore value is in gold. Small sample lots have yielded as high as \$40 per ton, but sample tests indicate that certain portions have gold values runing from \$3 to \$6 per ton. No systematic development has been prosecuted to demonstrate the extent of ore deposition or the average value of same. The conditions are favorable for economical work and present favorable inducement for operations on a large scale.

Coal.—Workable seams of a fair to good grade of bituminous coal are found. They appear a few miles northeast of Pagosa Springs, also along the Piedra river in the western portion of the county. The beds unite with the better developed coal fields of La Plata, the adjoining county. The coal belongs to the Montana Cretaceous group. Locally, this series has been largely removed by erosion.

Oil.—The presence of oil in this region was known in the early days of the Indians and trappers. Later, the flow from the springs was collected and utilized as a lubricant by the early settlers. The Navajo oil spring is best known. This spring issues from a crevice in the base of the Fox hill sandstones on the south side of Navajo creek, a short distance from the foot of the Conejos range. The oil trickles out into a small natural basin near the creek, and when left undisturbed for a few days a gallon of oil may be skimmed off. REPORT OF COMMISSIONER OF MINES

During the past year the oil excitement which has passed over Colorado caused no little research in this section. Interested parties procured the services of Prof. Arthur Lakes, who made a reconnoissance of the region. His reports show that it resulted in the discovery of another oil spring in Big Blanco basin and sufficient oil signs to proclaim the area between Edith and Navajo creek on the south, and Pagosa Springs on the north, a section about forty miles long by twelve miles wide, to be one of good promise for oil exploitations.

The favorable signs and conditions noted by Mr. Lakes were as follows:

"First—The right set of strata, the same as those of the productive oil region of Florence, Colorado.

"Second—That these strata were thrown into those anticlinal structures approved of by oil men as conducive to oil storage and accumulation.

"Third—The distilling influences of neighboring once heated volcanic rocks.

"Fourth—The actual discovery of flowing oil springs at two distinct geological horizons approximately from 1,500 to 2,000 feet or more apart vertically.

"Fifth—The presence of oil impregnated volcanic dikes, which when broken show oil in their fractures and cavities.

"Sixth—Other indirect signs of oil are the copious presence of hot and sulphur springs and of gas emanations. The approximate thickness of the strata to be penetrated before the oil horizons can be reached can not be readily determined. A rough estimate gives it at not more than 3,000 feet, whilst oil may be found at far less depth. Judging from the anticlinal structure of the strata much gas may be anticipated."

The oil from the springs proves under analysis to be part illuminating and part lubricating with a kerosene base.

Temperature of Distillation	a. Percentage of Products.	Nature of Oil.
At 150 degrees and under.	1.0	Light naphthas.
From 150 to 200 degrees	13.5	
From 200 to 250 degrees	12.0 Total 92.5 per	cent. Burning oils,
From 250 to 300 degrees	67.0 j	
Above 300 degrees	6.5	Residuum and coke.
Specific gravity of sa	mple, 0.923 at 60 degrees Fal	rrenheit.

VON SCHUTZ & LOW.

Denver, Colo., June 3, 1901.

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Following the favorable reports on this section many rushed in, numerous oil companies were organized and work began in a number of places. In nearly all wells drilled a small amount of oil usually accompanied by gas was found. At present writing, however, no regular producing well has as yet been developed.

BOULDER COUNTY.

This is one of the pioneer counties of the state and was organized in 1861. It is almost rectangular in form and occupies a north-central position, embracing a section twentyfour miles wide lying on the eastern slope of the front range of the Rocky Mountain system, extending from the summit eastward a distance of thirty-two miles. Its area of about 768 square miles includes the mountain side, the foothills flanking the base and an average of twelve miles of the western limit of the Great Plains country. Topographically it is naturally divided into three distinct types, viz.: mountain, foothills and plains. It possesses great natural resources. The mountain section contains the metal mines, mineral springs, timber and water supply; the adjoining foothills, building stones of great variety and clays for manufacture of brick, tile, etc., and the plains section affords a field of operation for the agriculturist and horticulturist, is largely underlaid with a good quality of lignite coal, and late developments demonstrate the presence of oil in paying quantities.

The drainage is through a number of roughly parallel streams that find source near the rugged crest and amphitheaters of the mountains, and have a general eastward course until they make exit through deep cut canons on the plains. Here they join with the St. Vrain river, which is one of the main tributaries of the South Platte. Locally the main streams are designated as the North, Middle and South Forks of the St. Vrain, Left Hand, James creek, North, Middle, Four Mile and South Boulder creeks.

The metal mines, the primary cause of settlement in this section, are located in the metamorphic rocks of mountain division. The principal rock types are granite, gneiss and mica-schist, generally designated as a granite-gneiss complex. The mountain section is traversed with a series of eruptive dikes of variable character and strike. The fissures containing the precious metal veins form a network over almost the entire area, and strike at all points of the compass. The main fissures, locally, appear to occur in east and west, northeast and southwest, or northwest and southeast systems, but considering the area as a whole the course of the fissures appear to be related to the eruptive dikes, local foldings in the metamorphic strata, or intrusive masses of granite.

The veins are of the true fissure type. Comparatively few are traceable for any considerable distance. The tendency to divide into branches, throw out spurs or small feeders that may connect with parallel veins, is marked. The vein width varies from a few inches to fifteen feet or more. The vein filling or matrix is in the main the decomposed or altered country, more or less silicified and mineralized, with values largely concentrated in bands of quartz near one of the vein walls. The minerals associated with the quartz bands and quartz ore matrix are those common to fissure vein sections. The amount of iron, copper and zinc sulphides present is variable. Lead sulphide occurs in many places. All carry values in gold and silver, but as a whole the gold values predominate. The amount of gold, silver, lead and copper present locally classifies the mine as a gold mine, copper mine, etc. In some parts of the county the ore value is almost wholly silver or gold, but this condition is largely confined to individual mines, is subject to variation even in those, and a "gold mine" and a "silver mine" are not uncommon in the same immediate locality. This sudden change in character of ore deposit appears to be due to local changes in the formation, or as the result of intrusive masses of granite or eruptive dikes, which may at this time only be noted, not discussed.

In common with other fissure vein districts the ore values are concentrated into ore shoots or pipes. The latter term appears more appropriate when applied to the "tellurium belt." These ores generally occur within restricted limits longitudinally, but vertically extend downward as far as development has as yet been extended. With but few exceptions the ore values are contained within the vein walls the Livingstone, on Sugar Loaf mountain, being the most marked exception. At this property the adjoining granite country, which is greatly altered and locally shattered by movement, is impregnated for considerable distance on each side of the vein proper. It is not improbable that like deposits are more common than is generally supposed, but the common firm and smooth walls usually mark the side limits of exploration.

The mining area is divided by somewhat indefinite boundaries into six mining districts, locally known as follows: Grand Island (Caribou-Eldora), Sugar Loaf, Magnolia, Gold Hill, Central (Jamestown) and Ward.

The county records show that lode claim, placer-claim, tunnel-site and mill-site locations filed for record aggregate nearly 15,000. Of these United States patent has been issued for about 1,000. The aggregate number of location certificates filed includes numerous relocations of the same property. In common with many districts of the state large groups of claims are held by parties unable to assume systematic development, or even comply with the statute requiring an annual expenditure of \$100 in labor or improvement upon each claim. Relocation is therefore resorted to and the numerical number of claims is constantly increased in the office of the county clerk or recorder.

The veins, however, are numerous and the aggregate number each year that receive some development is as large as any county in the state. The ores contained are varied and comprise the common forms of iron and copper sulphide, chalcopyrite, marcasite; the complex silver and copper sulphides are not uncommon. The so-called telluride belt, extending from Magnolia to Ballarat, produces the high grade gold and silver telluride ores and is also noted for its fine minerals. In the aggregate the major value of ores produced is in gold. Gold in free state is not uncommon in several localities. As noticeable examples of sudden changes in character of ore may be mentioned the Caribou mine at Caribou, a well-known silver producer with practically no gold; a short distance east the Boulder County mine, now operating its new mill on ores with principal value in gold. The Logan mine, one of the richest gold deposits in the county, joins the territory of the Yellow Pine, an old silver producer.

Considered as a whole the ores of the mining sections are complex, refractory, and of low grade. High grade ore shoots occur in nearly all of the veins, and most of the mining has been conducted with a view of finding and marketing this character of ore. The leasing system is much in vogue, and numerous properties are in this manner made to yield their owners a small annual revenue without effort on their part. The treatment of the low grade ores has received much attention, and nearly all known processes have been tested, and many without success. These failures, in the main, have been due first, to lack of capital, and later to lack of ore. Through the enthusiasm of the many process men, and their honest belief in their ability to reduce low grade ores to bullion, or a marketable product in some form, for a few cents per ton, the average mine operator is educated to a like belief. He therefore refuses to market his ore and pay the toll common to other sections.

The mines in the Grand Island district, or those near Eldora, Caribou, Cardinal, Nederland and Jenny creek, have not progressed as expected two years ago. The ores of this district are mainly low grade and sulphide in character. Profitable operation requires cheap transportation or local mills. The expected extension of the branch line of the Colorado & Northern Railroad to Eldora has not materialized, and the anticipated home market at the modern chlorination plant constructed is still in the courts. The assurance that next year would see the "Moffat Line" constructed from Denver to Rollinsville has recently given a great impetus to this section.

A number of properties are competent to furnish a large tonnage and yield a profit over operating expenses if the values are as represented. The Mogul tunnel alone has six thousand feet of development, and has intersected forty-two good-looking veins, many of which are opened for production. Several new enterprises have been launched and several consolidations of small properties perfected.

At Magnolia the custom of operating by lessees largely prevails. The old properties, well known for their high grade product, are producing the usual amount and reporting the usual number of discoveries. The near completion of the new electro-chlorination plant is watched with interest, and when completed is expected to provide a home market for the lower grade ores, unmarketable under present conditions. The Graphic group is being aggressively developed by a new company, and several other properties are likewise operating with new capital.

In the Sugar Loaf district the somewhat recent discovery on the Livingstone, or more properly the Douglass, a cross vein and near the junction of the two, is attracting much attention. The find is *bona fide*, and at the present time the indications favor its being one of the greatest ever made on this property. The Sphinx group, adjoining the Livingstone, and an extension of the same is showing well under aggressive mining methods. The careful management, systematic development and persistent ore bodies on the Logan group has perhaps done as much to stimulate legitimate mining as any property in the county. The Black Swan mill, near Salina, is running on a large contract.

Adjacent to Wall Street, on or near Four Mile creek and the Colorado & Northern Railroad track, the Dirigo tunnel, Tambourine, Nancy tunnel and Wood mountain tunnel are making good progress. The completion of the new mill at Wall Street is near at hand; this is a plant of 150-ton capacity, unusually well equipped, and is constructed for custom work. The Robinson and Greenawalt chemical process is being installed. It is practically a chlorination plant, in which electricity is utilized for solvent and precipitation. The main ore supply is anticipated from the mines operated by the Nancy Mining Company, the mill and mines having to some degree common ownership and interest.

The properties at Sunshine and Gold Hill are as active as for a number of years, and the production will show little variation. The Cold Spring Company is remodeling its mill at Rowena and installing the Wynn process. The Emancipation is sustaining past record; Grand View is operating under bond; Ingram under lease; Luck Star, Melvina, Richmond, doing extensive development; Slide and Spur and Prussian under lease; the latter remodeling Prussian mill and installing Beam process.

The Alaska tunnel, at Camp Talcott, is driving ahead, and all the properties held by this company have received the usual amount of annual development. At Frances the Big Five Federation is making a careful line of mill tests preparatory to changing or adding to their present one hundredton plant. The B. and M., Giles, Struggler and other old properties are active at Ward.

At Jamestown there is a marked increase in active mining; a.number of the old properties are being exploited and some new ones added. The Longfellow is making a good showing and doing good work at its new mill. The Wano is being systematically opened and adding large ore reserves prior to equipment of mill.

In Allen's park a new company has secured a large group of claims and is erecting a mill for treatment of low grade ores. The placer mines have received some attention and afforded employment to a few men. An attempt to open one of the placers on a larger scale met with the same difficulties from large boulders as has been the result in other sections, where the beds are along stream beds in comparatively narrow canons.

Electrical energy is being utilized at the Alaska tunnel, at Camp Talcott, on Left Hand creek. The power here is generated by water and used for operating air compressor and light purposes. At the Longfellow mine the power is generated from water at the Wano mill, two miles distant, and transmitted to mine at 10,000 volts, transformed down to four hundred, and used for operating mill, a ten-drill compressor and for pumps in mine. Both plants are well equipped and are highly commended by those in charge of operations.

Owing to spasmodic operation and numerous changes, it is very difficult to accurately determine the average number of properties in operation, or the average number of men employed in this section. As near as may be determined, the average number of properties working during this year is 240; the average number of men engaged in mining for the same period, 1,556.

The total precious metal product of Boulder county may not be accurately determined. Numerous estimates have been indulged in by various compilers with variable results. Inasmuch as placer gold, or "gold dust" was used as a medium of exchange during the early days and changed hands many times, it is logical to suppose that the estimates were over rather than under estimated production. The production for the years 1897-1901, inclusive, as compiled by this Department from the finished product, or the precious metals actually sold and marketed, is as follows:

Year.	Gold.	Silver	r. Lead.	Coppe	r. Total.
1897	\$512,657 34	\$ 82,743	50 \$ 10,448	09 \$ 6,139	77 \$611,958 70
1898	581,302 41	53,259	14 325	50 2,694	24 637,581 29
1899	547,858 35	45,501	84 1,253	52 13,879	50 608,493 21
1900	607,015 89	55,469	80 3,598	39 . 3,365	29 669,449 37
1901	771,298-20	67,074	49 8,320	72 3,672	89 853,366-30

A number of stone quarries more or less developed are located along the sedimentary beds flanking the mountain base from Boulder to the north county boundary. Those best developed and most productive are located at or near Lyons. The well-known "Red Beds" of the Trias are the strata most utilized, and afford good stone for building and other purposes. Although some stone is marketed as far east as the Missouri river, the home demand largely controls production. As a road metal, the basalt-dolorite, commonly known as the "Valmont Dike," at Valmont, is second to few if any produced in the entire country east or west. Its chief market is for the streets in Denver, and is used by the Tramway Company for lining their tracks in the paved districts. The clay shales exposed along the eastern base of the foothills are only utilized as vet for the manufacture of pressed brick. The product is a brick of bright, even red color, and its use for a number of years has demonstrated its quality to be of high The supply is almost unlimited, but the market standard. is largely that of local demand.

There are a number of mineral springs in the county. The Boulder spring, near Crisman, is the only one at present time being marketed. This water is in great demand, and practically the whole product is bottled or jugged and sold. The following analysis is by Dr. J. A. Sewall, of the Denver University: Carbonate of soda, .984; carbonate of magnesia, 6.020; carbonate of lime, 7.480; carbonate of iron, .081; chloride of sodium, 30.217; chloride of potassium, 1.100; sulphate of soda, 3.840; silica, 0.102, making a total of 49.824 grains to a pint of mineral water; carbonic-acid gas, 39 cubic inches.

The Seltzer spring, at Springdale, is one of a number of springs issuing from a fissure near the bed of James creek. They are improved to the extent of being walled in and used for supplying local demand, especially the guests of the hotel erected at that point. The following is an analysis by Dr. C. T. Jackson: Sodium carbonate, 9.37; calcium carbonate, 74.29; magnesium carbonate, 1.14; iron carbonate, 6.86; sodium sulphate, 184.46; sodium silicate, 6.86; sodium chloride, 8.51; sodium iodide and sodium bromide, 2.23; total parts in 100,000, 293.72.

During the spring of 1902, all industries of the county were overshadowed by the so-called "oil boom." The presence of petroleum in this section has been known for many years, but following the excitement in Texas and California active prospecting began, and oil was encountered at the first hole drilled. It has been roughly estimated that within sixty days after this discovery a sufficient number of oil companies had been formed, with an aggregate number of shares of stock, to supply every person in the entire country with a small "block of stock." The conditions at this time were comparable to that of all great excitements. The result was a number of drill-holes and the demonstration of the existence of petroleum of high grade with parafine base.

As near as may be determined from casual investigations made, the oil occurs in a band of Fort Pierre shale, and appears to flow to the drill-hole through small fissures more or less filled with calcite or selenite. This at least may be stated: At every drill-hole where oil was encountered the so-called "oil sand" showed the presence of calcite or selenite crystals. The outlook at the present time for a productive and lucrative field for operation is better than ever before. Several wells are pumping, others are being "shot," and one or two are producing from fifty to seventy-five barrels per day. The product for the year is estimated at 10,000 barrels. Until quite recently all the product was shipped to Florence, but the erection of a local refinery wherein all the contents may be saved and utilized will produce a beneficial change. An analysis of the oil by Messrs. Von Schultz & Lowe, of Denver, is as follows:

Analysis of sample of crude petroleum taken from the Arnold well at Boulder, February 11, 1902:

Temperature of Distillation.	Per Ct.	Product.	Nature of Product.
Below 150 degrees C	26.0		Naphtha.
From 150 degrees to 200 degrees	13.0	Light	Illuminating ails
From 200 degrees to 250 degrees	16.0	Heavier	Total 165 per cent
From 250 degrees to 300 degrees	17.5	Heaviest J	rotai 49.5 per cent.
Above 300 degrees	25.5	Mixed lubricating	oils and parafine.
	3.0	Residue.	
	100.0		

Specific gravity of crude oil at 60 degrees Fahrenheit, 0.8111.

The lignite coal beds of this county supply a large portion of the fuel demand for Denver and northern Colorado. These mines are located in the southeast portion of the county in the neighborhoods of Lafayette and Louisville. The only complaint made by the coal operators is that of their inability to meet the demand.

Mr. Henry Denman, the Coal Mine Inspector, reports twenty mines operating, employing 975 men, and the production (two months estimated) for 1902, 811,822 tons.

The transportation facilities of the county are better than those of most counties of the state. The Burlington & Missouri runs two trains daily Denver to Longmont, and one Longmont to Lyons. Lyons is the great stone center and is likewise the gateway to Estes park, one of the popular summer resorts of the state. The Colorado & Southern runs three trains daily Denver to Boulder, two Denver to Longmont. The Union Pacific runs daily train Denver to Boulder, via Brighton. From Boulder the Colorado & Northern has train service to Ward, which reaches most of the mining districts and is a very popular ride for visiting tourists. All railroad companies operate freight trains to meet the demands.

The United States Geological Survey now has this section under consideration. The topographers have already covered the field, and they will soon be followed by the other corps of engineers. The importance of this work is apparent and will doubtless prove as beneficial to this section as it has in other sections of the state.

CHAFFEE COUNTY.

This county occupies a central position in the state and has an area of about 1,150 miles. It was organized in 1879 by legislative enactment approved February 10, 1879, and was formerly a part of Lake county. It was named in honor of Hon. Jerome B. Chaffee. The adjoining counties are Lake and Park on the north, Park and Fremont on the east, Fremont and Saguache on the south, and Gunnison on the west. In form the county is quite irregular. The west boundary line is formed by the Continental divide of the Saguache range, and the east boundary follows the more prominent peaks of the Park range. The intervening valley embraces the Arkansas river, which with its tributaries affords drainage for the county. This valley varies from an altitude of 7,000 feet at the southern to 9,000 feet at the northern boundary. While it is quite narrow near the south-central portion of the county, the valley widens to twelve or fifteen miles and carries this width for about thirty miles in the central portion. The Saguache range on the west rises to 14,375 feet at Mt. Shavano, 14,245 at Mt. Antero, Princeton 14,190, Yale 14,187, Haywood 14,575, and La Plata 14,311 feet, above sea-level. The range summit is very rugged and may be crossed at Monarch, Alpine, Cottonwood and Lake creek passes, all of which are near to or above the 12,000-foot mark. The Park range on the east is less rugged but contains mountains varying from 10,000 feet to over 13,000 feet. Topographically, therefore, the aspect is that of an elongated basin.

On the west the main tributaries of the Arkansas river are Cash, Clear, Pine, Cottonwood, Chalk, Browns, Boyds, South Arkansas and Poncha creeks. On the east, Sweetwater, Badger and Trout creeks. These streams in the main course through the granite gneiss complex or metamorphic rocks common to the Rocky Mountain system. Near the base of the mountains they usually occupy more or less rugged canons and locally expose remnants of strata assignable to the Paleozoic.

The precious metal mines of this county have not been accorded the systematic development granted other sections. The early history of this section reveals the fact that the discovery of gold in the placer mines near Granite was almost coincident with that of the placer beds in Clear creek and Boulder counties. Great activity prevailed until 1862, when there was an exodus of many to other supposed better sections. Those remaining pursued mining in a lethargic manner; lode claims were located, mills installed and the success attained from the supposed exhausted placers and milling of the oxidized ores again attracted attention, and the mining districts were active again during 1874-76. Soon after this the discoveries at Leadville became the center of attraction. The great revival of the mining industry, which reached its zenith in 1880, again populated this section. The various mineral districts were thoroughly overhauled by the prospectors, and their favorable reports were productive of a short era of smelter and mill building. During the next few years the various prospective mines were gradually deserted for

the supposed better fields in the San Juan, Creede, and finally Cripple Creek.

Notwithstanding the apparent willingness of the prospectors to leave this county and follow any new excitement, the successful operation and production of a few properties has always retained this section among the list of producers. From 1897 to the present time interest in the mines of this county has been gradually increasing. The close of 1902 marks not only more active operation, but a great increase in the list of new operators, many of whom follow mining as a business and appreciate the advantages this section affords. In almost every mining district in the county there has been substantial improvement. Stimulated by the erection and completion of a modern smelting plant near Salida, and the rebuilding of the matte plant at Buena Vista, providing a home market and making ores of low grade valuable, many new hoisting plants have been placed, new companies organized and consolidations formed, that will doubtless add materially to the future production of the county.

Near Granite the placer mines, which have been operated on a more or less extended scale since 1861, have been operating with improved appliances. The placer season usually opens about April 1st and closes November 15th. Early in the season two 90-ton steam showels were being installed by the Twin Lakes Company (Limited), and an 80-ton shovel was placed on the Havden placer. A new company has had the affairs of the Young America placer in hand. This company controls about 10,000 acres of placer The "clean-up" for the season appears to have ground. been satisfactory to the operators, but actual results attained are not given. In addition to those above noted, several other plants have been operated in a small way. While the aggregate placer gold recovered is not given, it will doubtless be in excess of \$65,000.

The La Plata, Hope and Red Mountain districts, in the northwest portion of the county, have been more thoroughly prospected than for many years. The veins are in granite which is locally traversed by eruptive dikes. In the main the veins are large and of low grade, although small shoots of high-grade ore are not uncommon. The ores carry gold, silver, lead and copper, and, from reports made, are susceptible of concentration, amalgamation, or both. Among the properties that have been operated may be mentioned the Columbine group of seven claims and the Columbine placer, the Banker group of forty claims (principal development a 1,000-foot tunnel), the Tasmania group, the Edna May tunnel, Rocky Point, Blue Bird group, the Kosmon group (twenty claims), The Practical Gold Mining Company group. The Tasmania Company are contemplating the erection of a gravity tram from their main working tunnel to their twenty-five-ton matte smelter, near Winfield. The Bwlchgoch group, ten claims, two placers, and ten-stamp amalgamation and concentration mill, and the Independence (Mt. Ewing).

The lode mining in the Dewey and Granite districts, embracing the northeast portion of the county, has been more active than formerly, and several new mining companies have entered the field. The Washington and Smuggler are being actively developed, and the Magenta amalgamation and concentration mill has been thoroughly overhauled for handling the ore. The Belle of Granite has been newly equipped, and what is known as the Barker mill has been overhauled and repaired. Among the properties that have been operated or newly opened are the Josephine, Spring, Union, Magenta, New Year and Little Troy group. Gold is the predominating value of the ores of this section.

The Park range, forming the eastern boundary of the county, has been prospected from Granite south to the southern limit, and the usual number of valuable discoveries reported. In the neighborhood of Newitt several properties have been equipped with machinery and development prosecuted more systematically than ever before. The plant on the Futurity group was destroyed by fire early in November, but a new plant will soon replace the old. The ores in this section are mainly copper, with slight values in gold and silver.

One of the most active sections of the county is that adjacent to Turret, Whitehorn, Manoa and Calumet. During the past year a number of transfers have been made and a few consolidations, with a view of extensive development. Several properties have been equipped with mechanical plants, and the tunnel companies have been pushing their bores ahead. The production has not been large, and quite spasmodic. The district is not yet beyond the prospective stage, and the development from the shafts and tunnels is comparatively small. The ore is mainly an iron sulphide with gold value predominating. The ores shipped have been small assorted lots, but with a market now at Salida, the operators all express confidence in their ability to make a steady production. Among the more prominent properties are the Vivandiere group, the Ethel Consolidation, American Flag group, Hershberger Tunnel group, Mascot group, Sunset, Jasper, Holdredge group, Dangerfield group, Crete, Copper King, Anaconda, Golden Island, Independence, Gold Bug, and Nutmeg tunnel. The Calumet iron mine has been inoperative.

In the Cleora district, south of Salida, the ores are principally copper, with small percentage of gold and silver. The Sedalia, Gypsy Queen and Stockton properties have been the most active, and produced small amount of ore for market.

In the Chalk Creek district, especially, adjacent to Romlev, Alpine and St. Elmo, production, development and prospecting have gone hand in hand. The Mary Murphy has marketed a large and regular tonnage at the matte smelter, at Buena Vista, and is driving a 3,000-foot cross-cut for drainage and transportation. This group of properties attracted great attention in 1880, and yet, with all the advantages of equipment and good ore bodies, was operated at a loss. For the past several years the property has operated at a profit. and is a striking example of what careful, conservative and good business management may accomplish in mining. The veins in this section are fissures in granite, generally several feet between walls. The ores are iron, copper, lead and zinc sulphides in a quartzose matrix, or associated with rhodonite. Gold and silver values are about equally divided. As a whole, the ores are low grade, but free gold and high grade silver ores are found in somewhat limited quantities. The steady production of the mines in this section for a number of years has done more to stimulate systematic effort in adjoining districts than anything else. In addition to the Mary Murphy group, the following active properties may be noted: Iron Chest, Ole Bull, Maple Leaf, Rolla, Black Hawk, Baalbec, Flora Belle, The Colorado Gold Mining Company group, and the Forward Gold Mining Company group.

The erection of the lead smelter near Salida has given an impetus to mining in the Monarch district. This section has long been a producer of lead-silver ores, and embraces the southwest part of the county, the most active section being adjacent to the headwaters of the South Arkansas river. The ores occur near contact planes of the Paleozoic, and generally as a replacement of the "blue lime" of the Lower Carboniferous. Among the active properties are the Darling, Eclipse, Friend group, Lilly, Madonna group, Mason, and Song Bird group.

The records of the county clerk and recorder at Buena Vista show the filings on placer claims, lode claims, mill sites and tunnel sites to aggregate nearly 14,000. Of these about one thousand have secured United States patent. During the past year there has been an average of about 216 mines and prospects in active operation, and 625 men employed in mining.

The precious metal production for the past five years, compiled from the finished product, is as follows:

Year.	Gold.	Silver.	Lead.	Copper.	Total.
1897	\$226,935-93	\$ 32,126 89	\$ 57,000 02	\$ 18,153 55	\$334,216 39
1898	227,535 36	49,671 52	91,568 71	13,704 24	382,479 83
1899	216,662 94	87,784 58	53,330 41	122,695 21	480,473 14
1900	172,677 18	76,965 15	39,422 75	124,507 44	413,572 52
1901	158,683 59	44,970 60	9,091 35	95,398-35	308,143 89

The indications for a largely increased production the coming year are most favorable. The plant of the Buena Vista Smelting and Refining Company, last year destroyed by fire, has been replaced and is in active operation. The Ohio and Colorado Smelting Company has nearly completed its plant, located two miles above Salida. This property contemplates five lead furnaces and one matte furnace, aggregate capacity of 1,200 tons daily, with refining plant. Two "lead-stacks" are now in operation. These two plants will not only supply a market for Chaffee county ores, but will draw largely from adjoining counties.

Stone and marble quarries are opened at a number of places near the various railroad lines, and supply a high class of material. The lime beds are utilized both for constructural purposes and as a flux by the smelting plants.

The county abounds in mineral waters, both hot and cold. The most popular resorts are Cottonwood, Haywood and Poncha. The following analyses need no comment:

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STATE OF COLORADO, 1901-2.

CHALK CREEK HOT SPRINGS. Near Haywood, Chaffee County.

Chalk Creek springs; temperature, 150 degrees Fahrenheit. Constituents.

Potassium carbonate	
Calcium carbonate 3.35	
Magnesium carbonate 1.08	
Sodium sulphate 10.58	
Sodium silicate	
Potassium chloride 1.09	
Silica	
LithiaTrace	
Organic matter,	
*	
Total parts in 100,000	24.27

GEORGE E. PATRICK, Analyst.

PONCHA SPRINGS.

Poncha, Near Salida, Chaffee County.

Number of springs, 100+; temperature, 90 degrees to 168 degrees Fahrenheit; resort.

	Poncha.	Keg.	Arbor. No. 3.	Tank.
Constituents.	No. 1.	No. 2.		No. 4.
Silica	5.38	6.59	7.52	7.66
Sulphate of lime	10.71	10.71	10.71	10.71
Sulphate of soda	4.03	4.03	4.03	4.03
Chloride of potassium		.86	.86	.86
Chloride of sodium	3.99	3.99	3.99	3.99
Iron carbonate		.52	.52	. 52
Sodium carbonate	39.34	39.34	39.34	39.34
Total parts in 100,000	64.83	66.04	66.97	67.11

REGIS CHAUVENET, Analyst.

Buena Vista, the county seat, may be reached by three lines of railroad. The Denver & Rio Grande follows the Arkansas river from Pueblo to Salida (one of the main commercial centers), Buena Vista, Leadville, and thence west to Salt Lake. The Colorado Midland enters the mountains proper at Manitou, thence across South park, and, entering Chaffee county at Trout Creek pass, continues to Buena Vista, Leadville and the West. The Colorado & Southern follows the South Platte river into South park, thence over Trout Creek pass to Buena Vista, and up Chalk creek to St. Elmo and through Alpine pass or tunnel to the Pacific Slope. All roads afford fine scenic attractions and provide good accommodations.

CLEAR CREEK COUNTY.

This subdivision embraces the territory upon which the first remunerative placer mine was located in Colorado. The discovery was made by George A. Jackson, in 1859, near the mouth of Chicago creek. The county was organized in 1861, and embraces an area of about 391 square miles. While it is one of the smallest counties in area, it has always been a producer of precious metals and is one of the most prominent mining sections of the state. It occupies a central position, and the adjoining counties are Grand and Gilpin on the north, Jefferson on the east, Park on the south, and Summit and Grand on the west. Its topography is that of a rugged mountain section, with intervening narrow valleys or canons, formed largely by erosion. It embraces a number of prominent mountain peaks, among which may be mentioned Gray's peak, 14,411 feet; Torrey's peak, 14,336 feet, near its west boundary; James peak, 13,281 feet, on the north, and Mount Evans, 14,321 feet above sea level, on the south county boundary.

The main drainage is through Clear creek. This stream, near the west boundary, divides into the North, Middle and South Forks. The main tributaries from the north are Mill creek and Fall river; from the south, Chicago creek—all of which have a number of smaller tributaries bearing local names. Bear creek and tributaries afford an outlet for the waters in the southeast part of the county.

The geological formation is that common to the front range of mountains, viz.: granite, gneiss and schist, and is traversed by a series of eruptive dikes. The mineral-bearing veins are of the true fissure type, and the precious metal deposits were, in the main, subsequent to the dikes. Not infrequently the vein is in direct connection with the dike which forms one of the vein walls, or may locally constitute the vein material itself. The dikes are of frequent occurrence. of variable size and character lithologically, but are all generally called porphyry. The mineral-bearing veins are, in the main, roughly parallel to, when not in conjunction with, the dikes. While the dikes and veins show variable strike. the most persistent and common course appears to be from northeast to nearly east, with a northerly dip. The north and northwest veins are less prominent and generally not so persistent in mineralization. The ore veins vary in width from a few inches to zones or vein systems of 100 feet or more. Generally, the vein walls are well defined, guite hard, and separated from the vein proper by a thin selvage or "gouge" material. Locally, however, the "pay ore" or "mill dirt" may impregnate the adjoining country for some little distance.

The vein filling is generally an altered condition of the country rock, more or less impregnated with variable sulphides. The main values, however, occur in form of ore shoots concentrated near one wall. The shoots are more or less persistent longitudinally, in many places showing the ribbon structure, and vary from a narrow streak to a foot or more. The associated low grade ore bodies are generally larger. This common condition has caused the parlance of the district to designate the two ore bodies as "pay or smelting ore" and "mill dirt or mill ore." The ores are mainly sulphides of iron, copper, lead and zinc, with associated gold and silver values. Under former market conditions, the mines adjacent to Georgetown were worked for silver output, and established an erroneous belief that gold existed only in minute quantities in the western part of the county. The changed conditions have caused a search for gold-bearing ores, and the imaginary line that divided the gold-bearing and silver-bearing areas has been obliterated.

The most common method of mining is to break the "mill dirt," leaving the "smelting ore" to be taken down separately. This latter is assorted, the refuse put with "mill dirt" and the choice ore shipped direct to the smelter. Some shipments of assorted ore are very high in gold and silver values. As a rule, the ores are amenable to the ordinary methods of amalgamation and concentration, and mills of this character are found in all sections. Locally, the county is indefinitely divided into numerous mining districts. These districts are not regularly established and made matters of record, with possibly a few exceptions, but receive the name of some stream, mountain, mine or mining camp. The great number of veins and operating mines, prospects and mills precludes the possibility of complete individual mention. Neither do those hereafter enumerated signify them to be of more importance than those omitted.

The county records disclose nearly 23,000 lode and placer claims, mill and tunnel sites duty recorded. Of these about 1,300 have procured United States patent. The average number of mines and prospects at work during the past year was about 247; the average number of men employed in mining, 2,010.

Mining in the vicinity of Georgetown shows more activity than for several years. Among the important improvements is that of the United Light and Power Company, which has added materially to its plant and is now furnishing power and light to the Mendota, Joe Reynolds, Lamartine, Sun & Moon and Griffith mines, and furnishing light to the neighboring towns of Idaho Springs, Silver Plume, Black Hawk, Central City and Nevadaville. Within the city limits the Georgetown Gold Mining Co. is sinking a three-compartment shaft to develop known veins under the town. The Centennial mine is working steadily with small force. The ore is an iron sulphide, carrying almost exclusive gold values. The Dewey & Wheeler concentrating mill and the Chamberlain-Dillingham ore sampling works are both crowded with ores. The Griffith mine, also within town limits, is extending development. The Anglo-Saxon Extension, one mile north of Georgetown, has been recently revived by the Western Mines Development Company.

On Democrat mountain the Silver Glance, Red Oak group of eighteen claims, Mineral Chief and Queen City group are active and producing. The Kelley tunnel is in about 2,000 feet, and progressing at rate of 200 feet per month, and will cnt 3,000 feet below summit of mountain. The Comit and Capitol M. & T. Co. are pushing development.

On Leavenworth mountain the Aliunde Company is developing and making little effort to produce. A new organization, to develop a large group of claims covering the
extensions of Colorado and Aliunde veins by a cross-cut tunnel, has been formed.

Near Silver Plume the Dives-Pelican, Bismark and 7-30 are operated almost entirely by lessees. This group aggregates some twenty miles of underground workings. A consolidation of the Terrible, Dunderberg and Smuggler groups, in all about sixty claims, is a very important matter. The Elkins M. & M. Co. is the name of the new organization. Another revived property is the Baltimore group and tunnel on Brown mountain, which will be systematically developed under new management. A small force is opening up new territory on the Diamond tunnel. The Wisconsin, Mendota and Victoria tunnels are regular producers.

On Republican mountain, the Vulcan and Daniel Peters group, Dunkirk and Pacific group are active producers. The Prudential M. M. & T. Co. has started a new tunnel, now in 150 feet, designed to develop a large part of Republican mountain.

In the East Argentine district the Vidler tunnel is projected to cut through the range under Argentine pass, now in 250 feet. The Santiago group of eleven claims is practically a new proposition, opened with three adit levels. The Waldorf Company has recently installed a power drill plant and is driving a tunnel to develop a group of claims on McClelland mountain. The East Argentine M. T. D. T. & P. Co. is driving tunnel from base of Pendleton mountain to develop group of fifty-three claims.

One of the most important consolidations recorded for the year is that of several companies, aggregating about 100 acres of territory, on Seaton mountain, near Idaho Springs. All differences were in this manner adjusted and litigation stopped. The new company is operating partly through Newhouse tunnel and partly in shaft on surface. These workings are about 1,000 feet apart and will be connected. This company is operating the Newton, Wilkie, State Ore and Silver Age mills.; have also acquired control of the Seaton Mountain Electric Light, Heat and Power Co., and are extending their lines in all directions. Operations on the Newhouse tunnel breast have ceased at present. This great bore is projected to tap the deep mines at Central City, and the bore is now in some 13,000 feet, is well equipped, and transports material by means of electric motor.

During the year the Shafter shaft house was destroyed by fire and has been replaced and re-equipped with larger plant. The Mona mine, in Virginia canon, has recently added gasoline engine, compressor and air drills. A new steam hoist has been placed on the French Flag, in Gibson gulch. The Seaton Mountain M. & M. Co. is making good production and preparing for new hoisting and compressor plant. The Tropic is sinking to connect with Newhouse tunnel. The Comstock, January and Morning Star are pushing development.

The Specie Payment, on Belleview, is working good force and producing good tonnage. The Knickerbocker is being developed by small force. The Stanley group, one of the bestequipped and developed mines in the district, is inoperative at present on account of disagreement between parties interested. The Crockitt and Bullion King companies are developing their holdings. In the Banner district the Stevens group of fifty claims is undergoing systematic development.

Work on the bore of the Big 5 Company is progressing and new equipment being added. This tunnel is projected under Belleview, Pewabic and Quartz hill, to Nevadaville, and is practically parallel to the Newhouse tunnel.

Production on the Lamartine mine has been curtailed, but a force is employed on development. Another consolidation of diversified interests has been practically consummated in this district, and will, when completed, revive some good producing properties.

On Chicago creek the Little Mattie M. & M. Co. has lately perfected consolidation of properties covering 100 acres. This company has a 60-ton concentrating mill, employs a good force, and mines and mill are active. Among other active properties in this section are the Quito Consolidated, fifty claims; Fraction; Perkins tunnel; Sears tunnel, new gasoline engine and compressor; Little Albert; Burns-Moore tunnel; Star tunnel, and Big 40 group. This tunnel is projected from a point about five miles up Chicago creek to Empire station, about 26,000 feet.

The Freeland Ex. M. Co. is developing with good force of men. This was one of the important transfers of the year. The Poorman and New Era companies and the Gum Tree are also active in this section. The Monarch M. M. T. & P. Co.'s tunnel at Dumont is in 2,300 feet. The objective point is the old Freeland mine. The Kaverne M. Co. is making regular production.

At Lawson the Joe Reynolds mine is undergoing development and producing. The Reynolds group of forty claims on Red Elephant is being equipped with a power plant and will be developed by cross-cut tunnel.

Around Empire there is increased activity. A new postoffice, Marshall Park, has been established near Empire station, on the railroad. Here the Marshall Russell G. M. M. & T. Co. has a well-equipped tunnel plant and is driving a bore into Covode mountain, now in about 700 feet. The Empire G. M. & T. Co. is driving a cross-cut tunnel, operating the Gold Dirt mine and a 30-ton concentrator. Among other active properties are the Republic tunnel, on Douglas mountain; Covode tunnel, on Miller mountain; the Silver Mountain Company's mine and concentrator, on Silver mountain; Gold Fissure and Gold Bug, on Covode mountain.

In the Daily and Atlantic districts development has prevailed with small production. The Helen-Herold Company's group have extended development and excavated for a concentration mill to be crected next season. The Dunton group of nine claims has been worked in a small way continuously. The Bobtail and other claims, near Jones pass, have been operated by lessees, while a number of claims have been worked to the extent of annual assessment.

On Lower Fall river, the Lucania T. Co.'s group, comprising about 120 acres, is being developed by 8x8 cross-cut tunnel. The Dover mine is producing. The Omar tunnel is in about 600 feet. The United G. M. M. & T. Co. is operating its mine and a 20-ton stamp and concentration mill.

At Yankee hill the active properties are the Lombard group and mill, Louisa, Cumberland, Bully tunnel, Joyce tunnel, Rio Grande tunnel, Oro Verde tunnel and Texas.

The number of cross-cut tunnels in this county is probably greater than that of any other section in the state. The mountains rise quite abruptly and give good depth by tunnel work. The ore deposits are so persistent that with few exceptions tunnels driven to the veins have proven a good means of development in this section.

The total precious metal production of this county, like that of Boulder, has been subjected to many estimates, none of which may be accurately verified or disproven. The production as compiled by this Department for the past five years is as follows:

Year.	Gold.	Silver.	Lead.	Copper.	Total.
1897	\$782,648 88	\$850,500 76	\$177,893 32	\$ 54,183 57	\$1,875,226 53
1898	605,527 65	913,949 49	212,128 74	38,090 76	1,769,696 64
1899	546,824 85	895,427 82	322,566 82	51,591 31	1,816,410 80
1900	465,447 06	834,035 62	236,228 64	40,324 00	1,576,035 32
1901	540,975 24	749,388-32	168,601 96	62,004 10	1,520,969 62

At Idaho Springs are located some of the most noted mineral springs in the state. They include both hot and cold waters, and are equipped with bath houses, private tubs, swimming pools, and caves or tunnels for steam baths. The following analysis is by Regis Chauvenet:

Constituents.	High Rock.	Springs.
Silica	. 6.550	6.100
Sulphate of lime	. 47.590	46.410
Sulphate of potassa	. 13.450	12,300
Chloride of magnesium	. 7.890	6.623
Chloride of potassium	. 0.425	2.060
Bicarbonate of iron	. 0.921	0.614
Bicarbonate of magnesia	. 11.278	12.312
Bicarbonate of soda	. 177.948	174.667
Parts in 100,000	. 266.052	261.116

The Colorado & Southern Railroad enters this county from the east and extends practically through the center to the western boundary. Two passenger trains daily run from Denver to Silver Plume, the west terminal, and a sufficient number of freight trains to handle the traffic. En route it passes through all the principal mining camps of this section, and one of the most rugged canons in the state. Between Georgetown and Silver Plume the ascent is made by a complete circle in the track. At the steel bridge, where the track crosses over itself, one of the finest of mountain views may be enjoyed. "Around the Loop" and through Clear Creek canon is one of the most popular trips for Colorado visitors. The round trip from Denver is made in one day, and during the summer season three or four extra trains daily are not

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uncommon. Observation or open cars are used, and the engines use oil for fuel, so that the annoyance from flying cinders is obviated.

CONEJOS COUNTY.

Conejos was one of the original seventeen counties organized by the territorial legislature, in November, 1861, and embraced nearly all of the southern portion of the state. Its original name was Guadaloupe, in honor of the patron saint of Mexico, but was later changed to Conejos, meaning rabbit. As now constituted, Conejos has an area of about 1,200 square miles, with the seat of government at the town of Conejos. It is one of the central-southern border counties of the state; its southern boundary line is a part of the north boundary of New Mexico. The adjoining counties are Rio Grande and Costilla on the north, Costilla on the east, and Archuleta on the west.

The west boundary line is the summit of the San Juan mountains, which at this portion form a part of the Continental divide. This section is quite rugged, and contains mountain peaks that reach an altitude varying from 11,000 to 13,000 feet above sea level. The San Juan mountains at this point mark nearly the southern limit of the great andesitic lava flow common to what is generally designated as the San Juan country. This volcanic mass is locally traversed by a series of dikes, the basalt flows being prominent near the mountain base and capping many of the adjoining foothills.

The Rio Grande river forms the east boundary and separates this county from Costilla. The eastern portion of the county embraces the southwest part of the San Luis valley. This valley is unusually level, has an average altitude of 7,500 feet above sea level, and is devoted to farming and stock raising.

The drainage of the county is through the Alamosa, La Jara, Conejos, San Antonito and Los Pinos creeks. These streams head well back toward the mountain summit, envelop numerous small tributaries, and all unite with the Rio Grande river. Ordinarily the water supply is ample for the irrigation demands of the valley.

The mining section is confined to the mountains in the west end of the county, and, compared with many other counties of the state, is quite limited. It may not improperly be classed as one of the undeveloped mineral reserves of the Desultory mining operations have been carried on in state. a few districts for many years, and of late years have been prosecuted almost entirely by lessees. The veins are, in the main, quite large and more or less mineralized throughout. The principal value is in gold, and the opening of an occasional small pocket of gold and silver telluride ores makes it possible for lessees to obtain a marketable product, together with remuneration for labor. Compared with some sections of the state where mining operations are more active. this section is far less inviting, as it is essentially a low grade district and requires capital for proper milling plants.

Platora and Stunner are the leading mining centers, but during the past season prospectors have made some discoveries near the extreme northwest corner of the county, which are valuable, if anything like represented.

The county records show about 1,100 claims recorded and sixty-eight patented. The best developed properties are the Mammoth, Home Stake, Blue Belle, Brownie, Geyser, Tunnel Lode No. 1, et al., near Platora, commonly known as the Mammoth group. The property is equipped with steam plant, and development aggregates about 3,500 feet. Near Antonito there has been considerable prospect work for turquoise, and some very good material was produced in limited quantity.

The mining sections of Conejos county are tributary to the Denver & Rio Grande Railroad, and are of comparatively easy access from Conejos or Antonito.

COSTILLA COUNTY.

This is one of the south-central border counties of the state. Adjoining Saguache and Huerfano on the north, Huerfano and Las Animas on the east, Conejos and Rio Grande on the west; New Mexico forms the southern boundary. It was organized in 1863; is in form quite irregular, and has an area of about 1,800 square miles.

The summit of the Sangre de Cristo and Culebra outline the east boundary line of the county. At their western base lies the great San Luis valley, a comparatively level tract, having an average elevation of 7,500 feet above sea level. The mountain ranges on the east rise quite abruptly and contain some of the highest mountain peaks in the state, among which may be named Purgatory, 13,719; Culebra, 14,079; Trinchera, 13,340; Blanca, 14,464; Baldy, 14,176, and Grayback, 12,887 feet, above sea level.

The metamorphic rocks of the mountains proper are locally flanked with Silurian and Carboniferous strata, and mining operations are conducted in a small way in all of the geological horizons.

The drainage is through the Rio Costilla, Rio Culebra and Rio Trinchera, which are fed by numerous tributaries, and eventually join the Rio Grande river, which marks the west county boundary line. Near the north end of the county are a number of small lakes, the largest being known as the San Luis lakes, and contain several square miles. These lakes are fed by numerous springs around the mountain base near Mosca pass and San Luis and other small streams coming in from Saguache county. There is no apparent outlet to lakes, and the tendency of all the streams in this section is to sink out of sight and appear only at intervals.

The history of this county reveals a number of mining excitements, but development has been spasmodic and production small. This is in part due to the fact that until within a few years the greater portion of the county, which is held as one of the old land grants, was not open to prospectors or miners. Under present conditions mineral veins may be located, operated and title procured from the Grant Company by complying with certain regulations. These rules and regulations differ little from the general statutes of the state governing mining operations, but in some respects are more liberal.

The Blanca section has attracted considerable attention, and has been the scene of active development on a small scale. The main ore value is in gold, and a new gold and silver telluride mineral, designated as "Van Diesite," is found near the extreme summit of Mount Blanca. This mineral was named after Prof. P. H. Van Diest, who was responsible for its determination and classification. During the past two years the main development work has been that of driving cross cut tunnels, which, owing to meager development on veins, is a questionable procedure. The principal properties are known as the Hamilton, Gold Anchor and the Homestake group.

In the Grayback district, which lies about twelve to fifteen miles east of Blanca, and is often considered as one and the same, there has been but little work done. Above Russell, which is near La Veta pass, the placer deposits have been prospected by a few men, and on Grayback mountain several of the veins near to, or in conjunction with, the large eruptive dike that crosses near the summit of the mountain, have been accorded annual assessment work.

In the Plomo district the Plomo Mining Company has kept a few men employed exploiting their territory and testing product in a 10-stamp mill on the plant. Their development in shafts and adits aggregates about 1,800 feet and two large open quarries. This property is practically a large deposit of auriferous quartz and quartzite, carrying an average value of \$3.00 gold per ton. The management is in skillful hands, and, although the deposit is very low grade, under existing conditions it may be operated on a large scale profitably. The manager claims the demonstration of an ore body 1,800x2,600x100 feet that will average \$3.00 per ton in gold or better.

The Denver & Rio Grande Railroad has two lines in this county—one, a standard gauge, crossing the range at La Veta pass and ending at Alamosa; the other line enters from Poncha pass, on the north, and passes through Alamosa to Durango.

CUSTER COUNTY.

This county was segregated from Fremont in 1877 by act of legislature, and as now constituted, embraces an area of about 720 square miles. It occupies a south-central position in the state, and is joined by the counties of Fremont on the north, Pueblo on the east, Huerfano on the south, and Saguache on the west. The west and south boundaries follow natural topographical divisions and make the form of the county somewhat irregular. The topography, in a general way, is that of a comparatively level basin or valley, within two mountain ranges. The average altitude of the valley is about 8,000 feet. On the west the Sangre de Cristo range rises quite abruptly to 12,000 feet, and contains mountain peaks that reach an elevation of over 14,000 feet above sea level. The range front is scarred by deep ravines or gorges, with precipitous cliffs or walls. Rising some 6,000 feet above the valley, the bold, rugged front and pyramidal peaks present one of the most striking views in the mountains. The main rock of the mountain top is granite, but of somewhat different type to that common to the front range. Along and flanking the mountain front Carboniferous sandstones and conglomerates predominate.

The valley which bears the same name as the mountain range on the east—viz., Wet Mountain—is about twenty-five miles long and fourteen to twenty miles wide. It is one of the widest mountain valleys in the state, and well known for its agricultural products and fine range land.

The Wet mountains on the east, originally known as the Sierra Majado, is a comparatively low mountain range. The highest points are about 11,000 feet, somewhat irregular and separated by comparatively shallow valleys, with easy slopes. The rock mass composing this range is a coarsegrained granite.

The main drainage of this section is through Grape creek and its numerous small tributaries, which empty into the Arkansas river a short distance above Canon City. Ordinarily, Grape creek is a comparatively small stream, but owing to the large area it drains, it becomes at intervals during the rainy season a raging torrent.

For a number of years this section has not attracted as much attention through its mines as formerly, or as much as the existing conditions justify. Its history is that of a number of mining districts in the state, and may be summarized as the scene of activity in the early '70s and large production of precious metals, a season of ill-advised millbuilding, a so-called "boom" just prior to '80, followed by a natural decadence. It is not logical to suppose that the mines which attracted so much attention and produced so largely have been entirely worked out or that none others may be developed. Next to the construction of milling plants that prove failures are the ill-effects of a "boom," which is productive of large individual holdings of mining territory by those generally incompetent to develop. They, therefore, locate and accumulate mining property to sell, and, under the prevailing excitement, offer for sale at such exorbitant prices and upon terms so unreasonable as to discourage buyers competent to mine. This condition, aided by the rapid failure of the numerous and expensive milling plants, probably hastened immigration to other sections; but the object lesson has not been confined alone to Custer county.

The leading mining district, known as Hardscrabble, embraces the eastern part of the county and the towns of Silver Cliff, Westcliffe, Rosita and Querida. In part II of the Seventeenth Annual Report of the United States Geological Survey this immediate section is considered at length. Mr. Whitman Cross, the geologist in charge, and a recognized authority, says in part : "The mines of the Silver Cliff and Rosita districts are, for the most part, in volcanic rocks, but the area mapped includes, also, a number of hills of granite and gneiss. The eastern portion of the area to be described is occupied mainly by the volcanic group of the Rosita hills. There are here both massive and fragmental volcanic rocks, and the investigation has shown that at this point there was a volcano, whose products accumulated on a surface very similar to that of to-day. * * * At and near Silver Cliff there are massive and fragmental rocks belonging to the rhvolitic period of the Rosita volcano. No other rocks of eruptive sequence are found at Silver Cliff. * * * The non-volcanic hills of the area * * * represent the ancient gneisses and granites which form the adjacent portions, at least, of the Wet mountains and their western slope."

In writing of the geological relationship of the district, Mr. Cross says: "The volcanic phenomena of the district may be compared with those nearly or quite contemporaneous in other portions of Colorado. * * * Both the Cripple Creek and Rosita volcanoes are to be regarded as small, outlying vents connected in origin with the much larger eruptions of the San Juan and of the South Park regions, which were in part also of Eocene age, though probably continuing into the Meocene."

In describing the rock formations: "The eruptive rocks of the Silver Cliff-Rosita Hills district, which are later than the granites, present a variety quite unusual in such a small area. They may be considered in two divisions, corresponding in a general way to differences in time and conditions of eruption. The older of these divisions embraces three rocks-peridotite, diabase and syenite-which are known in dikes only and belong to a period much earlier than that in which the others were erupted. The later series includes rocks closely related to one another in time and conditions of origin. * * * At least seven types of considerable geological importance can be distinguished, and for the most part the relationships of the various forms are clear. A number of minor types belong in this series. These rocks are found cutting one another and also spreading out upon a surface corresponding closely to that of the present day. The Rosita hills are built up by them. * * * The rocks are intimately related in occurrence, and, from a geological standpoint, they must be regarded as a series of products from the same volcanic or eruptive source. * * * Most of these rocks are found as surface masses, and also as dikes. The eruptions of two of the rocks were plainly begun by explosive volcanic action, producing much fragmental material. In one of these cases there were also many outpourings of thin fluid lava. But the other effusions were massive eruptions which produce even-grained almost identical with the dike rocks forms. The order of eruption can be clearly established for most of the types * * * as follows: Rosita andesite. Bunker andesite, Fairview diorite, Bald Mountain dacite, rhyolite, Pringle andesite, trachyte."

Accompanying the geological report of Mr. Cross is a paper on "The Mines of Custer County," by Mr. S. F. Emmons, whose standing is pre-eminent on mineral veins and ore deposits. After a detail discussion of several properties Dr. Emmons generalizes in part as follows:

"The ore-bearing veins cut the trachyte, thus proving their mineralization to have been subsequent to its eruption. * * * With few exceptions, they are vein deposits on fault planes in some of the many varieties of igneous rocks that outcrop in the region. They are in general rather narrow fissures, which do not bear evidence of having at any time constituted large open spaces, but in which the ore-bearing solutions have deposited their contents by first filling the interstices between the sheets of sheared and banded rock, and afterwards partially replacing these sheets or bands by vein materials. The ore in these cases is generally confined to the fault fissure, and the deposits may be characterized as well-defined vein deposits, or true fissure veins. * * * It is interesting to contrast the deposits of this region with those of the now famous Cripple Creek district, which lies in a very analogous geological position, forty miles to the northward, and which presents in its geological structure so many points of resemblance. There, as here, the main ore deposition has taken place in and around a central volcanic focus, where a series of comparatively recent igneous rocks have broken through an older series of pre-Cambrian crystalline rocks. There, as here, the principal deposition has taken place along a system of fracture planes traversing both the eruptives and the underlying crystalline complex, and, while not strictly confined to the eruptives, it has, so far as present developments show, been more abundant in the former than the latter.

"In the Cripple Creek region there has been one principal and predominant system of mineralized fractures running about north and south. In this district a system running north and south, or a little west of north, is apparently the more frequent, but there are also abundant fractures running east and west, and others quartering between the two. The geological history of this region has been more complicated; there have been a greater number of successive eruptions, and it is probably in consequence of this fact that the fracture systems are more varied and complicated.

"Mineralogically, the contrast is greater. In Cripple Creek the important metal is gold, which was deposited mainly in the form of telluride, and the prominent earthy mineral associated with it is fluorite. Here, gold as telluride occurs in certain parts of the district, and fluorite is sparingly found, but the greater part of the valuable minerals are silver minerals in their usual association with sulphides of lead, zinc and iron, and with barite as the prominent gangue mineral. They differ from the ordinary deposits of this class mainly by their greater average richness."

The mining conditions in this county are better than for several years, and the indications are favorable for an increase in systematic mining in all the local districts. During the past two years this section has been a favorite field for prospectors and representatives of capital. Several new organizations have been perfected, and more are under consideration. The production may not show any marked increase, but there has been a greater increase in systematic development. The Bassick mine has been thoroughly overhauled, the old shaft abandoned, a new shaft sunk 1,760 feet, and systematic development prosecuted for the past The mill in connection with this property has likevear. wise been remodeled, added to, and was started about October 1. The conservative methods pursued by this company have exerted a good influence on the entire section. Among the properties that have been more or less active in the Hardscrabble district may be mentioned the Bon-Ton; Bull-Domingo (which was started in May, 1902); Democrat tunnel; Florence M. & M. Co. group; Hector; Humboldt; Immortal; Keepsake; Maverick mine; P. & O. (an old property near the Bassick, that has been newly equipped); Powhattan tunnel; Pointer group; Tip Top; Toledo (recently equipped with new shaft house and machinery); Terrible (a concentration mill in connection with mine): Valley: Valley View, by the Little Burnice company; Combination; American Flag; Aburdix group; Lucile; Leonora; and a group of claims near Querida, by the Custer M. & R. Co. The La-Rand M. & M. Company erected a new twenty-stamp amalgamating and concentrating mill, with tables and jigs, near Westcliffe, and started work in July.

The most recent excitement is the reported gold discovery on the Great Wonder mine. This property is located about 2,500 feet east of the corporate limits of Silver Cliff, consists of seven claims, and has been located and relocated several times since 1879. Reports indicate a body of low grade ore some two hundred by five hundred feet. Several trenches have been made, and a shaft sunk about forty feet deep. Sample tests yield from \$4.00 to \$44.00 in gold. The discovery of gold-bearing ores in a section always considered strictly silver-producing has created a great deal of interest and resulted in numerous relocations. Should development demonstrate this find to be comparable to reports, it is certainly one of great importance.

In the Oro Verde district, near the base of the Sangre de Cristo range, in the west part of the county, considerable prospect work has been done and a small amount of ore produced. The veins here are quite large, but low grade, deposits in the Carboniferous conglomerate. Copper occurs in the native form, finely disseminated through the gangue; also as sulphide, with associated silver values. The S. A. K. tunnel has been the principal producer. The Hermit Lake Copper Company has developed a large body of low grade copper ore and erected a twenty-stamp concentrating plant, operated by water power.

The county records show an aggregate of 8,167 lode and placer claims, mill and tunnel sites, duly recorded. During 1901-02 an average of 337 men were engaged in mining, and about 126 mines and prospects worked.

The production of this county as compiled by this Department is as follows:

Year.	Gold.	Silver.	Lead.	Copper.	Total.
1897	\$ 2,129 01	\$ 16,011 25	\$ 71,015 19	\$ 91 77	\$ \$9,247 22
1898	723 45	14,165 82	36,186 64	177 00	51,252 91
1899	1,054 17	3,577 18	37,409 16	162 54	42,203 05
1900	20,835-36	50,727 73	33,552 22	380 13	105,495 44
1901	11,120 46	29,707 26	17,356 85	6,709 41	64,893 98

The completion of the Westcliffe branch of the Denver & Rio Grande Railroad has done much to revive this section. This branch leaves the main line at Texas Creek, which is between Canon City and Salida, and extends to Westcliffe. The terminal point is about two miles west of Silver Cliff, the county seat.

DELTA COUNTY.

This county occupies a west-central position and lies entirely upon the western slope. It has an area of about 1,150 miles and was organized in 1883 by an act of legislature segregating it from the domain of Gunnison county. Mesa county forms the north and west boundaries, Montrose the south, and Gunnison the east.

The principal industries are agriculture, horticulture and stock raising. The Gunnison river, with its numerous tributaries, affords drainage and ample water supply for present demands of irrigation. The streams, after leaving the more rugged sections on the north and east, flow through comparatively broad and fertile valleys. The north and east county boundaries are outlined by natural topographical divisions. The higher points rise from 10,000 to 12,000 feet above sea level, and the valleys vary in altitude from 4,800 to 6,500 feet.

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The mineral resources are practically undeveloped. The coal beds are drawn upon for local consumption only. The precious metal deposits are in the east and southeast part of the county and have not passed the prospective stage. Each year there is a small gold product from some of the stream beds in the vicinity of the southeast corner of Delta county. All reports agree that there are several places in that section where fair mining wages may be made with pan or rocker. There is some doubt as to the exact location of these deposits. That is to say, whether they are in Delta, the northeast part of Montrose, or west part of Gunnison counties.

Delta is the county seat and principal commercial center, The Denver & Rio Grande Railway passes through the county and has recently constructed a branch line from Delta up North Fork of the Gunnison to Hotchkiss. It is expected that with transportation facilities the coal deposits of this section will be developed and that within a short time the anthracite beds near the east end of the county will be drawn upon.

DOLORES COUNTY.

This subdivision was segregated from the county of Ouray by an act of legislature, approved February 19, 1881. It occupies a southwest portion and borders on the state of Utah. The adjoining counties are San Miguel on the north, San Juan on the east, and Montezuma on the south. It embraces an area of about 1,000 square miles. The east part of the county is mountainous, with rugged peaks rising from 12,000 to 14,000 feet above sea level. The west (and by far the greater) part consists of elevated plateaus sloping gradually to-ward the west and varying from an altitude of 8,500 feet near the mountains to about 6,000 feet near the Utah line. The mountain area is drained by the East and West Forks of the Dolores river and numerous tributaries. These streams have a general southwest and south course and unite about twenty miles below Rico in Montezuma county. The main river makes a somewhat lengthy detour south and west, then turns northward and crosses Dolores county a short distance east of the Utah line.



Stock-raising and agriculture are engaged in to a limited extent in the valleys and plateau section, but the principal industry is that of precious metal mining. The mining history of this section centers about Rico, the present county seat and leading commercial center. It practically begins with the year 1879. Since that time the mines at or near Rico have demonstrated Dolores to be one of the important mining counties of the state. Like all mining sections it has been more active at certain periods than others, but at no time since 1880 has it failed to contribute its quota of precious metals toward the aggregate production of the commonwealth. The predominating value in the ores is in silver, which occurs in all the richer sulphide forms, at times native, but generally associated with lead, iron, copper and zinc, in a quartz gangue. Although the mines were formerly spoken of as silver-lead producers, and the general impression was established that gold was not associated in appreciable quantities, under present market conditions, and with somewhat recent developments, the producers of this section are now ranked as gold-silver-lead mines. In common with many other districts in the state a number of mines are now operating upon ores in which gold values predominate.

In the well known Havden atlas, based upon work of the survey in 1874-'6, the mountains of eastern Dolores county are designated as the "Bear River mountains." The more recent work of the geological survey has for good reasons changed the name to the Rico mountains. The geology of this mountain group is exceedingly complex by reason of its somewhat isolated position, prominence and formation in connection with the numerous eruptive intrusions, dikes and planes of faulting. In the twenty-first annual report of the United States Geological Survey the "Geology of the Rico Mountains" is described at length by Mr. Whitman Cross and Mr. Arthur Coe Spencer. This report, in connection with like reports on the Telluride and La Plata quadrangles and the Silverton geology, clearly sets forth the many complications of this section. In this report Mr. Cross says, in part:

"A detailed survey of the Rico mountains has been made both on account of the economic importance of the district and as a necessity in connection with the areal geological mapping of the San Juan and adjacent mountains, now in progress. In the course of this work the Rico quadrangle was taken up in 1897 and finished, with the exception of a small area about Rico, where the geology was found to be so complicated as to require an accurate and detailed topographical base. It was also seen that an intelligent exploitation of the mineral resources of the district was practically impossible until such a geological map should be available.

"The Rico mountains form a small, compact group of peaks resulting from a deep dissection of a local dome-like uplift of sedimentary and intrusive igneous rocks. This uplift appears on the eastern border of the Dolores plateau, which is continuous westward with the Great Sage plain of Utah, extending to the brink of the Colorado canon. The termination of the Dolores plateau on the line passing through the Rico and La Plata mountains is due to a change in the altitude of the underlying sedimentary formations. Beneath the plateau they are approximately horizontal, but on the line mentioned they come under the influence of the monoclinal folding which has taken in a broad zone adjacent to the San Juan mountains. * * The Rico mountains consist of a circle of high and rugged peaks divided into two crescent-shaped halves by the Dolores valley. There are twelve peaks, each extending 12,000 feet in elevation above sea level, and the narrow crest connecting them rarely sinks below 11,500 feet on either side of the river. In passing through the group the Dolores receives several important tributaries on each side. These lateral gulches are all deep, with steep sides, and their streams are still actively engaged in the work of erosion.

"The Rico mountains are due to forces which have been very local in their action. The principal structural feature is a dome-like uplift of sedimentary beds resulting from a distinct vertical upthrust. A part of the elevation of the strata is clearly due to the intrusion of numerous bodies of molten material injected between the beds after the manner of laccolites. But the elevation was not in a large degree due to the intruded masses of molten material, and it appears certain that a part of the upthrust occurred after the magmas had solidified to rock. This conclusion is necessary because of the numerous and important faults occurring in the mountains, the dislocation upon which has plainly added materially to the uplift, and these faults traverse porphyry sheets as well as sediments. * * * A considerable disturbance must have been caused by the large cross-cutting monzonite stock on the west side of the river, but the exposures about this mass are so poor that the evidence of the part this intrusion has played is very unsatisfactory. * * The vertical extent of the uplift is estimated at about 4,500 feet."

The Rico mountains are composed of stratified rocks from the lowest Paleozoic known in the San Juan region to the base of the Dakota Cretaceous, together with intrusive sheets of igneous rocks commonly designated as porphyry. Mr. Cross and Mr. Spencer estimate the thickness of the stratified rocks exposed in the vicinity of Rico at 5,300 feet. This is exclusive of the intrusive sheets of porphyry. The limited space in this report forbids even a summarizing of the description of the igneous intrusions and dikes and strata of this section as given in their report, or from quoting important sections in regard to veins and ore deposition as set forth in papers on this region by T. A. Rickard and John B. Farish.

In a general way the precious metal deposits occur in veins, filling fissures along certain planes of stratification as replacements, and in shattered zones as impregnations. The parlance of the district divides the ore bodies in "verticals" and "contacts." The so-called "verticals" contain the richer ores and are veins occupying planes of faulting, or fractures crossing the strata at nearly right angles. There is another system of fissures that are of later period that cut through the verticals, generally producing more or less additional faulting. The so-called contact does not appear to apply to any particular horizon or any particular strata, but is applied to any mineralized zone in which "pay ore" is discovered and mined. "Pay ore" bodies appear to be confined within certain well defined horizons. Ore deposits, however, occur at different horizons where the fissures cut through from one to the other, and these are locally designated by the terms "upper or lower contacts." The so-called "lower contact" is a matter of great importance to this section. The ore bodies so far opened are of low grade, too low in the main to have any great commercial importance at the present time. But this horizon is practically undeveloped, and may yet be demonstrated to be as valuable as the "contact" above.

The mining area is locally divided into two districts by the Dolores valley. That on the west is called the Lone Cone and on the east the Pioneer. During the past year one of the most important consolidations in the history of the camp has been effected. It is known as the United Rico Mines Company, and includes the Enterprise, Rico-Aspen, Futurity, Grand View, Rico Town-Site, Barlow group, Atlantic Cable group, Black Hawk group and several other claims—in all, about 2,000 acres in the heart of the Rico mining section. The new company is officered by thorough mining men, and development on a large sale will follow.

Quite a number of the mines in this section are operated in part or wholly by lessees, but leases within the territory of the above consolidation are not being renewed at expiration. The Pro Patria tunnel on Dolores mountain is connected with a well equipped concentrating mill, located on railroad in Rico, by a first-class tramway. Both mine and mill report good results. The zinc plant has been operating on the Atlantic ores. The Wellington group has been a steady producer. The Argentine, on Silver creek, is making extended tests for separation of the zinc from the heavy lead and iron sulphide product. Among other active properties are the C. H. C., Butler and G. V. G. group.

The mines adjacent to Dunton, on West Dolores, are more active than at any time in their history. Among the leading mines of this section are the Emma, which is largely developed and equipped with a 100-ton concentration mill; the Smuggler-Almont group, connected with 10-stamp mill by tramway; the American group, near the Smuggler, operating under lease, and the Eclipse group. In Horse gulch, the Robinson group, Palmetto group, Johnny Bull, Caledonia, Belzora and other properties have been actively developed.

The veins in this section are of the fissure type and are found in conjunction with or roughly parallel to one of the two systems of igneous dikes that traverse the country northwest and southeast or northeast and southwest. Some of the mines in this section bid fair to become large and permanent producers. The ores are sulphide in character, carrying gold and silver.

The mineral springs at Dunton have never been analyzed by a competent chemist, but have long been known as waters possessing great curative properties. They are somewhat crudely improved, and the existing accommodations are generally taxed to their capacity.

West Dolores creek is utilized, in part, to supply the power needed for milling and mining purposes, but within a few miles of Dunton are workable seams of coal of fair quality for steam-making purposes. Some of these beds are owned and operated by the mining companies.

The mining possibilities of Dolores county, when considered as a whole, are most inviting. It offers a good field for the prospector, partially developed properties may be obtained at fair valuation, and mining operations may be conducted for about one-thirid less than in the majority of San Juan camps. The county is traversed by a section of the "Around the Circle" trip so extensively advertised by the Denver & Rio Grande Railway system, and may be entered either via Durango or via Montrose and Ridgway. The Rio Grande Southern operates daily trains between Ridgway and Durango, via Telluride and Rico.

DOUGLAS COUNTY.

This county occupies a central position in the state, and was one of the original seventeen counties organized by the territorial legislature, in 1861. Its present area is about 900 miles. The adjoining counties are Arapahoe on the north, Elbert on the east, El Paso and Teller on the south, and Jefferson on the west. Castle Rock is the seat of government and leading commercial center.

This section embraces in part the western limit of the Great Plains country. In the west and southwest parts it is traversed by a spur of the Front range of mountains, locally named the Rampart range. This range is quite rugged, and in individual peaks reaches an altitude of nearly 10,000 feet above sea level. It is composed of metamorphic rocks, and flanked by Trias-Cretaceous strata. The western slope is drained by the South Platte river and tributaries, the east slope by Plum creek and tributaries, and in the east part of the county is what is known as the Cherry Creek plateau, drained by Cherry creek and tributaries.

Owing to its close proximity to the first gold discoveries in Colorado, the search for gold soon extended into the Douglas county area. Its early history, therefore, reveals it to be one of the first settled upon in the state. The search for gold was rewarded, but only to a limited extent. The placer bars did not afford very lucrative employment, but have nevertheless been worked in a small way each year up to the present time, the annual production amounting to but a few ounces.

The principal industry is stock-raising, the undulating and comparatively well-watered hills affording good range feed. The stone quarries are quite well developed, produce a good quality of building and other stone, and afford employment to a good force of men almost constantly throughout the year. During 1895 the "overflow" from the Cripple Creek district, in Teller county, created considerable interest in the Rampart range near the southern limits of the county. The following year several small mining camps sprang up, but the developments did not meet expectations. At present, beyond a little prospecting by a few men, and the annual assessment work on a few claims, there is no activity. This section has a number of narrow fissures filled with gold-bearing veins, but the ores have not been demonstrated as yet to exist in commercial quantities.

EAGLE COUNTY.

Eagle county occupies a central position in the state, and embraces an area of about 1,700 square miles. The adjoining counties are Routt and Grand on the north, Summit on the east, Lake and Pitkin on the south, and Garfield on the west. Its mining history practically begins with the year 1879. The discovery of ores somewhat similar in character and occurrence served in a measure to relieve at that time the crowded condition of the Leadville district. The first valid locations were made in 1879, but production was limited until the completion of the Denver & Rio Grande Railroad into Eagle canon, in 1882.

The drainage is to the Pacific Slope and through the Frying Pan, Eagle and Grand rivers and the Piney. The Frying Pan and tributaries are in the southwest part of the county. The Eagle river rises near the southeast corner, flows approximately north to the center of the county, then turns west and joins the Grand. The Grand river flows in a southwest direction through the northwest portion, and the Piney, in the east and northeast, flows northwest and joins the Grand. All these streams have numerous tributaries of more or less importance. The crest of the Park range of mountains on the east forms the dividing line between Eagle and Summit This range is quite rugged, and rises in peaks to counties. over 12,000 feet above sea level. Near the south boundary the most prominent landmark is Mount of the Holy Cross. This peak rises to an elevation exceeding 14,000 feet, and practically marks the northern limit of the Saguache range. It derives its name from an almost perpetual cross on the

north slope. The northern slope is quite precipitous and is traversed by two transverse fissures crossing at right angles. These fissures are protected from the sun and are almost constantly filled with snow or ice, thereby forming a large white cross on a dark background.

The general geology is a granite-gneiss mountain nucleus, penetrated by volcanic dikes and flanked with Silurian, Carboniferous and more recent strata. Remnants of basalt flows cap some of the hills, ridges and plateaux in the west-central portion. The topography is that of a rugged mountainous section subjected to the influences of erosion. The principal industry of the county is precious metal mining, although stock-raising, agriculture, and lumber manufacturing are actively pursued. Locally the mining section is divided into districts, the names of which are generally common to the nearest mining camp or prominent mountain, as Battle Mountain, Holy Cross, Fulford, McCoy, etc.

The Battle Mountain district includes Red Cliff, the county seat, and Gilman, an adjoining camp. This has been the most productive area, and was originally spoken of as the center of the "carbonate belt, only thirty miles north of Leadville." The Eagle river, which heads near the top of the west slope of Tennessee pass, soon passes into a canon that for grandeur is exceeded by few if any in the state. Locally the sides rise almost precipitously for several hundred feet and then slope upward to 2,000 to 2,500 feet, and in places the canon is barely wide enough for the river and the Rio Grande Railroad track which occupy it. A few miles below Red Cliff, where the canon of Rock creek comes in at almost right angles, the precipitous rock walls exhibit an especially good geological section. At the base is granite-gneiss, and resting upon it the Cambrian quartzite, Silurian limestone and porphyry, in the order named, the latter forming the main upper portion of Battle Mountain. These strata have a uniform average dip of about fourteen degrees to the northeast. In the parlance of the district, the ore deposits are found in "fissures" in the granite, carrying gold, silver, lead and copper; in the "quartzite contact," carrying gold, with slight silver values, and the "lime contact," carrying large bodies of lead-silver-iron ores, with slight gold values. Prior to 1884 the production was almost entirely from the "lime contact," or the mineralized zone between the lime and porphyry. During that year the discovery of rich gold ore in the Ground Hog mine was made by Mr. Charles H. Taylor, on the "quartzite contact." The ore deposition in the "lime contact" is comparable to that at same horizon in Leadville. That in the "quartzite contact" is well described by Mr. F. G. Bulkley in his description of the Combined Discovery workings, which is applicable to mines similarly located in this section:

"The quartzite bed containing the ore deposit consists of a white or grayish metamorphosed sandstone of very fine texture, with the planes of stratification well preserved. Owing to the compactness and purely silicious character of the rock, the effects of weathering are slight. In the upper portion of this bed, which is exposed to view throughout its entire thickness, occurs a stratum of quartzite of much looser texture, nearly resembling sandstone, having a constant thickness of five feet, and having, also, clearly defined, its planes of contact with the contiguous rocks above and below. This stratum appears to constitute a zone to which is confined the ore-bearing mass of a valuable mineral deposit. The nature of this deposit is that of a sheet of mineral matter of variable thickness, of indefinite depth and lateral extent, being divided at times into two or more parallel sheets, with but a thin interval of separating medium. This sheet is enclosed within the distinctly marked boundaries of the porous stratum of quartzite before mentioned; has identically the same strike and dip, and occupies a space of from three inches to five feet; while its outcrop can be distinctly traced for a distance of 600 feet upon the surface. By far the greater portion of this sheet consists of gangue composed of impure sandy clays, colored by from five to fifteen per cent. of oxide of iron; minute traces of copper occur as carbonate, and from one to five ounces of silver, probably in the form of chloride. The gangue is somewhat banded in appearance, owing to the unequal disposition of the coloring matter, and in this feature of arrangement shows unmistakable evidences of the action of a current of water. As is usual in metalliferous veins, the ore mass is confined to shoots, which in this instance traverse the vein sheet in a direction a little east of north, with a varying width of from ten to sixty feet. A careful study of these productive localities following vein structure, with considerable uniformity reveals the throughout.

"The cap rock or hanging wall consists of a compact quartzite, which has a singularly even and clearly defined surface. Under this comes from two to six inches of banded aragonite, followed by four to ten inches of quartzite, varying in texture from extremes of compactness and hardness to friability and softness. Next comes one to six inches of massive fine-grained argentiferous galena, carrying from sixty to three hundred ounces silver per ton and occasionally more. After this is a thin sheet of hard quartzite, which in places is lacking. Then follows six inches to three feet of a soft ochreous clayey mass, of a yellow to red color, containing galena disseminated, together with its secondary products, cerussite, anglesite and minium, all yielding silver in good proportions. Immediately under this comes the foot-wall, which is of the same material as the hanging. In some parts of the vein the aragonite is lacking, in which case its space is unoccupied, leaving a crevice without filling. In other parts this crevice is only partially filled, the aragonite being still in process of deposition in stalactite form. Stalagmites do not occur, however, owing to the very gradual percolation of the waters carrying the carbonate of lime in solution, and to its evaporation before sufficiently accumulated to form drops. The means by which the enclosing crevice of this vein was formed must remain a matter of speculation, so far as exact proof is concerned. It may have been the result of one or several combined causes. There are some facts shown, however, by an examination in its entirety of the geology of this section, which offer material for a satisfactory theory. An inspection of the district is sufficient to show that the portion of the vein which is open for investigation is located at a point between the foot and summit of an immense anticlinal fold, which involved all the present existing beds; and corroboration of this fact is found in the gradual increase of dip as the strata enter further to the north. In fact, the locality for miles is one of great geological folding. and doubtless from this cause a separation of the strata may have occurred, especially midway between the foot and summit of such folds, forming the parallel crevices ready for the reception of their metalliferous contents. With reference to the formation of the filling, it may be said generally that the conditions therein found accord perfectly with the theory of lateral secretion, and that the filling came by percolating waters from above, which very probably, to a considerable extent, drew their metallic contents from the porphyry rock. This conjecture gains strength from the fact that percolating waters from above are now depositing the band of aragonite before referred to. Undoubtedly this mineral is dissolved out from the superincumbent beds of limestone. The contorting of the strata here was undoubtedly the occasion of the evolution of the intense heat. This would increase the solvency of the waters, and, however weak the solution may have been, the existence of a crevice would permit the accumulation until filled by precipitation carried on through a long interval of time. What agency caused the precipitation is an unsolved problem, but that the metals were originally deposited as sulphides there is little room for doubt, because they are now found in that chemical condition, both as the nucleus or unaltered interior of masses of lead carbonate ore, and also where enclosed and protected by unchanged quartzite, from the subsequent influences which have perhaps repeatedly had their effect. No doubt many features of the vein, as they are now exposed, are the result of secondary action. Thus sulphides have been changed to oxides and carbonates, and ensuing sulphurous waters have perhaps acted upon the enclosing rocks with more or less effect."

In common with nearly all mining sections in the state during the past two years, Eagle county has been the scene of many transfers of property, new organizations and developing enterprises on a large scale. The principal producers and most active properties are in the Battle Mountain mining district, among which are the Bleak House, Combined Discovery, Uncle Sam, Iron Mask, Crown Point, St. Joe, Percy Chester, Tom Scott, Wilks-barrie, Little Chief, Cora, Belden, Black Iron, Ground Hog, Ben Butler, Last Chance, Iron Will, California, Red Cap, Black Tiger, Wyoming, Alpine, Warrior's Mask, Harrison, Eagle Bird, Alligator and King-fisher.

In the Fulford district the Mendota mine has been under systematic development and some ore was milled at their 25-stamp amalgamating and concentrating mill. The Kittie B., New York, Adelaide and Layton were also worked quite extensively. A number of properties have been revived in the Holy Cross and the Cross Creek districts. At the head of Lime creek there has been considerable prospect work. At or near McCoy the copper mines have attracted much attention, but the work done was for the most part confined to development, annual assessment work and prospecting.

The mines of this section are generally opened up by tunnels or inclines, and require comparatively little machinery. Tramways for transporting product to railroad are quite common, but mills are fewer in number than any comparable mining district in the state. The aggregate mine development is below what the natural conditions and advantages justify.

The records of the county show an aggregate of 7,467 lode and placer claims, mill and tunnel sites of record. During the past two years there has been an average of 345 men employed in mining, and an average of about fifty-six mines and prospects operated.

This section is traversed by the main line of the Denver & Rio Grande Railroad from Denver to Salt Lake, via Leadville, Red Cliff and Glenwood Springs, and is one of the noted scenic parts of the line.

EL PASO.

Prior to 1899 this was the most productive precious metal subdivision of the state. By an act of the Twelfth General Assembly, approved March 23, 1899, Teller county was established and its territory taken largely from the west end of El Paso. The new county absorbed all the welldeveloped mining districts, leaving El Paso with but little mining preserves. As now constituted, El Paso has an area of about 2,140 square miles, occupies a central position, and the adjoining counties are Elbert and Lincoln on the east, Pueblo on the south, Fremont and Teller on the west, and Douglas and Elbert on the north.

The western limit of this county embraces the summit of Pike's peak, and the eastern limit is some thirty-five miles from the base of the mountain on the Great Plains section. The topography is that common to all the counties lying on the east slope of the Rocky Mountain front range and embracing the adjoining foothills and plains sections. The geological history of this immediate section is well disclosed by erosion and the uplifted sedimentary strata along the mountain base. Resting upon the granite-gneiss complex of Pike's peak, or this portion of the front mountain range, are the Paleozoic rocks of the Carboniferous and Silurian periods, followed in order by the red-beds and variegated marks of the Jura-Trias, the Cretaceous sandstone, limestone and shale, and the 'Tertiary conglomerates, sandstone and shale.

The history of this section begins practically with the year 1859. At that time Pike's peak was a name more familiar than Colorado, and this section therefore received a large proportion of the immigrants from the Eastern states. Colorado City, located near the base of Pike's peak and the entrance to Ute pass, became temporarily the leading town of the territory, and its importance was enhanced by being made the first territorial capital. Later the seat of government was removed to Golden, in Jefferson connty, and finally to Denver. The removal of the capital from Colorado City in 1861 was followed by a somewhat continued depression. The Pike's peak placer mines had not proven lucrative and the prospectors moved on to the west and north. In the fall of 1871 the Denver & Rio Grande Railroad reached this section, producing a marked change in existing conditions. Those who had remained recognized the advantages of the surroundings, and Colorado Springs sprang into existence on a comparatively level platean two miles east of Colorado City. It soon became famons as a health resort, and each year added to the population. Many who came to sojourn remained as permanent residents. It was the home of many who were engaged in mining in other sections of the state, likewise the chosen place of abode by many men of wealth from other states. Following the advent of Cripple Creek, or since 1892, the growth has been phenomenal. The enterprising citizens were quick to take advantage of the unusual gold discoveries within their own county borders, and a great proportion of the wealth realized from the mines in the Cripple Creek district has been and is still absorbed by the people of Colorado Springs.

About five miles west of Colorado Springs, nestled in the eroded gulches at the base of Pike's peak, is Manitou Springs. This place has gradually increased in population and popularity as a pleasure and health resort. Annually the number of visitors continues to grow, and the town contains people from all parts of the world. The celebrated Manitou soda and iron springs occur in or near the town, within a radius of one-half mile. The following analyses are by Mr. Oscar Loew :

realiser of springs, e,	ic mpcre		to to acgre	CD L UIII C	uncre, rei	501 0.
Constituents.	Ute Iron.	Little Chief.	Manitou.	Navajo.	Ute Soda.	Sho- shone
Sodium carbonate	59.34	15.16	52.26	124.69	23.82	\$8.80
Calcium carbonate	59.04	75.20	111.00	129.40	40.00)	100 50
Magnesium carbonate	14.56	13.01	20.51	31.66	6.10 5	102.90
Lithium carbonate	Trace	Trace	0.21	0.24	Trace	Trace
Iron carbonate	5.78	1.80	Trace		1.40	
Sodium sulphate	30.86	51.88	19.71	18.42	12.24	37.08
Potassium sulphate	7.01	6.24	13.35	16.21	Trace	5.12
Sodium chloride	31.59	47.97	40.95	39.78	13.93	42.12
Silica	2.69	2.22	2.01	1.47	Trace	Trace
Total parts in 100,000	210.87	213.48	260.00	361.87	97.49	281.62

MANITOU SPRINGS.

Number of springs, 9; temperature, 43 to 60 degrees Fahrenheit: resort.

To-day Colorado Springs, Colorado City and Manitou constitute practically one city, equipped with rapid transit, both steam and electric, and all modern conveniences. There is probably no other section where scenic attractions are more varied within so small an area. These may not at this time be entered into, but the tourist who has seen all of the attractions in this vicinity, which may be done without hardship, is, or should be, well versed in mountain structure, its beauties and grandeur.

Within the past few years this health resort, with its mineral springs, grand scenic attractions and almost unsurpassed climate, has been developing into a great manufacturing, railroad and commercial center. It is the eastern terminal of the Colorado Midland Railroad, whose line passes west through Manitou up Ute pass, connects with the Midland Terminal, running to Cripple Creek, and on to Leadville, Glenwood Springs and to Salt Lake. It is also the terminal of one branch of the Chicago & Rock Island Railway system from the Middle States. It is likewise the terminal of the Colorado Springs & Cripple Creek Railroad, constructed by local capital, commonly known as the "Short Line," which passes up Chevenne canon to the mining districts. From Manitou to the top of Pike's peak is one of the most unique roads in the world, known as the Manitou & Pike's Peak Cog Railway, but more generally called the "Cog Road." It is eight and three-quarter miles between terminals at the base and the summit of Pike's peak, and in that distance rises 7,518 feet. The maximum grade is 25 per cent.; the average grade about 16 per cent., or 844 feet per mile. The "rack rails" are midway between the ordinary rails, but of special make, and no expense has been spared to guarantee absolute safety. In addition to the foregoing, the main lines of the Denver & Rio Grande (the pioneer), with a branch to Manitou; the Colorado & Southern and the Atchison, Topeka & Santa Fe pass north and south through the county, making Colorado Springs a common point.

About three miles from Colorado Springs, on the track of the Colorado Springs & Cripple Creek Railway, the Portland Gold Mining Company is operating a chlorination plant having a normal daily capacity of 300 tons. This is a new plant, and is thoroughly modern in every particular.

At Colorado City the United States Reduction and Refining Company is operating two modern chlorination plants, known as the "Standard" and the "Colorado," the former having a normal daily capacity of 500 tons, the latter 350 tons. The Telluride Reduction Company is operating a "bromination mill," with a normal capacity of 100 tons, which will soon be increased to 300 tons daily.

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The sedimentary rocks flanking the mountains between Colorado Springs and Manitou contain large reserves of building and other stone. A number of stone quarries are actively operated, and among them are some of the largest in the state. East and north of Colorado Springs there are workable deposits of good coal. Mr. Denman, the Coal Mine Inspector, reports six mines working, and the product for 1902 (December estimated), 183,871 tons.

In common with the front range of mountains in other sections, the range here is traversed with eruptive dikes and embraces fissure veins carrying precious metals. Prospecting is indulged in, a few veins are located and worked to the extent of annual assessment, but the ore values appear to be too low to permit of extraction and reduction at a profit. While ores of economic importance are not as yet found within the new western limit of the county, this section has long been noted for its rare minerals, notably at Pike's peak, Florissant and Buffalo peak.

FREMONT COUNTY.

This is one of the subdivisions originally established by the territorial legislature in 1861. Since that time the area has been gradually reduced by several legislative enactments. As now constituted, it occupies a south-central position in the state and embraces an area of about 1,550 square miles. The adjoining counties are Park and Teller on the north, El Paso and Pueblo on the east. Pueblo and Custer on the south, Saguache and Chaffee on the west. Embracing, as it does, a part of the western limit of the Great Plains country in the eastern portion, and its west boundary being outlined by the crest of mountain ranges, flanked with foothills, it is topographically divided into three natural divisionsviz.: mountains, foothills and plains. The geology has many features in common with that of Boulder and other border counties, differing mainly in the fact that in Boulder the Trias rests directly upon the granite gneiss of the mountain proper, while in Fremont the Paleozoic rocks of the Carboniferous and Silurian periods are exposed and rest upon the granite floor. The uplifted strata are well seen along the Arkansas river from the mouth of Grand canon eastward.

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This stream flows approximately east and west throughout the county, and has numerous tributaries from the north and south, which, collectively, afford the drainage for the county.

Canon city occupies an east-central position, and is the seat of government. About two miles west from this city the Arkansas river emerges from the Royal gorge, a profound canon with granite sides rising from 1,500 to 3,000 feet. This gorge is one of the most noted points of scenery in the state, and is in one place so narrow that the track of the Denver & Rio Grande Railway is suspended for a short distance over the river by truss-beams resting against the granite walls.

This county is liberally endowed with natural resources, was among the first settled sections of the state, and has at all times been an important factor in the advancement of the commonwealth. Since 1881 the precious metal mines have been more or less active and productive. The production, however, has never been large, and the mines may be said to have scarcely passed the prospective stage of development. The original mines, or those that first attracted general attention, were in the neighborhood of Cotopaxi and on Grape creek. The Gem mine, near this stream, gained much notoriety on account of nickel being found associated with silver ores.

Following the advent of the Cripple Creek mines in the adjoining county on the north, the northern part of Fremont county was the scene of much prospect work, which gradually worked westward and centered mainly about Whitehorn and the Cameron districts. There are a number of small camps in this part of the county bearing local names, and in the aggregate a large amount of development work has been done. The ores are mainly gold-copper, in a quartzose gangue. In the section immediately south of the Cripple Creek district a number of properties have been worked extensively. In the Wilbur section, on the Florence & Cripple Creek Railroad, some systematic development has been carried on by Eastern capital. The veins here are strong, varying from a few feet to twenty or more in width, principal value in gold. In addition to gold, some good bodies of wolframite ores have been developed; also smaller deposits of uranium ores. In the west part of the county a number of encouraging goldsilver-lead-copper prospects are reported, on the east or northeast slope of the Sangre de Cristo range, especially in the neighborhood of Hayden pass. Nearer Coaldale, the

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Bushnell mine and a group of properties controlled by the Montezuma G. M. & M. Co. have been actively developed. On Greenhorn mountain, about seven miles south of Parkdale. the Copper Girl is being actively worked by the Greenhorn Mountain Copper Mining Company. This company has a group of properties, and has erected a forty-ton mill at Parkdale for reduction of their ores, which are mainly copper. The Rocky Mountain Boy, one of the old patented properties. and a group owned by the Canon M. & M. Co., have likewise been under development. The Dawson section, four to six miles southwest of Canon City, has been the scene of considerable activity. A number of claims have been developed more or less, and a few produced a fair grade of copper-goldsilver ores. The most systematic work has been on the Copper King and Copper Boy properties. The Copper King is one of a group aggregating nearly 1,000 feet in development work. During the present year, a forty-ton concentration plant was erected at the base of the mountain and treated about five hundred tons of ore. The Copper Boy has an eighty-foot shaft and two hundred feet of drift work.

The oil fields of Fremont county are located about six to eight miles east of Canon City, at or in the vicinity of Florence, the second largest settlement in the county. This field has been productive since 1887, and during 1901 produced about 17,000,000 gallons. During the past year this section has shown increased activity, and new derricks have been going up in all directions. The oil is encountered at depths varying from 1,200 to 3,000 feet; does not "flow," but is raised to surface by pumping. The extent of the oil field is not yet determined, or the source of supply fully understood. The oil appears to be found at different geological horizons, the Fox hill shales underlying the coal measures being the most productive. The oils from the various wells do not differ greatly in character. A number of tests published, and made by competent chemists, show the naphtha and benzine to be about 4 to 6 per cent.; of illuminating oils, 25 to 28; paraffine and heavy oils, 55 to 60; and a residuum, mainly coal tar, 6 to 7 per cent. The refined products are consumed by the Western trade, and the residuum is utilized for fuel purposes.

At the close of the year 1902 there were fifty-seven wells producing, and several new holes nearing the oil horizon. The production will probably not differ much in the aggregate this year from that of last. There are two local refineries, with a combined capacity of about two thousand barrels per day. The following is a list of producing companies: Florence Oil Refining Company, Triumph Oil Company, Griffith Rock Mountain, Fraser Oil and Gas Company, Fremont Oil and Gas Company, Keystone, Columbia Crude Oil Company and United Oil Company.

The southeast portion of the county is underlaid with workable beds of a good grade of coal. Mr. Denman, the Coal Mine Inspector, reports seven mines operating, and the product for 1902 (December estimated), 710,306 tons.

The transportation facilities for this county are good. The Denver & Rio Grande and Atchison, Topeka & Santa Fe railroads parallel each other from Denver, via Colorado Springs and Pueblo, and thence up the Arkansas river to Canon City. Each line throws out several laterals to the coal mining section. The Rio Grande continues beyond Cauon City to Leadville, Glenwood, Grand Junction and Salt Lake. From Florence a narrow-gauge line known as the Florence & Cripple Creek Railway extends to Cripple Creek. From Canon City a line operated in conjunction with the Florence & Cripple Creek likewise extends to the Cripple Creek district.

The many advantages possessed by Fremont countyviz., low altitude, good climate, abundant fuel and water, structural material, limestone, etc.-are gradually transforming the sections adjacent to Canon City and Florence into manufacturing and reduction centers. The Dorcas Mining, Milling and Developing Company has crected at Florence a 125-ton cyanide plant and is increasing its capacity to 150 tons. The United States Reduction and Refining Company has two chlorination plants at Florence, viz., the Union, a 400-ton plant, and the National, with 150-ton daily capacity. The Rocky Mountain Smelting Company has a plant of 300-ton daily capacity. Near Canon the United States Reduction and Refining Company has erected a 350ton zinc-lead plant, and the Empire Zine Company a 50-ton concentration plant. The Diamond Fire Brick Company has a modern plant, manufacturing a high-class fire brick at the rate of \$,000,000 per year. It employs sixty men and owns and controls a large tract of land near by that produces a great variety of clays. Six miles east of Florence is a new plant for manufacture of Portland cement, which is the largest in the West, and covers about five acres of territory. One of the largest plants in the West for the generating of electrical energy is located at Canon. This plant supplies the power for a large number of mining properties in the Cripple Creek and adjoining districts.

Numerous limestone quarries are opened along the Arkansas river and are drawn upon largely for flux by the reduction works at home and at Pueblo. There are a number of good marble quarries and large deposits of gypsum. The Cotapaxi granite quarry produces a superior quality of granite.

There are numerous mineral springs throughout the county, those best improved being at Canon City. The following analyses by Mr. Oscar Loew show the constituents of the most prominent:

Number of spring:	s, 5; tei	mperature.	57 to 104	degrees;	resort.	
Constituents. I	Duke. Iron	Duke. Little	Ute. Big	Vida. C Aqua	ongress.	Hot.
Sodium carbonate	0.1267	0 1266	0.0594	0.1258	0.0332	0.0119
Calcium carbonate	0.0535	0.0374	0.0732	0.0678	0.0482	0.0553
Magnesium carbonate	0.0249	0.0234	0.0257	0.0302	0.0300	0.0211
Sodium sulphate	0.0201	0.0207	0.0280	0.0249	0.0310	0.0134
Sodium chloride	0.1372	0.1956	0.2258	0.2070	0.0652	0.0301
Total parts in 100	0.3626	0.4040	0.4122	0.4559	0.2076	0.1318

GARFIELD COUNTY.

This county was organized in 1883, and the first seat of government was located at Carbonate. Later it was removed to Glenwood Springs, the present county seat and main commercial center. It was named in honor of Hon. James A. Garfield. It is one of the west border counties, lying wholly upon the Western slope, and has an area of about 3,250 square miles. The adjoining counties are Rio Blanco on the north, Eagle on the east, Pitkin and Mesa on the south, and its west boundary is common with the east line of Utah. The drainage is through the Grand river, which enters the east county boundary near the center and flows in a general southwest direction, passing through the south boundary line west of the center. The main tributaries from the south are Roaring Fork, Divide and Maroon creeks; from the north, Elk, Rifle, Parachute and Roan. These streams occupy narrow valleys, which locally open out into comparatively wide and level parks, and in other places are closely confined by narrow walls.

The principal industries are coal mining, agriculture, horticulture and stock raising. While metalliferous mines exist, they have been but little developed, and the production is very small. The first discoveries that attracted attention were in 1878. In 1879 the reports of the previous year were apparently verified and enlarged upon. This section at that time formed a part of the Ute Indian reservation, and prospecting was attended with considerable risk. Notwithstanding the conditions, prospectors from the Leadville and Aspen districts were numerous in 1880, and many locations were made. The geological formation from Glenwood Springs north is the same as exposed in vicinity of Aspen, and the prospectors were confident of finding similar ore deposits. As yet their hopes have not been realized. The few locations made have not passed the prospect stage, and under present economic surroundings are of little value. A geological section from east to west through the county would show the Silurian and Carboniferous strata of the Paleozoic, followed by the strata of the Jura-Trias, Cretaceous and Tertiary, in the order named. In the northeast area of the county the Paleozoic strata dip to both the east and west on like sides of the White River plateau. From the west end of the plateau the dip of the strata gradually decreases and finally flattens out to almost a horizontal position at the west county boundary. Lava flows of basalt cap many of the hills and prominent points in the east and northeast end of the county.

The large coal deposits of this section were among the many inducements that led to the building of railroads. In 1887 the Denver & Rio Grande extended its line down the canon of Grand river to Glenwood Springs, and thence to Rifle in 1889. During 1888 the Colorado Midlaud Railroad reached Glenwood, via Hagerman pass and along Roaring Fork. This line was extended to New Castle the following year. In 1890 the two lines were extended to Grand Junction. With transportation facilities, the coal beds were rapidly developed and coal mining soon became one of the leading industries. For 1902 Mr. Denman, the Coal Mine Inspector, reports 165,353 tons of coal mined, and 57,762 tons of coke manufactured. The coal occurs in a number of seams varying from a few inches to forty feet. Those most developed and worked are from four to eight feet thick. Taken as a whole, the coal is of variable grade, but a large percentage is a high-grade bituminous quality.

During the past year the general excitement in oil circles reached this section. The known existence of a number of oil springs caused no small amount of prospecting. The results as yet attained are of no commercial importance.

Glenwood Springs, the present capital of the county, is one of the most popular resorts in the West. The town is located in a comparatively level valley, on Grand river, near the mouth of the Roaring Fork. Along the river for a distance of a half-mile or more are the noted hot springs. They occur at intervals, and appear to issue from a fissure in the Paleozoic rocks. The largest and best-improved are on the north side of the river, where a large hotel and bath houses have been erected. The flow is partly conducted into large reservoirs built of masonry and utilized as swimming pools, both summer and winter. The largest group of springs, called the Yampa, has a flow of about 2,000 gallons per minute and has a temperature of 120 degrees Fahrenheit. The commodious bath houses are equipped with all modern appliances. A short distance above the swimming pool the fissure from which the hot waters issue widens into a cave or canon, and has been improved for bathing purposes. The natural cave has been somewhat enlarged, so that a dozen or more may be seated and derive benefit from the steam and gases that escape. The temperature of the main room with door closed is about 130 degrees Fahrenheit. This is only one of a series of caves that have been used for bathing purposes for many years. Prior to the establishment of the town or railroad connections, crudely constructed pools and the caves were used by many as a cure for rheumatism and other ills. Even at present those afflicted who are unable to bear the expense incident to the highly improved baths, utilize the caves and less pretentious springs. A large amount of the Yampa water is bottled and sold as a table water. The analysis of the waters of this spring is by Dr. Charles F. Chandler, of New York, and does not take into consideration the various gases the water is constantly giving off:

REPORT OF COMMISSIONER OF MINES

YAMPA SPRINGS.

-R	es	or	t.
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Constituents.	Grains.
Chloride of sodium	1089.8307
Chloride of magnesium	13.0994
Bromide of sodium	0.5635
Iodide of sodium	Trace
Fluoride of calcium	Trace
Sulphate of potassa	24.0434
Sulphate of lime	82.3861
Bicarbonate of lithia	0.2209
Bicarbonate of magnesia	13.5532
Bicarbonate of lime	24.3727
Bicarbonate of iron	Trace
Phosphate of soda	Trace
Biborate of soda	Trace
Alumina	Trace
Silica	1.9712
Organic matter	Trace

GILPIN COUNTY.

This subdivision was named in honor of Hon. William Gilpin, Colorado's first territorial Governor, and was organized in 1861. The adjoining counties are Boulder on the north, Jefferson on the east, Clear Creek on the south, and Clear Creek and Grand on the west. It has an area of about 125 square miles, and the one industry is that of precious metal mining. Although the smallest in area, it has always been one of the most important mining sections of the state. Its history begins with 1859, since which time mining operations have been continuous, the production large and gradually increasing. During the past two years there have been more transfers of property recorded, a greater number of locations and relocations recorded with the county clerk, in proportion to its territory, than in any section of the state. Although the character of mechanical appliances originally
adopted have been generally adhered to, there is marked change in the more recent hoists and mills installed.

The geological structure of this county is principally metamorphic granite, or granite-gneiss, much contorted and disturbed. The country is traversed by a series of eruptive dikes, and is much altered through physical and chemical changes. The bedding planes are frequently tilted at a high angle, but the general dip is easterly toward the plains. The metalliferous veins occupy fissures of the "true-fissure" type, and have been explored to a depth of 2,200 feet below apex. The more persistent veins appear to occupy lines of faulting, but the displacement is small-generally not in excess of a few feet. The veins are not all of the same age, but are, so far as observed, of later age than the porphyry dikes, which they invariably cut with little or no change in strike. The veins vary in width from one to twenty feet or more. The vein filling, in the main, is comparable to the adjoining country rock, is often scarcely distinguishable from it, but is generally more or less decomposed and sparingly impregnated with the sulphides of iron, copper and sometimes zinc and lead. The higher grade ores generally occur at intervals in a more or less concentrated form near one of the vein walls, in streaks or bands. Locally, the ore bodies are termed "smelting" and "mill" ores. The smelting ore is that which may, with some assorting, be shipped direct to lead or copper reduction plants. The mill ore is the refuse from the smelting and the ore bodies adjoining that must be marketed in concentrated form, and is, therefore, milled. The vein walls in this district are, owing to the character of the country rock, generally hard and well defined, and encompass the ore deposits. In many instances, however, one wall is often shattered, and the ore may impregnate this section for some distance laterally. This condition is more marked when a vein crosses a dike, or the fissure is in close proximity to it.

The ores of this section, as above indicated, are composed, in the main, of iron, copper, lead and zinc sulphides, in conjunction with a granular quartz, calcite and other minerals common to fissure veins in granite-gneiss areas. Near the surface, or to a depth varying from 50 to 200 feet, the ores are highly oxidized and the gold contents free, or amenable to treatment, and almost complete recovery, by amalgamation. In the sulphide ores the gold present is minutely blended or associated with the base metals. The fact that a large percentage of gold present in the sulphides may be, and is, recovered by amalgamation indicates that a complete chemical combination does not exist.

From 1859-'60 to the present time placer mining has been prosecuted each year. The placer deposits are somewhat limited in extent, and have been "worked out" a number of times. There is little doubt that a large percentage of the gold recovered from the placers during the past few years has been deposited since the time of first discovery. The large amount of oxidized ores in the numerous veins and dumps exposed to atmospheric influences and especially freshets or "cloud-bursts," must cause such results. During the present year an aggregate of about 100 men have been "placering" in North Clear creek, Nevada, Illinois, Gamble, Lump and South Beaver gulches. The water supply is limited, and the appliances used differ little from those used by the pioneers.

This, like all of the mining counties, is divided by somewhat indefinite lines into mining districts having local names. These names appear to differ with individuals. The "oldtimers" have one name and the more recent arrivals another for the same section. The result is confusing, unless the entire list becomes familiar. It will not be possible to mention all the operative properties or the numerous changes and improvements during the past two years, and those hereafter mentioned do not indicate them to be of greater importance than those omitted.

At Central City the East Boston, shaft 450 feet; Galena-Burgher, 600-foot shaft, and Newfoundland, are producing smelter and mill ore.

In the Nevada district the Kansas-Burroughs Gold Mining Company has four shafts, and is making a good production. The Phœnix-Burroughs, 1,200-foot shaft; Pease-Kansas, 700 feet; University Kansas, 500 feet; English-Kansas, 700 feet deep. This company controls about 20 claims. The Ophir-Burroughs and Mackey-Burroughs shafts, 1,300 and 800 feet deep, are operated by "home pools," or combinations of home capital; both producing. The Gould-Burroughs has been equipped with new plant of machinery, and is operating under lease, through 700-foot shaft. Pazo, 150-foot shaft, smelting ore. The Avon Mining and Milling Company are operating mine and mill, and have recently placed new machinery on San Juan. Clark Gardner, 800-foot shaft, milling ore. The Nevada Consolidated Gold Mining and Milling Company is operating the King, Lamberson, Warren and Oronoke. The Shafts Extension has been newly equipped with machinery, and is under active development. Alps, 1,300foot shaft, worked by lessees. Delmonico, 900-foot shaft, sinking and developing. The Jones, 700-foot shaft, producing. The California shaft is 2,250 feet below apex of vein.

In the Eureka district, which lies west of Central, and embraces Gunnell hill, Eureka and Proser gulch, the West Whiting, one of the Gunnell company's properties, is operated by a home pool, and producing. The Gunnell Gold Mining and Milling Company owns a large group of properties, main working shaft, 1,300 feet. Also, three mills at Black Hawk. A portion of their territory is under lease. Gold Collar, 300foot shaft, leased. The Concrete Gold Mining Company owns the Penn and Iron City mills at Black Hawk and the Concrete mine, shaft 1,200 feet. Butler is operated by the Butler Consolidated Mines Company. All the above properties are producing. The Straub and Bon Ton have both been equipped with new machinery, and are actively developing. The Buckly is being unwatered and preparing to sink shaft.

The Gregory district embraces Black Hawk, the Bates and Bobtail hills. The Boston-Denver Consolidated Mines and Milling Company is a comparatively recent consolidation of a number of the old producers of this section. It is the largest enterprise in the county, and embraces the Gregory, Bobtail, Fisk, Cook, Minnie and other properties; also the Boston S0-stamp mill. Present operations are confined to the Cook shaft, the Bobtail and Gregory incline. The American, 900-foot shaft, is worked by lessees. The Carr is operated in conjunction with Randolph mill, mine and mill connected by tramway, owned by Colorado-Carr Mines Company. The Chicago-Carr, 300-foot shaft, operated by lessees. Bates, 600-foot shaft, under lease; recently equipped with new buildings and plant. Gregory-Buell has put up extensive buildings and done a large amount of development work: is operated by Consolidated Mining and Milling Company and in part by lessees. Hamlet and Hamlet No. 1, 400-foot shaft, under lease. Running Lode, 800-foot shaft, has been improved with new equipment. This property has good reserves blocked out, and carries a good percentage of lead ore. Elliott, under lease, shaft 300 feet. Ontario-Colorado Gold Mining Company, operating Ontario, shaft 700 feet; also mill in connection with mine. Next President, 400-foot

shaft, operated by lessees. All the foregoing properties in this district are making regular shipments to smelter and mills. The Bant has been recently purchased by the Nebraska Mining Company, and the 100-foot shaft is being sunk. The Senator has been equipped with new buildings and plant; shaft, 350 feet deep, and is undergoing systematic development. The National Tunnel Mining and Milling Company is driving three tunnels in the mountain south of North Clear creek, and doing a large amount of development.

In the vicinity of Chase gulch, Maryland mountain and Winnebago hills, north of Central City, there is increased activity and several new enterprises launched or under consideration. The Lyons-Kyle Mining Company is erecting a lead concentration plant and systematically opening up territory in their 500-foot shaft. The Belden has been newly equipped and is operating under lease and bond. The Ingeborg is another property being operated by a home pool; new buildings and plant added and shaft being sunk. The Robert Emmett is being operated by lessees; shaft 400 feet, equipped with cage.

In the section north of Black Hawk, generally called the Enterprise district, the ores are largely silver-lead. The Reward Gold Mining Company is driving a cross-cut tunnel to develop a group of eighteen claims; now in 125 feet from portal. The Four Mile Gulch Tunnel and Mining Company is driving three tunnels, two of them on vein and producing. The Fannie is another property worked by a home pool; shaft 125 feet; ship at intervals. The P. K. mine is under development and shipping some ore.

In the Russell Gulch district, which lies southwest of Central City and extends to the Clear Creek county line, there is much renewed interest. On the Saratoga a very large ore body has been opened up on the 1,000-foot level. Its extent is not yet fully determined, but the operators and all adjoining properties are much elated. The Pewabic, which has been idle for several years, is sinking two shafts and produc-The Old Town is a large and regular producer. The ing. For-for has been revived, unwatered, and commenced produc-Robert Fulton, producing. Russell and West Pewaing. bic, sinking shaft. Fairfield, sinking 375-foot shaft; small Prompt Pay, under lease. Gem, under lease; shipper. steady production. Gold Rock, shipping. Charter Oak, sinking and developing; small shipments. Kemp Calhoun, sink-

ing 330-foot shaft deeper; operated by lessees; producing. Lotus group of twenty claims, main shaft 800 feet; sinking and developing; producing. The Hall mine, 100-foot shaft, steam plant; shipping. "2-40," worked by lessees through tunnels; producing. East Centennial, 300-foot shaft, steam plant, developing. Holland, 200-foot shaft, new plant and buildings, operated by lessees, sinking. Eldorado, 150-foot shaft, whim, shipping. Waltham, new machinery added. 150-foot shaft; producing. Frontenac, operated by lessees, developed by shaft and tunnel Searle, 150-foot shaft, whim, producing. Haseltine, one of eight claims owned by Druid Gold Mining Company; new machinery installed; sinking new shaft. Powers, shaft 220 feet, equipped with new plant machinery; shipping. Chase, 500-foot shaft, under leasing system. West Notaway, 500-foot shaft; producing. The Golden Wedge group is working the Annie-Mary, Pittsburg and Meeker shafts; regular shipments; Meeker shaft will be equipped with large plant and used as main working shaft for group. East Notaway, operating on leasing system; forty men engaged. Hampton, 150-foot shaft; developing.

In the Vermillion district, which adjoins Yankee hill, in Clear Creek county, the operations have been mainly prospective and driving ahead cross-cut tunnels. The production has been small. Among the properties operated are the Free Life group, 345-foot cross-cut tunnel; Philadelphia group, and Golden Sheaf group.

Among the active properties in the Illinois Central district, about one mile south of Central City and embracing Illinois and Leavenworth gulches and eastern portion of Quartz hill, are the Barnes, 600-foot shaft; producing. Continental, 200-foot shaft, newly equipped; shipping. Sapp, 150foot shaft; worked by lessees. Great Mammoth, 150-foot shaft; newly equipped by lessees. Cascasomme, 150-foot shaft; equipped with whim. Scandia group, 800-foot shaft; producing and well equipped.

In the Pleasant Valley district, two and one-half miles south of Central and adjoining the Russell district on the south and east, there is a marked improvement. One of the important transfers is a group of thirty-six claims known as the Hall Ranche property. The purchaser, The Fostoria Gold Mining and Milling Company, will add complete plant and pursue systematic development work. The Viola Gold Mining and Development Company controls group of nine claims and expects to equip and develop on extended scale. The Banta Hill properties, 147 acres, have done little work; this plant is well equipped. Klondike, 125-foot shaft, whim; development. Ohio, 150-foot shaft, gasoline plant; sinking. Mary-Maggie group, seven claims; developing by tunnel. Mida, working good force on development. The Bertha Gold Mining and Milling Company group was operative until September.

In the Lake district, known generally as Lake gulch, about one mile southeast of Central, the Washinton Extension, 400-foot shaft, worked by lessees. Mingo, 225-foot shaft, added new plant and buildings; developing. Clay County, 500-foot shaft; operated by lessees. Hidee, 300-foot shaft, new plant and buildings added; developing. Grace Darling, 200-foot shaft, new plant and buildings; sinking. St. Louis-Justice, 400-foot shaft; worked by lessees. Williams, 700foot shaft; operated by new company; Justice, 600-foot shaft; working under lease. Unexpected, 400-foot shaft; developing.

In the Central district, embracing the camp of Gilpin and Lump gulch section, the most active property has been the Victoria. The Peterson ten-stamp mill is kept in steady operation, and some ores are hauled to Black Hawk or shipped. About forty or fifty men are employed, but mining operations have been largely restricted to annual assessment work.

In the Apex, Nuggett, Elk Park, Moon Gulch, and near James peak, west of Apex, or all that section from Rollinsville along the northern part of the county to Grand county, there has been great activity during the past year. The work has been principally that of prospecting, locating new and relocating old claims. The assurance that the new "Moffat road" would pass through that section en route to Salt Lake is the cause of increased interest. This section has a network of veins carrying low values in gold and silver, and with transportation at hand will doubtless be developed and some good producers added to the list. The Bullion and Mascot groups, in the Pine district, have been undergoing systematic development, and the company operating the latter is erecting a reduction plant. The developments in Moon gulch are quite encouraging.

In the Perigo section, about nine miles north of Central, also known as the Independent section, the Perigo, Gold Dirt, Idaho, Penobscot and Josephine are the principal operative mines. The Perigo is extensively developed and has a 3,000foot tunnel; also a thirty-stamp amalgamation mill, treating about eighty tons per day of twenty-four hours.

In the Hawkeye and Silver Lake districts near the head of Silver creek and Tip Top mountain, the Snowden and Buckhorn Extension group of eight claims was recently sold and is operative and producing. The Stewart, 170-foot shaft, is shipping and contemplating a mill. The Reform mine and mill have also been revived by eastern parties.

The foregoing brief and incomplete summary of operations in this county recites the fact that one mine has reached a depth of 2,200 feet, several have passed the 1,000-foot mark, a larger number are over 500 feet deep, but the greatest number operating are less than 500 feet in depth. To this may be added that the deeper mines have demonstrated the ore values and ore deposition to be persistent; of better grade, perhaps, at some horizons than others in each mine, but as a whole, unusually even in grade or value per ton. Under such conditions the future of the section in mining is obvious. Gilpin county ore deposits, however, are essentially low grade propositions, notwithstanding the fact that free gold is not uncommon, and that small shoots of very high grade gold ores are quite frequently encountered. They may be handled profitably, but necessarily require discreet management and close application of business methods. The tribute or leasing system is largely in vogue in this section, and the results appear very satisfactory. There is no denving the fact that all men work better when their remuneration is in accord with labor expended.

As previously stated, the ores of this section are oxidized or sulphide in character. Also that both are susceptible to treatment by amalgamation. With rare exceptions, all carry gold and silver values, and the major value is associated with the iron and copper sulphides. The common method of treatment is therefore stamps, amalgamation and concentration of pulp after leaving the plates. From thirty to sixty per cent. of the value is recovered by amalgamation, and additional five to twenty per cent. is saved in the concentrates. These latter carry an excess in iron and a variable percentage of copper, and command a ready market at the smelting plants. The controversy between the stamp mill operators regarding the virtue of slow-drop stamp with deep issue, and the accompanying fine crushing and low tonnage, and the quick-drop with low issue and greater tonnage, may not at this time be considered. When the character of the ores and percentage saved is alone considered, leaving time and investment out of the problem, the slow-drop mill is doubtless the better. The ordinary slow-drop stamp, as used in this section, crushes about one ton per day of twenty-four hours, while the rapid drop crush from two to three.

Gilpin county is one section wherein the milling capacity is below demand. The water supply is limited a good portion of the year and is a serious detriment. Even now the water is settled and resettled and used over and over again. The best results in milling and concentration can not be attained with scant water supply. At the present time part of the ore produced is being milled in Clear Creek county, and the amount of crude ores transported to better watered sections will doubtless continue to increase. The matte smelter at Golden has done much to relieve the situation during the past year, and the ability to market direct the low grade crude product has done much to stimulate mining in this section. The following is a list of the mills, with number of stamps:

	Stamps.		
	Slow	Rapid.	
Hidden Treasure	75	10	
Meade	40		
Polar Star	40	• •	
Eagle		35	
Gilpin	50		
Rocky Mountain	25		
New York	50	20	
Randolph	50		
Iron		25	
Perigo		35	
Peterson	15		
Avon		30	
Boston		80	
Tucker		10	
Totals		245	
Total number of stamps		590	

The Rocky Mountain Concentrator is a new plant equipped with Cornish rolls, jigs and vanners and Huntington mills, capacity fifty tons. The Boston Occidental mill, at American City, near Apex, is a new chemical reduction plant, 50-ton capacity. There are two sampling works at Black Hawk—one operated by The Miners' Ore Sampling Co., the other by Chamberlain & Dillingham. Each has a 100-ton capacity daily.

The transportation facilities are supplied by the Colorado & Southern Railroad. Two passenger trains daily are operated each way between Denver and Central City, and freight trains sufficient to handle traffic. The trains for Central City and Georgetown are run as one to the Forks of Clear creek. Here they are divided and proceed as separate trains.

There is a local tram-road, with a twenty-four inch gauge and about twenty-five miles of track, which reaches the ore bins of the principal mines and does a large business. It transports ores to the mills and supplies to the mines. Its initial point is at Black Hawk.

GUNNISON COUNTY.

Gunnison is one of the central Western Slope counties, and, as now constituted, embraces an area of about 3,200 square miles. This subdivision was organized in 1877, and was named in honor of Capt. J. W. Gunnison, who was killed by the Indians in the fall of 1853 while in charge of a government corps of engineers surveying a route across the mountains to the far West. The adjoining counties are Pitkin on the north, Chaffee and Saguache on the east, Saguache and Hinsdale on the south, and Ouray, Montrose and Delta on the west.

Gold was discovered in the Tin Cup and Washington Gulch districts during 1861. In 1879 the reports circulated by prospectors were so favorable that, during the following year, there was a "rush" to this district second to none in the history of the state. Mining camps sprang up at numerous points, and were followed by the usual number of ill-advised smelting plants and mills. Precious metal ores were found in abundance, but development was too meager to supply the demands of a smelter, and transportation of ores to outside markets, even in concentrated form, left small margin of profit. The toll on freight at this time was more often calculated by the pound than by the ton.

In a general way, the early geological history of this county is comparatively simple. The Continental divide or Saguache range, which forms the east boundary line and has a general north and south course, formed the shore line of the Paleozoic seas, and the strata of the Silurian, Carboniferous, Cretaceous, Jura-Trias and, in part, the Tertiary, were deposited in regular sequence. Later, when the uplift occurred that formed the Elk and West Elk mountains, which cover a large portion of the north and west parts of this section, the strata was broken, contorted, tilted in all directions and separated by intrusive masses and sheets. Still later, the whole was bisected by a series of igneous dikes traversing the mountains in all directions from somewhat local centers, and, later still, the deposition of mineral veins in formed fissures or along the numerous fault planes.

The main drainage is through the Gunnison river, which flows westward and departs from the county south of its center through the well known Black canon. Numerous tributaries join the river in the canon. From the south the principal streams are Lake Fork and White Earth creeks; from the north, Curecanti, Sapinero, West Elk and Ohio creeks. Near Gunnison, which is the county seat and occupies a southcentral position in the county, the Tomichi joins the river. This stream carries the waters from the southeast part and its main branches find source well up toward the Continental divide. Gunnison river is formed by the junction of Slate and Taylor rivers at Almont, about nine miles north of Gunnison. These streams, with tributaries, care for the waters in the northeast; the North Fork of the Gunnison carries the drainage from the northwest, and the extreme north section is drained by Rock creek, which is tributary to the Grand river.

Operations in precious metal mining during the past two years have been pursued without any great change. There has been no marked "boom" in any particular section, yet all show improved condition; many transfers and new installations of machinery are common to all districts. In the Rock creek section the Mineral Point M. Co. erected and operated, in connection with their mines, a small matte furnace, located near Marble. The North Pole M. Co added new buildings and machinery and have made fair production. The Black Queen mine is under active development. Among others, some of which are old mines revived, that have been actively operated, are the Lead King, Carbonate tunnel, Bon Ton, Hard Cash and Duke of Wellington. The Crystal River Land and Improvement Company has carried on extensive development in their marble quarries and added materially to their plant. At Elko a concentration mill has been put in active operation. The mines on Ule creek have had little work beyond annual assessment.

The districts tributary to Gothic have shown more activity than for several years. In Rustler gulch, the Maroon M. Co. has worked a fair force on development work. The Sylvanite group, near head of Copper creek, has produced some high grade silver ore, and the silver-copper properties on the divide between Copper and Maroon creeks have been prosecuting development. On Brush creek, in the vicinity of Teacolli mountain, there has been little work beyond annual assessment. In Washington gulch, which attracted so much attention in the early days, and has since been the scene of much prospect work, on a somewhat extended scale, for the sources of the gold found in the placers, there has been a slight revival, and several properties are developing.

In the vicinity of Pittsburg, and especially in the Poverty Gulch section, there has been a marked revival. The most important development enterprise is that of the Standard Mining Investment Company. This company has two co-ordinate mining companies, under the names of Black Queen Gold Mining and Milling Company and the Augusta Metal Mines Company. A cross-cut tunnel from the Poverty Gulch slope is being driven to cut the Augusta vein 1,350 feet below the apex. This working is now in 1,900 feet, and should reach its destination early in the coming year. During the summer the upper workings of the Augusta were operated, and produced the silver-gold-lead ores known to exist in this property. Another cross-cut tunnel is being driven to tap the Excelsior group at a depth of 1,100 feet and has been advanced several hundred feet. A common compressor plant, thoroughly equipped, is used. The result of this work, which is of great importance to this section, will be watched with great interest.

At Irwin, or the Ruby district, the Forest Queen, Bullion King and a few other properties have been actively operated. The Forest Queen mill was run during the summer months. These properties are old-time producers, but are under bond and lease, and development is given preference over production.

In the vicinity of Pitkin, which occupies a picturesque location on Quartz creek, about fourteen miles west of the Alpine tunnel of the Colorado & Southern Railroad, a number of old properties have been revived and many transfers made. In near proximity to the town the ores are mainly silver bearing, and mining has not been as active as in adjoining districts. Some of the largest consolidations in the state have been effected, and development plans accord with the holdings. The Colorado Smelting and Mining Company has five tunnels started, one driven 4,500 feet. A cross-cut is driving on the Ben Ezra group; the Maid of Athens and Citizen are producing and developing. The ores are silicious, main value in silver. The Belzora Mining and Developing Company are driving the Belzora tunnel, also working Little Charlie and D. C. group. Among active properties in the Gold Brick district are the Whig. Cortland, Chloride and Treasury tunnel. In the neighborhood of Ohio City the Granite Mountain, Yukon, Ashland tunnel and Lamplighter are among the active properties.

From Tin Cup north to Italian peak, or the section tributary to the headwaters of the Taylor river, there has been a great increase in active mining and prospecting. A new line of railroad is expected to soon relieve this section from its present inaccessibility to market. The ores are of variable character, but carry a fair percentage of gold. In Taylor park, Union and Emma parks, and along the streams leading to and from them, the territory is largely held by placer companies. The Gold Cup mine is working under lease. A cross-cut tunnel is being driven to cut Jimmy Mack. This mine is well equipped and has a 100-ton mill in connection. The Forest Hill added during this year a 10-stamp concentrating mill. Red Cloud is being developed by cross-cut tunnel now in 1,000 feet. The Commercial group, Independence tunnel, Kentucky Gulch and Robert E. Lee are undergoing development. The Enterprise is working a good force, is producing, and is well equipped. The Taylor Park Mining Company operated their placers during the summer. The Iowa

Mining Company installed new steam plant, hoist and compressor, and during summer operated Burger placer. The Beaver Mining and Milling Company is operating a group on Cross mountain and producing. The Union placer and Hepburn placer were operative during summer months.

In the White Pine district the old May-Mazeppa and a group of claims aggregating about 150 acres is being developed by a cross-cut tunnel. It is now 2,000 feet from the portal, and should reach the objective point in six or eight months. This will demonstrate conditions at greater depth than ever before attained. This work is being prosecuted by the Akron Mining Company. Near the mouth of this tunnel is the South-Western Smelter plant, which is likewise controlled by the Akron company. The Tomichi Valley Smelting Company made another successful run this season, cleaning up all the stock on hand. This is a modern 50-ton leadsmelting plant, in charge of Mr. R. H. Terhune. The Eureka-Nest Egg group is operating under lease, and lessees are also operating the 50-ton concentration plant of the Tomichi company. Quite a number of other properties have been active and marketed their product "at home." On Cochetopa creek the Colorado Mines Consolidated Milling Company have erected a 20-ton mill. The Standard adit tunnel is in 1,000 feet from portal. A shaft will be sunk on the vein and connect with tunnel about 500 feet from mouth.

In the "gold belt," south of Gunnison, the Vulcan group has been inoperative for nearly a year. The shaft on the Good Hope is down 500 feet, and property is producing about two cars per week. In the Spencer district the Old Lott is producing and the Headlight Mining Company is developing through shaft. The DuBois tunnel, in Goose Creek district, is now in 1,200 feet and equipped with power drill plant. The Davenport tunnel is 800 feet from portal, and the Adair tunnel 400 feet. The Headlight group is under active development.

The foregoing summary is by no means complete, but is given, so that some idea may be gained of the numerous operative properties in the various districts, some districts being entirely omitted for lack of accurate data.

The ores and ore occurrence differ more or less in each section, and may, therefore, only be mentioned in a general way. In the Elk Mountain section the veins are of the fissure type, filling small fissures, but more commonly the veins occur along fault planes. These faults break across both the sedimentary and eruptive rocks, demonstrating the age of the veins to be late in Cretaceous times. Locally, the vein matter is in narrow seams, separated by bands of country rock, or, in other words, occupy a fissured zone composed of a series of parallel fractures. The ore is usually found within the vein walls, but, in shattered zones, sometimes impregnates the adjoining country. The most persistent ore deposition appears to be in close proximity to igneous dikes or intrusive sheets. The ores are generally in a quartz matrix, in form of iron-copper-lead or zinc sulphides in variable proportions. Native silver is quite common, and nearly all of the higher grade silver sulphides are found associated in many places. The principal value is in silver.

In the so-called gold belt south of Gunnison the country is granite, gneiss and schist, and it is traversed by a series of practically vertical fissures filled with gold-bearing ores. The gangue is as a rule a very hard compact quartz and the gold is to a great extent free. This section is traversed by a series of eruptive dikes that have a general northeast and southwest course. The main fissures are either in conjunction with or parallel to the dikes.

In the White Pine and Pitkin sections the veins are both fissure and "contact." In the granite-gneiss sections the veins cut through like the eruptive dikes in practically a vertical position. In the sections where the Silurian and Carboniferous strata predominate the veins often occur between the strata or may have an intrusive porphyry sheet for one wall. In the vicinity of White Pine the ores are mainly lead-silver; between Ohio and Quartz creek gold predominates over the silver. At Pitkin silver values predominate. At Tin Cup the values in gold and silver are about equal, while north of Tin Cup the value is mainly gold. Silver-lead ores again predominate in the vicinity of Italian mountain. The west slope of the Saguache range is traversed with a series of dikes and good veins are found in the granitegneiss at different points over the whole section. Flanking the base, the Paleozoic strata is much contorted, stands at a high angle or locally may lean from the mountain. This portion is locally capped with porphyry and cut with numerous dikes. In many respects the Chicago Park district near Pitkin is comparable to the Aspen district and may develop into one equally as profitable.

In the Taylor Park section are some extensive placer operations, large and expensive canals have been constructed and the existing conditions are favorable for lucrative returns.

The iron and manganese deposits of this county are large. The largest deposit is on White Earth creek, about twenty-six miles southwest of Gunnison. The development is slight, but a section of territory about two and one-half by one-half mile appears to be an almost solid mass of manganic iron. The economic value is great if the titanium and phosphorus associated is not too high. Another large deposit occurs about thirty miles northeast of Gunnison, on Taylor river. A number of analyses from these beds show portions to be well adapted for the manufacture of a high-grade spiegeleisen. At White Pine there is a series of large veins of magnetite. Other smaller deposits occur in various places. Most of these deposits are owned or controlled by a close syndicate together with large tracts of coal lands and lime beds. Gunnison City occupies a central position and would afford a "down-hill" pull for all supplies necessary for iron and steel manufacture.

The transportation facilities are the Denver & Rio Grande and Colorado & Southern railroads. The Denver & Rio Grande crosses the Continental divide at Marshall pass, follows down Tomichi creek to Gunnison, then down the Gunnison to Grand Junction. At Gunnison a branch line extends up to Crested Butte and the anthracite field to the north. Another branch extends west to Irwin and the anthracite field lying west of that place. At Crested Butte the bituminous coal beds are worked extensively, and a large amount of superior coke is manufactured.

The Colorado & Southern Road enters the county by a tunnel under Alpine pass, thence down Quartz creek to Pitkin, and on to Gunnison. At Gunnison a branch line extends up Ohio creek to the coal fields on the opposite side of Wheatstone mountain from the Crested Butte coal beds.

The coal product for 1902 from this county (December estimated) is given by Mr. Henry Denman, the Coal Mine Inspector, as follows:

Bituminous coal		32,448 tons
Anthracite coal	6	3,767 tons
Coke		32,720 tons

The state capitol building at Denver displays to good advantage the superior granite quarried in Gunnison county. The Dakota sandstone is likewise quarried extensively at several places. In clays of all description the supply is comparable to any county in the state. Mineral springs, both hot and cold, occur in various localities, but are little improved, and no reliable analysis is obtainable. During the present year there has been considerable prospecting for oil, but as yet satisfactory results have not been attained.

GRAND COUNTY.

This county occupies a north-central position in the state, and was segregated from Summit in 1874. The territory then granted has been reduced by subsequent legislative enactments. As now constituted, the county has an area of about 2,100 square miles. The adjoining counties are Larimer on the north, Larimer, Boulder, Gilpin and Clear Creek on the east, Clear Creek, Summit and Eagle on the south, and Routt on the west. In form this section is very irregular, the boundaries being outlined by the crest of mountain ranges. On the east is the front range; on the south, the Williams River mountains; on the west, the Park range; and on the north, an east and west range that connects the Front and Park ranges, separates North from Middle park, and forms the Continental divide. The area embraced within these mountain ranges constitutes the subdivision known as Grand county.

The entire drainage is through the Grand river and its tributaries. This stream flows practically east and west through the center of the county, and its tributaries have a general north or south course. Near the east boundary the Grand river proper divides into two main branches, known as the North and South forks. These branches, with their tributaries, drain the west slope of the Front range. From the south the Frazer, Williams and Blue rivers are the main tributaries to the Grand river, and all flow in a northerly course. Between the Frazer and Williams river there is a mountain range called the Vasquez mountains. Between the Williams river and the Blue is a range known as the Williams River mountains. These ranges or spurs are roughly parallel to the Park and front ranges, and the east and west slopes have a number of small streams that are tributary to the main streams which occupy the intervening valleys. The north part of the county has a series of streams that flow south to the Grand. The principal streams from east to west are the Stillwater, Willow, Troublesome and Muddy creeks. Each of these streams has a number of tributaries and occupies a valley separated by ridges, but not so pronounced as those on the south side.

The central portion of the county is known as Middle It differs materially, however, from the broad, open park. and comparatively level and timberless basins known as North and South parks. Middle park is practically a series of valleys along Grand river, with the contiguous valleys of the tributaries of the river. The intervening ridges are as a rule heavily timbered, and little idea of the general topography may be gained except from some of the prominent surrounding mountain peaks. Locally the valley land is much restricted, but generally the valleys are of good width and comparatively level. They vary in altitude from 7,000 to 9,000 The surrounding mountains have numerous peaks feet. that reach 12,000, and Long's peak, on the east, passes above the 14.000-foot mark.

Owing to inaccessibility to market the section has produced but limited quantity of precious metals. History shows this section to have been the scene of much prospecting in 1859. At that time, and for a number of years afterwards, it was one of the favorite hunting grounds for the Indians. The reported discoveries at different times since then have eaused an influx of more or less people, and in the aggregate considerable amount of development work has been done. At one time Lulu, in the extreme northeast corner, became quite a flourishing camp. Also, Gaskill, at the mouth of Baker gulch, a few miles south. At the former camp the veins are in granite-gneiss, are locally well defined, but the copper-ironsulphide ores, carrying gold, with some silver, appear to occur in short shoots or pockets so far as exposed by meager development. Up Baker gulch the veins are much better defined and ore deposits are more persistent. The Wolverine properties and a number of others, names unknown, showed fair bodies of low grade sulphide ore. In the vicinity of Grand lake there has been quite an amount of prospect work.

Grand Lake is one of the largest sheets of water in the state. It is located at the northwest base of the Long's Peak group, a very rugged mountain section. The lake is formed from the numerous streams and streamlets from this section which center here and constitute one of the main branches of the North Fork of the Grand. The town of Grand Lake stands upon the east and west shores near the lower end of the lake, and communication is maintained by boats or by wagon road going around and fording the outlet. The altitude here is about 8,100 feet above tide-water, and the surroundings are well described by the name of the town and lake. This place is becoming quite a resort, and a number of citizens with homes in other sections of the state maintain cottages for use during the summer season. A very rugged trail leads up from Grand lake to Buchannan pass into Boulder county. In the mountains from Buchannan pass south to Boulder pass, a number of prospect holes show the prevailing ore to have lead-sulphides predominating. On the head waters of the Frazer river a large amount of prospect work has been done. During the past few months this immediate section has been more carefully prospected than ever before. The new railroad from Denver is expected to pass through James peak by a long tunnel and down Frazer river to the valley of the Grand. South and west of James peak is Berthoud pass, over which is the main traveled wagon road to Grand county. Berthoud pass is reached by a daily stage running from Georgetown, the county seat of Clear Creek county, located on the Clear Creek branch of the Colorado & Southern Railway. West of Berthoud pass and in the vicinity of Jones pass are a series of veins that cross over the range and are worked each year in a desultory manner in both Clear Creek and Grand counties. These ores are mainly lead-silver with fair values in gold. Around the head waters of the Williams river there are a number of prospects reported that make an encouraging showing. All these veins in the places mentioned are of the fissure type, in granite-gneiss, and the stronger veins are more or less intimately associated with eruptive dikes. In the extreme southwest corner of the county, locally known as the Red Gorge section, the ores have principal value in copper and gold. North from this point, along the east face of the Park range, there is more or less evidence of the prospector. At Kremling, a town located in an open park near where the Muddy joins the Grand river, some fair looking ores were exhibited, said to have come from near the head of the stream and to occur in large bodies. These representations were not verified by an examination.

At the head of Willow creek there is quite a large deposit of hydro-carbons, principally grahamite. These deposits occur in vein-like form between lavers of Cretaceous strata, and although only opened in a few places may doubtless be found extending over quite a large area. On Buffalo mountain, west of the hydro-carbon deposits, there are several strong veins developing. These veins occur in an eruptive center and carry lead-silver ores, with lead largely in form of sulphate. This immediate section is traversed by a very prominent series of quartz-porphyry dikes that vary from four to twenty feet in thickness. Locally they stand up like immense walls twenty to fifty feet high and a half-mile or more in length. Their general course is a little south of west. although they occur of variable strike and at times cross each other. Along Willow and Stillwater creeks and nearly all of their tributaries, and locally along Grand river, there are somewhat shallow placer deposits that yield a high grade gold. Hydraulic mining is conducted at various places in a small way. and the results are reported as being fairly remunerative.

The reconnaissance made in this county was somewhat incomplete, owing to the dilapidated condition of the trails and seeming inability to procure guides acquainted with the various districts. In many places there were evidences of marked activity in the past, such as houses going to ruin, wagon roads covered with fallen timber, and "jack pines" growing on the road bed at least ten or fifteen years old. With transportation facilities which now seem assured the mineral production of this section will doubtless steadily increase. Already the various districts are under inspection by a number of prospectors, and a number of old and abandoned locations are being relocated.

Owing to the inaccessibility, the principal industry of this section has been that of stock-raising. The natural grasses grow profusely and are very nutritious. The valley lands are mainly a sandy loam, comparatively free from rocks, and with irrigation yield fair crops of the cereals and large crops of alfalfa, timothy or native hay.

The principal business center is Hot Sulphur Springs, which is also the county seat. This town takes its name from a group of springs on the north bank of the Grand river. They are quite well improved, have small swimming pools, private baths and a "cave bath." The cave is a natural basin some twenty feet across and eight to ten feet deep, and the water is so conducted as to pour over one edge. An outlet leaves the water in the pool about twenty to thirty inches deep, and the bather, after becoming inured to the heat, can stand under the constant running stream where the falling water strikes with some force. This basin is covered with a bath house, which is provided with retiring rooms and all essentials. In connection with the springs there is a desirable hotel of about thirty rooms, which is usually crowded. Great claims are made for the medical properties of these waters. The following analyses are by Mr. E. J. Mallet, Jr.:

HOT SULPHUR SPRINGS.

Number of springs, 22; temperature, 91 degrees to 117 degrees Fahrenheit; resort.

Genetitusetu	Spring	Spring	Spring	Spring	Spring	Spring
Constituents.	NO. 1.	NO. 2.	NO. 5.	NO. 4.	ANO. 0.	AVO. 0.
Sodium carbonate	58.57	50.45	20.37	29.42	39.37	22.42
Calcium carbonate	10.08			8.46	3.68	6.43
Magnesium carbonate	6.57	4.14		2.66	1.93	
Sodium sulphate	8.48	8.97	17.53	14.25	9.85	25.11
Potassium sulphate	0.59	0.07	1.03	7.03	0.96	1.69
Magnesium sulphate			5.26		0.96	
Sodium silicate		1.46				
Sodium chloride	14.61		13.29	12.18	13.97	13.11
Silica			0.61	0.54	1.31	1.36
Magnesia		Trace				
Lithia	Trace	Trace	Trace			
Iron	Trace	Trace	Trace	Trace	Trace	Trace
Ammonia			Trace	Trace	Trace	Trace
Carbonic acid (free)	2.94		8.42	0.42	9.49	4.69
Total grains per gallon	101.75	65.09	66-51	71.96	80.56	74.81

HINSDALE COUNTY.

This subdivision occupies a southwest position in the state, has an area of about 960 square miles, and is one of the five counties that embrace the section known as the great "San Juan country." The adjoining counties are Gunnison on the north, Saguache and Mineral on the east, Archuleta on the south, and La Plata, San Juan and Ouray on the west.

Topographically this section is that of rugged mountain chains, with comparatively narrow valleys intervening, well watered by streams. The valleys occasionally widen into comparatively level parks and vary in altitude from 8,000 to 9,000 feet above the sea level. The mountains in individual peaks are from 12,000 to over 14,000 feet above tide-water. Uncompangre peak, in the northwest corner, is 14,289 feet, and is one of the highest in the state. The San Juan mountains form the west boundary in the northern part and cross the south portion of county in a southeast direction. Near the center of the west boundary a spur extends from the San Juan range in a northeast direction and joins the Cochetopa hills in Saguache county. This range-spur forms the Continental divide at this point. The territory embraced within county boundaries is therefore on both the Atlantic and Pacific Slopes. The north portion drains through the Gunnison river, the south through the San Juan, both streams emptying later into the Colorado on the Pacific Slope. The central portion drains through the Rio Grande to the Atlantic side.

The history of this section practically begins with 1874, when the first valid mineral locations were made. The population rapidly increased until 1879, when the effects of inaccessibility to market were fully realized. In 1889 the Denver & Rio Grande Railroad constructed a branch line into Lake City, the county seat and commercial center of the county. This branch leaves the main line at Sapinero and follows up the Lake Fork of the Gunnison river, and trains for Lake City are operated so as to connect with main line trains. Following the advent of transportation facilities, there was a marked revival in all the mining districts. The general depression of 1893 again retarded advancement, for the reason that nearly all ores developed at that time were lead, silver and copper. Since 1894 the advance has been steady, and, in common with many other sections, the existence of gold-bearing ores has been demonstrated. During the past two years, a number of large development companies have entered the field, and more active prospecting than ever before is the history of the county.

This county, in its northern limits, borders the great San Juan lava flows, and is almost wholly composed of a

series of volcanic rocks common to that area. In places where the topography affords good exposures the different lava flows are readily distinguishable and present a stratified appearance. The geology of Hinsdale is, in the main, similar to to that of San Juan and San Miguel counties, which have been described in detail by Mr. Whitman Cross in his reports to the geological survey. The mineral veins are mainly of the true fissure type, and occupy fissures that are practically vertical, and traverse the country in all directions. There is no uniform system of fissures, but developments indicate those having a northeast to east course to contain the more persistent ore deposits. In width, the veins vary from a few inches to twenty-five feet or more. In the latter, however, the "vein" is generally a series of parallel fractures, with bands of country intervening, or a series of parallel veins which may be mined as one vein. The vein-filling is largely comparable to the adjoining country, more or less decomposed, altered or silicified. In common with all fissurevein sections, the valuable ores are concentrated at intervals along one of the vein walls in form of ore shoots, and present the accepted band or ribbon structure. In nearly all of the ores the sulphides of iron, lead, copper and zinc are present in variable quantities, and the associated minerals are quartz, calcite and the high grade sulphides of silver and copper, such as "silver glance," "grav copper," "brittle silver," etc. The foregoing are of most common occurrence. To these might be added a long list of complicated sulphides carrying antimony, bismuth, etc., which occur locally in varjable quantities. The ores of the district are, as a whole, of low grade, and require concentration prior to shipment to market. Native gold, native silver and the telluride ores, petzite predominating, are not uncommon. These ores, however, may be considered exceptional, and are not to be depended upon as a permanent asset in any of the mines. In a few instances these high grade ores have been persistent for a considerable distance, and have proven highly remunerative. The result is that mining operations in this section have been largely conducted with a view of encountering and producing high grade ores. The most marked advance in this district during the past few years is that of development, with a view of later installing plants for the purpose of handling profitably the low grade ore bodies.

In common with other mining sections, the county is divided in mining districts having somewhat indefinite boundaries. The Galena district is that section along Henson creek extending west from Lake City to the Ouray and San Juan county lines. The name indicates the predominating ore, or at least the character of ore that has as yet been most produced and marketed. The Ute and Ulay, about four miles up Henson creek from Lake City, is the largest producer in the county. These veins are closely related, and the mine is equipped with a 100-ton concentration mill, producing a product high in lead. A new twenty-one-drill compressor was added during the year, and a new three-compartment shaft is now being sunk. This is practically the beginning of a plan of development that will require two or three years to consummate. The Hidden Treasure, adjoining the Ute and Ulay, has a 100-ton mill, and is largely developed. The California is under lease to a Black Hills company, which is driving a cross-cut tunnel to develop the group, now in five hundred feet. The Red Rover M. Co., about seven miles from Lake City, has a group of eleven claims; principal development on the Lilly. During the year, this company has done extensive development and has constructed a modern fifty-ton concentration mill. Electrical power has been installed, energized by water power. The pipe-line is 3,700 feet long, two feet in diameter and gives a head of nearly four hundred feet. The Hanna M. & M. Co., on the Moro and Ajax, near Capitol City, have erected and are operating a fifty-ton concentration plant. The property is developed by three adit levels, and exposes a four to six-foot vein throughout the workings. Mine and mill connected with a 4,600-foot tramway. The T. M. Anchor Co. is driving a cross-cut tunnel to develop a group of claims east of Shafer basin; tunnel driven 1,000 feet. The Silver Star group is being developed by a cross-cut tunnel, which is in 1,000 feet. They expect to cut the vein about 1,500 feet from portal and 600 feet below apex. The Henson Creek Lead Mines Company has been under development for two years; ore, galena, iron and copper pyrites; a 100-ton concentration mill nearly completed; electric power generated by water. The Gold mine, in Horse Shoe basin, is being developed by tunnel. Nearly all the numerous claims in this section have been accorded development, at least to extent of annual assessment.

The Lake district embraces the north and east portions of the county, and adjoins the Galena district on the west. The Lake Fork river is the principal stream passing through this section. The principal mining operations have been on Hotchkiss mountain, about four miles south of Lake City. The Golden Fleece group of eighteen claims has been largely developed through a system of tunnels, the lower being driven about 4,000 feet. The property is well equipped and has in connection a fifty-ton concentration mill. This property nas produced a large amount of high grade telluride ore. petzite predominating, and the old or upper workings are being overhauled by lessees. The Hotchkiss M. & R. Co. has carried on extensive development work. The main feature is an 850-foot cross-cut tunnel branching from Golden Fleece tunnel, and connecting with upper works from tunnel level. The company owns the Black Crook and Hiawassee groups, aggregating about 300 acres.

In the Burrows Park section there has been great activity, both in development and prospecting. Several important strikes caused no little excitement and resulted in many locations and relocations of property. The veins in this district are generally very large and gold-bearing. The Isotde opened up some high grade telluride gold ore during the year, and has maintained fair production. This property has about 1,500 feet of development and is about eighteen miles from Lake City. The Pennsylvania group is undergoing systematic development. La Belle, equipped with power plant and driving cross-cut tunnel; 715 feet driven. The Tobaseo G. M. Co. has been systematically developing its holdings, and has erected a new 100-ton mill; mill operated by electricity, generated by water power, nine miles from plant. The Bon Homme has been producing regularly and developing on a somewhat extended scale; the cross-cut tunnel, now in 1,650 feet, is expected to cut the vein at a depth of nearly 1,000 feet below apex in a short time. George III., near Carson, is being developed by a cross-cut tunnel. The results from development throughout this section have stimulated mining, so that a number of new organizations contemplate starting operations.

The foregoing brief review, by no means complete, evidences a very satisfactory condition of the mining industry in this county. There is no boom, and none is expected or counted by the residents and mine owners. The mineral re-

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sources are great, and are of a character that insure permanency of output, at least for many years, when the veins are properly opened and equipped.

HUERFANO COUNTY.

Huerfano county was organized in 1861 by the territorial legislature, but original boundaries have been reduced by subsequent legislative enactments. As now constituted, it occupies a south-central position in the state, and embraces an area of about 1,750 square miles. The adjoining counties are Custer and Pueblo on the north, Las Animas on the east, Las Animas and Costilla on the south, and Costilla and Saguache on the west.

This subdivision is very irregular in form, being outlined largely by natural topographic divisions. It borders the Great Plains country, its western boundary being the crest of the Sangre de Cristo and Culebra mountain ranges. In the south portion are the Spanish peaks, and in the north the southern extremity of the Wet mountains. The drainage is through the Huerfano and Cuchara to the Arkansas river. Nearly all of the geological divisions, from the Archaen to the late Tertiary, are represented by the rocks.

The precious metal deposits of this section have received more or less attention since 1875. During the past few years the Sangre de Cristo section, and especially that in close proximity to Sierra Blanca, has been the scene of considerable systematic development. The McMillan group, on the north slope of Mount Blanca, has been opened by a cross-cut tunnel, and a 40-ton concentration mill installed. The main workings are on a mammoth vein fifty to sixty feet between walls, carrying gold and silver, iron and copper sulphides. This vein is mainly the granite common to the adjoining country, greatly altered, with ores more or less concentrated along certain lines. High-grade gold ores occur in this section, locally called sylvanite, but more likely to be the new telluride discovered by Prof. P. H. Von Diest in a vein on the mountain summit, and classified as "Von Diesite." The existence of this ore has caused no small amount of development in this section. In common with many rugged districts, long tunnels have been projected, started and most of them

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stopped before reaching the veins. The country is traversed by a series of igneous dikes, and the general conditions compare favorably with some of the large producing mining districts in other parts of the state. The numerous prospects demonstrate the existence of "pay ore," but whether or not it occurs in sufficient quantity, or is sufficiently persistent to have commercial value, has not, as yet, been fully determined. The McMillan group, above mentioned, may be an exception; but the actual net results of operations are not made public. Several companies have operated in a desultory manner in the vicinity of Pass creek and La Veta. In the Spanish peak and Wet mountain areas there has been the usual amount of location and assessment work.

The best developed industry in Huerfano county is that of coal mining. There are a series of coal seams varying from two to nine feet in thickness, two of which are quite extensively worked, and produce a good quality of semicoking or domestic coal. Mr. Denman, the Coal Mine Inspector, reports the product for 1901 as 955,945 tons, and for 1902, 1,114,939 tons (December product estimated).

Stone of good quality for building and other purposes exists in large amount. This resource is developed but little, beyond the requirements for home consumption. The stone most utilized is a light gray and very firm sandstone of the Upper Dakota. Other sandstones, of variable color and well suited for structural purposes, occur in practically unlimited quantities. The fire-clay beds, which are of common occurrence in the Dakota formation, are from six to ten feet thick, and locally demonstrated to be of very high grade. The limestone deposits are comparable to those used by the counties along the base of the Front mountain for lime manufacturing or by the reduction works for flux.

The seat of government is located at Walsenburg. Both the Denver & Rio Grande and the Colorado & Southern railroads traverse the county, and reach the leading commercial and coal-mining centers. The line of the Rio Grande crosses La Veta pass into the San Luis valley, and both extend their lines south to Trinidad.

JEFFERSON COUNTY.

Golden, the present seat of government for this county, was established in the summer of 1859, and was one of the first settlements in the state. The county was organized by territorial legislature in 1861, and in 1862 the territorial capital was removed from Colorado City to Golden. For some time following it was the leading commercial center of the territory. In 1868 the construction of the Colorado Central, now the Colorado & Southern Railroad, was begun, and in 1870 the road was completed and put in service. Jefferson county occupies a central position in the state and embraces about 725 square miles. It is wedge-shaped in form, seventy-two miles long, twenty miles wide on the north, and terminates in a point at the southern extremity. The area within county boundaries lies in part on the east slope of the front range of the Rocky Mountain system and includes a portion of the Great Plains country. Flanking the granite gneiss complex of the mountains are a series of foothills or hogbacks composed of Triasic-Cretaceous strata. Near the base of the mountains the strata dips at a high angle and locally stands on edge or even past the vertical with dip toward the range. The drainage is to the South Platte river through a series of mountain streams, among which are North Fork, Bear, Turkey, Clear and Ralston creeks. These streams have a general easterly course, cutting their channels through the uplifted and folded strata skirting the mountains, and collectively showing a complete geological section.

The first mining in this section was upon the placer beds near Golden. Although the placer territory is limited, the aggregate production has been quite large. In common with the "placer diggings" near the head of the stream in Clear Creek and Gilpin counties the beds have been reworked a number of times and are still worked in desultory manner each year. The appliances used are little in advance of those used by the pioneers. The few who annually engage in this pursuit report that they make fair wages by hard work, and occasionally find a small bar that "pays well." Several attempts have been made by capital to systematically work the bed of Clear creek and recover the gold deposited near bed-rock. Another inducement has been to collect the concentrated losses from the many mills farther up the stream. There is little doubt that great values exist along or under the present stream bed, but so far attempts at recovery have proven futile on account of the physical conditions encountered, viz., granite boulders too large to handle that require breaking up before removal. Following the placer excitement was the discovery of large veins of copper with small associated values in gold and silver. These discoveries are made annually throughout almost the entire granite-gneiss region, but do not appear to pass the location and annual assessment stages. The veins and ores exist, but are apparently too low in grade or limited in deposition to mine with a profit.

Last year smelting operations were resumed in this section by the erection of a pyritic smelter at Golden by the Clear Creek Mining and Reduction Company. This process is well known and is operating successfully. It is practically fire-concentration, whereby the fused material is separated. The quartz or silica with added fluxes forming the slag and the basic metals drawn off in concentrated form called matte. This company is buying low grade basic ores to a limited extent, but can operate independently upon ores from working properties which it owns and controls. It is more than probable that this favorable market for low grade ores may stimulate mining in many districts, to the production stage.

The coal seams in this section were among the first opened in the state. The coal is of fair quality for all domestic purposes and the seams conform to the enclosing strata and run in an almost vertical position.

One of the principal industries is the mining and manufacture of the existing clays. The fire-clay bed that occurs in the Dakota formation almost continuously with the mountain range has in this section been somewhat extensively mined and manufactured at home, or shipped in crude form to other sections. A number of plants are located at Golden, and the required clays for the manufacture of fire brick, pressed brick, tile, sewer pipe, pottery, etc., have been found by development to exist in large quantities.

A number of stone quarries are developed in a small way and produce good building and other stone. The lime quarries at Morrison are drawn upon largely by the reduction works in the vicinity of Denver for fluxing purposes. Golden is but twelve miles from the business center of Denver and is connected by the Denver & Lakewood Railroad or street-car line. The Colorado & Southern Railroad also passes through Golden en route to Clear Creek canon and runs four passenger trains daily between the two points.

The Colorado State School of Mines is located at Golden and is directly under state control. This institution, through careful and able management, has gained a high standing among the technical schools of the world. Applicants for admission are in excess of the accommodations. The scientific appliances are being constantly added to and the institution is growing as fast as the annual funds appropriated will permit. In a strict sense, it is a "School of Applied Science," but in accordance with the intent of the legislative enactment authorizing its establishment, mining and metallurgy are made most prominent. Instruction is not only thorough, but theory is made practical by mechanical appliances and actual field work. Located as it is in the heart of the commonwealth, where mining in almost all of its branches is pursued, and mineral deposition occurs under almost every known condition, and metallurgy has gained deserved recognition, the student has advantages that few, if any other institution of the kind affords.

LAKE COUNTY.

As originally organized by the territorial legislature, Lake county embraced a large portion of the west-central part of the state. By subsequent acts the original subdivision has been reduced and made to contribute to fourteen new counties, leaving an area of about 360 square miles. The adjoining counties are Eagle and Summit on the north, Park on the east, Chaffee on the south, and Pitkin on the west.

The embraced territory of Lake county is better known as the Leadville district. The city of Leadville is the county seat and one of the leading commercial centers of the state. It is situated on the west flank of the Mosquito range, near the head or north end of Arkansas valley, and has a mean elevation of 10,200 feet. The Saguache range on the west and the Mosquito range on the east have a comparatively uniform elevation of from 13,000 to 14,000 feet above sea level. The north as well as west boundary form the Continental divide. This basin-like area is drained by the Arkansas river, which flows in a southerly course, and a number of tributaries that rise in the mountain ranges upon the east and west sides. In the vicinity of Leadville the Arkansas flows through a comparatively flat and level valley, six to ten miles wide. On either side mesa-like benches rise one above the other to the foothills flanking the mountain ranges. The city of Leadville occupies one of these mesas, about three miles west of the river valley proper, near the base of the rounded foothills, and north of California gulch.

California gulch was the scene of the first mining excitement in this section. The gold discoveries were almost contemporary with that of other sections, but proved more extensive. In 1860 placer mining was at its zenith and all territory was appropriated and worked so far as available water extended. The placer locations made during this period have since proven the source of great litigation, and only recently have some of the more important suits been adjudged by the courts. Although the placer excitement abated somewhat after 1862, the fortunate owners continued work with good results for a number of years, until later discoveries of leadsilver ores absorbed general attention. Notwithstanding this excitement, these beds have been operated more or less actively every year and are not yet exhausted, and in the near future will again probably be extensively operated with modern appliances.

The geological structure and topographical features of this section have been accurately described at great length in an exhaustive monograph compiled by Mr. S. F. Emmons, geologist in charge, and published by the United States Geological Survey. The field work was actively prosecuted during 1881-1882, and the publication, with atlas, followed soon after. Its appearance was opportune and there is probably no work of the survey that has contributed so much to the material welfare of the state. The undertaking of such a complete report and portraval of existing conditions was far too great for individual enterprise, and yet its necessity was perhaps most appreciated by many of the able mining engineers who were actively engaged upon individual properties. At that time the mine development was limited in extent, the complex conditions were little understood, and even Mr. Emmons, with all the facilities and resources of the survey, was compelled to resort largely to theory in making his deductions. In the light of more extended development, the deductions made and theories advanced have been confirmed to a remarkable degree, and stand as a monument to the painstaking care and ability of Dr. Emmons. The value of such work can not be overestimated, and the phenomenal success attained in mining in this section was materially aided by this comprehensive report. Let us hope that steps may be taken to again procure the services of the geological survey and have the work brought up to date. There is little doubt that the results would prove as beneficial in the future as they did in the past.

The following is a generalized statement of the geological history of the Leadville district. In Paleozoic times the front or Pike's peak range on the east and the Saguache range on the west formed roughly parallel Archaean land masses in the almost universal seas. The uplift resulting in the Mos-quito range, now the prominent east boundary of Lake county, did not occur until the close of the Cretaceous. The Cambrian, Silurian and Carboniferous strata, together with superincumbent beds assignable to the later grand geological divisions, were deposited in regular order upon the granite sea bottom. The eruptions of the porphyries that now separate and lie above the Silurian and Carboniferous formations, occurred during long intervals of time. These eruptions formed great masses through vents and fissures in the Archaean bottom and overlying strata and flowed over extensive areas, or, failing to break through the strata, intruded the lava in form of sheets along lines or partings in the strata affording the least resistance. The "white porphyry," which now forms the country rock of a large portion of this section as the result of erosion, and covered with a thickness of talus or "wash," was intruded mainly on the line of contact between the "blue" limestone and the overlying Weber shales and grits. The "gray" porphyry was a later intrusion, and forced itself mainly between the lower limits of the blue limestone and the upper stratum of the white limestone. The gray porphyry eruptions also cut the strata in form of dikes, which throw out comparative thin sheets between various bedding planes and locally between the blue limestone and the overlying white porphyry. Following the porphyry intrusion the elevation of the Mosquito range took place. The dynamic action resulting in the uplift was accompanied by the usual movements and produced the folding and faulting of the district. The main faults occur in a system practically north and south, and roughly parallel to the axis of the Mosquito range. The throw is variable and the portion west of the fault is uplifted, the strata having a general dip of ten to fourteen degrees eastward. Another system of faults occurs at right angles to the main faults, together with many minor faults of variable throw.

During the early days of the district the ore deposits were generally supposed to be restricted to the horizon immediately below the white porphyry and limited to the somewhat prolific deposits of carbonate of lead-silver bearing ores. The extraction of these ores marked the first supposed decline of the Leadville district. Subsequent development, however, demonstrated that the overlying porphyry was the upper limit of the ore horizon, but that the underlying blue limestone was practically the vein or most valuable ore zone. Locally immense bodies of sulphide ores have replaced the entire stratum, and with associated values in gold and silver sufficient to yield large returns above tolls incident to mining, transportation and smelting. The ore deposits of this section have been subjected to much research and study. That the ore deposits are closely related to the intruded porphyry, whether they occur in dikes or intercalated sheets, has been auite thoroughly demonstrated. Ores therefore occur at various horizons, from the underlying granite to the overlying white porphyry, and may yet be demonstrated to be in part derived from mineral-bearing waters and vapors from deepseated fissures in the underlying granite. Although this section has produced an immense tonnage, aggregating many millions of dollars in value, the end is not yet, and somewhat recent developments afford good ground for the belief that the present large production will be maintained for many years to come.

The past two years in the Leadville section has differed little from former years. There has been the usual number of successes and disappointments, with the general results very encouraging. In tonnage the year 1901 was second to none, but the close of the year and the greater part of the present year production of low grade ores have been restricted by market conditions. These conditions, however, have had little appreciable effect upon the launching of new enterprises or retarding the operations of those already under way.

The Yak tunnel, which was originally projected for economical handling of the Iron Hill ores, has gradually developed into a great transportation and drainage proposition. Its heading is now near the extensive workings of the Ibex Company group of mines, better known perhaps as the Little Jonny. Satisfactory arrangements have been made by the two companies that are mutually advantageous. The drainage of these properties alone will so far reduce operating expenses that large bodies of ore heretofore valueless may be handled at a profit. The tunnel is now in nearly 11,000 feet from the portal, and may be advantageously continued for almost an equal distance, provided the facilities for transportation and drainage are equal to farther increased demands.

The development of the zinc industry is gradually increasing. Those having zinc production in hand, however, are proceeding in a conservative manner. Zinc is practically a new product that occurs intimately associated with iron and lead sulphides in bodies of great magnitude. Until within the past few years these ore bodies were worthless on account of the zinc sulphides present, and were therefore as far as possible left intact in the mines. The extraction of the more valuable ores has, nevertheless, developed large bodies of zinciferous ores that are now a valuable asset. The problem of separating the zinc from its closely allied associates has not as yet been fully solved. Two mills are now operating, one on Carbonate hill and one in California gulch, the former sixty and the latter 50-ton daily capacity. A fair separation is made from the ores being milled on an ordinary concentration table, Wilfley pattern. The product is a triple one, viz., a lead, iron and zinc concentrate. Neither one of the products would alone yield a profit above expense incident to mining and milling, but collectively the margin of profit is sufficient to stimulate efforts to supply the apparent increasing demand. The three-fold product at one operation is necessarily accompanied with quite a large mechanical loss. Present operations, however, are conducted with a view of financial rather than technical success. In addition to these plants regular shipments of crude product are made to the zinc plants at Canon City, Denver and in Kansas.

The Resurrection group in the so-called gold belt, near the base of the Mosquito range, has near completion a 150-ton concentration plant, to be supplemented by a magnetic separator. This plant is the result of a long line of carefully conducted tests, and is in no sense an experiment. The separation of the zinc from the silica has been thoroughly demonstrated by the Colorado Zinc Company, which has a plant of this character in Denver operating on ores from Leadville district.

A 50-ton modified cyanide mill is nearing completion on the Ballard property. The mine product is a low grade goldbearing silicious ore that exists in large quantities. The results attained by practical operation will be watched with great interest and in event of success will be followed by others. The Ibex Company constructed a cyanide plant a few years ago which proved unsatisfactory on account of the talcose ore retarding leeching.

Near the closing part of the present year the American Smelting & Refining Company announced a new schedule on low grade iron-sulphide ores in unlimited amounts and for a somewhat indefinite period. The result is a greatly increased tonnage of this character of ore. All treatment charge is waived upon ores netting the miner \$3.00 or less per ton on a forty per cent. iron excess basis. Whether or not this schedule is the result of recent independent plants that have entered the market, or is to supply an existing shortage, may not as yet be determined. In this connection it seems impossible to determine the exact relations existing between the producer and smelter in regard to the ores from this section. The latter claims a general reduction in treatment charges in the aggregate, and the individual mine operator claims an advance in treatment charges that is practically prohibitive to profitable production. There is probably no section of the state from which ores of as low grade are marketed as that of Leadville. The margin of profit is small and a few cents advance or decrease per ton often means a profit or a loss to the operator. The ores, as a rule, are of a desirable character for the lead smelters and command the best market price. As compared with other districts the tolls for treatment at the smelters are and always have been largely in favor of Leadville. Restricted market conditions for the ores of this section have called attention to a possible contingency never before considered by the mine operators. It will doubtless result in a period of mill building, the marketing of a concentrated product, or the independent reduction to bullion by means of some of the recent improved methods. There are fewer operative mills of this character in Lake county than any county in the state. It is true a large proportion of the ores occur as practically solid sulphides that are not susceptible to further concentration. But it is likewise true that there are large bodies of developed silicious ores, gold bearing, in the mines and upon the dumps, that are susceptible of treatment by the recently improved methods of chlorination or cyanidization, provided the values are equal to representations made. These ores may embrace disqualifying elements not discernible by ordinary inspection, but to all appearances they differ little from ores that are elsewhere successfully and profitably manipulated.

To review in detail the mining operations of this section for two years is not possible. The present result is a tonnage of about 2,000 short tons per day, and during the past summer the greatest production ever made in the history of the camp was maintained for a few weeks. One of the important new enterprises is that of the Frver Hill Mines Company. This property controls about 150 acres of territory on or adjacent to Fryer hill and includes the old well known Little Pittsburg, Chrysolite, Matchless, Robert E. Lee and New Discovery properties in the combination. With the exception of a few lessees this section has been practically idle for a number of years. The new company has installed large pumping plants, removed the water and will sink to greater depths or to geological horizons that in other sections of the district contain the large sulphide deposits. None of the original work was prosecuted below the "first contact," or, if so, to a very limited extent, and there is no apparent reason for the non-existence of valuable ore deposits at lower horizons in this immediate section.

Among the most recent discoveries reported is that of the Cady mine, on Fryer hill, operated by the Progressive Mining Company. The reports appear to be authentic and the discovery of the old-time high grade carbonate ore in a section generally accepted as being barren is creating considerable interest, and will doubtless result in active prospecting in that vicinity. Already several new shafts are started and their success will start many others.

A consolidation of the Mahala and A. M. W. combination places under one management about 100 acres of territory on and adjacent to Carbonate hill, the possibilities of which are perhaps better known by those in charge than any one else.

Without mention of names, the well-developed and oldtime producers located in the central area are, with few exceptions, maintaining their regular output. One of the most marked features of mining in this section is a general revival in the outlying districts. With but few exceptions, new companies and home pools have revived and re-equipped old properties with signal success. In Iowa gulch there is much active mining. From Weston pass to as far north as Alicante work is in progress on a somewhat extended scale on several old-time properties. At East Tennessee pass the developments on the Helen Gould group has stimulated prospecting. There is more activity in the St. Kevin districtthan for many years, and similar statements may be made regarding Sugar Loaf, Taylor Hill, No Name, Two Bit, Lake Park, Mount Elbert and the Twin Lakes districts.

The central area, or the mining districts in close proximity to Leadville, have absorbed interest to such an extent as to retard development in the outlying sections. In many places the conditions are as favorable for lucrative mining as exist in some of the old and producing sections in other counties of the state. That appreciation of this fact is growing is evidenced by the systematic development that has been under way and increasing during the past two years. If the ore values come up to representations, there will be several good producers added to the Lake county list in the near future, and transportation facilities, now wanting, will soon follow.

The placer beds in the Twin Lakes district have also been more actively developed. Several new organizations have entered the field, and modern appliances, such as steel shovels, are fast displacing old methods. The results attained or placer gold recovered is not stated for reasons best known to the operators. Representations are made that the beds average from 20 to 30 cents pere cubic yard, and often attain a value of \$1.00 to \$1.50 per yard. The gold recovered is comparatively coarse, and varies in value from \$16 to \$19 per ounce. The physical condition of the beds is only fair, and operations are more or less retarded by large boulders that require breaking before removal. This condition will, to a great extent, be overcome by the steam shovels which may be utilized, and save a great deal of hand labor and annoyance.

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The Denver & Rio Grande, Colorado Midland and Colorado & Southern railways make Leadville a common point, and afford excellent transportation facilities.

LA PLATA COUNTY.

The original territory granted this subdivision by territorial legislature in 1874 has since been greatly reduced and absorbed by the organization of new counties. As now constituted, it has an area of about 1,840 square miles, and occupies a southwest position in the state. The adjoining counties are San Juan on the north, Hinsdale and Archuleta on the east, and Montezuma on the west. New Mexico forms the southern boundary.

The topographical features of this section are those common to rugged mountains, flanked by foothills and lofty mesas, intersected by streams and gulches cutting through the country at irregular intervals. In the north part of the county are the Needle mountains, in the west-central portion the La Plata mountains, each containing peaks that reach an altitude of between 13,000 and 14,000 feet above sea level. The valley and mesa lands vary from an elevation of 6,500 feet, at Durango, to 6,100 feet, near southern border. The county is well watered, and drains through three principal streams, viz., La Plata, Animas and Los Pinos rivers. These streams are roughly parallel, rise in the lofty mountain ranges lying on the northwest and north, and flow in a southerly course. The La Plata drains the west, the Animas the central and the Los Pinos the east portions of the county.

The geological structure of the county is well exposed along the valley of the Animas river. This valley affords a good north and south section through the central part of the county, and discloses an unusually complete record of the strata from the underlying granite to the late Tertiary, in accordance with the accepted geological divisions. Mr. A. Lakes, in describing this section, says in part:

"Resting on the Algonkian rocks are 200 feet of Cambrian quartzites, succeeded by Devonian strata consisting of heavy white limestones showing some Devonian fossils. One of the few places in Colorado where these rocks are represented. The succeeding Silurian and Lower Carboniferous are poorly represented, but the sandstones, grits and shales of the Upper Carboniferous obtain a thickness of 2,000 feet." This is followed by a description of the Mesozoic rocks aggregating 7,000 to 10,000 feet in thickness, which, with the Wahsatch Tertiary and underlying Paleozoic rocks "gives a united thickness of the sedimentary rocks in the state of 10,000 to 12,000 feet. This does not include the vast thickness of Algonkian schists and quartzites lying between the sedimentaries and the granites."

The La Plata mountains form a compact group of high peaks near the north and south center of the west boundary line separating La Plata and Montezuma counties. This group is somewhat isolated from the main mountain range on the north, and is the result of a local uplift, which, according to Mr. Whitman Cross, was later than the last great eruption in the San Juan mountains. The La Plata mountains are comparable in structure to the Rico, El Late and other groups along the west border of the state.

Prior to the uplift that formed the La Plata group, the strata had doubtless been deposited in the same order as now disclosed in the valley of Animas river. The volcanic eruption was not violent enough to break through the superincumbent beds and permit the lava to flow freely over the adjoining county. It did, however, have sufficient force to break through in part and fine vent between the planes of contact of the variable and pliable strata in form of intrusive sheets. While the older sedimentary rocks are not exposed, it is logical to presume that they were likewise separated at different horizons, the same as those of the younger rocks that are exposed. This eruption was followed by others of a somewhat different magma, which added to the already complex conditions, and finally the group was left by erosion in its present form. The mountain structure, as it now appears, may be summarized as that of lofty mountain peaks composed of stratified Triassic, Jurassic and Cretaceous rocks, the strata of which are separated by intrusive sheets of eruptive rocks at different horizons, and the whole cut or displaced by a series of igneous dikes or masses. The igneous rock types are comparable to those of other eruptive centers, and are generally classed under the broad name of porphyries. The veins occupy fissures that break across both the stratified rocks and the intrusive igneous sheets. These fissures have been filled in part by dikes and in part by mineral. The strongest veins appear to vary in strike from northeast to nearly east, and the most persistent ore deposition is generally in the vicinity of the intercalated porphyry sheets.

This immediate section has had the careful consideration of the United States Geological Survey, which has published Folio No. 60, entitled "La Plata Folio." In this the general geology is entered into at some length by Mr. Whitman Cross, geologist in charge, assisted by Mr. Arthur Coe Spencer. Also, the economic geology, by Mr. Chester Wells Purington. These papers are accompanied by the usual maps and illustrations, and collectively constitute a comprehensive and accurate portrayal of conditions.

The search for precious metals began in this section as early as 1861. At that time placer mines were alone sought and the history of the pioneers is that of great hardships endured and dangers encountered. In 1873 ditches were constructed near the old site of Animas City, and some gold was recovered from the placer deposits in that section. More recent attempts have been made at various places, but the gold is generally fine, hard to recover, and exists in limited amounts over comparatively large areas. Owing to the great interest in the adjoining San Juan counties, there was but little prospecting for gold and silver deposits in veins in the La Plata mountains prior to 1878. Since that time nearly all of the numerous gulches have been the scenes of more or less excitement. Following meager development the usual proportion of ill-advised mills have been erected, and served to retard rather than advance active mining operations. The ores of this district are mainly gold-bearing pyrite or telluride compounds. Of the latter, petzite and sylvanite are the prevailing types. These ores generally occur in a quartz gangue, and more or less intimately associated with the minerals common to metalliferous veins, viz., chalcopyrite, zinc and lead sulphide, calcite, barite, fluorite, etc. The section is traversed by a series of veins that are comparatively well mineralized, vet the annual production and development is below what the seeming favorable conditions justify. The ores extracted are in part very rich and the values may be estimated by the pound rather than the ton. It is possible that these rich pockets of ore may, in measure, serve to retard development by causing adjoining properties to be valued at prohibitive While high grade ores serve, as a rule, to stimulate prices. active development work, their discovery in this section, at

various times, has created more or less excitement, and has doubtless advanced prospects to mine prices.

Among the most active properties in this section are the Durango Girl group of five claims, in Wall's gulch. The development aggregates about 500 feet. The Durango Girl is best developed and has produced some high grade telluride ores. This vein appears to be a porphyry dike that is much altered and impregnated, the ore being in part a replacement of the original porphyry. The Jenny Lind, in same district. is also undergoing active development, and the vein is similar in character to the Durango Girl. In Leavenworth gulch the Porcupine Mining Company is developing its group of twelve claims. The aggregate development is about, 1,100 feet. The Londonderry has a small force on development work. This company owns a group aggregating about 180 The Neglected mine is the largest producer in the disacres. trict. This property has about 1,400 feet of development, and is employing a force of about thirty-five men. During the past year there has been a large number of prospectors in the district, and a number of new locations made. Nearly all the numerous claims in the several gulches have been worked to the extent of annual assessments, and a few to the extent of fifty or one hundred feet of development work.

The district as a whole, is comparatively near transportation and market, but some of the properties occupy very rugged territory. The Rio Grande Southern road passes along the southern base of the mountain, and Durango furnishes an ore market. The smelting plant is one of several operated by The American Smelting and Refining Company, and is thoroughly modern in all its equipment. Its ores are drawn from all the surrounding districts in the adjoining counties.

Durango, the county seat, is the leading commercial and manufacturing center of southwest Colorado. The Denver & Rio Grande Railroad reached this from Alamosa, in July, 1881. The following year a branch line was constructed up Animas river to Silverton, the commercial center of San Juan county, and soon after this the Rio Grande Southern was completed via Mancos, Rico, Telluride and Ridgway, and formed the connecting link of the now popular "Around the Circle" route.

The coal deposits of the county cover considerable area, and are largely productive. The coal is of bituminous and coking quality, and occurs in seams varying from four to eight feet thick. The market, in addition to local demand, is the adjoining mining counties.

Clays of variable character and grade, and building and other stone occur in great abundance, but are developed only for supplying local demands. Mineral springs, both hot and cold, occur in several localities. The best improved, and quite a place of resort, are the Trimble Hot Springs, about nine miles from Durango. The following is an analysis, furnished by the parties in charge:

TRIMBLE HOT SPRINGS.

Temperature, 130 degrees Fahrenheit; one litre of mineral water contains the following: Carbonate of potash..... Trace Carbonate of baryta..... Trace Sulphate of iron..... 15 milligrammes Sulphate of magnesia......201 milligrammes Sulphate of copper..... Trace Iodide None Bromide None

The principal industries of the county are agriculture, horticulture, and stock-raising. The valleys are comparatively broad, very fertile, and generally protected by surrounding hills or ridges. The climate is mild, and product from the soil large and remunerative. The hills and mesas afford good range for stock, and the mountains are covered with a good supply of pine and spruce timber.

REPORT OF COMMISSIONER OF MINES

LARIMER COUNTY.

This subdivision is one of the northern tier of counties and has Wyoming for its north boundary. The adjoining counties are Weld on the east, Boulder and Grand on the south, and Routt on the west. It was one of the original counties organized by the territorial legislature in 1861, and has an area of 4,100 square miles. In an east and west direction, this county has an average length of ninety miles. The east portion embraces about eighteen miles of the western limits of the Great Plains section. In the central portion the Front range of the Rocky Mountain system ceases. and merges into the Medicine Bow range. These ranges have a general northwesterly course, and pass through near the center of the county. The Park range, on the west, separates Routt and Larimer counties, and the north limit of the Front range is topographically connected with the Park range by an east and west chain, which chain, with the Park and Front ranges, form the Continental divide. North park is a large basin-like section, in the west part of the county, lying between the Park and Medicine Bow ranges, and north of the range connecting the two, and separating North and Middle parks, the latter in Grand county. North park proper is a broad, comparatively level basin, free of timber, thirty miles wide, east and west, by forty miles long, north and south. The altitude ranges from 8,000 to 9,000 feet above sea level. The plains section in the east part of the county varies from 5,000 to 5,500 feet, and the mountain chains culminate in numerous peaks ranging from 11,000 to 14,000 feet above tide-water.

The drainage of the east portion is through the Little and Big Thompson and Cache la Poudre rivers, which flow in a general southeast direction and unite with the South Platte river. The North Platte river finds source through a number of radiating tributaries in North park and flows north into Wyoming. The Big Laramie river and tributaries drain the east slope of the Medicine Bow range and flows north into the Laramie plains of Wyoming.

The mountain sections are largely composed of granite, gneiss and schist, which are locally traversed by granite, quartz-porphyry and felsite dikes. Skirting the base of the Front range, there is a series of hogbacks with intervening glades, and on the adjoining plains eroded stream-beds that collectively expose the strata of the Triassic-Jurassic and Cretaceous in regular sequence.

Among the leading industrial pursuits, that of stone has been prominent for many years. The stone resource is large and the stone is of variable texture and color, and well suited for structural purposes. The Colorado & Southern Railroad has two branch lines into the stone-producing sections, along which a number of quarries have been opened and are fairly well equipped. One of these lines extends from Fort Collins to Stout via Bellvue. The other from Loveland up the Thompson to Arkins. From the various quarries, almost any character of stone desired may be obtained. The principal market is local and the leading cities of the state.

On the branch line from Loveland the gypsum beds are well developed near Wild's spur. The plaster mill at that point is well equipped and is operated by a company that practically controls the Colorado production. The plaster of paris produced is of high grade and is marketed over a large area of country. In addition to the higher grades of plaster, suitable for dental and like work, the company is making a plaster cement that is meeting with much favor. The gypsum deposits of this county are large and workable beds are found from the south to the north boundary lines.

The precious metal deposits of Larimer county have been worked in a desultory manner for a number of years. During the past year the greatest activity has been in the vicinity of Pearl. This camp is located within a few miles of the Wyoming line, near the northwest corner of the county. This section has attracted more or less attention since the favorable developments of the mines at Battle Lake, west of Grand Encampment, and the territory from that section to Pearl and Independence mountain and Pinkhampton has been subjected to careful scrutiny by the prospectors. Pearl, within the past two years, has grown from one or two houses to a rather lively camp of about 100 inhabitants. The veins occur in fissured zones of the granite-gneiss country, the yein filling being largely altered country rock with variable gold and silver bearing copper ores associated. Lead sulphide is found in a few places, but iron and copper pyrites and phyrrotite are invariably present. The latter possesses the peculiar bronze color that is indicative of the presence of nickel. No tests for nickel, however, have been reported. Bornite and other high-grade copper sulphides occur sparingly.

Among the most active properties are the Big Creek Mining Company's group of six claims, which is being opened by a tunnel and is in over 800 feet from portal. The Big Horn and Sierra Madre Company have installed machinery. The Wolverine, Big Horn, Red Elephant, Tellev, Zirkel and others are undergoing development, and the prospects are very favorable. The remoteness from market will retard rapid advance unless the ores can be marketed at Grand Encampment, about twenty two miles distant. The Independence Placer Company, Snowshoe Placer Company and Big Horn Placer Company have large holdings in the vicinity of Independence mountain, but have been inoperative this season. In the vicinity of Pinkhampton a number of new locations have been made and considerable development work done. There has also been a revival of interest in the southeast part of North park, in the vicinity of the old camp of Teller. The ores in this section are mainly lead, with high-grade silver ores associated. On the slopes of Mount Richthoven there has been a marked increase in development. The properties around Cameron pass have nearly all been granted annual assessment work. At Manhattan and Rustic the old properties have had limited development, and a few new companies have recently entered the district and propose extensive development. Near St. Cloud and Tie Siding there have been the usual number of reported rich finds. In all of these sections, however, ores are too low in grade to permit of shipment except in assorted lots, and development is too meager to justify the erection of mills or reduction plants. Immediately west of Fort Collins and within four miles of a branch of the Colorado & Southern Railroad, the Empire mine has produced considerable ore. The main value is in copper with gold and silver in small amounts. This plant is fairly well equipped and is the only property in the county using power drills. The vein is in banded gneiss and has been developed to depth of 250 feet. The ore occurs between narrow bands of the country which is greatly altered and is locally mined with and treated as ore. On Big Thompson and Buckhorn, west of Loveland, the ores are mainly gold. But little work beyond annual assessment has been done.

The main industries of the county are agriculture, horticulture and stock growing. North park is almost wholly controlled by stockmen, and throughout the mountainous sections ranches are found in the small parks or valleys, the adjoining hills affording good feed through the native grasses. The large crops of hay and alfalfa grown in the eastern part of the county has developed it into one of the great stock-feeding sections of the state. Recently sugar beet factories are under construction, and will doubtless develop into a large industry.

Fort Collins is the county seat and leading commercial center. Loveland and Berthoud are also towns of considerable importance. The Colorado & Southern Railroad operates four passenger trains daily between Denver and these points.

Larimer county has a number of places of resort that are largely patronized during the summer months. Each vies with the other in scenic attractions and all afford good accommodations. Those near Fort Collins are known as Cherokee park, postoffice St. Cloud, and Zimmerman's, postoffice, Home. The resort at Estes park is one of the largely advertised places in the state. It is located near base of Long's peak and is reached by several routes, the best being that of the Burlington & Missouri Railroad to Lyons, thence by stage. There are a number of mineral springs in this section, the following being an analysis of the two most popular:

ESTES PARK SPRINGS.

Number of springs, 2; temperature, 58 degrees Fahrenheit; resort.

Constituents.	River Spring.	Ranch Spring.
Calcium carbonate	2.84	6.89
Magnesium carbonate	2.01	1.83
Iron carbonate	6.66	3.12
Potassium sulphate	0.99	1.09
Sodium chloride	1.31	1.32
Silica	0.78	0.99
Alumina	Trace	Trace
Organic matter	1.79	2.06
Total parts in 100,000	16.38	17.30

C. F. CHANDLER, Analyst.

LAS ANIMAS COUNTY.

Las Animas county was created by legislative enactment in 1866, but the original territory embraced has since been materially reduced. As now constituted, it is one of the southeast border counties, and has an area of about 4,700 square miles. The adjoining counties are Huerfano, Otero, Pueblo and Bent on the north. Baca on the east. Costilla and Huerfano no the west; New Mexico forms the southern boundary. The county has an extreme length of 120 miles, east and west, but the western portion is irregular in form, and is largely outlined by natural topographic lines. The county includes within its western boundaries the eastern slope of the Spanish peaks, with outlying spurs and foothills. lts southern boundary passes over the summit of the Raton mountains. The mountainous sections are covered with a good growth of pine timber, and interspersed with comparatively broad valleys. Adjoining the foothills the mesas, or table lands, merge into the level plains on the east.

The drainage of the county is through the Purgatoire or Las Animas river, and the Apishaba and their numerous tributaries. The head waters of these streams rise in the mountain sections, and the main streams flow in an east-northeast direction and join the Arkansas river. The valley lands adjoining the streams are noted for their fertility, and with irrigation yield large returns. The adjoining hills and mesas are utilized for stock-raising purposes.

The principal industries of this section are those of coal mining and coke manufacturing. The coal deposit is widely distributed over this section, and occurs in three workable seams, varying from four to nine feet in thickness. The coal is of superior quality and well suited for domestic and manufacturing purposes. Within fifteen or twenty miles of Trinidad, the county seat and leading commercial center, there are a number of small towns devoted almost entirely to the coal industry. Mr. Denman, the State Coal Mine Inspector, reports for 1902, nineteen mines at work, and the coal production (December estimated), 3,418,209 tons. The coke manufactured, 600,161 tons.

The metalliferous deposits of this county are confined to the mountainous section in the western part. Spasmodic prospecting has been the rule for many years, and each year reports from prospectors create a ripple of excitement. The ores are mainly copper, with low values in gold and silver associated. Periodically gold finds are reported in the vicinity of Trinidad and other valley towns, but these reports are doubtless ill-founded. Each year there is a small production that appears to be justly assigned to Las Animas county, but the main product that is marketed from Trinidad is derived from the mines at La Belle and Red River sections, in New Mexico.

The county is traversed by the Denver & Rio Grande, Colorado & Southern, and the Atchison, Topeka & Santa Fe Railways, which make Trinidad a common point. The resources in building stone and clays are large, but the production is largely confined to home consumption.

MESA COUNTY.

This county was created from the west part of Gunnison, in 1883, and has an area of about 3,000 square miles. It is one of the western border counties, its west boundary being common to the eastern limit of the state of Utah. The adjoining counties are Garfield on the north, Pitkin, Gunnison, Delta and Montrose on the east, and Montrose on the south.

The drainage is through the Grand and Gunnison rivers, two of the largest streams in the state. In the valley where these streams unite, Grand Junction, the county seat and leading town, is located. The valleys along these streams and tributaries are of varying width, but are, in the main, comparatively wide and very fertile. In the vicinity of Grand Junction the valley is approximately four to fifteen miles wide, forty to fifty miles long, and has an average altitude of about 4,600 feet above sea level.

The leading industries may be classed, in the order of their importance, as horticulture, agriculture, stock-growing and mining. In mining, the coal beds are best developed. The State Coal Mine Inspector reports for 1901, four mines, producing 35,998 tons of coal; for 1902, two mines, producing 26,123 tons. The coal reserves are large, but are not as extensively developed as in some other sections. In the precious metal mines the developments are meager, and the value of the properties appear to be yet not fully determined. The Copper Creek or Unaweep district, in the south-central and southwest parts of the county, has been the most active, and during the past two years has attracted considerable attention. The ores are mainly low grade, copper values predominating, and only assorted lots may be shipped direct to market. Mr. B. C. Howell, who is thoroughly conversant with this section, kindly furnishes the following :

"Development work to date has not shown up any large bodies of copper ore, but there are fairly encouraging indications at several of the properties. At one, the Nancy Hanks, a pocket of ore was found at the contact of the quartzite with the granite, from which some fifteen cars have been shipped, which returned from ten to sixteen per cent. copper, two or three dollars gold, and from three to six ounces silver. The ore was, for the most part, malachite and azurite, with some chalcopyrite. That this body of ore is an indication that larger ore deposits of the same general character will be found, there is little room for doubt, and persevering, intelligent effort, backed with sufficient capital, is the needed essential in discovering and developing them. The discovery of this body of ore led to a 'boom' about 1897-'98, with the usual result of a 'set-back,' from failure to immediately discover other ore bodies, which was, for the most part, due to well intended but misdirected outlay of time and money. During the year 1901 an average of fifteen men were employed. and for 1902 twenty men were engaged in prospect and development work. Prior to 1901 the outlay for substantial equipment was very small, indeed, while for 1901-'02 the outlay for labor and equipment will reach the sum of not less than \$20,000 for each year. These efforts continued for another year give promise of substantial results."

The above letter refers to properties on the Dolores river side of the district. Unaweep canon crosses the Uncompany plateau and is drained by East and West creeks, the former a tributary to the Gunnison, the latter to the Dolores river. This canon is about twenty-four miles long, from one to three thousand feet wide between perpendicular walls varying from 300 to 1,000 feet in height. Dr. A. C. Peale, in his report of this section (Hayden Report, 1875, United States Geological Survey), thinks the canon to have been at one time the bed of a large stream. This eroded river bed affords a good section, and discloses the strata of the Jura-Trias above **a** granite floor, the ore deposits being in the latter.

On the east or northeast side of the plateau, on the two branches of Dominquez creek, the eroded stream beds expose the granite floor overlaid with strata of the Carboniferous and Jura-Trias. The west fork of this stream has been pretty actively prospected and attracted considerable attention. The ores and conditions are comparable to those on the Dolores river side. Both sections are practically in the prospective stage, and regular production may only result from more extended and systematic development.

In common with a number of other sections of the state, Mesa county has been the scene of somewhat extended prospecting for oil. A number of holes have been drilled, and in a few instances oil in small quantities encountered, but no permanent oil producers have been added to the list. Neither have operations been sufficient to demonstrate the non-existence of remunerative oil deposits.

Grand Junction is already a commercial and manufacturing center of considerable importance. It possesses many natural advantages that assure a future steady and healthy growth. As a railroad center it now has the Denver & Rio Grande and Colorado & Midland Railroads; is the eastern terminal of the Rio Grande Western, and western terminal of the Rio Grande narrow-gauge, via Marshall pass.

MINERAL COUNTY.

Mineral county occupies a southwest position in the state, and embraces an area of about S60 square miles. It was created from Saguache, Rio Grande and Hinsdale by act of legislature, approved March 27, 1893. The adjoining counties are Hinsdale and Saguache on the north, Saguache and Rio Grande on the east, Archuleta on the south, and Hinsdale on the west.

The early growth and development of this section was phenomenal. While it had many times been looked over by prospectors, it was practically unknown prior to 1890. In 1891 a branch line of the Denver & Rio Grande Railroad was completed, and the camp was a large producer. In March, 1893, it was created a county. Prior to the construction of the cross-cut tunnels, one of the most notable features in connection with the mines was the almost complete absence of waste dumps. The mines yielded "pay ore" from the grass roots, and the ordinary expensive development was largely eliminated. This fact becoming known, the general rush to this section during 1891 and early in the following year are notable events in the state's history, too recent to require reviewing.

The county boundaries enclose an almost rectangular section 36 miles long north and south, and 24 miles wide east and west. With the exception of a small portion in the northwest corner, the lines were run in accord with the cardinal points of the compass, regardless of natural topographical conditions that usually control. The drainage is through the Rio Grande river and numerous tributaries. The water-shed of the Rio Grande river is a basin-like area of horseshoe shape. On the north edge of Mineral county the La Garita mountains have a southwesterly course, and near the west boundary of Hinsdale county unite with the San Juan mountains. This latter range, from point of junction, trend southward, and, gradually turning to southwest, pass through the southern part of Mineral county. The crests of the two ranges form the Continental divide, which may be said to encircle the county on the north, west and south sides.

Considered as a whole, the topography is unusually rugged. The surrounding mountain chains rise from 10,000 to over 13,000 feet above sea level. From these occur somewhat detached spurs, culminating in peaks 12,000 feet and over, and occupying the central portion. The intervening valleys are, in the main, quite narrow, but locally widen out into enclosed basins or parks of considerable size.

Creede, the county seat and main commercial center, occupies a north-central position in the county, and is located in a small park-like opening on Willow creek at an altitude of about 9,000 feet above sea level. The territory adjacent to the town embraces the best developed mining districts. This section is near the present eastern border of the great area of eruptive rock common to the "San Juan country." In this immediate vicinity the successive lava flows, aggregating a great thickness, have been tilted almost upon edge and stand nearly vertical. They have a comparatively uniform bedded structure, with a dip approximately sonthwest of 70 to 85 degrees and northwest strike. These lavas are the variable andesites and rhyolites of the San Juan volcanoes, designated in the Hayden atlas as trachorites, but generally by the miners as trachytes and porphyries.

The precious metal deposits occur in and adjacent to veins filling fissures, and may properly be termed "fissure veins." These veins have a variable strike, but the prevailing direction is either approximately northwest or north. The northwest veins occur in the bedding planes of the lava, and conform in dip, viz., southwest 70 to 85 degrees. These veins are quite numerous, and may show a narrow band of quartz between unaltered walls or one wall decomposed and sparingly mineralized. The north veins have proven the most remunerative, and have been extensively developed. These veins have a comparatively uniform dip of 60 to 70 degrees west, and fill comparatively narrow fissures that cut the country at a sharp angle.

In a general way the vein proper is a hard, compact quartz, more or less banded and of variable width, carrying iron and copper pyrites, zinc blende and the silver minerals, with small values in gold. The more valuable ore deposition, however, appears to occur without the vein proper and generally adjacent to the hanging wall. The lateral extent is variable, but may extend several feet or more into the country rock, and has proven, by development, unusually continuous. These impregnated zones present a somewhat complex mass of altered and broken country, more or less silicified, replaced and cemented together. Taken as a whole, the ores are of low grade, but their production has been highly profitable.

The mines of this section are operated largely through cross-cut tunnels. These were driven for drainage purposes and as economic measures to reduce great expense of pumping and hoisting. The Commodore is opened by a series of five tunnels, and the shaft has been continued below lowest level, but is at present dormant. This property maintains its large production of several years past. The Big Kanawah Leasing Company is operating on Bachelor mountain through the Wooster tunnel, 1,480 feet on dip below apex of vein; also, the Humphrey's mill, near portal of tunnel, and driving the Humphrey's tunnel as a feature of development. The Wooster tunnel is, perhaps, better known as the Nelson tunnel. It is 35 feet below and parallels the Commodore, and was driven along the Bachelor vein. It is called

the Wooster tunnel up to the north end of the line of the Amethyst, a distance of 9,000 feet. Here it enters the territory of the United Mines, has been driven 600 feet beyond. and this is known as the Humphrey tunnel. The United Mines, viz., Last Chance, New York, Del Monte and Amethyst, are large producers, and transport product through this tunnel. The Corsair, three miles west of Creede proper, is a regular producer, and is sinking shaft from lower tunnel level. The Equity Mining and Investment Company is driving cross-cut tunnel to cut Bachelor vein at a point about five miles north of Creede. In the King Solomon mining district the Ridge mine and mill are operating under lease. Zine and lead concentrates are separate products of mill. The King Solomon mine and mill are producing a regular output of lead and zinc concentrates. The Mattie S., on Campbell mountain, north of Creede proper, is producing under lease. The Mary Anderson group, near Upper Creede, is being developed by cross-cut tunnel, now 1,500 feet from portal.

The above is a brief review of the more active properties the last quarter of the present year, and is by no means complete. Mining operations in this county are in the main on a somewhat extended scale, and the production is from comparatively few properties. Market conditions since 1893 have been somewhat discouraging. As previously stated, the ores are mainly low grade, and until within a few years have been almost strictly silver-lead ores. Below the 500-foot level in the Bachelor vein there has been a marked increase in gold values and this has added new vigor to operations. In common with some other sections of the state, concentration of values is receiving more attention, and several new mills are contemplated. The new Humphrey's mill has proved quite successful, but improvements are being added to increase the percentage of saving. The zinc-lead properties are gradually increasing their output and have been encouraged by an advance in the price paid for zinc ores.

In various sections of the county there has been an increase in prospecting and development of claims already located. On Bear creek the International Reduction Company, operating the Good Hope group, are installing a mill for treatment of gold ores. There have been several good strikes reported from this section. In the southwest corner, on the western slope and practically tributary to Pagosa Springs, there has been considerable activity and a small milling plant erected on a low-grade property. During the past year there has been a number of rumors of rich strikes near the headwaters of the streams tributary to the Rio Grande that as yet have not been locatable. Some of the ores exhibited appeared to be some of the telluride compounds, probably petzite or sylvanite, but detailed information was withheld.

The production of Mineral county is as follows:

Year	•	Gold.		Silver.	Lead	. Copp	er. Tot	tal.
1897	\$	61,327	89	\$1,831,598 5	58 \$205,526	75 \$ 157	50 \$2,098,6	510 72
1898		46,383	48	2,433,209	68 197,947	68 1,767	48 2,679,3	308 3 2
1899		91,671	45	2,262,192	42 253,769	14 3,561	27 2,611,1	194 28
1900		209,387	10	1,400,171	34 707,227	52 431	83 2,317,2	217 79
1901		102,812	58	1,070,545	56 455,932	25 166	71 1,629,4	457 10

Creede is the present terminal of a branch of the Denver & Rio Grande Railroad from Alamosa. This branch is being changed from narrow to standard-gauge track, and when the change is complete, will add materially to transportation facilities. The change evidences the faith this company has in the future of the district. The other leading towns are Wagon Wheel Gap, Wason, Spar and Antelope Springs. Wagon Wheel Gap is one of Colorado's scenic attractions and is located at the mouth of a canon, with perpendicular walls, rising several hundred feet on both sides of the Rio Grande river, leaving barely space enough for the railroad bed. This place is also guite a resort on account of its hot and cold mineral springs. They are quite well improved and provided with hotel accommodations. Antelope Springs, in Antelope park, is also becoming a favorite resort. The following analyses of the Wagon Wheel Gap Springs are by Lieut, G. M. Wheeler and Mr. Oscar Loew:

REPORT OF COMMISSIONER OF MINES

Number of springs, 3; temperature, 140 to 150 degrees, Fahrenheit.

Constituents.	No. 1.	No. 2.	No. 3.
Sodium carbonate	69.42	Trace	144.50
Calcium carbonate	13.08	31.00 /	
Magnesium carbonate	10.91	5.10	22.42
Lithium carbonate	Trace	Trace	Trace
Sodium sulphate	23.73	10.50	13.76
Potassium sulphate	Trace	Trace	Trace
Sodium chloride	29.25	11.72	33.34
Silica	5.73	1.07	4.75
Organic matter	Trace	Trace	Trace
Sulphuretted hydrogen	Trace	12.00	
Total parts in 100,000	152.12	71.39	218.77

OSCAR LOEW, Analyst.

Constituents.	No. 1. 150° F.	No. 2. Cold.	No. 3. 140° F.
Sodium carbonate	69.42	Trace	144.50
Lithium carbonate	Trace	Trace	Trace
Calcium carbonate	14.08	31.00	22.42
Magnesium carbonate	10.91	5.10	22.42
Potassium sulphate	Trace	Trace	Trace
Sodium sulphate	23.73	10.50	13.76
Sodium chloride		11.72	33.34
Silicic acid	5.73	1.07	4.72
Organic matter	Trace	Trace	
Sulphuretted hydrogen	Trace	12.00	
Total parts in 100,000	152.12	71.39	• 218_77

LIEUT. G. M. WHEELER, U. S. A. Analyst,

MONTEZUMA COUNTY.

This subdivision was segregated from La Plata by legislative enactment, which received executive approval April 15, 1889. It occupies the extreme southwest corner of the state, and has an area of 2,642 miles. A somewhat unique feature in connection with the southwest boundary corner of the

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state and Montezuma county is noted by Major Hooper in one of his booklets on the "Cliff Dwellers," who says: "In construction the monument is a mound of stone about four feet square for a base, and on that stands the stone monument, rising about six feet high, and on the four sides are engraved, respectively, the words Colorado, Utah, Arizona, New Mexico. This monument is the only one in the world that marks the junction of four states, territories or provinces." The adjoining counties are Dolores on the north and La Plata on the east.

At various places throughout the west and southern portion of this county are found the ruins of a prehistoric race. To students of archaeology and ethnology it is a field of inestimable value and well merits governmental supervision. Steps have been taken toward their preservation, but unless made effective in the near future, many of the most striking structural remnants will be almost entirely obliterated through vandalism or the commercial pursuit of the "relic hunters." Nearly every museum in the county has been supplied with relics from this section to a greater or less degree. The present condition shows a marked change over that existing in 1874, when Mr. W. H. Jackson made a careful investigation and reported to the United States Geological Survey. This report was published in 1875, and is accompanied with numerous illustrations.

Topographically, Montezuma county embraces the eastern limits of the Utah plains, through which two isolated groups of mountains have risen. The El Late group occupies about forty square miles in the southwest portion, which, in individual peaks, reach an altitude of 10,000 feet above sea level. The La Plata mountains are in the northeast part of the county, and the culminating peaks reach an altitude of over 13,000 feet. The plateau, from the base of the La Plata group, descends in a gradual slope from 7,000 to 5,000 feet at the west county boundary. The drainage of the east and south portions of the county is through the Rio de la Mancos and its tributaries. The northern portion drains into the Dolores river, which enters, makes a big bend, and finds egress through the north boundary line.

The rocks exposed along the various gulches and canons are the varying stratified shales and sandstones of the Cretaceous period, overlaid in part by the Tertiary in the western part of the county, except in vicinity of the two mountain groups above mentioned. These isolated mountain groups, together with the Rico and La Sal mountains are considered by Mr. Whitman Cross and other eminent geologists as comparable in many ways and probably nearly contemporaneous in point of time in their up-building. In the vicinity of the La Plata group the strata underlying the Cretaceous. viz.: the Jura-Trias, has been lifted up above its normal position by the numerous intrusive sheets of porphyry and probable underlying mass of same. By this is not meant that the porphyritic mass is immediately under the Triassic or sandstones of the "Red Beds." Exposures in other sections afford good ground for the belief that underneath the exposed Triassic beds in this section are the strata of the Carboniferous and older Paleozoic measures, and that these strata have likewise been penetrated or separated at intervals by intrusive sheets of porphyry. The southwest exposures of the higher mountains of this group, notably Mount Hesperus and Banded peak, are most picturesque. The names indicate, in a way, the present physical conditions, but convey no idea of the beautiful contrasting coloring of the varying strata, which must be seen to be fully appreciated.

The mining history of this district begins with the pioneers of 1873-74. Since that time there has been several short-lived revivals of interest. All energy, however, was expended in search for gold in placer deposits until about twelve years ago. At that time Mr. George A. Jackson, who was the discoverer of the first pay placer mine in the state near Idaho Springs, called public attention to the so-called Baker, or Jackson contact on the West Fork of the Mancos. Somewhat later his enthusiasm enlisted the co-operation of capital to the extent of an investigation, and the erection of a small milling plant. Expectations were not realized, and the district soon ceased to attract general attention. While several placer beds were spasmodically worked, and prospecting was followed to a limited extent thereafter, not until 1896-'97 was there any activity in lode mining. Since that time the districts adjacent to the headwaters of the Mancos have shown a slow but gradual increasing activity.

The formation of the La Plata mountain group and the subsequent dike and massive intrusions have been summarized in the chapter on La Plata county. Likewise, the fissures, veins, ores and ore deposition to which reference is made, the two districts being practically one and the same. In addition to the veins filling single fissures, the closely parallel veins in fissured zones, and the mineralized dikes therein mentioned, deposits, common to both districts, occur as impregnated or mineralized zones and as bedded deposits. These were not mentioned in the La Plata chapter, because none of that character were operative in that district. In the Mancos, locally known as the California mining district, the name being handed down from the Californians who first entered this section in 1874, there are several deposits at different horizons locally called "contacts," or "blanket veins," that show promise of developing into large producers.

During the past four or five years negotiations have been pending on a group of properties on the East Fork of the Mancos. These are generally known as the Doyle group, James Doyle of Portland mine fame being the moving spirit. Somewhat recently this group of twenty-one claims has been merged into the Mancos Consolidated Gold Mines and Development Company. A ten-stamp amalgamation and con-centration mill has been installed, and a supplemental cyanide plant is to follow. While production has been somewhat limited the smelter returns show average gold value of over \$40 per ton, gross, for 300 tons shipped direct. About 700 tons passed through the mill yielded on plates an aver-age of \$15 per ton, bullion, 900 fine. Shipments of concentrates show 2.23 ounces gold, 11.4 per cent. silica, 45 per cent. iron. These values are quotations from actual mill and smelter returns, and evidence the fact that pay ore exists in these bedded deposits. It is not probable that the entire "contact" will prove of equal grade. It occurs in sandstone metamorphosed into quartzite, conforming in dip to the stratum, viz.: 12 degrees northeast, and has been penetrated by adit 180 feet. Openings have been made at various places, aggregating 1,000 feet or more in length, and showing a varying thickness of one to five feet. The ore bed is highly colored from varying oxidized products intermingled with small quartz stringers carrying iron pyrite, in the main. The value is almost wholly in gold. The above is entered into in some detail for the reason that other beds of like character occur in the district. The source of the deposit is not fully determinable, but is probably from some of the dike veins that show in the immediate vicinity. The reports of values from other like deposits vary from \$3.00 to \$12.00 gold per ton.

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Like values will doubtless occur in the Doyle "contact" and more extended development will probably demonstrate a system of ore shoots or channels of more concentrated values running through the bed at varying intervals. Like development in other beds where as yet only low grade ores have been encountered may also open up better grade ore bodies comparable to that in the Sundown and other claims on the Doyle contact.

Among other properties more or less active in this section are the Narrow Gauge, Shackley group, five claims; Grouse group, three claims ; Pike, Tammany and R. A. P. The Tenderfoot is opened by five cross-cut tunnels, aggregating 140 feet, and 200 feet drift work. The ore in this property is a honey-combed quartz, in "blanket" vein, with several small fissure veins connecting. The gold is largely free, and near the fissures the ore is said to at times yield as high as twentyfive to fifty cents to a pan, when treated in that manner. The Timberline is a northwest fissure in conjunction with a dike. The ore is mainly oxidized with quartz, carrying sulphides, developed by about 1,000 feet of work in two tunnels, connected by upraise. Ore varies from one to two feet in width, and is of shipping grade. The Trail is a dike about four feet wide, highly altered and of very low grade. On West Mancos the Mancos M. & M. Co. is actively developing their properties in a systematic manner.

In a district where gold is the predominating metal, and locally occurs in free state, deposits in placer beds are a natural result. Placer locations are quite numerous and are operated spasmodically to a limited extent, but apparently not very successfully. The gold recovered is of high grade and nearly pure, but the conditions so far as developed are not very encouraging for large operations.

The lode mines are located at altitudes varying from 9,000 to 12,500 feet and at an average distance of ten miles from the Rio Grande Southern Railway. The market for ores is Durango, in the adjoining county east. These mines may be classed as low-grade propositions that have barely passed the prospect stage. The ores are mainly a complex sulphide, but susceptible to concentration or reduction on the ground. Good timber is abundant and the water supply ample at no great distance from the properties.

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The principal industries of the county are agriculture, horticulture and stock growing. The eroded valleys near the streams are well protected and yield good returns for labor expended. The coal, clay and timber resources are large, but the latter is the only one utilized beyond local demands. Cortez is the county seat and commercial traffic is divided between Cortez, Mancos and Dolores, the two latter being located on the railroad.

MONTROSE COUNTY.

This subdivision was segregated from Gunnison county by act of legislature, approved February 11, 1883, and has an area of about 2,300 miles. It lies wholly upon the western slope, and its western boundary is common with the east boundary of Utah. The adjoining counties are Mesa and Delta on the north, Gunnison and Ouray on the east, and Ouray and San Miguel on the south. The northeast portion of the country embraces the southern limit of the West Elk mountains. Through this section the Gunnison river flows and occupies an almost impassable canon. Active steps have been taken to divert a large portion of the water of this stream by a tunnel into the valley of the Uncompangre river. This valley, in which is located Montrose, the county seat and leading commercial center, is noted for its great fertility, horticultural and agricultural products. It embraces a large area, only a small portion of which can at the present time be utilized, owing to limited water supply for irrigation purposes. The state has already assumed control of this most important enterprise; irrigation of these arid lands, when completed, will more than double the present arable land and very much increase the population.

The Denver and Rio Grande Railroad enters the county from the east via Black canon of the Gunnison river. The canon of the Gunnison being impassable below the junction of Cimarron creek, a detour is made and the track follows south up the latter named stream for a few miles and passes over Cerro hills, between Tongue and Vernal mesas, thence down to Montrose and along the Uncompany valley to its junction with the Gunnison at Delta, in Delta county. The Cerro hills separate the valleys of the Uncompany and Cimarron, and both have streams that rise well back in the rugged San Juan mountains, lying south of the southern boundary line. The Uncompander river flows north and northwest through the country to its junction with the Gunnison river. On the west and southwest side of the river the broad valley rises gradually from 6,000 to 10,000 feet above sea level to another broad mesa known as the Uncompandere plateau. From the northeast slope of this plateau a number of streams flow in a northeasterly course and join the Uncompandere river. Still further west there is another comparatively level mesa known as the San Miguel plateau. This plateau is drained by tributaries that flow westward and join the San Miguel and Dolores rivers. Just beyond the west border is the Sierra la Sal mountains.

The rocks which compose this section are largely the strata of the Cretaceous overlying that of the Jura-Trias, the former predominating. Good exposures are afforded along the various streams, which locally have cut deep and narrow canons through the strata.

Uncompangre and San Miguel plateaus lie roughly parallel and have a general northwest course across the country. They appear to be folds or uplifts subsequent to the deposition of the sedimentary strata that may have been coincident with or related to the formation of the Sierra la Sal mountains. lying to the west. This group of mountains is somewhat isolated and is comparable in structure to the Rico or La Plata groups described more in detail under the counties of same name. The plateaus are locally eroded by narrow gulches, which in places open out into comparatively broad level vallevs, surrounded by precipitous walls; notably Paradox and Sinbad valleys. The sedimentary beds exposed usually lie nearly horizontal, but are frequently faulted and locally flexed. Underlying the strata of the Jura-Trias a series of shales occur of unknown age, and locally a portion of what appears to be the Upper Carboniferons is found between the Juri-Trias and the shales.

Precions metal mining has been prosecuted in this county in a desultory manner for a number of years. Along the various stream beds placer locations are quite common and evidence the fact that hand sluicing has been indulged in to considerable extent. Along the San Mignel river, in the western part, several attempts have been made to operate the placer beds on a more extensive scale with hydraulic appliances, but the results apparently have not proven very remunerative.

The most active mining section during the past two years has been near the western limits of the county, lying east of the La Sal mountains. Owing to great distance from market only the higher grade ores may be handled profitably. At present time ores having a gross value of \$60 per ton leave small margin for mining and profit after paying wagon and railway freight and treatment charges. This district is reached by stage from Placerville, a town on the Denver & Rio Grande Southern Railroad in San Miguel county. This stage runs via Norwood, Shenandoah and Naturita to Paradox, a distance of about sixty-five miles. From Paradox horses or vehicles can be obtained, the former preferable, and Cashin and adjoining localities visited.

Although metalliferous veins were known to exist in this section for many years, general attention was first called to the district through its deposits of uranium compounds during 1888-89. The uranium ore, having a bright canary-yellow color, was first analyzed and found to be new mineral by Mr. C. Friedel and E. Cummge, and named carnotite, in the spring of 1889. This mineral has since caused investigation by scientific men in various sections of the globe. In the fall of 1899 a brief reconnaissance was made in this section by Messrs. F. L. Ransome and Dr. A. C. Spencer on behalf of the United States geological survey. Mr. Ransome's report on this section is in part as follows:

"The La Sal Creek Deposits.—These occur in the extreme western portion of Montrose county, southwest of Paradox, and about six miles up La Sal creek from Cashin postoffice. They are reached by trails from Paradox valley and from Cashin. The deposits are on the south side of La Sal creek and about 700 feet above the stream. They occur for a distance estimated at more than a quarter of a mile, along the sandstone cliffs which descend from the mesa into the canon of La Sal creek, and only a few feet below the level of the mesa surface. * * *

"As revealed by numerous small openings near the crest of the bluff, the carnotite, which is the material here sought, is found chiefly in a massive bed of nearly white sandstone. Some of the ore, however, lies between the sandstone and a lower bed of light-gray shale. Although the prospecting openings all lie at about the same level along the cliffs, the deposit is not nearly so regular as the vanadiferous band near Placerville.

"The carnotite of La Sal creek occurs as irregular, bunchy 'pockets' in the sandstone, or along the contact of the sandstone with the underlying shale. These have all the appearance of being impregnation deposits, the solution carrying the uranium compounds having deposited the ore wherever they found ready passage through the rock usually along bedding planes. No roscoelite was detected with the carnotite.

"The most remarkable and interesting fact in regard to the La Sal creek deposits is their very superficial character. The ore bodies are usually flat-lying streaks, a few inches thick, which grade above and below into the common lightbuff sandstone, and which die out and disappear when followed into the hillside. In tunnels run but a few feet underground, the vellow impregnation of carnotite can be seen to gradually die out, to be succeeded by light-colored sandstone, showing no apparent trace of the mineral. It is doubtful whether any appreciable quantity of carnotite occurs as much as twenty feet from the surface, on any of the locations, although this distance is given from memory and not from measurements on the ground. As before stated, the impregnation has usually taken place along bedding planes; it has also proceeded along surfaces of minor and superficial movement in the rocks. In one case it was observed that a portion of the overlying sandstone had moved upon the underlying shales, the disturbance being apparently a superficial one, of a kind commonly enough observed where massive beds rest on yielding shales on a steep hillside. In other words, the movement appeared to be directly related to the present topography. The deposition of carnotite was here plainly subsequent to the movement, and had taken advantage of the small openings and dislocations in the shale afforded by this very recent disturbance. It was reported that some of the best nests of ore had been found in 'slide rock'-i, e., rock which had slipped to some extent down the slope—but I was unable to verify this statement further than is indicated in the preceding description. There can be little doubt but that the deposits of carnotite on La Sal creek are not only very superficial in character, but very recent in age."

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"The Roc Creek Deposit.—The principal claim is the Copper Prince, owned by J. R. Duling, on the north side of Roc creek, three or four miles above its mouth, and near the foot of the Miller trail to Paradox. It is reached by this trail from Paradox valley, or by trail from Hydraulic on the Dolores river. This deposit is in the La Plata sandstone, according to Dr. Spencer's observations, and has been more extensively exploited than any other seen. The sandstone, which at this point is nearly horizontal, is cut by an east and west fault, the fault plane dipping north at about 70 degrees. The amount and character of the throw could not be determined. It is probably less than fifty feet. The carnotite occurs in the hanging wall of the fissure, as small irregular branches in a loose mass of crushed sandstone, and also as an impregnation of some of the firmer portions of the bed. No roscoelite was seen. Several small tunnels have been run in on the hanging wall side of the fissure (which itself carries no vein or ore-body), but they had been securely closed by planking, and no examination of their inner ends could be made. I am thus unable to tell what becomes of the deposit as it is followed in from the surface. A few hundred pounds of picked carnotite ore has been shipped from this claim, and is reported to have sold for \$1.25 a pound in Denver. The character of this deposit is similar to others examined, except that in this case a well-defined fault has provided a zone of crushed and porous rock in the hanging wall, along which impregnation could take place. A few hundred feet farther west the crushed sandstone adjoining the fault has been impregnated with cupriferous solutions and is spotted with stains of the blue and green carbonates of copper.

"Other Deposits.—It is known that several carnotite claims have been taken up in Gypsum valley in what is known as the Disappointment district. The impregnated sandstone is said to cap a hill and to constitute an extensive deposit, but it was not visited. Carnotite was also reported from the Blue Mountain district, but I have no personal knowledge of these occurrences. It seems highly probable that the material will be found widely distributed in the Mesozoic sandstones of western Colorado and eastern Utah, although perhaps nowhere in very extensive bodies."

In addition to the uranium ores above described there occur in this section a series of practical vertical fissures, cutting through the nearly horizontal strata, which contain fairly persistent deposits of ores carrying copper, with considerable value in gold and silver. The production for 1901 aggregated \$70,562, divided as follows: Gold, \$1,550; silver, \$59,751; copper, \$9,261. Owing to reasons previously stated only the higher grade ores could be marketed. During the past two years a series of somewhat extensive tests have been made by lixiviation, and later a matte furnace was constructed. Those in charge were not satisfied with results and have nearly completed the erection of a copper smelting plant. Coal and required fluxes occur in the neighborhood and the successful operation of the plant will greatly increase active mining in this section and provide a home market for lower grade ores. Under present conditions ores having a gross value of less than \$60 per ton leave small margin for mining and profit after paying freight and treatment charges to outside markets.

The leading property in this section is a group of twelve claims located near Cashin, on La Sal creek, and owned by the La Sal Mining Company. The tunnels, drifts and shafts on the group aggregate in the neighborhood of 5,000 feet of development work. The plant is operating under a long-time lease to Messrs. Laughlin & Hall. The main vein is in a fault fissure about seven feet wide, cutting the Jurassic sandstone. The vein filling is largely brecciated material cemented into a mineralized mass of copper sulphides and quartz and reported to average from seven to nine per cent. copper, with gold and silver values associated. A number of other properties are operated spasmodically, but the combined product in connection with the comparatively near by mines over the Utah line are confidently expected to supply ample material for the smelting plant.

In addition to the metalliferous mines, agriculture, horticulture and stock-raising are largely engaged in. The county is resourceful in deposits of coal, building stone and clays. None of the latter are developed beyond the requirements of local demand.

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OURAY COUNTY.

This subdivision occupies a southwest position in the state and is one of five counties composing the great "San Juan" country. It was created by legislative enactment in 1877, but the original territory has since been greatly reduced by later acts. As now constituted it embraces about 450 square miles. The adjoining counties are Montrose on the north; Gunnison and Hinsdale on the east; San Juan on the south, and San Miguel and Montrose on the west.

Although comparatively small in area Ouray county is one of the most important mining sections of the state. Its history practically begins with the year 1875, since which time the precious metal production has shown a gradual annual increase. The completion of a branch line of the Denver & Rio Grande Railroad from Montrose to Ouray late in the fall of 1887 overcame to a large extent the great expense incident to freighting ore out and supplies in by wagon, and was followed by increased activity in mining and all lines of business.

Mining operations in this section have never been inflicted by a so-called general boom, but have advanced somewhat slowly upon actual merit. During the past year the much advertised sale of the Camp Bird group in Imogene Basin has done more to advise the general public of mining possibilities in the "San Juan," and of the large operations that have for years been quietly conducted, than any event in its history. Many old properties that have lain idle for years have been revived by the organization of syndicates or mining companies; many locations have been filed upon sections of the district heretofore looked upon as unprofitable ground; and a general but healthful impetus has been given to extensive prospecting and systematic development.

As now constituted Ouray county has its boundaries determined by the watershed of the Uncompany river and its tributaries. The main stream rises at the south limits of the county and flows north and its tributaries come in from the east and west, rising well up toward the summit of the rugged mountains outlining the east and west county boundaries.

Ouray, the county seat and main commercial center, is near the southern part of the county on the Uncompany river and occupies a small but comparatively level park at an altitude of 7,700 feet. It is recognized as one of the most picturesque locations in the state. The mountains rise almost precipitously on all sides from 2,000 to 3,500 feet, and even the means of exit and entrance are hidden by a bend in the river canon a short distance north of the town. South of the city the river enters an almost impenetrable canon for about four miles, and this is made accessible by a wagon road practically blasted out of the east canon wall, and in places several hundred feet above the stream bed. The scenery surrounding nearly all of the "San Juan" towns and cities beggars description, but is universally pronounced as equal to or even surpassing the noted scenic sections in foreign countries.

With the exception of a small portion in the north end, the topography of the county is that of rugged mountains, a number of which reach an altitude of 13,000 to over 14,000 feet above sea level. The various streams head, generally, in large open basins, or glacial cirques, well up above timber line, and near the top of the culminating ridges connecting the more prominent mountain peaks. Below the basins, these streams occupy eroded valleys or gulches, gradually deepening into somewhat narrow canons, and finally uniting with the Uncompander river, and making exit through the north county boundary line at an altitude of 6,500 feet. Timber is abundant on the various mountain slopes, and grows to an elevation of 10,500 to 11,500 feet above sea level.

Ouray county, in its southern portion embraces a small part of the San Juan mountains composed almost entirely of volcanic rocks. These rocks consist, in the main, of tuffs, agglomerates and lavas of andesite and rhyolite. In the upper horizons the different lava flows lie practically horizontal, differ somewhat in color and present a stratified appearance. Later, this volcanic complex has been penetrated by a variety of eruptive rocks in the form of somewhat massive intrusions and numerous dikes.

The geological history of Ouray county is very complicated, and has not as yet been fully interpreted. The adjoining territory, on the west, has received the careful consideration of the United States Geological Survey, which has somewhat recently published the results of its investigations in folio form, entitled the "Telluride Folio." Inasmuch, as the mountain section of Ouray and that treated in the Telluride Folio are largely comparable, reference is made to this publication or to brief extracts from same under head of San Miguel county in this report. The predominating ore deposits of this section occur in form of veins, filling fissures that have a varying strike and are generally near the vertical. The word vein, as commonly used in this district, is not a comprehensive term, for the reason that it includes not only a single vein occupying a single fissure, but likewise that of a system of narrow parallel veins embraced in a fissured zone, the whole being worked as one vein. Space will not permit in the following brief review of operations to describe in detail existing conditions.

The county is locally divided into mining districts which, in part, conform to natural topographic divisions. Mount Sneffles, the largest producing district, embraces the southwest corner of the county, or the properties tributary to Canon creek. The most prominent mine or group in this district is the Camp Bird, in Imogene basin. The Camp Bird vein, or some one of its near neighbors embraced in the group, is doubtless an east extension of the well-known Pandora vein, in San Miguel county. The strike of the vein is nearly east and west, and dips about 75 degrees, on an average, to the south. The history of this great property is well known, and need not be repeated beyond calling attention to the existing conditions at the time of its discovery early in the '80s. At that time prospecting was almost wholly prosecuted for silver-lead ores, and gold assays were seldom asked for by prospectors when having their samples tested. The Camp Bird vein occupies a fissured zone. One of these fissures near the foot-wall was filled mainly with lead and zinc sulphides carrying low values in silver, and was located and worked to a limited extent for this ore, which, under existing market conditions, was of little value. Near the so-called hanging wall there is another band that near surface appeared to be an almost barren quartz. This was, when removed, thrown into the waste dump as worthless. The discovery of the value of this ore by Mr. Thomas F. Walsh, later developments and production will long be remembered as an object lesson of what "might have been" had a small additional expense been incurred in having all parts of the "vein" thoroughly tested. This property, like the majority of others in the San Juan, is operated through tunnels. The lower opening is a cross-cut tunnel 2,200 feet long, connected at its portal with a mill by

a Bleichert tram. All the ore removed from mine goes direct to mill, where it is crushed and stamped to 40-mesh, passed over silvered copper plates, and tailings over vanners, thence to cyanide plant. Under the original management the ore stock passed through mill had an average value of about \$40 per ton. At times, however, the value of the stock would be as high as \$150 to \$200 per ton. The loss or value left in tailings was reported as not to exceed \$5.00 or \$6.00 per ton. This latter was probably underestimated, but there is little doubt that the percentage of saving was high as compared with many other milling plants. These high results, likewise, demonstrated the gold to be largely in the free state, or combined with the pyrite, sphalerite and galena, mixed with the quartz and quartzose ores. The presence of telluride ores were suspected, and a good sample was sent to Dr. Wm. P. Headden, chemist at the Agricultural College, Fort Collins, who says:

"The sample of Camp Bird ore was duly received and I have given it an examination for the purpose of determining the minerals probably present in it, and my conclusion is that the associated minerals are galenite PbS, Sphalerite ZnS, Alabandite Mn S, Aragonite CaCO₃, possibly Ankerite Ca¹/₂ Fe¹/₂ CO₃, with some Mn CO₃, quartz and free gold. There are traces of both Bi and Cu, which is probably due to some Chalcopyrite. The small flitter of gold herewith, easily obtained in the wet way, is proof enough of the richness of the ore. The gold may not all be free, but the mill returns would make it probable that it is. I can not find any tellurium."

The equipment of this property is first-class in every particular, the mechanical part being operated by electrical energy transmitted across the high mountains between Imogene basin and Ames, in San Miguel county. Especial attention has been given to the "bunk and boarding" houses, thus adding materially to the comfort of employes. They occupy sleeping rooms furnished with iron bedsteads, two in a room, large reading and dining rooms, wash and bath rooms, with hot and cold water. The whole thoroughly heated by steam and lighted by electricity.

The Imogene Basin Gold Mining Company is developing a group of claims near the Camp Bird group, viz.: Tempest, Forest and Mountain Quail, by shaft and tunnel. The Camp Bird Extension Company has a 1,200-foot drift on Monument vein and is driving cross-cut with electric drills

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to cut Camp Bird vein. The Madison Mining Company is developing the Evening Star group, near Stony mountain, by shaft. The Governor, on Stony mountain, has been equipped with a large compressor plant and is driving cross-cut to known ore bodies. The Trust Ruby is being operated by the T. M. Anchor Mining Company. The mill has been newly equipped and is producing a good grade of concentrates. The Pilot Mining Company is developing the Pilot. The Altoona group of nineteen claims, in Yankee Boy basin, is developing by shaft and tunnel. The oldest and best developed properties in this section are those operated through the Revenue tunnel. This bore was originally projected to cut the Virginius vein, which it does at about 7,500 feet from the portal, and 2,000 feet vertically below the apex. Drifts on the vein from tunnel level passing under the divide between Virginius and Marshall basins, give a vertical depth of nearly 2,500 feet. to which may be added the depth of a shaft of 500 feet, sunk on vein from tunnel level. This makes a vertical depth of about 3,000 feet on vein below apex, the greatest explored depth of any mine in the state. The Virginius is one of the first mines of the district, and was originally worked near the top of Virginius basin at an altitude of 12,500 feet. The vein runs northwest and dips about sixty-five degrees southwest. In the upper workings the vein was not as well developed as found below. The ore values, however, were concentrated into a narrow band that was hand assorted, and was a highgrade silver-lead ore. Connection has been made between the lowest upper workings and the tunnel level and large production has been made for a number of years. The "pay-streak" in upper workings was but a few inches in width. In the lower it averages about a foot wide. The gross value per lineal foot is about equal in both parts of the mine. The vein occupies a fissured zone, and the quartzose filling, without the "pay-streak," is largely altered country. The minerals in the "pay-streak" are mainly argentiferous lead and zinc sulphides and gray copper, closely associated with quartz and calcite. The ore is now treated almost entirely by a concentration plant at portal of Revenue tunnel. The heavier lead being in part automatically assorted after coarse crushing. The mill is being thoroughly overhauled and improved. The power used for operating the mill and trolley cars in tunnel is electrical. This energy is generated from water power at three stations along the bed of Canon creek. A thoroughly modern electric plant is near completion at Ouray, about nine miles from the mines. At this point fuel will be used for generating electrical energy.

The Red Mountain district embraces the southern portion of the county and became famous for its rich coppersilver ores through the Yankee Girl, Guston and other mines. This section is practically tributary to Silverton, with which it is connected by the Silverton railroad. The ore deposits in this immediate section occur in the form of vertical "pipes or chimneys," oval to round in form. The ore deposition was first described by Mr. T. E. Schwarz, several years superintendent of the Yankee Girl, in a paper published in Vol. 1, Proceedings of the Colorado Scientific Society. It has later been more fully described by Mr. Frederick Leslie Ransome, in Bulletin No. 182 of the United States Geological Survey. This bulletin was published in 1901, and is one of the most valuable, complete and comprehensive reports issued by the department. During the past several years this district has been comparatively quiet and production small. The present year shows increased activity, a number of transfers of property, and the organization of several new companies. The Red Mountain Railroad, Mining and Smelting Company has secured, by option and purchase, a large tract of territory that includes the Yankee Girl, Guston, Genessee, Vanderbilt, Hudson and other well-known properties, and will develop the same by tunnel. The Treasury Tunnel, Mining and Reduction Company hold a large group of properties on the line of tunnel, now in 4,500 feet from portal and directed toward Savage basin, in San Miguel county. Power drills are being used. Among active properties are the Oom Paul group, in Copper gulch, Grey Hound group of twelve claims, and Mountain Lion, on Mount Hayden; Mahoning group of ten claims, near Ironton; Bobtail mine, in Commodore gulch, developed by 3,000-foot adit tunnel; Des Ouray group, on Mineral creek, and Saratoga, near Ironton. The Saratoga mill is to be converted into a pyritic smelter. The development on this property exposes a large body of pyrite and chalcopyrite, reported to have a gross value of \$8.00 to \$12.00 per ton in gold and silver, gold predominating. This property was originally developed for an ore deposit in the lime at plane of contact with underlying quartzite. Mr. Ransome classifies the quartzite as probably Algonkian and the limestone as Devoniān.

A large exposure of Algonkian quartzite and shales standing on edge is afforded in the picturesque canon of the Uncompangre river, between Ironton and Ouray. Near the town, and lying unconformably on the quartzites, are some large limestone beds, classed by Mr. Whitman Cross as "Ouray limestone," on account of its prominence. Near the top of these beds, locally known as the Mineral Farm, the mining property is operating under lease. The ore occurs in bedded form and is doubtless a replacement of the lime. comparable to that of the Saratoga. Nearer the town and close to the river the Trout and Fisherman have attracted attention, periodically, by the production of very high-grade silver ores, encountered along local fissures in the limestone. The development is meager, and is likewise retarded by the heat from the numerous mineral springs in that vicinity. These thermal waters occur in about the same geological horizon on the south and east parts of Ouray, and are utilized mainly for bathing purposes. The water is piped into bath houses, equipped with private tubs and a large swimming pool. The temperature of the water at various springs is variable, but the hottest is about 130 degrees Fahrenheit. In the neighborhood of the Trout and Fisherman some of the largest springs occur in the bed of the stream, and the combined springs have volume and heat sufficient to keep the river from freezing over during the winter season for a considerable distance on its course. No authentic analysis is at hand for these waters.

West of Ouray there has been increased activity in the gold mines of that section. The Ceramic City Mining and Milling Company is developing a group of claims through an adit tunnel (on the vein), and also by a cross-cut tunnel to cut vein 1,600 feet below apex. The Ouray Chief, in the amphitheater east of Ouray, formerly known as the Portland, is again active and producing.

In the Sentinel district, north of Mount Sneffles, the Cleveland, operated by The Delta Home Mining Company, has cut vein after two years' work on cross-cut tunnel. The Homer cross-cut has reached vein at 1,400 feet from portal, approximately 2,000 feet below the apex of vein. Both report good ore bodies. The Blaine and Sunset, Nos. 1 and 2, are also pushing development.

In the Paquin district, which embraces the northeast part of the county, the ore veins occupy fault fissures that have a general east and west strike. They are closely allied to a series of porphyrite dikes that traverse the Jurassic and Cretaceous shales, sandstones and limestones, which, with the underlying Triassic, may be said to flank the northern limit of the mountains proper. The ores of this section are almost strictly silver-lead, with slight values in gold. Any one of the better developed mines would require more space to describe in detail than may be granted the whole chapter on the county. The vertical throw of the faults is generally but a few feet, but may locally amount to twenty or twentyfive feet. The lateral or horizontal throw is, in the main, not in excess of four to six feet. The apparent effect upon the ore deposits in certain horizons and general vein structure is most interesting, but must be omitted at this time.

Among the most active properties in this district are the Bachelor and Khedive. These properties are extensively developed through cross-cut tunnels and have 500-foot shaft below tunnel level. They have been regular and large producers for a number of years, and recent developments are by no means discouraging. A fifty-ton concentration plant is operated to full capacity and yields a good lead and iron concentrate; also a fair zinc product. The Caliope-Dexter is operating mine and ten-stamp mill with small force. The Black Girl has three tunnels and an aggregate development of about 5,000 feet. The Newsboy group has about 6,000 feet of development. The Float, near Bachelor Switch, Salisbury, on Corbett creek, and Rock of Ages, on west side, are intermittent producers.

The American-Nettie group, in the so-called gold belt, two miles north of Ouray, is operating mine and mill, and making good production. The development on this group aggregates in the neighborhood of 60,000 feet, and the ore deposition is distinctly different from that of all other properties mentioned, being, in short, a series of deposits along planes of fracture in the quartite of the Upper Jurassic that occur at intervals at almost right angles to a porphyrite dike.

On Bear creek, south of Ouray, the Grizzly Bear and American Flag are the most active. The Bonanza, on Mt. Hayden, just opposite Bear Creek falls, is operated by the Bonanza Mining and Milling Company.

In the Poughkeepsie Gulch section there is less activity than the conditions justify. This is recognized as one of the best mineralized sections in the county, and is noted for its
numerous and persistent fissure veins. The ores are, in the main, low grade, but are susceptible to concentration. It was the scene of the first excitement in this county, in 1874, and was most productive when transportation cost more per ton than the present gross value of the average ore mined in the county. A somewhat recent sale of the Pickett in this district may be a start toward resumption of active mining.

The average number of men engaged in mining in this county during 1901, was 1,918; during 1902, 1,609. The annual production for 1902 will compare favorably with that of 1901, notwithstanding unfavorable market conditions. The following production evidences the importance of this section:

Year.	Gold.	Silver.	Lead.	Copper.	Total.
1897	\$ 552,839 82	\$1,656,119 02	\$ 263,106 37	\$ 229,433 82	\$2,701,499 03
1898	852,554 82	827,342 23	101,637 68	124,267 44	1,905,802 17
1899	1,694,940 00	1,397,862 39	337,770 45	53,741 67	3,484,314 51
1900	1,437,908 55	1,219,152 46	448,340 48	58, 211 19	3,163,612 68
1901	1,546,322 70	963,080 89	342,590 74	108,093 72	2,960,088 05

PARK COUNTY.

Park is one of the original subdivisions made by the territorial legislature in 1861. It occupies a geographical center of the state and embraces an area of 2,100 square miles. The adjoining counties are Summit and Clear Creek on the north, Jefferson and Teller on the east, Fremont and Chaffee on the south, and Chaffee, Lake and Summit on the west.

The history of this region practically begins with the year 1859. Soon after the reputed gold discoveries in Arapahoe county the placer beds at Tarryall attracted general attention. This excitement was followed by a chain of events similar to those of all the pioneer mining districts. It has been a constant producer, and although "lode" mining has at times been very active and paramount, the placer beds have been and are yet operated to a profit, and possess large reserves.

Within the county boundaries, and surrounded on all sides by hills or rugged mountains, one of the large plateaus of the mountain systems is located, viz., South park. From it

the county derives its name. This plateau or basin is comparatively level and has an average altitude of about 9,000 feet above sea level. It is about forty miles long by thirty miles wide, and has an area of 1,200 square miles in the park proper. On the east or northeast side the park extends to the west base of the Front range of the Rocky Mountain system, composed of the granite-gneiss complex common to that range. Along the south border of the park is a series of hills, with somewhat isolated peaks, attaining an altitude of 9,000 feet, composed largely of various eruptive rocks in the form of dikes, intrusive masses, and locally the late basalt lavas capping hill tops. On the west are the Trout Pass hills and the Mosquito mountain range, and on the north a transverse mountain section connecting the Mosquito and front ranges. The drainage may be said to be from all sides of it, toward the park center. the tributaries uniting with the North, Middle and South forks of the South Platte river. The geology of the Mosquito range, separating Chaffee and Lake from Park county, has been fully described by S. F. Emmons in the second annual report, and later at greater length in monograph XII, of the United States Geological Survey, to which reference is made. It appears advisable, however, to in this connection give a general outline of the geological history of this immediate section. In Paleozoic times the Colorado front range on the east and the Saguache range on the present west boundary of Lake county, formed a chain of islands, or two comparatively small and roughly parallel land strips in the almost universal seas. During long periods of succeeding times the eroded sediments were deposited, one above the other, until the "stratified rocks" amounted to from 10,000 to 12,000 feet in thickness. Without mention of some of the intervening minor strata, and naming only those best known, the Cambrian quartzite was first deposited upon the underlying granite-gneiss sea bottom. Above this, in order named, the Silnrian, magnesian or white limestone, parting quartzite, blue or Lower Carboniferous limestone, a series of shales, thin limestones and sandstones, the red beds of the Triassic, the highly-colored marks of the Jurassic, sandstones of the Dakota group, with fire clay beds intervening, limestone of the Colorado group, shales of the Montana group, sandstone, clays and coal of the Laramie group.

These strata were deposited in the order named, not between the Front range and the Mosquito range, but from the

Front or Pike's peak range to the Saguache range, now forming the west border of Lake county. The Mosquito range was not uplifted until after all the above strata had been deposited, nor until after a series of volcanic eruptions had occurred and the eruptive rocks found their way through the granite floor, and intruded masses and sheets through and between the overlying sedimentary beds. That the uplift which resulted in the Mosquito range occurred after these long continued and intermittent eruptions is shown by the folding and faulting of the eruptive rocks themselves, together with the enclosing stratified rocks. That the eruptions were intermittent is proven by the different kinds of eruptive rocks or porphyries of Leadville and Park county. This elementary abstract is made to comply to an oft-repeated request from miners of these sections and to show in the plainest way possible that the "Cambrian quartzite," "blue and white lime" and "white, gray and birdseye porphyries" of Leadville and of Park county must of necessity be one and the same.

Following the porphyry intrusions, the Mosquito range was uplifted, not by an applied force or pressure from below, but by pressure in the main from the sides, caused in part by the cooling of its interior. This range is one of the most rugged in the state and contains a number of peaks as high or higher than Pike's peak. The uplifting of such a great mass of stratified and injected igneous rock was necessarily accompanied by a vast amount of crumpling, folding and breaking into. The latter would also result in the independent movement of the broken sections along the line of fracture, and produce faults in the strata.

On the western slope are a series of faults that have let down the sedimentary rocks in successive steps. On the eastern slope these rocks have been carried in part to the mountain summits and have an easterly dip toward the park, which is overlaid mainly with Cretaceous rocks. Great planes of faulting occur on the South park side of this range, and locally the granite and gneiss, which forms the mountain core, is thereby exposed or in the gulches by erosion. A summarized section of the sedimentary strata of most importance to the miner, from Mr. Emmons' report, is as follows: Cambrian quartzite, 200 feet; Silurian limestone and quartzite, 200 feet; Lower Carboniferous limestone, 200 feet; Middle Carboniferous shales and grits, 2,500 feet; Upper Carboniferous grits and conglomerates, 1,500, making a total of 4,600 feet.

The original precious metal deposits in the Mosquito district were formed during the period intervening between the eruptive intrusions and the subsequent dynamic movements which uplifted the mountain range. The ores occur as replacements of the lime, in fissures or faulting planes, in the Cambrian quartzite, but are closely allied to some of the numerous dikes of varying types or intrusive porphyries in form of intrusive sheets or beds. In the granite areas the ores occur in fissure vein comparable to those of Clear Creek county. The ores are mainly silver-bearing sulphides in form of iron and copper pyrite, chalcopyrite and galena, the latter when oxidized yielding carbonate or sulphate of lead ores.

The history of this county reveals the fact that lode mining began as early as 1860, and that for some time previous to the discovery of the "carbonate" ores at Leadville, similar deposits had been operative in the Mosquito range. Later, operations in the Leadville district so far overshadowed this section that production, instead of showing a gradual increase, showed a decrease. From 1880 until within the past few years mining operations in Park county have, with but few exceptions, been conducted upon a comparatively small scale. The past two years have witnessed many progressive movements, involving development upon a larger scale, and the support of new organizations, with apparent financial ability to complete enterprises undertaken. Diamond-drill prospecting has been followed to considerable extent in search for ore bodies in the same geological horizon that have proven so productive in the Leadville district. The result of this work is not known, but, being succeeded by the accumulation of large tracts of territory, the presumption is that the discoveries made were satisfactory.

The deposits of placer gold, which first attracted attention to this district, are comparable, in the main, to those of other sections, being the usual beds and banks along the various streams. These have shown increased activity, and are yet sufficiently large for a number of years to come, owing in part to the limited water supply, except for a short period during the summer season. The water supply is dependent upon the snowfall during the winter months in the higher altitudes. The snowstorms, therefore, are welcomed by the

placer miner and deprecated by the lode miner. During the past summer, although the "season" was short and the water supply unusually small, the general "clean-ups" are reported as highly satisfactory, beyond which no information of a reliable character is obtainable. In addition to the placer gold deposits adjacent to streams, large tracts of territory have been somewhat recently taken up along the mountain flank, and ditches surveyed, etc., for their operation.

The county is locally divided into mining districts which have somewhat indefinite boundaries, but conform, in the main, to natural topographic divisions, or embrace the territory adjacent to a stream or town, viz., Tarryall, Beaver Creek, Consolidated Montgomery, Buckskin, Mosquito, Sacramento, Fairplay, Horseshoe, and others. Among the most active properties may be mentioned the following: The Cincinnati. Kansas & Colorado and Snowstorm placers, in the vicinity of Fairplay; the Rhodus, Safe Deposit, Beaver and Australia placers, on Beaver creek; the James G. Blaine, Red Cross Mining Company, Golden Era, Rollins-Phillips tunnel, Kentucky Belle lode mines and the Buckskin placer, in the Buckskin district; the Hill Top, Last Chance, Peerless Maud, Stormy Petrel and Hill Top, in the Horseshoe district; the Brownlow, Champaign, Fanny Barrett, Gray John, Good Samaritan, Gold Ore, Hock Hocking, Eclipse, London, Mascotte, New York, Oliver Twist, Ophir, Orphan Boy, Pensawkee, Sir James, Shelby and Taxlo Mining Company, in the Mosquito district; the Adrian, Creskill group, Silver Gem, Alma placer, Democrat group, Lee Goss, Ling, Neversink group, Russia, Telegraph and Viking, in the Consolidated Montgomery district; the Atlantic, Dorthula group, Gold Cord, Great West, Iron, Kansas, King Solomon, Link, Morning Star, Magnolia, Mineral Ranch, Oregon, Queen Elizabeth, Queen of Sheba, Smuggler, Stanley, Silver Heels company, Winona, Whale and Yellowstone, in the Tarrvall district.

In the south and southeast part of county there has been considerable prospect and development work done. So far, work has been on a comparatively small scale, and with a view of exploiting, rather than production. This section is divided into mining districts known locally as the Russia, Conrad, O'Brien, Freshwater, Black Mountain, Red Ruth, Cover Mountain, Alhambra and Hartzel districts. In all of these there are a number of prospects of more or less promise.

The transportation facilities of this county are comparatively good. The Colorado & Southern Railway follows up the South Platte river from Denver to the junction of North Fork, and thence along this stream through north part of county to Grant, thence in a southerly course, via Jefferson. Como and Garo, across Trout Creek pass, into Chaffee county. At Como a branch line extends northwest across Boreas pass to Breckenridge and Dillon, in Summit county. From Garo a branch line extends to Fairplay, the county seat, and thence to Alma. A branch from Alma reaches London mine, and a branch from Fairplay extends to the Hill Top mine. The south-central portion of the county is traversed from east to west by the main track of the Colorado Midland Railway, between Denver, Leadville, Aspen and Grand Junction. It enters the county from the east border and passes out over Trout Creek pass, via Lake George, Lidderdale, Idlewild, Spinney, Hartzel and Hill Top.

There are a number of mineral springs in the county that are more or less improved and utilized. The only one that is improved sufficient to be termed a resort is at Hartzel, which, from additional improvements, appears to be growing in public favor. Here there are five springs, with an average temperature of 105 degrees Fahrenheit. The following analysis of this water is by Mr. Geo. E. Patrick:

Constituents.

Sodium carbonate	
Calcium carbonate	
Magnesium carbonate 11.09	
Sodium sulphate	
Sodium chloride	
Potassium chloride	
Silica	
Alumina 0.65	
Sulphur	
Total parts in 100 000	370.40

The park area, in addition to the coal and clay deposits which are at present utilized to a very limited extent, is now being exploited for oil. A number of companies have been organized, and, having the same geological horizons that have

proven productive at Florence, together with other features supposed to be favorable, are confident of the success of their enterprises.

PITKIN COUNTY.

Pitkin county occupies a central position on the Pacific Slope, was organized in 1881, and has an area of 950 square miles. The adjoining counties are Garfield and Eagle on the north, Lake on the east, Gunnison on the south, and Gunnison and Mesa on the west.

The topography of this county is, taken as a whole, diversified. On the east is the Continental divide of the Saguache range, separating Pitkin and Lake counties, and the south and west sections embrace in part the Elk mountains. Both of these ranges contain noted landmarks, such as Mt. Massive on the east, 14,424 feet, and Castle peak, 14,115 feet, and Maroon mountain, 14,008 feet above sea level, on the south. The general drainage is toward the northwest through the Roaring Fork, one of the main tributaries of Grand river. The main tributaries of Roaring Fork are Frving Pan, Hunter, Woody, Lincoln, Difficult, Castle, Maroon, Sopris, Avalanche and Rock creeks. These with their numerous small feeders receive the waters from drainage basins near the mountain divides at a varying altitude of 10,000 to 13,000 feet, and eventually unite and pass out through the Roaring Fork valley at an altitude of about 6,600 feet.

The geology of this district has received the careful consideration of the United States Geological Survey, the result of which has been published in monograph XXXI, to which reference is made for detail. Mr. J. E. Spurr, in an outline of the monograph, gives the following:

"The fundamental rock in the Aspen district is a granite, with occasional gneissic structure. Above this come successively the sedimentary beds of the Cambrian, Silurian, Devonian, Carboniferous, Jura-Trias and Cretaceous. The beds of the Cambrian, Silurian and Devonian are comparatively thin, while the Carboniferous, which is divided into three distinct formations—the Leadville, the Weber and the Maroon—attains a great thickness. The Jura-Trias and the Cretaceous are also very thick, the latter containing the various subdivisions of the Dakota, the Colorado, the Montana and the Laramie. Separating these different beds at intervals are various unconformities and planes of erosion, which help one to read the history of the rock and to understand the conditions under which the beds were laid down.

"Into these sedimentary rocks were intruded, probably in Cretaceous time, rocks of igneous origin. These are of two distinct types—one a diorite-porphyry and the other a quartz-porphyry. Both occur as sheets nearly parallel to the bedding of the sedimentaries, and as occasional cross-cutting dikes. The diorite-porphyry occurs chiefly as a single sheet, which widens toward the south and ultimately runs into the main diorite mass of the Elk mountains. The quartz-porphyry, on the other hand, has probably ascended along narrow channels in the immediate vicinity of Aspen, and the structure of this rock shows it to belong to a type which characterizes the Mosquito range, on the east side of the Sawatch, rather than the Elk mountain district.

"Subsequent to the deposition of the Laramie and the intrusion of these eruptive rocks, physical disturbance began. Among the first changes was the elevation of the Sawatch range, so that the beds which lay around its flanks assumed a general dip away from the main uplift. At about the same time occurred some minor folding, which was apparently due to a lateral thrust exerted from the westward, and in the Aspen district was most pronounced in a narrow zone. Here an overthrown anticline was formed, which culminated in a great break, called the Castle Creek fault. Probably beginning at the same period, but continuing afterwards, was the development of a dome-like uplift, which affected both granite and sedimentary rocks in a restricted region east of the Castle Creek fault, now occupied by Aspen mountain and Tourtelotte park. This uplift was marked on the north side by a sharp bending-up of the strata. while on the west side the movement took place along the previously formed Castle Creek fault; on the other side the extent of the uplift can not be accurately judged, on account of its running into the granite. The bending-up of the beds was accompanied by faulting, which has gone on continuously from that time to the present day. At the beginning few faults were developed, but these appear to have had an important throw. As erosion progressively removed the overlying load of strata, the faults became more numerous and complicated, but the amount of throw ln each case grew less A number of distinct fault systems have been identified. differing chiefly in point of age. This difference in age is shown by the faulting of one system by a later system, and also by the fact that certain faults have developed before and certain others after the ore deposition. It is also shown that some faults have developed almost entirely in post-Glaclal time, and that in many cases the fault movement is going on at the present day.

"Along the channels afforded by faults hot-spring waters rose and brought about certain chemical changes. One of the most interesting of these is dolomization, and the combined evidence at Aspen and at Glenwood Springs, where the change is now being brought about by hot as-

cending waters, shows that the process is essentially a chemical interchange effected between the calcium carbonate in the limestone and carbonate of magnesia brought in by these circulating waters. Thus zones in the limestone following water courses which are parallel to the bedding or which cut across it are locally altered to dolomite. There is, however, evidence of an earlier period of dolomization, which preceded the faulting and probably came about very early in the history of the rocks. Thus the Silurian sediments and those of the lower part of the Leadville formation were early converted into dolomite, probably by the action of magnesium salts contained in the waters of a shallow and evaporating sea.

"Associated with the formation of the dolomite along fault fractures and water courses is the deposition of silica and of iron, and both these processes must be referred to the same caues as the dolomization.

"The ores of the district consist chiefly of lead and zinc sulphides, carrying silver, with a gangue of barite, quartz and dolomite. On oxidation the sulphides change to sulphates, carbonates and oxides. The deposition of the metallic minerals has taken place almost exclusively along the faults, but it is only in certain places that the fault zones become sufficiently mineralized to form valuable ore, for it is chiefly at the intersection of two or more faults that rich shoots are found. The intimate association of the metallic sulphides with dolomite, quartz and other gangue materials suggests a common origin for all—that they were deposited by ascending hot waters. Since the ore has been found chiefly at the intersection of faults, the theory is advanced that solutions ascending along one of these channels were precipitated by solutions which circulated along the other.

"Among the more recent chemical changes in the rocks, mainly subsequent to the ore deposition and its attendant phenomena, is the formation of sulphates. Thus a considerable quantity of gypsum has been locally precipitated, and soluble sulphates occur as incrustation on rocks which have been exposed to oxidizing influences. By a process of reduction there has also been locally formed a large amount of native silver.

"The ore deposits have been laid open to the hand of man chiefly by erosion, which has stripped off the overlying rocks and has carved deep valleys through the metalliferous deposits. It is estimated that since the beginning of disturbance 15,000 feet of sediments have been removed from that part of the Aspen district which lies east of the Castle Creek fault. The most recent of the erosive processes was glaciation. There is evidence that a general ice sheet at one time covered the whole of the Aspen district, moving over hill and valley westward from the Sawatch. This has left its trace in the rounded and fluted forms into which the hilltops are carved, and in deposits of morainal material, generally finely ground. Subsequently this ice sheet shrank to smaller dimensions, so that there resulted local glaciers which followed the course of pre-existing valleys and carved them into their present forms. These glaciers have left lateral and terminal moraines. At about this period, also, there existed in the Aspen valley temporary lakes, probably resulting from damming up of the glacial waters."

The mining history of this section practically begins with 1879. Prior to this the district had been passed over casually a number of times by prospectors, without any discoveries of importance being made. In the Leadville district the scramble for territory, and large operations started, caused the numerous prospectors who had gathered there to look for new fields. In common with Eagle and Summit connties, the Continental divide was crossed and the territory now embraced by Pitkin county was carefully prospected. That the experience and knowledge gained by the prospectors during their sojourn in the Leadville district was well utilized is demonstrated by the fact that during 1879 nearly all of the mining claims were located that have since made Aspen and surroundings prominent in the mining world. The general conditions connected with ore deposition in Leadville and Aspen are largely comparable, and although the most active centers in Pitkin county were first in the vicinity of Ashcroft, Aspen mountain, and later Aspen, were made prominent as early as 1883-4. Owing to inaccessibility to market, production was restricted until the fall of 1887, at which time the Deuver & Rio Grande Railroad reached Aspen. The stimulus given mining by the advent of rail transportation was added to by the completion of the Colorado Midland Railroad to Aspen early the following spring. Production, which prior to this had been subjected to a freight charge of \$50 to \$100 per ton, could then be moved for \$10 to \$15 per ton. The result was a largely increased tonnage and a realized profit from ores that were valueless prior to the advent of railroads. Operations were in a short time conducted on a large scale, and the developed conditions of ore deposition were productive of litigation of like large proportions. The value of the ore product was almost wholly in silver, and the decline in market price of that metal in 1893 aided in restricting production. By this time the mines had attained greater depths, encountered heavy flows of water, and operating expenses had so increased that the raw ore could not, as a whole, be marketed at a profit. Mills were therefore erected and the values concentrated into smaller tonnage. The recent low market price of silver will doubtless again materially restrict production in the strictly silver producing sections, provided it remain at present price for any considerable period of time.

The silver ores of the Aspen district are as a whole very low grade. High grade silver ores, which at first attracted general attention to this section, are still encountered, but are not of frequent enough occurrence to make operation for these alone profitable. The success attained in the milling of the low grade ores is second to that of no other section in the state and could be advantageously followed by various districts where existing conditions are even more favorable than at Aspen. The mine equipments, method of timbering, and general mining methods in vogue are all good and evidence the skill of the mining engineers directing operations. In applied electricity this section claims to be the pioneer. The mountain streams near Aspen afford good, available water power and it has been and is largely utilized for generating electric energy, which is transmitted to a number of the mines and mills.

This, like other mining counties, is somewhat indefinitely divided into local mining districts, viz., the Roaring Forks, including the territory adjacent to Aspen; Highland, south of Aspen; Columbia, south and east of Highland; Independence, southeast of Aspen and adjacent to Independence; Lincoln, south and east of Independence; Woody, north of Aspen; Dry Pine, north of Woody; Frying Pan, north and east of Woody.

While the main value of ores produced in Pitkin is in silver, the eastern portion of the county gives fair promise of developing some permanent gold producers. This section and other outlying districts have received more attention during the past few years than for many preceding. The present market price of silver has a demoralizing effect on the large silver producing districts, but will serve in a measure to stimulate the development of the gold bearing deposits. These ores may prove, as a whole, to be low grade and not permit of transportation to market direct without dressing, either by concentration or some other method. The results obtainable by concentration have, however, been fully demonstrated in the mills at Aspen, and the auriferous and copper bearing ores with less zinc and heavy spar present will doubtless prove comparatively easy propositions to demonstrate. That these outlying districts have not received more consideration in the past is due to the great producers near Aspen. which have absorbed general attention. The same conditions exist in the Leadville district on the east side of the range, and if reports received from operators on both slopes of the Saguache mountains may be credited, some very satisfactory results may be confidently expected in the near future.

A large proportion of the ores mined in the county are marketed through the Taylor & Brunton and the Aspen Sampling Company's sampling works. The Smuggler Company is operating what is locally called a "lead concentrator" and zinc concentrator, having a combined daily capacity of 500 tons. The Argentum-Juniata and Hunter Creek Milling Company are also operating modern concentration plants.

The largest operative companies in the vicinity of Aspen are the Smuggler, Percy, La Salle, Newman Tunnel, Aspen, Argentum-Juniata, Della S. and Johnson, Park Regent, Mineral Farm, Bushwhacker, Durant, Spar, Millinee, Monongahela and Bonny Bell. The properties in the vicinity of Tourtelotte park are mainly operated by lessees and upon a comparatively small scale, among which are the San Jacinto, Keystone, Bay State, Iowa Chief, Castle, Mayflower, Houston, Highland Light, Edeson, Lottie and Good Thunder. In the southeast part of the county, from twenty to twenty-five miles from Aspen, there has been considerable activity. The Lincoln gulch and Hunters' pass sections have been quite actively prospected. The Morning Sun and Three Friends groups marketed a small product. The Ruby, Mammoth and Highland groups are under lease. The lessee says: "We are so far from railroad we never try to ship ore that runs less than \$100 per ton." Among other properties in this section that have been operative are the Mascott, Lizzie K., Isabella and Golden Zone. This section has not as yet been granted a wagon road. In the vicinity of Ashcroft the Montezuma mine is operating with fair force of men under lease, and prospectors have been quite active around Castle Peak and Pearl Pass sections. In the Woody district, six miles north of Aspen, the Woody Creek Mining Company has been the principal operator, beyond annual assessment work. On Porphyry mountain, fifteen miles north of Aspen, there has been considerable prospect work, the principal properties being the Genesce, Branch group. In the Frying Pan district the May Queen Company, near Meredith, has made small production and other properties have been given annual assessment work. The lime quarries near Meredith and Thomas-

ville have maintained good production for fluxing purposes at the smelting plants at Leadville. In the Highland district, south of Aspen, the most active properties have been the Little Annie, Midnight, Winnie and Porphyry Bell.

In the west end of the county there are large coal reserves. The coal is of good quality and a large tract of coal land is fairly accessible. During the past year the State Coal Mine Inspector reports three mines operated, and 413,-090 tons of coal produced.

The precious metal production of Pitkin county for 1897-1901, inclusive, is as follows:

Year.	Gold.		Silver.			Lead.		С	opper	.	Total.	
1897	\$ 164,429	85	\$2,743,867	79	\$	150,628	96	\$	877	80	\$3,059,804 4	10
1898	71,001	45	2,316,759	78		577,303	66		546	36	2,965,611 2	25
1899	52,233	09	2,477,758	23	1,	137,989	59		3,407	71	3,671,388 (32
1900	13,456	17	2,529,549	14	1,	298,491	90		1,004	75	3,842,501 9	96
1901	4,692	09	2,082,622	74	1,	419,363	81		8,407	62	3,515,086 2	26

PUEBLO COUNTY.

Pueblo occupies a south-central position in the state, and embraces an area of about 2,500 square miles. It lies almost wholly upon the Great Plains country, and is drained by the Arkansas river and its tributaries. The adjoining counties are El Paso on the north, Otero on the east, Las Animas and Huerfano on the south, and Custer and Fremont on the west.

This section, while never prominent as a producer of precious metals, and not likely to be in future, possesses many advantages that have caused it to be an important factor in the development of the commonwealth. Pueblo, the county seat, and one of the leading commercial centers of the state, is located on the banks of the Arkansas river, near a point where Fountain creek joins it. This point is a natural distributive center, from which all roads leading to the various sections diverge. In early days the lower, or Arkansas, river route, became very popular with the immigrants, who naturally concentrated more or less at the point where Pueblo now stands. The genial climate and natural advantages for pursuit of stock-growing and agriculture caused many to abandon their proposed journeyings further and to remain in that vicinity. Those inclined to indulge in barter or mercantile pursuits also recognized the advantages of a natural center, and the result was an early establishment and quick growth of one of the leading commercial points in the state. This position it has ever maintained, and, with the development of other sections, its advantageous location and abundant resources for manufacturing were appreciated and have been utilized. At the present time it is often spoken of as the "Pittsburg of the West."

Among the most important manufacturing establishments are the Colorado Smelting Company, the Philadelphia Smelting and Refining Company and the Pueblo Smelting Company. These plants have a combined daily capacity of about 2,000 tons, and are thoroughly equipped with all modern appliances. Through the development of these and other plants in the state, Colorado metallurgists have obtained an enviable position in the metallurgical world, and those in control are now recognized and accepted as authority on methods for reduction of complex precious metal ores.

The most important manufacturing establishment, not only of Pueblo, but of the West, is that of the Colorado Fuel and Iron Company. This company is the result of a consolidation, made in 1892, of the properties and equities of the Colorado Coal and Iron Company and the Colorado Fuel Company. Its growth and development has since been so quietly and ably conducted that its present magnitude and great importance to the state have been little appreciated. During the present year the controversy between interested parties, or stockholders, for control, not only attracted the attention of the residents of Colorado, but of the whole country, and resulted in one of the most fierce financial battles in the history of Wall street. Prior to this struggle and attendant notoriety through the press, the Colorado Fuel and Iron Company was generally regarded as a comparatively small institution, owned and officered by a few well-to-do Colorado men. A company that produced a little steel and iron, operated a few coal mines and manufactured a little coke for the lead smelters. This, notwithstanding the published annual reports of production, iron and coal mines operating and great number of men employed. During the contest general interest increased with a better knowledge of the magnitude of the company's operations. This interest was intensified by a growing belief that the success of the so-called Steel Trust

to absorb the Colorado Fuel and Iron Company would be contra to the best interests of Colorado. Be that as it may, the Colorado Fuel and Iron Company still remains the only important iron and steel producer that is independent and may successfully compete in the open market with the large combined plants of the East. The achievement of this result. by Mr. J. C. Osgood, and the retaining control of the management as against the desires of the financial magnates of the country, has seldom, if ever, been equaled, and his success was accorded praise generally throughout the state. The financial ability of Mr. Osgood has been tested before in a minor degree, but without notoriety. The development of a plant comparable to that of the Colorado Fuel and Iron Company of to-day is not the work of a day, and periods of depression are always encountered. The present status is not only the result of ability and enterprise, but also that of good judgment in choice of trusted representatives and the power to organize the various operative departments into a symmetrical whole to which each department lends a loval support. To those conversant with the operations of this company the ability and lovalty of its various officers from J. A. Kebler and A. C. Cass to the foot of the line are very marked. The company operates the following properties in Colorado: The iron mines at Orient, in Saguache county; four coal mines in Fremont county, three coal mines in Gunnison county, one coal mine in Garfield county, five coal mines in Huerfano county, seven coal mines in Las Animas county, and two in Pitkin county. This company also operated 2,250 coke ovens in the state during the past year, producing 697,698 tons of coke, and in Pitkin and Garfield counties, twenty miles of standard and twelve miles of narrow gauge railroad. connecting with the Rio Grande system at Carbondale. Coal and iron mines are likewise operated in New Mexico and Wyoming.

The production for 1902 is as follows (last two months of 1902 estimated):

	Pounds.
Pig iron	481,804,934
Spiegel	17,522,599
Steel rails	312,406,486
Merchant iron and steel	129,442,317
Castings	27,547,711
Iron pipe	19,477,687
Spikes, bolts and nuts	25, 222, 335
Iron ore1	,029,124,800

A large part of the spiegeleisen is manufactured from the manganese ores produced at Leadville. This ore is comparatively free from phosphorus and other undesirable elements, and is the only required factor for steel manufacture not owned and operated by the company. The limestone is quarried from the beds at San Carlos, several miles south of the works. These quarries furnish employment to about one hundred men.

The total pay-roll shows the employment of 50,087 men, and the annual disbursement for salaries alone aggregates \$8,780,400 annually.

Near the plant at Pueblo one of the best equipped and thoroughly modern hospitals in the West is maintained by the company and officered by surgeons and physicians of high repute. Under the recently established Domestic Science Department, a corps of efficient teachers is sent into the different camps to establish kindergartens for the children and teach advanced methods of cooking, sewing, etc. At Redstone, in Garfield county, one of the best appointed club houses in the state affords comfort and opportunity for intellectual advancement to the employes. In short, the welfare of employes is receiving careful consideration, and while these superior advantages are not common to all properties controlled and operated, they are being gradually extended.

The precious metal mines of this county are restricted to the southwest portion, where the granite and gneiss of the lower slopes of the Wet mountains are exposed. Reported rich strikes from this section recur annually, but so far have resulted only in a small amount of prospect work.

A number of quarries have been opened at various places. The principal product is limestone for flux and quicklime. Sandstones suitable for structural purposes are quarried to supply local demand. The Dakota sandstone exists in large exposures and is comparable to the same stone used largely in other sections. Other sandstones of later age have been produced to some extent, but they have not, as a rule, proven satisfactory where any considerable weight is to be sustained.

The fire clay beds that occur in the Dakota sandstones have been little developed, but are doubtless as good as those in Fremont county, which are drawn upon for manufacture of a number of refractory products by the Standard company at Pueblo.

The existence of oil is being exploited south of Pueblo, but no satisfactory results have been yet attained. The marble quarries at Beulah have been mainly inoperative during the past year.

The most noted mineral springs are the Parnassus springs, near Beulah; Clark's magnetic springs, at Pueblo, utilized as a bathing resort; Carlisle spring, near Beaver creek; artesian well at steel works; Mineral Park artesian well, half a mile above Pueblo; Salt Creek springs, Salt creek, and "Stinking Springs," two miles from Salt creek. The following analyses are by Mr. Oscar Loew:

PARNASSUS SPRINGS.

Number of springs, 5; temperature, 59 degrees to 71 degrees Fahrenheit.

Constituents.	No. 1.	No. 2.	No. 5.
Sodium carbonate	126.04	118.45	73.32
Calcium carbonate)	=1 00	54.54	46.91
Magnesium carbonate	71.00	22.43	17.03
Lithium carbonate	Trace	1.78	0.15
Iron carbonate	1 54	2.23	2.75
Sodium sulphate	8.78	3.98	3.28
Potassium sulphate	9.22	18.44	14.54
Sodium chloride	102.96	104.13	53 .23
Silica	4.21	7.94	6.00
Organic matter	Trace	Trace	Trace
Sulphuretted hydrogen	· · · · · ·	• • • • • • •	'Trace
Carbonic acidIn e	xcess	In excess	In excess
Total parts in 100,000	323.75	333.92	217.21

CARLISLE SPRINGS.

Temperature, 65 d grees Fahrenheit.

-						
8 44	ma	2 2 3	11.1	1260	23.	10
00		5 L I		ue	11	1.0.

Sodium carbonate	15.42
Calcium carbonate	38.40
Magnesium carbonate	19.52
Iron carbonate	0.51
Sodium sulphate	34.28
Potassium sulphate	1.20
Sodium chloride	19.30
Silica	Trace
Organic matter	Trace

RIO BLANCO.

128.63

Rio Blanco is one of the northwest border counties, with an area of 3,600 square miles. It was organized in the spring of 1889, being segregated from Garfield county. The adjoining counties are Routt on the north and east, and Garfield on the south. The state of Utah forms the western boundary. The drainage is through the White river, which flows in a general westward course through the north part of the county. The main tributaries are Marvine, Big Beaver, North Elk, Miller, Curtis, Sulphur, Flag, Strawberry, Piceance, Yellow and Douglass creeks.

The principal industry of this section is stock-growing, supplemented by agriculture. Its remoteness from market restricts the agricultural products to that required for local consumption and feed for stock, which are permitted to roam at large over the hills and mesas during the summer months. The valley lands are somewhat limited in extent, and are generally flanked by rather steep hills rising several hundred feet on either side. At intervals the valley widens into parks that bear local names. Gradually the mesa lands are coming under cultivation by the construction of expensive canals. White river is one of the large and rapid streams of the state, and its great fall makes it possible to conduct the water from the stream bed to the adjoining plateaus. The embraced territory is practically that included within the drainage basins formed by the Yampa plateau, Danforth hills and Williams River mountains on the north and east, and the White River plateau, Book cliffs and Roan or Book plateau on the south. The White River valley rises from an altitude of 5,000 feet at the western boundary of the county to 9,000 feet near the eastern limit. The mountain peaks in the eastern part vary from 10,000 to 12,500 feet, and the plateaus on the north and south from 8,000 to 9,500 feet above sea level.

Meeker is the county seat and main commercial center, and is located on White river, near the lower or west end of Agency park. This park was the government agency in control of the Ute Indians for a number of years, and the early history is replete with incidents of murder and rapine. At intervals along the river are small settlements, connected by a good wagon road. The upper part of the valley is the recognized hunter's and fisherman's paradise, and the annual revenue received by residents from those seeking recreation is by no means small in the aggregate. This section is reached via the Denver & Rio Grande Railroad to Rifle, from which a daily coach runs to Meeker. At this point good accommodations are ample, and means of conveyance may be procured to any desired section.

The uplifted and subsequently eroded sections disclose the sedimentary rocks from the Silurian to the Tertiary, inclusive, the younger rocks predominating. The main mineral resource is that of extensive coal measures. These are comparable to the measures of Routt county, the anthracite area excepted. Through a large portion of the county, each consumer has his own coal mine, which may be drawn upon *ad libitum*.

The precious metal mines of Rio Blanco county are in the prospective stage. A number of prospects are worked annually in a desultory manner for silver-lead ores, and a few placer beds for gold. The production, however, has not as yet been sufficient to credit to the county. Oil springs, asphaltum and allied hydro-carbons are reported as existing in the west part of the county, but these reports have not been verified by actual inspection.

This section is one of the few counties of the state without-a railroad. Several roads have been projected, but have not as yet proceeded beyond that of lines of survey. What is generally called the new "Moffat road," construction of which has started, and will extend from Denver through Grand into Routt county, is confidently expected by the residents of Rio Blanco to pass through or reach Meeker, via a branch line. The result is marked activity in the securing of large holdings of valuable coal, oil and timber lands.

RIO GRANDE.

Rio Grande county was first organized in 1874, but the boundaries at that time established have since been materially changed. It occupies a south-central position in the state, and as now constituted embraces an area of about 900 square miles. The adjoining counties are Saguache on the north, Costilla and Conejos on the east, Conejos on the south, and Mineral on the west.

The west portion of the county embraces the eastern slope of the San Juan mountains and adjoining spurs, which are composed, in main, of volcanic debris and lavas common to the "San Juan region." These mountains attain, in a number of peaks, an altitude of 11,000 to nearly 14,000 feet above sea level; the most prominent landmarks being known as Del Norte, Belleview, South and Cornwall mountains. The eastern and major portion of the county embraces the flanking foothills and mesas and the western limit of the San Luis valley, which here has an average altitude of about 7,700 feet. The Rio Grande river passes easterly through the northern portion of the county, and with tributaries affords draimage. The principal tributaries from the south are Park, Abiti, Wolf, Los Pinos, San Francisco and Alamosa; from the north, Beaver, Bear and Embargo creeks.

Del Norte is the county seat and one of the leading commercial centers. Monte Vista, the next town in importance. Both of these places are located in the valley of Rio Grande river, and reached by a branch of the Denver & Rio Grande railroad, which extends from Alamosa to Creede. The principal mining centers are Summitville and Jasper, on the Rio Alamosa and near the sonthwest portion of the county. These camps are tributary to Del Norte and Monte Vista, with which they are connected with good mountain roads, the best road

to Jasper being via Monte Vista, and to Summitville via Del Norte. The county is divided into mining districts by somewhat indefinite lines, locally known as Summit, Jasper or Decatur, Meyer's creek, Summer, Coon, Elwood and Cat creek.

The mining history of this section practically begins with the year 1870. The reported gold discoveries of that year resulted in a rush to that section in 1871. Introduction of mills followed during 1874-75. In 1883 this district gained the distinction of being the third largest gold producer in the state. Nine amalgamation mills, aggregating 155 stamps, were at that time actively operated. The percentage of value saved by the mills was low, even from the highly oxidized or surface ores. As depth was gained the prevalence of base metals made milling unprofitable, and in 1893 the district was practically deserted. During the past few years there has been a gradual return to former activity. Not in search of the phenomenal pockets of "free gold ores," but through the application of advanced methods in metallurgy to recover the values from the large low grade deposits. This has been particularly true of the sections adjacent to and between Jasper and Summitville. The mines in the vicinity of Summitville that caused the first general excitement, when visited some years ago, failed to show any well defined ore veins. The ore values appeared to be more or less concentrated at the different horizons being worked, but there was little or no difference between the so-called "country-rock" and the "vein." A more recent visit to the section immediately north of the Alamosa river at Jasper confirms this view, though neither investigation was sufficiently thorough to permit of unqualified statements. The formation in which the ore values occur, gold predominating, is volcanic debris containing silicious concretions in a highly altered mass, the latter being locally reduced almost to a paste. Whether or not the entire mass is impregnated is not known; but at the numerous openings visited it showed varying quantities of pyrite, which doubtless is gold bearing and its oxidation has, near surface. left the gold in free form. In the quartz or quartzose portions, the gold is often visible in form of small grains or stringers, and occasionally is concentrated in a high degree. That this vast deposit is gold bearing there is no doubt, and that values will be found sufficiently concentrated along certain horizons to have commercial merit will in all probability be demonstrated by systematic exploitation. It is one of

the important developments now receiving careful consideration.

Near Jasper the Sanger Mining and Milling Company has erected a 100-ton modified cyanide mill. This company owns a group of claims, and the mill is the result of a number of tests made during the past two years. A partial run was made during the summer, but owing to necessary mechanical changes, was of short duration. The success of the enterprise is not fully determined, although the management claim there is no doubt as to the success of the mill or of values in ore sufficient to prove remunerative.

The Sadie I. Mining and Milling Company has also erected a tifteen-ton testing plant and adopted the Gage process. The trial run of this plant was also deterred by breakages. The management claim the results sufficient to demonstrate a saving of \$8.00 per ton, and to justify the erection of a 100-ton plant. This company owns a large group of claims. Another group of eighty claims has been undergoing patent proceedings, and the ores a series of experimental tests to determine best method of treatment. Machinery and lumber for a large plant are in part already on the ground.

On Prospect mountain, The Summitville Belt Mining and Milling Company has driven tunnel 600 feet, and contemplates the erection of a milling plant. At Summitville, on Old South mountain, a large group of properties, including the well-known Annie, Golconda and Iowa claims, that first attracted attention to this section by "free gold" production, has been undergoing systematic development for the past two years. The development work aggregates several thousand feet, and a milling plant is in transit and will probably be operating early in the coming season.

During the past season the southwest part of Rio Grande, the southeast portion of Mineral, the northeast of Archuleta and northwest of Conejos counties have been actively prospected and many locations made. Fabulous finds are reported, but it is doubtful if any systematic development or regular production will precede the established success of the milling plants before mentioned. The character of the mining men back of some of these enterprises largely eliminates donbt as to results, and lends credence to the belief that Rio Grande county will again take a prominent position among the other precious metal producers. All of the old fissure vein claims south of the river and in

adjoining districts, not patented, have been granted annual assessment work or relocation. These ores carry gold, but a higher percentage of silver, and are mainly iron and copper pyrites and chalcopyrite in a quartz gangue, and in the main well adapted to concentration. Ores of high values occur in limited quantities, but the main bodies must have values in concentrated form to permit of transportation a distance of thirty-five miles to present nearest railroad point.

ROUTT COUNTY.

This subdivision was organized in 1877, and embraces an area of about 7,300 square miles in the extreme northwest portion of the state. It was named in honor of Governor John L. Routt. The adjoining counties are Larimer and Grand on the east, and Eagle and Rio Blanco on the south. The state of Utah forms the west and state of Wyoming the north boundary. The embraced area may be briefly described as a strip of territory 120 miles long east and west by sixty miles wide north and south, including the L-shaped adjunct of the southeast corner. It lies wholly on the Pacific Slope and includes the major portion of the plateau between the Wasatch mountains on the west, and the Park mountains on the east. The crest of the latter range forming the dividing line between Routt and Larimer counties. The rock exposures now afforded by folds, local uplifts, eruptive intrusions and subsequent erosion, disclose almost a complete geological record from the Archaen to the Quaternary.

Near the northeast corner of the county the eruptive mountain group called the Elk Head mountains is the most prominent uplift. This group contains a number of culminating points that reach an altitude of nearly 11,000 feet, the most prominent and perhaps best known being Hahn's and Anita peaks. Both of these are very prominent landmarks, the latter being generally called the "Bear's Ears," on account of its peculiar formation. Along the south part of the county the Williams River mountains, Danforth hills and Yampa plateau, are elevated portions varying in altitude from 8,000 to nearly 10,000 feet. The main drainage is through the Yampa or Bear river, which flows in a general westward course through the center of the county and is joined by numerous tributaries from north and south. The main streams from the north are Elk, Elk Head, Fortification and Little Snake; from the south, Williams river and Milk creek.

Steamboat Springs is the leading commercial center of the county. It is located in a comparatively broad and level section of the Yampa River valley, at an altitude of 6,780 feet above sea level. The Yampa is a beautiful stream and flows along the south part of the town. The name Steamboat Springs is derived from one of the numerous mineral springs that adjoin the town. One of these would intermittently liberate the accumulated gases and water with a short series of explosions, producing a sound not unlike that of the steam exhaust of a steamship. This feature of the spring has been somewhat recently destroyed by officious tampering, such as dropping rocks in the throat or aperture to hasten the explosive outbursts.

The great variety of mineral waters in this immediate section in conjunction with the genial climate and scenic surroundings are alone sufficient to make this point a great sanitarium. There are 150 or more mineral springs, all of which differ more or less in amount of solids held in suspension and accompanying gases. Space will permit mention of but a few. The analyses given were made by Mr. Regis Chauvenet at the State School of Mines. One of the most popular is known as the Pavilion spring, and is the only one walled up and covered with a building. It is highly charged with carbonic-acid gas and is a fine effervescent, sparkling water for table use:

Analy, is,	Temperature, 58 degrees Fahrenheit.
Chlorlde of sodlum	
Chloride of magnesia	20.42 parts in 100,000
Chloride of potassium	9.16 parts in 100,000
Bicarbonate of soda	
Blearbonite of lime	
Blearbonate of Iron	0.50 parts in 100,000
Silles	2.88 parts in 100,000
Total solids	

What is known as the Heron spring is also a sparkling water, but somewhat warmer than the Pavilion:

Analysis.	Temperature, 74 degrees Fahrenheit	
Chloride of sodium	7.59 grains in one pin	t
Carbonate of iron	2.79 grains in one pin	t
Sulphate of lime	5.23 grains in one pin	t
Sulphate of magnesia	2.97 grains in one pin	t
Sulphate of soda	2.84 grains in one pin	t
Sulphate of potassa	0.81 grains in one pin	t
Silicic acid	0.51 grains in one pint	t
Phosphoric acid	Trace	
Hydro-sulphuric acid gas	0.05 cubic inches	
Carbonic acid gas		t
	Enderstand sectors	
Total solids	22.74 grains in one pint	t

The Purple spring derives its name from the peculiar and variable color. This water is popular by reason of local reputation of effect upon the skin when used for bathing. It is said to be superior to any artificial sulphur bath, and to quickly restore a harsh, dry skin to a normal state. The water is also said to have most pronounced medicinal properties:

Analysis.	Temperature, 77 degrees Fahrenheit.
Sulphate of lime	
Sulphate of potassa	
Sulphate of soda	
Chloride of sodium	
Chloride of magnesium	13.06 parts in 100,000
Bicarbonate of soda	
Bicarbonate of iron	0.76 parts in 100,000
Bicarbonate of manganese	0.35 parts in 100,000
Total solids	

The Steamboat spring before mentioned is a highly charged alkaline-saline water:

Analysis.		Cemperature,	80 de	grees I	ahren	heit.
Chloride of	sodium		14.62	grains	in one	pint
Sulphate of	potassa		0.61	grains	in one	pint
Sulphate of	magnesia		0.85	grains	in o n e	pint
Sulphate of	lime		1.57	grains	in o ne	pint
Carbonate o	f soda		5.48	grains	in one	pint
Phosphoric a	acid	Тı	ace			
Silicic acid .		Tı	race			
Iron oxide .		Tı	race			
Total s	olids		23.13	grains	in one	pint
Hydro-sulph	uric acid gas		0.14 c	eubic in	ches	
Carbonic aci	d gas		0.90 0	eubic in	ches	

The Bubbling spring is well named. It occupies at present a round pool about ten feet in diameter and two or three feet deep. Its surface is in constant ebullition and is comparable in appearance to a boiling seething cauldron. Among the escaping gases that of sulphuretted hydrogen is very pronounced. While not improved, a small box building has been erected over the outlet and the water is utilized largely for bathing by those affected with rheumatism and other diseases.

Analysis.	Temperature, 75	degre	es Fal	iren <mark>heit</mark> .
Sulphate of	lime	. 49.81	parts	in 10 0,000
Sulphate of	potassa	. 27.30	parts	in 100,000
Sulphate of	soda	. 16.11	parts	in 100, 000
Chloride of	magnesia	. 14.50	parts	in 100,000
Chloride of	sodium	. 193.13	parts	in 100,000
Blearbonate	80da	.423.41	parts	in 100,000
Blearbonate	iron	. 0.39	parts	n 100,000
Blourbonate	manganese	. 0.35	parts	in 100,000

The Bitter spring derives its name from the pronounced pungent and somewhat bitter taste. The solids held in suspension at this spring exceed that of any of the others:

Analysis.	Temperature, 73 degrees Fahrenheit.
Bicarbonate of soda	
Bicarbonate of iron	1.79 parts in 100,000
Chloride of magnesium	11.84 parts in 100,000
Chloride of potassium	17.89 parts in 100,000
Chloride of sodium	
Sulphate of lime	
Sulphate of potassa	5.16 parts in 100,000
Silica	
	6000 00000
Total solids	

The above springs, with numerous others that appear to be equally as good, occur adjacent to an anticlinal fold in the Dakota sandstones. They are all near the western limit of the town and are extensively used by the inhabitants. The aggregate flow of the various springs is approximately 2,500 gallons per minute. Near the eastern limit of the town there is a thermal spring, with an approximate flow of 200 gallons per minute. This is locally called the "Bath spring," and is utilized for bathing purposes. This spring is improved with a bath house, which contains two swimming pools and several rooms with bath tubs. The average temperature of the water is 103 degrees F.

Analysis.	
Carbonate of lime	1.71 grains in one pint
Sulphate of soda	0.69 grains in one pint
Sulphate of magnesia	0.76 grains in one pint
Sulphuric acid	0.07 grains in one pint
Silicic acid	2.79 grains in one pint
Phosphoric acidTu	race
PotassaTı	race
Alumina	race

Apolycic

About six miles from the town of Steamboat Springs there is a group of thermal springs issuing from a fissure, that have an aggregate flow of about 350 gallons per minute and a temperature of 140 degrees F. It is quite a favorite resort for picnic parties, who use the water for cooking meals. In various parts of the county many mineral springs occur, that are locally utilized to more or less extent.

Early in the '60s Routt county was invaded by the prospectors in search of gold. Since 1866 the placer beds of the Hahn's peak section have been more or less actively worked, and there have been several minor excitements at different times in lode mining. Notwithstanding this, the precious metal deposits of this county are but little developed. This is mainly due to the great cost for transportation of ores to market. Ores that would yield a profit after paving expense of mining, \$30 to \$50 per ton freight charge to railroad, railroad and smelting tolls in addition, have been produced, but in somewhat limited quantity. The most active mining center has been in the Hahn's peak district. The extensive placers of this section were discovered by Joseph Hahn in 1865, and this section, the most prominent peak of the Elk Head mountain group, and the town of Hahn's Peak, are named in his honor. Hahn's Peak is the county seat of the county and is located near the south base of the peak, in a somewhat broad, open park, which embraces the main placer deposits. The water supply at this point is quite limited. and one of the first and most expensive ditches constructed in the state is that bringing in the water from Elk river to Hahn's Peak. The placer beds, as near as may be determined, have a value varying from fifteen to twenty-six cents per cubic yard, and have been somewhat extensively operated. The long and comparatively level park affords poor facilities for disposing of the refuse material after washing, and this, with other physical conditions, has prevented the large returns confidently expected when operations were conducted on a somewhat extended scale. The product of a comparatively coarse and high-grade gold has been quite large in the aggregate, but the actual profit of operating companies small. There are a number of smaller placers in this vicinity that are worked a few months each year, which yield good returns for the labor expended. These, however, are operated in a small way, and with primitive appliances.

The Elk Head mountains form an isolated group and are composed in the main of trachytic lavas. The phenomena of the formation of this group is comparable in a general way to that of the La Plata mountains, in La Plata county, to which chapter reference is made. The subsequent erosion in the Elk Head group has been great, especially so in localities where the later eruptives have not formed a protective covering for the softer underlying stratified rocks. On the south and east slopes of Hahn's peak there are at present but small remnants of stratified rock remaining. The formation and erosion of this mountain group accounts for the placer beds that occur in the valleys adjacent thereto. The whole mountain mass appears to be slightly gold-bearing, but the more concentrated values were doubtless in conjunction with the sedimentary rocks and intrusive igneous sheets, as better seen in other sections or shown by the "float" and meager development of the "blanket" veins in the vicinity of Columbine, located west of Hahn's peak.

In the vicinity of Hahn's peak there has been a large amount of exploit work done, but the search has been almost wholly devoted to "high-grade" ores, which occur in the veins in form of small pockets and shoots at irregular intervals.

There has apparently been very little effort made to determine accurately whether or not the lower-grade ores may not be handled profitably by some of the late improved methods. The conditions for remunerative ore deposits in the Elk Head mountains are favorable, and it affords a good field for systematic prospecting and development.

The Four Mile placer field, some forty-five miles west of Hahn's peak, is in some respects more promising even than the Hahn's peak section. Considerable development work has been done in this section and the water supply is much more satisfactory. Along nearly all the streams heading in the Elk Head mountains gravel beds occur at intervals that yield fair returns with sluice box or antiquated rocker.

•North and northwest of Hahn's peak are the Whiskey park and Three Forks districts. Both of these districts, together with the Farwell district, east of the peak, have attracted considerable attention during the past few years. These combined districts embrace the territory between the Elk Head mountains and Battle lake, in Wyoming. Battle Lake is the leading mining center of what is better known as the Grand Encampment mining district. The ores in the districts above mentioned occur in fissures in granite-gneiss. In the Three Forks, lead-silver ores predominate; in the Whiskey park, lead-copper-silver, and in the Farwell, coppersilver. All the ores carry more or less gold values.

Desultory mining or prospecting has been prosecuted along the granite-gneiss Park range, from the Wyoming line

to the Rabbit Ear peak. This peak is one of the well-known land marks between Routt and Grand counties and west of Muddy pass, which forms a passageway to North park, in Larimer county. At Buffalo pass, or, more properly speaking, Buffalo park, there has been considerable work done on copper-bearing veins. Buffalo pass is directly between Steamboat Springs and Walden, in North park, over which the state road passes, connecting the two towns. The granitegneiss of the Park range, from the Wyoming line to the Rabbit Ears, shows, in the main, a bedded structure, much folded and distorted, with no eruptive dikes or masses. The fissure veins are mainly copper-bearing, and can be traced but for short distances. In the Rabbit Ear district the ores are mainly lead-silver, and, although but little developed, appear to occur in quite large deposits. The eruptive dikes common to the east and west range that separates North and Middle parks, traverse this district. From here south to the Grand river there has been more or less prospect work. In the vicinity of McCoy, which is near the boundary line separating Routt and Eagle counties, there has been considerable activity, the ores having a copper, silver, gold value in the order named. A smelting plant is under consideration for this section, but the prospects, although promising, are not sufficiently developed as yet to instify such an outlay. From the extreme northwest part of the county reports indicate the existence of copper-gold ores in remunerative amounts. Also, that a small copper smelter has been operated with more or less success.

One of the most valuable resources of Routt county is its large coal reserves. This, like other resources, is undeveloped beyond that of local demands. The coal measures occur in Laramie Cretaceons and Post-Laramie, in numerous seams, aggregating locally over 60 feet in thickness. While practically undeveloped by man, the various folds and breaks in the strata afford good opportunity for inspection. The coal area of the county has been subjected to numerous estimates, varying from 400 to 1,100 square miles. The former figure is thought to be as much too low as the latter is high. The area of coal seams of easy access and of workable thickness is doubtless somewhat in excess of the first figure, and the probable coal area is not much less than the last. In the Oak creek, Bear river, Twenty-Mile park and Pilot mountain sections small openings for home consumption are numerons.

The coal is of variable quality, but is, in the main, a lignite of somewhat better grade than that mined so extensively in the mines north of Denver. In the Pilot mountain section, development by drifts and somewhat extended diamond-drill prospecting have largely demonstrated quite a large tract of anthracite coal. This section adjoins the western limit of the Elk Head mountains, and the change from lignite to anthracite coal is due to intrusive sheets, dikes or masses of basaltic lava. The transition is more or less complete, in accordance with proximity of the lava to the coal seam and its amount or thickness. Analyses, therefore, vary from a high grade to a semi-anthracite. The result of prospecting above mentioned indicates an anthracite seam, or seams. larger in area than any heretofore opened in the state, and of equally as good or better grade. Samples of coal were taken, as below designated, with considerable care, not for the purpose of obtaining a high result, but one that would fairly represent a mine run of the coal when marketed. None of the openings exceeded a drift of over 100 feet in length and "rusty" coal of the outcrops had not entirely disappeared. The following analyses were made by Dr. Wm. P. Headden. chemist at the State Agricultural College, which is a guarantee of their accuracy:

No.	Water.	Vol. and Organ.	Ash.	Fixed Carbon.
1	4.97	39.49 (5)	2.60	52.93
2	5.89	41.60	5.18	47.33
3	1.76	5.31	18.28	74.65
4	4.97	38.82	7.30	48.91
5	1.99	13.18	22.65	62.18

DESCRIPTION OF NUMBERS.

No. 1—Wadge mine (8-foot vein) Bear river, at mouth of Wolf creek.

No. 2—Hutchinson bank (11-foot vein), Twenty-Mile Park.

No. 3—Anthracite (10-foot vein), James H. Crawford Company, Pilot mountain.

No. 4-Next above anthracite (7-foot vein), James H. Crawford Company, Pilot mountain.

No. 5-Semi-anthracite, James H. Crawford Company, Pilot mountain. Space will not permit a detailed description of the various coal outcrops, but the field will stand a heavy extraction for many years to come, and the quality is that of a good lignite, to semi-coking and anthracite. With transportation facilities, the coal measures of the county will prove one of its most valuable resources.

In building stones there are several sandstones and limestones that have been utilized for local use. The Dakota sandstone in this section is of a light gray color, even grain and generally easy of access by reason of its ability to withstand ordinary eroding influences. Its use, therefore, is most common in the sections where it occurs.

Near Steamboat Springs quite an extensive deposit of "onyx" has been developed in a small way. This stone is of variable texture and color, and is sufficiently hard to partake of a high polish and display to good advantage the different highly-colored bands. Marble of fair grade is found locally, but has apparently attracted little attention as yet.

The present leading industry of the county is stockraising. To this is naturally allied that of agriculture. The county, as compared with many, is well watered, and the present demand for the irrigation of the extensive meadow lands is far below the supply. The soil, while quite sandy prior to irrigation, soon presents a rich, black, loamy appearance, and a "failure in crops" is rarely taken into consideration. The intervening mesas, plateau and rolling hills afford good grasses for grazing during the summer season, and while some stock is permitted to "rustle" the whole year, the large majority of those engaged in the business feed the homestend hay and grain during the winter months.

The "oil fields" have been given considerable attention during the past few years. In several places "oil springs" occur, and the exuding oil has been collected in small basins and utilized for many years. Samples of this oil indicate it to be of high grade and almost entirely free from asphaltum. Oil strikes have been reported from some of the holes drilled, but have not, as yet, been satisfactorily verified. The existing conditions in the south part of the county and west of Steamboat Springs appear favorable, and embrace many of the features considered most favorable for oil deposition. Samples of asphaltum and various hydro-carbons have been brought to the department, said to be from Routt county, but these products have not as yet been definitely located, although their existence in certain sections is little doubted.

General mention of these matters is made to in part comply with the many demands for information. The section as a whole is very resourceful, and will afford homes and employment to many times the number of its present inhabitants. With railroad facilities, its advance will doubtless be very marked. At the present time the most convenient way of visiting this section is via the Denver & Rio Grande Railroad to Wolcott (a station between Leadville and Glenwood Springs), thence via stage to Steamboat. Springs, a distance of 71 miles. Between Wolcott and Steamboat, McCoy, Toponas, Yampa, Pallas and Sydney are passed through. From Steamboat Springs regular coaches are run to Clark, Hahn's Peak and Columbine, Hayden and Craig, or good private conveyances may be procured.

SAGUACHE COUNTY.

This subdivision occupies a central position in the state and was organized in the winter of 1866. It has an area of about 3,240 square miles. The adjoining counties are Gunnison and Chaffee on the north; Fremont, Custer and Huerfano on the east; Rio Grande and Mineral on the south; and Mineral, Hinsdale and Gunnison on the west.

The general topography of this section is quite diversified. The east county boundary is outlined by the high crest of the Sangre Cristo mountains, which in Crestone Peaks reaches an altitude of 14,223 feet. A number of other culminating points attain an elevation of over 13,000 feet, connected by a rather narrow and sharp crest. Along the western flank of this range is the upper or north portion of the great San Luis valley. At the southern county limits this valley has a width of nearly forty miles and presents the appearance of a broad plateau slightly lower near the center. Toward the north this plateau gradually narrows and ends in a comparatively small park known as Homer's Park. The average altitude of the valley section is about 7,600 feet. The west of the valley is flanked by a series of foot hills gradually attaining a greater elevation and culminating in peaks that reach 10,000 to 11,000 feet in the northern, and from 12,000

to 14,000 feet above sea level in the southern portion. These mountains are a terminal or southern extension of the Park range and are known as the Cochetopa and La Garita hills and form the Continental divide. On the west or Pacific slope the descent to the valley of the Tomichi is more rapid and the west county boundary includes the drainage basins of the Cochetopa creek and tributaries, which form one of the main tributaries of the Tomichi river. The drainage of the county is therefore to both the Pacific and Atlantic oceans. On the Atlantic slope the main drainage is through Saguache creek and numerous tributaries finding source in the Cochetopa hills, and San Luis creek and numerous tributaries rising in the basins of the Sangre de Cristo range. Notwithstanding the surrounding high mountains and the existence of almost perpetual snow, the valley proper into which the waters drain is in the main an arid section. This is due to the fact that when the valley is reached a large portion of the streams sink and make their way through covered channels. These waters appear lower down in the valley in quite large lakes, which have no apparent outlet. Both the Sangre de Cristo range on the east and the "hills" on the west are composed of granite and metamorphic rocks, flanked with remnants of the Silurian and Carboniferous strata. The hills on the west are in turn capped with volcanic rocks, which are doubtless the remnants of the northeast part of the San Juan mountain lavas. These beds are comparatively thin when considered as a whole, and the underlying granite is found exposed in places where gulches have been eroded to considerable depth. Both sections are traversed by a series of ernptive dikes that locally cut all formations.

Saguache is the county seat and is located in a broad and fertile park that is well protected by hills on three sides and is practically an arm or bay of the San Luis valley. As early as 1867 the place had gained considerable prominence as a distributing point, but the history of precious metal mining practically begins with 1879-80. During the years of 1880-81 it attained its greatest prominence. This result is largely attributable to the Gunnison excitement of these years. To reach this latter section the most favored route at that time was via Poncha Pass to Saguache, thence over Cochetopa Pass. Many who started to and returned from the Gunnison district remained in Saguache county. In the summer and fall of 1880 Cochetopa creek, Bonanza, Ford creek and Crestone were active mining centers, especially that of Bonanza on Kerber creek. During 1881-82 "locations" were recorded to the number of 4,000 or more. Of these less than 200 have been patented. This season of great activity was followed by the usual period of mill and smelter construction, and afterwards, decline. Several years ago there was quite a revival of interest in the Crestone section. This, however, was quieted by litigation brought about by reason of locations having been made on one of the old Spanish land grants, known as Baca Land Grant No. 4. The litigation was finally adjudicated in favor of the Land Grant Company, which company later declared the territory open to prospectors under certain "rules and regulations." Within the past few years mining operations have again been revived, not only in the Crestone and Baca sections, but in all parts of the county, and indications favor a largely increased production for the future.

The ore deposits of this county occur under variable conditions, that of "fissure veins" predominating. Locally "blanket veins" occur as replacement of the carboniferous limestone, but these deposits are not far distant from igneous dikes, intrusive or overlying sheets. The ores are variable and may only be generalized. On the "western slope" the main value is in gold, often in free form or associated with iron pyrite in a hard milk-white quartz occurring in fissures in granite. On the eastern slope of the hills the veins are generally larger and fill fissures in the volcanic rocks. The ores below limit of oxidation are mainly sulphides of iron, copper, lead and zinc, carrying both silver and gold values. The per cent. of gold and silver is variable. During the past season some high grade gold ores have been discovered in limited amounts, probably a petzite or hessite. The predominating value, however, appears to be in silver. These ores occur in a more or less concentrated form along one of the vein walls in a quartz gangue. The vein filling is generally the altered country more or less impregnated with same minerals. In the Sangre de Cristo section the predominating value is in gold, generally associated with the same sulphides in varying amounts. The surface or oxidized ores are in the main amenable to amalgamation, but the deeper seated sulphides of the entire county are as a whole "refractory."

The county is locally divided into numerous mining districts. These local names are so numerous that they serve to confuse rather than aid in the location of a particular section by reason of the different names applying to practically the same section.

Bonanza camp is located about twenty miles north of Saguache and sixteen miles northwest of Villa Grove, on Kerber creek. During the past season the Bonanza mine and forty-ton concentration plant was operative, and the development work is still in progress. The Juretta is driving cross-cut tunnel, now in over 400 feet from portal. In Rawley gulch, two and one-half miles from Bonauza, the Erie mine has been a small producer during the past year. At the Rawley mine a new fifty-ton concentration plant has just been completed and will soon be actively operated. The mine has an aggregate development of about 1,200 feet, and is one of the leading properties of this section at this time. The Legal Tender, on Round mountain, three and one-half miles north of Bonanza, has been under active development. The Hortense and Senator, in Copper gulch, are both being developed by tunnel. The St. Joe, near the upper part of the town, has encountered vcin and good ore body in tunnel, and regular shipments are now expected. The Eagle mine, three miles southwest, is equipped with steam plant, and has been making regular shipments from 300-foot shaft during the summer. The Chloride mine, in same section, has also added new plant of machinery, and has been steadily operated during the year. The Cliff, two miles east of Bonanza, is developing with tunnel. A new property, named the Cuba Libera, is being opened in Maniton district, four miles northeast of Bonanza. In Finley gulch, about nine miles north of Saguache, the Central Colorado Gold Mining Company has been quietly developing, with small force, for past two years, a group of thirteen claims, known as the Klondike group. Some high-grade gold ores have been encountered in this property.

Near Embargo, in the vicinity of Tornado mountain, generally known as the Meyers Creek district, located about sixteen miles southwest of Sagnache, a number of properties have been under active development, the principal ones being the Golden Income group, which is equipped with small steam plant and development aggregates about 600 feet. This property has been a small producer. The Little Ray group has cross-cut tunnel of 750 feet, and has encountered two veins en route.

The San Luis Valley Land and Mining Company, near Crestone, has confined operations during the past year
largely to sinking a new three-compartment shaft on the Independent claim. The shaft has reached a depth of 500 feet, at which point a station will be cut. This property has a fine equipment, together with a 100-stamp quick-drop mill and forty concentrating tables. The ore value is principally in gold. This company owns the Baca Land Grant, No. 4. The Bonanza, owned by this company, has been operated in a small way.

The real estate boom at Crestone has subsided and the mining properties in that section are again receiving consideration. Among the most prominent are the Sun Beam, developed by 800-foot tunnel; Crestone Star, in Burnt gulch, one and one-quarter miles east of Crestone, with 500 feet of development and an 800-foot cross-cut tunnel started; Garfield, in Pelican gulch; St. Louis group, 400 feet of development; San Gertrude, 300-foot shaft, 500 feet of drifts, equipped with steam plant and twenty-five-ton concentration mill; on North Crestone creek, a cross-cut, driven 217 feet, to vein of Kinney group, now drifting on vein.

Above Orient, in Steele canon, the Steele Canon Mining Milling and Transportation Company has a group of claims with development aggregating about 2,000 feet, equipped with steam plant for power drills and good substantial houses. The San Isabel, in the Blake district, four miles north of Crestone, has developed large bodies of low-grade ore and will ship product to Salida smelter. The Gold Dirt group of fifteen claims has an aggregate development of nearly 2,000 feet, and contemplate the erection of a milling plant.

Pike Post Office is a new camp, established about two years ago, on Reto Alto creek, in the Blake district, about twelve miles north of Crestone. A number of properties were operative in this section during the past year, and a small amount of ore was marketed. Cottonwood is three miles north of Pike, and claims in that vicinity have been worked on a small scale. Two miles north of Cottonwood, on Short creek, the Regulas Mining and Milling Company has made slight production, and a number of prospects have been granted annual assessment work.

• In the Music Mining district, located on Short creek, about twelve miles southeast of Crestone, there has been considerable activity. There are two Short creeks in this county —the one now under consideration is on the west base of the range, and adjoins the Baca Grant on the south. Liberty

is the postoffice. One mile east of Liberty the Cripple Creek Idaho Mining and Milling Company has been developing steadily for eighteen months, with fair force of men. A fiftyton mill is nearing completion, and the developments expose a large body of low-grade gold ore that is claimed to have been demonstrated to yield a good profit. The Byron group, one and one-half miles northeast of Liberty, has been under steady development for over a year with small force. The Frazier properties, on Pole creek, are opened quite extensively. During the past year a two-stamp mill has been operated on one of these, and a recovery of over \$700 in gold is claimed. On Sand creek, one and one-half miles south of Liberty, the Blanca Mutual Mining and Milling Company have a 250-foot shaft equipped with steam plant. Also a five-stamp mill, to which a cyanide plant is to be attached. A cross-cut tunnel, now in about 400 feet, is under way and expected to cut vein when advanced 180 feet farther.

At Orient one of the main producing iron mines of the Colorado Fuel and Iron Company is located. This property produces a superior "brown hematite" ore, and is operated on a large scale, the product being moved by the train load, rather than the car. Prospect work during the year, with a diamond drill, has been productive of satisfactory results.

The mining properties in the Cochetopa district, on the Pacific slope, are tributary to Gunnison. Iris, one of the most active camps in this section, is near the county line and only about ten miles southeast of Gunnison city, with which it is connected by good wagon road. Several minor camps are located in this section, all of which have attracted considerable attention at various times by rich free gold strikes. The ores, as a whole, are low grade and have been quite extensively developed at several properties.

The oil excitement common to many other sections of the state has been in evidence in Saguache county. Several companies have been organized which have been more or less active, but the results so far are reported as simply encouraging. The emanation of gas from many of the numerous artesian wells in the valley section is quite common, and is considered by many a good indication. This gas may arise from deepseated sources, but is more likely to prove a decomposition product arising from organic matter buried under the local drift and given vent by the comparatively shallow borings made for artesian water. The principal industries of this section have been that of stock-growing and agricultural pursuits. The adjoining hills afford a fine quality of native grasses and the products of the soil are prolific. Good pine timber abounds on the mountain sides and is manufactured to meet local demands. The comparatively recent revival of interest in precious metal mining bids fair to surpass all other industries. In the main, the mining operations are being conducted on more conservative lines than during the early days, and the decaying remnants of former misdirected effort have a restraining influence on many who might otherwise become too sanguine.

This section may be reached in two ways by rail. The Denver & Rio Grande has a standard gauge line from Denver to Alamosa via Veta Pass, and a narrow-gauge line or branch that extends from the main line at Salida over Poncha pass to Alamosa. From Villa Grove, one of the leading towns of the county, another branch extends to Orient. The Bonanza and Cochetopa mining sections are tributary to this point via Saguache. Other districts along the Sangre de Cristo range are tributary to Moffat or Hooper, and the south portion of the Cochetopa hills, generally called the La Garita mountains, to Del Norte. The latter place is the county seat of Rio Grande county, and is on another branch of the Rio Grande system about midway between Alamosa and Creede.

SAN MIGUEL COUNTY.

This subdivision was established by legislative enactment approved February 27, 1883. It is one of the most prominent counties forming the "San Juan Country," in the southwest portion of the state. Its eastern boundary is formed by Ouray and San Juan counties, its west by the state of Utah. The adjoining counties on the north are Montrose and Ouray, and Dolores on the south.

The topography is diversified. In the eastern portion it is characterized by rugged mountains with numerous cliff exposures, cut by deep, narrow canons. The mountains culminate in numerous peaks that reach an altitude of nearly 14,000 feet above sea level, and the intervening gulches have been eroded to a mean elevation of about 9,000 feet. The west portion of the county embraces the eastern limit of the Great Sage plains of Utah, having a mean elevation of about 7,500 feet.

Inasmuch as that portion of San Miguel county most prolific in precious metal deposits has received the careful attention of the United States Geological Survey, and the Folio published is of limited circulation, extracts from the generalized portions of the report will be quoted, to the exclusion of detail mention of some of the operative mining plants. The geology of this section is comparable, to a great extent, to that of Ouray, San Juan, and the other "San Juan" counties, and the following may be applied to them for general structural relations. Mr. Whitman Cross, the geologist in charge, and recognized authority, in his report of the Telluride quadrangle, says, in part:

The geological history of the San Juan region is too complex and as yet too imperfectly known to admit of even an outline statement of satisfactory accuracy. The pre-Tertiary surface of the entire region was completely buried by the volcanic formations which now cover the main area, and, while erosion has again exposed some of the older rocks on all sides of the volcanic complex and even in some of the exterior valleys, * * the present resurvey has thus far covered too small an area to afford the solutions to many of the problems in the earlier geological de-

velopment of this most interesting field. In view of this condition, no attempt will be made at this time to present a thorough review of San Juan geology, but in order that the significance of the observations made in the Telluride quadrangle may be more fully appreciated, an outline sketch of the geologic development of the region will be given. This outline is particularly applicable to the western part of the San Juan, for it is in the valleys of this portion, near the mountain front, that the best exposures of the older rocks may be found.

Ancient granites, gneisses and schists are known in the Animas valley on the south, and in the Uncompahyre plateau on the north. These rocks have usually been considered as belonging to the Archean, but some of them are probably younger than the great series of quartzites exhibited in the Needle mountains and beneath the volcanic in the canons of the Uncompahyre above Ouray, which have been referred by Van Hise and Emmons to the pre-Cambrian age of sedimentation—the Aigonkian. These latter rocks have suffered great metamorphism and are seen standing on edge or greatly disturbed, and the relations of the isolated exposures to contemporaneous exposures elsewhere are quite unknown. These quartzites were called "Metamorphic Paleozoic" upon the Hayden map. Clearly great continental movement followed by enormous erosion preceded the earliest Paleozoic deposits thus far discovered in the region. These latter formations are now exposed in the Animas valley and near Ouray, and

are referred to the Devonian, from fossil evidence. Succeeding the Devonian comes a great series of calcareous sandstones and limestones containing abundant Carboniferous fossils.

Above the Carboniferous strata appears an important series of reddish conglomerates, sandstones, marls and thin limestones, in the upper part of which Triassic fossils occur. These beds are the lowest exposed in the Telluride quadrangle. They occupy a much larger area than the Carboniferous in the zone adjacent to the mountains and are conspicuous in the Animas, Dolores, San Miguel and Uncompander valleys.

In the Rico mountains a Permo-Carboniferous fauna has been found in the lower portion of the reddish series, and this fossiliferous zone is called the Rico formation. It has also been identified in the Animas drainage, but its presence in the Uncompany valley has not as yet been demonstrated.

Succeeding the red Triassic beds come other formations correlated in general with the fresh water Jura of other parts of Colorado, and following them comes the Cretaceous section, from the Dakota to the uppermost coal-bearing member, the Laramie. Below Durango the Post-Laramie formation, made up of eruptive rock debris and known as the "Animas beds" rests upon the Laramie, and is in turn overlain by the Puerco and higher Eocene deposits.

Structurally, the most striking feature in the present attitude of the formations described, from the base of the Devonian upward, is the general southerly or westerly dip away from a point in the west-central part of the San Juan mountains not far east of the Telluride quadrangle. As seen in the section of the Animas valley, all of these formations appear to be conformable. None of the various unconformities by overlap represented upon the Hayden map as occurring in the area between the Animas and San Miguel rivers exists in fact within that territory. But at least one great orthographic disturbance not indicated in the Animas section is clearly shown on the northern slopes of the San Juan, and probably also on the southern side, not far east of the Animas river. The red Triassic formations and all older sediments are wanting in the plateau traversed by the Gunnison and its southern tributaries east of the Uncompahgre river, and the granites and gneisses are overlain by the probable equivalent of the La Plata sandstone, of assumed Jurassic age. A similar condition exists east of the Animas, in the drainage of the Los Pinos and Piedra rivers, according to the Hayden map, but no observations appear to have been made on either side of the San Juan mountains to show the actual position or character of the great overlap which must occur at the base of the La Plata sandstone, or at least below the Dakota Cretaceous.

Other periods of uplift, erosion or subsidence in Paleozoic or Mesozoic time are indicated by the apparent absence of Cambrian and Silurian sediments, the insignificant development of the lower and middle Carboniferous beds, the local development of the fossiliferous Trias, and the absence of the marine Jura and of recognized equivalents of the great "Lower" Cretaceous section of Texas.

The geologic structure and constitution of the San Juan mountains of to-day are mainly the result of the dynamic forces which were intensely active during three great periods of Tertiary time. In the first of these periods the long cycle of upper Cretaceous sedimentation was terminated by a Continental uplift of unknown extent, but which may have been very great. The land thus elevated was greatly eroded, and finally subsided, leading to the formation of the early Eocene lakes. Present knowledge does not tell us to what extent the San Juan mountain area was covered by the Cretaceous sea, but the sediments of that sea are now exposed, dipping at generally low angles away from the mountains on the northern, western and southern sides. In the Telluride and Silverton guadrangles is the evidence, to be given much more fully further on, that the erosion of the period under discussion produced a plain of moderate relief across the oblique edges of the entire series of Mesozoic and Paleozoic formations. This plain seems to have bordered a higher land mass in the heart of the San Juan mountain area, and to have extended a considerable distance-how far, must ever remain a matter of hypothesis-to the north, west and south. This nearly plane surface of erosion became, in the region where it is now exposed, the floor of the San Miguel lake, and the sandstones and conglomerates deposited upon it had already attained a thickness of several hundred feet when the great period of volcanic activity began, producing the complex of rocks out of which the present San Juan mountains are sculptured.

In the second period the volcanoes of the San Juan, assisted, perhaps, by vents in adjacent regions, emitted an enormous amount of volcanic material, partly in fragmental form and partly in hava flows, covering an area of certainly not less than 15,000 square miles to a depth of many thousand feet in the central portion. This volcanic area has not been studied in detail except in the Telluride quadrangle. The vents from which the lavas came are unknown, and the lavas themselves have been examined only in sufficient degree to show the predominant presence of andesites, with other types ranging in composition from rhyolite to basalt. Penetrating the bedded series are several massive bodies of often coarsely granular rocks, such as gabbro and diorite, and it now seems probable that the intrusive bodies of diorlte-porphyry and the allied varieties found in the sedimentary beds adjacent to the San Juan mountains on the west are also of later date than many of the surface lavas.

The volcanic eruptions in the San Juan area probably continued at intervals until late in Tertlary time, although only the products of the earlier outbursts are known. Thus the volcanic period of building-up was in part synchronous with the third great period already referred to that of sculpturing by erosion—by which the mountains now existing have been produced. Within the volcanic area little evidence has been discovered by which the sequence of events can be correlated with the established divisions of Tertiary time. Deposits of Eocene age are known in the zone bordering the volcanic area, but they have not been found direct in contact with the lavas. While it may be safely assumed that the closer study of the San Juan will result in the recognition of different epochs of eruptive activity and of orthographic disturbance, the Tertiary history of this region may be summarized as a conflict between volcanic forces, building-up by stupendous emissions of lava, and the agencies of erosion, removing the igneous material and carving deep canons to the very base of the vast lava plateau. The former was most effective in the earliest stages of its activity, nearly the entire thickness of 5,000 feet of volcanic rocks found in the western San Juan being of that epoch, while the agents of degradation are still actively at work upon the higher mountain masses.

Quantitatively, the work performed by the geologic agencies acting in this region in Cenozoic time was very great, but the estimation of the post-Cretaceous disturbance, as well as the general deciphering of all earlier geological history, has been rendered very difficult by the mantle of volcanic rocks; and the original extent of this covering is left to speculation on account of the more recent erosion. The examination of the Telluride quadrangle has thrown much light on these great problems. Thus the San Miguel conglomerate becomes of first importance in their solution. since its base presents the best evidence as to the post-Cretaceous erosion and its top forms the surface upon which the volcanics rested in the western part of the district. Within the quadrangle the San Miguel conglomerate increases in thickness from 200 feet of boulder beds on the eastern side to nearly 1,000 feet of much finer sediment in Mount Wilson, and upon it, in the latter locality, is a remnant of the San Juan tuff. Both of these formations are also present in Dolores peak, some six miles west of Mount Wilson, but there does not seem to be any possibility of the preservation of either of them at any point farther west.

The amount of Tertiary and recent erosion which has taken place in the Telluride quadrangle from the Dakota plateau to the summit of Mount Wilson is 5,250 feet vertically, and a great thickness of still higher volcanics must still be added.

• The present elevation of this entrie region above sea level is to be regarded as the result of numerous oscillatory movements of uplift or subsidence which have taken place since the close of the Cretaceous, affecting greater or smaller areas. A slight tilting of the San Miguel formation in an easterly direction may be connected with the uplift of the extreme western San Juan region, leading to the great erosion which has caused such an abrupt face to the mountains in and about the Telluride quadrangle. There are some reasons for thinking that this part of the San Juan is still rising. Much more work must be done before the various movements can be distinguished and given their relative values.

Isolated Mountains.—The Mount Wilson group of peaks is only partially included within the quadrangle. It is the eastern and largest of several groups on a general east-west line, which together constitute the San Miguel mountains. These high peaks are due to a great stock of diorite laid bare by erosion of the soft strata penetrated by it.

To the north of the San Miguel river are three mountain masses, Gray Head, Whipple and Hawn mountains, illustrating the laccolithic type of the plateau country. They are prominent by reason of their comparative isolation. A corresponding mass in Flat Top, on the southern border, south of the Dolores river.

New Names for Mountains.—New names have been given on the map to several prominent summits of the quadrangle, for which no local designations were in use at the time of this survey. Of these, Ruffner, Whipple and Hawn mountains, to the north of the San Miguel, have been named from early scientific explorers of this part of Colorado; Gilpin peak, south of Mount Sneffles, after the pioneer governor of the territory; Mendota peak, from the noted mine near it; while Gray Head, near Sawpit, Black Face, west of Trout lake, and Flat Top, on the southern border, possess physical features suggesting the names chosen.

The following is a generalized section of the Sedimentary and Bedded volcanic series from the Columnar Section Sheet of the Folio: GENERALIZED SECTION OF THE SEDIMENTARY AND BEDDED VOLCANIC SERIES OF THE TELLURIDE QUADRANGLE.

Period.	Formation Name. Thickness in Feet.	Character of Rocks.		
	Potosi rhyolitic series1300+	An alternation of rhyolite flows and tuffs, the former predominating near the base. Some of the thin upper flows are glassy. A thin augite-an- desite sheet occurs between rhyolite flows in the lower portion. Thirteen hundred feet is the maximum thick- ness preserved in the quad- rangle.		
JENE and NEOCENE .	Intermediate series1300	An alternation of andesite and rhyolite flows and of tuffs containing both rocks. Ande- site flows are usually promi- nent near the base. Some of the rhyolite flows are glassy. The series is of very irregu- lar development in different places. The maximum thick- ness of 1300 feet is found near Ophir pass.		
EOC	• San Juan series2000	Almost exclusively andesitic debris. Near the base it is a well stratified tuff, but be- comes coarser and less dis- tinctly bedded in its upper portion. Fossils are not known. The series varies greatly in thickness from both primary causes and ero- sion preceding eruption of the Intermediate series. The ob- served maximum thickness of 2000 feet is present on Mar- shall creek.		

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REPORT OF COMMISSIONER OF MINES

Chiefly a coarse conglomerate containing boulders of granite, gneiss, Algonkian quartzite and schist, Paleozoic limestones, and rarely red sandstone. In Mount Wilson sandstone and shale become prominent. No fossils are known.

-UNCONFORMITY-

Gray sandy shales, with local calcareous bands and sandstones. Embraces the Colorado group and a portion of the Pierre division of the Montana. Fossils occur sparingly. Gryphaea newberryi and Ostrea congesta characterize different layers near the base. The full original thickness of the Mancos shale is nowhere preserved in this having vicinity, been removed, with still higher Cretaceous beds, by the pre-San Miguel erosion.

Gray or rusty-brown quartzose sandstones, with a variable conglomerate containing small chert pebbles at or near the base. Carbonaceous shale partings occur at several horizons. Coal is locally developed in these shales. Poorly preserved plant remains are the only fossils.

EOCENE

San Miguel formation.200-1000

Dakota formation, 125-175

	McElmo formation600-900	Many alternating beds of fria- ble, fine-grained, gray sand- stone and variegated shales, often sandy. Fossils have not been found.
	La Plata sandstone100-175	Two white, even and fine- grained sandstones, separated by a thin black limestone or calcareous shale. No deter- minable fossils have been found.
	Dolores formation1550+	A series of reddish quartzose sandstones, grits and con- glomerates, the latter usually containing granitic debris and fragments of Algonkian schists and quartzites. Sev- eral thin limestone conglome- rates with small pebbles char- acterize the upper part. These contain fossils, among which are the teeth of a croco- dile (Belodon) and of a meg- alosauroid Dinosaur, remains of a ganoid fish, a gastropod like Viviparus, a Unio, and some undetermined species of plants.

Intrusive Series—Stock Rocks.—The cross-cutting masses of the Telluride quadrangle are petrographically complex, and it is impossible either to represent the known complexity upon the map or to express it in legend names for the rocks of the larger bodies. While some of the existing complication is apparently due to several eruptions of somewhat different magmas within certain stocks, a still larger part is due to gradual transitions in the composition of the rock from place to place. The designations of the map merely express the predominate rock characters in the larger masses, as explained in detail below.

General Characters.—The rocks of these stocks are mostly granular, with a local tendency to porphyritic structure in the large masses or in dikes or arms extending out into the surrounding rocks. They are usually rather fine-grained, but coarse faces occur in most of the larger stocks.

JURA-TRIAS

The variation in composition, partly expressed in the names, is gradual in many places, as in the Ophir Needles and at Mount Wilson; but rather abrupt changes at other places seem to indicate dikes. The rocks as a group are made up of the minerals plagoclase, orthoclase, and quartz on the one hand, and the dark silicates, augite, hypersthene, hornblende and biotite on the other. According to the ratio of these minerals to one another, the rock assumes from place to place the characters of the various types to which distinct names are given.

Monzonite.—The largest stock of the district—that of Grizzly peak, Rolling mountain and San Miguel peak—is made up more prevailingly of a single rock type than any other of the corresponding masses.

Diorite-monzonite.—This compound name has been applied to the rocks of Mount Wilson and Ophir Needles stocks, of the connecting arm between them, and of the irregular Black Face mass. The name expresses the fact that the greater part of the rock in question is intermediate between diorite and monzonite. * * * In the Mount Wilson stock the prevailing rock is diorite tending toward monzonite. * * * In the mass of Yellow mountain and Ophir Needles a quartz-monzonite is very conspicuous, and probably exceeds the dioritic facies in amount. But the most basic modification of this eruption is found in the Ophir Needles, especially in the upper part of the mountain. Here gabbro rich in the dark silicates occurs, either in the fine-grained dike-like bodies or in more irregular areas grading into other facies less abruptly.

The structure of these rocks varies, but by far the greater part is moderately fine and even-grained. Coarsely granular development is local. But while the stock parts are generally granular, the sheet-like connection and the Black Face intrusion are more or less distinctly porphyritic. The groundmass in these portions is much less in amount than the phenocrysts, but occasionally a few large orthoclase crystals develop and make the structure pronounced. Such a growth of orthoclase may also occur locally, even in the large stock of the Mount Wilson group.

The transitions observed between the many structural and mineralogical varieties occurring in the rock masses here under consideration are, as a rule, so gradual that the several facies can not be regarded as of distinctly different periods of eruption, the later ones cutting the older in dike form. It seems more in accordance with observation to assume that the magma injected into these stocks was not homogeneous in composition, and that much of the existing variation in the rocks is due to original variation in the magma. There is no apparent regular relation of changes in composition to form of the masses, suggesting a differentiation within the magma after eruption. An exception to this statement may be presented in the Black Face mass, where orthoclase and quartz are frequently found in vein-like or irregular areas, often intergrown as graphic granite, but yet showing zones of transition into diorite-monzonite of subordinate porphyritic structure. These appear to be due to segregations of magma rich in potash and silica, and are not limited to any particular portions of the exposed rock.

Gabbro-diorite.—This term is applied to the stock rock of Stony mountain and Mount Sneffles and of a number of small cross-cutting bodies. The compound name indicates primarily that, much of the rock is intermediate between gabbro and diorite, and also that there is a transition from gabbro to diorite.

The principal rock of Stony mountain, as seen at its summit and down the eastern slope, is a dark, coarse or medium-grained gabbro, composed chiefly of a plagioclase rich in lime, with abundant hypersthene and diallage-augite. Even in this rock there is some orthoclase and quartz, while in some phases of the rock here included there is a considerable amount of these two minerals, and a transition develops toward the rock called monzonite.

In Mount Sneffles, so far as the mass is now known, gabbroitic phases are predominate, partly coarse-grained, but with large amounts of the fine-grained, almost aphanitic type seen in the Ophir Needles, of which an analysis has been already given. A dark gabbro-porphyry occurring in dikes is very prominent on the southwest side of the mountain and at the pass on the south. This porphyry is characterized by thin plates of plagioclase in more or less marked parallel arrangement. They appear dark themselves, from the great number of dusty inclusions they carry and because they lie in a dark aphanitic groundmass of the other minerals common in these rocks.

The lighter-colored fine-grained rocks of the connecting arm between Stony mountain and Mount Sneffles, and the rocks of the smaller stocks and dikes mapped as gabbro-diorite, are less rich in dark silicates than the gabbro proper. Their plagioclase is like that of the diorite-monzonites, and they have some orthoclase and quartz. Usually these rocks are fine-grained in texture and gray in color, and hornblende is sometimes the most distinct constituent. They have the general habit of diorite.

Diorite-porphyry.—The rock forming the large bodies of Gray Head, Whipple and Hawn mountains, Flat Top, and numerous thin sheets adjacent, have been designated diorite-porphyry. They contain phenocrysts or distinct crystals of a soda-lime feldspar (andesine or labradorite), hornblende, biotite, and occasionally augite, in a gray groundmass of orthoclase, plagioclase and quartz. The crystals are never very large. In the laccolithic masses the groundmass is so coarse and the crystals are so small that the porphyritic structure is rather subordinate, but appears distinctly when thin sections of the rock are studied under the microscope. In the thin adjacent sheets the groundmass is very fine-grained, and hence contrasts with the phenocrysts embedded in it.

The mineralogic composition of these rocks does not vary greatly. Quartz is not very abundant in any of them and is nearly lacking in the rock of Flat Top. Orthoclase is always so subordinate that no decided approach to monzonite-porphyry can be found. *Granite-porphyry.*—Above Ophir occurs a porphyry body, cut in two by Howard Fork, which is in some respects analogous to a laccolith, although somewhat irregular in its relations to the enclosing sedimentaries. This rock is called a granite-porphyry. It contains pink orthoclase crystals, some of which are half an inch long, and many smaller ones of white oligoclase, quartz, green hornblende and brown mica, which lie in a groundmass consisting chiefly of orthoclase and quartz. The large orthoclase crystals especially characterize this rock.

Dike rocks.—Under the general name "Basic dikes" a number of dark dike rocks have been represented on the map. These dikes are younger than any other igneous masses of the region, and several varieties occur which will be specially described.

Pyroxene-andesite.—By far the majority of all the observed dikes are of a pyroxene-andesite very similar in composition to the rock of the flows in the Intermediate series, but dense in texture and usually quite aphanitic. These dikes prevail in the eastern portion of the quadrangle, all of those represented on the map in that section belonging to this type. The small dikes in the vicinity of Sawpit belong in this group, as do the dikes about the Lizard Head and the one shown on the ridge south of Mount Wilson.

A few inconspicuous dikes in Campbell peak and Ruffner mountain are hornblendic.

Plagioclase-basalt.—The dike at the mouth of Big Bear creek is a very simple normal basalt, having abundant fresh olivine crystals and a holo-crystalline groundmass consisting of augite, olivine, labradorite, magnetite and a little biotite.

Augite-minette.—In the ridge running southeast from Gladstone peak, in the Mount Wilson group, are two narrow dikes of a dense, dark, almost black rock, cutting Cretaceous strata. These contain abundant augite, and brown biotite, with a few decomposed olivine crystals, in a smoky-brown glassy base with crytocrystalline spots. It is believed that this glassy base must be rich in potash and that the rock belongs with the minettes on account of the prevailing character of similar dikes in adjacent districts.

Vogesite.—On the ridge running east from Gladstone peak, and in Bilk Basin, are narrow dikes of an ash-gray rock with black semivitreous contact zones. The center of the larger dikes contains much augite and dark-brown hornblende, with some olivine, in a colorless base, which consists largely of delicate interlocking, branching crystals of orthoclase. The contact zones are dark glass with augite crystals alone.

Augite-camponite.—The small lenticular plug to which Black Face owes lts name is composed of a dense black rock, in which the naked eye can detect only a few minute particles of feldspar and dark grains of augite. The microscope shows much augite, brown hornblende, plagioclase in microlites, orthoclase in irregular grains, and a dust of magnetite.

The chemical composition of this rock is very nearly the same as that above given for the gabbro of the Ophir Needles.

The important position now occupied by San Miguel county as a producer of precious metals has been attained by regular stages. The early mining history practically begins with the year 1875. Notwithstanding the high grade ores mined at that time, remoteness from market greatly retarded production. In 1890 the Rio Grande Southern Railroad was completed to this section, and since that time advance in production has been marked. Prior to the advent of rail transportation ores carrying high values were the only ones mined to any extent. Since that time lower grade ores have been marketable, and later, ores of still lower values have been made marketable through the introduction of milling plants and the concentration of values into a smaller tonnage. At the present time the main production from this section is derived from ores having a gross value of from \$8 to \$20 per ton.

Mining operations are generally conducted on a large scale, and the largest producers are equipped with expensive milling plants. These plants may be generalized as those common to amalgamation and concentration. The brittle, friable character of the high grade gold and silver bearing sulphides disseminated through the gangue minerals makes recovery very difficult, and the most common adjunct to the mills is that of canvas tables, following the ordinary belt or rotating concentration tables. At the Liberty Bell mill, the ores pass from stamp batteries over silvered-copper plates, to tables, removing in part the free gold and metallic sulphides. The tailings from tables are tanked and subjected to evanide solution. This is drawn off and the residue shoveled into a lower set of tanks and again treated by cvanide solution. The management claim that the mechanical mixture obtained by shoveling is productive of better results than may be obtained in any other manner. The residue, after final treatment with cyanide, is then conveyed to a large canvas table plant. The percentage of values saved in each manipulation from the head to tail of mill is said to be in excess of cost of same, and the aggregate saving sufficient to make an otherwise valueless ore, profitable.

The mines of this section are located as a rule at high altitudes and are therefore subject to short summer seasons

and heavy snowfall in winter. These objectionable features are largely overcome by the precipitous character of the mountains, which permits of mine operations through crosscut or adit tunnels. This precludes the necessity of the erection and maintenance of expensive pumping plants, and mine operations may be conducted without hindrance from flows of water.

The most marked characteristics of this and adjoining mining sections are the observable length of the fissures on their strike, and the persistency of ore deposition in the included veins. Locally, the ores having value may occur in small pockets, or more or less extended shoots, at irregular intervals in the vein, but the largest developed properties disclose a remarkable persistency of ore deposition, permitting the removal of the entire vein material for a distance of onehalf mile or more. The country is divided into a number of mining districts having local names. In each of these the most pronounced fissures may be grouped into a system, but considering the district as a whole the fissures strike in all directions. The dip of the fissures is likewise variable, but is rarely far enough removed from the vertical to retard the ordinary methods of drift and "back-stope" mining.

The veins of San Miguel county are comparable to those of Ouray and San Juan counties. They may occupy a single fissure, or the so-called vein may consist of a series of parallel veins in a fissured zone, the veins being separated by intervening bands of country rock. Gold and silver occur in native state, but are generally associated with iron pyrite, chalcopyrite, lead sulphide and zine blende. The main gaugue minerals are quartz, calcite and rhodonite.

The economic geology of this section has been ably considered and reported upon at some length by Mr. Chester Wells Purington, who acted as assistant geologist to. Mr Cross in the preparation of the Telluride folio before mentioned. Concerning the origin of the fissures and ores of this section, Mr. Purington says:

Origin of the fissures.—The fissures penetrate all the rocks exposed in the area, and were formed later than the extrusion of the rhyolite and the intrusion of the diorite stocks. Although from the preliminary character of the present investigation it is considered unwarrantable to assign a definite cause to the fissuring, there is little doubt that it was produced by dynamic action having its source or sources in an area apart but probably not far removed from the field under consideration. If the fissuring be due to pressure acting as above described the inference is that a considerable amount of open space would be formed along the zones of narrowly spaced fissures, caused by the crushing and grinding up of the country rock by the repeated motion of the walls. Examples of faulting along the fissures on a large or even perceptible scale have been rarely observed, but there is reason to suppose that minute faulting of the rock in connection with the fissuring was of widespread occurrence.

The presence of columnar joints in the lava flows, especially in the rhyolite which caps the divides, may to some extent cause confusion in the study of the fissuring. The effects of subsequent disintegration have, in addition, masked the original structure of all the rocks, especially those which outcrop at the higher altitudes.

Origin of the ore.-The ore now filling the veins in the Telluride district appears, from all the evidence collected, to have been deposited from ascending hot water solutions which penetrated all portions of the fissured zones, wherever open space was found. Surface waters, descending by capillarity, or possibly in part by means of the fissures themselves, have taken into solution, in the form of sulphides, alkalies from the constituents of the igneous rocks encountered in their paths. Getting hotter as they descended toward the source of the magma from which the igneous rocks have been derived, the alkaline solutions probably became further charged with sulphydric and carbonic acids derived from volcanic sources, thus becoming solvents for the metals, and for the silica, lime, etc., they gathered from the more basic portions of the magma. By these ore-bearing solutions the metals-gold, silver, lead, copper, iron and zinc-as well as sulphur, lime, silica, and the alkalies, were probably all brought up from the subterranean region to be deposited in various combinations as the waters approached the surface. The gold quartz and the sulphides of the metals were deposited in the veins themselves, while the penetration of the wall rocks by the alkaline solutions containing sulphydric acid resulted in changes in the form of the iron of the ferromagnesian silicates of the rock and the deposition of potash combined in the silicate sericite. Carbonates, especially of lime, were deposited in the walls, probably for the most part from action of the percolating waters on the lime feldspars. Silica was set free from the bisilicates and feldspars, and has passed mostly away from the wall rocks, being present only in exceptional cases. As has been stated, the gold appears to have been carried into the walls to some extent. Fluorite, which occurs largely in the Tomboy and some other veins, may be accounted for if it be presumed, as Mr. Penrose suggests in regard to the Cripple Creek occurrence, that hydrofluoric acid, or other fluorine compounds in which silica forms a part, accompanied the other elements in solution, and, uniting with lime, deposited fluorite in the veins. The fluorite is not purple here, but of a lightgreen color. Sericite, often spoken of as "talc," occurs in the veins, sometimes in considerable amount, and perhaps represents the form in which a portion of the potash and silica of the ore-bearing solutions has combined.

Small amounts of kaolinite are occasionally mixed with this. Chlorite is notably scarce. It is not likely that more than one general deposition of ore has taken place. In local instances successive crystallizations, at intervals not far apart, of the ore and gangue minerals are evident, but these cases are not frequent and no correlation can be established.

No evidence in favor of the lateral secretion theory, in the narrow application advanced by Sandberger, has been found. The hypothesis outlined above seems the most plausible in view of the evidence at hand. In cases where tests for the precious metals have been made in the constituent minerals of igneous rocks, in previous investigations of ore-bearing districts, the basic minerals, hornblende, augite, biotite, etc., have been found to contain the larger quantities. Much more basic phases of the Telluride igneous rocks than those generally exposed are occasionally seen in the quadrangle as dikes, inclusions, etc., of small extent. It appears probable that, in the magma wherein the rocks had their source, a basic portion, of which these fragments are representative, exists. This more basic portion is a possible source of the ore, since it does not seem necessary to go beyond the limits of the rock magma for the required constituents. The ore deposition was probably not greatly subsequent in age to the close of the volcanic eruptions, although it must necessarily have taken place later than the fissuring of the country.

The city of Telluride is the county seat and main commercial center of the county. It is located in a comparatively level valley on the headwaters of the San Miguel river. On both the north and south sides the mountains rise quite abruptly, from 2,000 to 4,000 feet above the town. The surroundings are both picturesque and grand. East of Telluride about four miles, at an abrupt ending of the valley, Pandora is located, and is one of the main milling centers. This county is reached by the Rio Grande Railroad, either via Marshall pass, Montrose and Ridgway, or via Veta pass, Alamosa, Durango. Telluride is on a branch line extending from Vance Junction, on the main line of the Rio Grande Southern Railroad to Pandora. The Rio Grande Southern is the conecting link of the "Around the Circle" trip which has been so extensively advertised, and is the most scenic route in the state.

Only a few of the many operating mines in this county may be here mentioned. In Savage basin, located in the southeast part of the county, the Tomboy Gold Mines Company, Limited, has largely increased its area of mining property, and during the past year added a new sixty-stamp amalgamation and concentration mill. The annual report for the year ending June 30, 1902, by Mr. J. Herron, the manager,

shows a classification of property into three groups. The Tomboy mine proper produced during the year 48,644 tons of ore which vielded \$329,232.18, an average of \$6.77 per ton, at an expense of \$257,968.31-a profit of \$71,263.87. The Argentum group, in the same period, produced 35,408 tons of ore, vielding \$534,796.97, an average per ton of \$15.10, at an expense of \$242,966.81-a profit of \$291,830.16. The Columbia-Menona group was bonded in March and under development only three months. The ore produced was 1,674 tons, which yielded \$10,557.43, an average of \$6.31 per ton, at an expense of \$10,435.11-a profit of \$122.22. Mr. Herron adds to this letter: "The expenses noted include straightening and taking up the floor of the old tunnel and drifts, relaying with new track and heavy rails, and running air and ventilating pipes into the workings. The development work during the same period aggregated, in drifts, raises and crosscuts. 5.371 lineal feet."

The Japan Mines Company has a number of claims, aggregating about 180 acres, that embrace a large part of the territory between that of the Tomboy and Camp Bird. This property is under bond, and during the past year has been non-productive, the only work being that of driving a cross-cut tunnel to cut veins at lower horizon. This tunnel is expected to reach the vein 2,700 feet from the portal, and 2,000 feet is completed.

The Smuggler-Union Mining Company has a large tract of property west of Savage basin, in what is generally known as Smuggler basin. This property has an aggregate development of nearly thirty miles of drifts, cross-cuts, shafts and raises. The ore is transported from mine to mills at Pandora by an ærial tramway. The Pandora, or new mill, has eighty, and the old mills sixty stamps, both having the required complement of concentration and canvas tables.

The Liberty Bell Gold Mining Company has a group of twenty or more claims in Cornet basin. This property is operated through two cross-cut tunnels, and a new one, to be 2,500 feet long, is being driven. The aggregate drifting in this property is about 6,500 feet. A tramway is used to transport the ore to the mill in the valley between Telluride and Pandora, mention of which has been made.

The North American Exploration Company is operating a group of claims in Upper San Miguel, among which are the Nellie, Ella, Golden Cross, and others. The Bear Creek stamp mill is connected with the property by tramway.

The Alta Mines Company is operating the Bessie concentration mill in conjunction with the mines. This property is located about twelve miles southwest of Telluride, in Alta basin, above Turkey Creek basin. The Four Metals Mining Company is developing a group of twelve claims in Turkey Creek basin and driving a cross-cut tunnel.

The Butterfly-Terrible Gold Mining Company has a group of claims and a thirty-stamp mill near the Ophir loop. Mine and mill are connected by tramway. This property has an aggregate development of about 5,500 feet, and both mine and mill are operating.

The property of the Ophir Consolidated Mines Company is located near the Ophir loop and embraces a large part of Yellow mountain. About seventy-five claims, aggregating 800 acres, have been consolidated, and are under this management. The plant is well equipped in every particular, and includes a fifty-stamp amalgamation and concentration mill of modern pattern. Mill and mines are connected by aerial tramway. The development on the mines aggregates about 11,000 feet and exposes large reserves of low grade or mill ores. A cross-cut tunnel to intersect the vein about 1,800 feet below the apex has been started.

The Carribeau is working a good force of men. This property has an aggregate development of about 11,000 feet. The San Barnardo mine and mill, near San Barnardo are operating under lease.

The Contention Mining Company has developed the Contention, Summit, Savage, Slide, Leland No. 2, and Refuge claims, with an aggregate of about 4,000 feet of drifts and raises. This property is connected with the Pandora mill by aerial tramway. In Bridal Veil basin, five miles southeast of Telluride, the Double Eagle is developing by tunnel, and the Lake View mine is operated by the Blue Lake Mining and Milling Company. In Ingram basin, five miles east of Telluride, the Andrus group of twelve claims is under development by tunnel.

There are a number of placer mines in the county, the most prominent being the Keystone placer, on the San Mignel river, below Telluride. This deposit extends from near Vance Junction to Pandora and forms a comparatively level valley. Its surface is several hundred feet above the main stream at Vance Junction, and is doubtless composed of the debris eroded from the adjoining mountains which was retained in its present location by a glacier along the main stream acting as a dam. This placer bed is well equipped, but no data as to amount of gold recovered is available.

A large number of the mechanical appliances at the various mines and the mills ore operated by electrical power transmitted from the plants of the Telluride Power Company. This is one of the largest and best equipped plants in the state, and has apparently overcome the difficulties incident to electrical transmission at high altitudes. The energy is generated by water power at two central plants, one lower than the other, and permitting the use of water the second time. This company is driving a tunnel, now in 875 feet, to tap Lake Hope and increase the water supply. This lake is a few miles above Trout lake, the present source of supply. Power is also transmitted to the Camp Bird properties and others in Ourav county, and its use is generally reported as being highly satisfactory.

The somewhat recent discovery and development of vanadium and uranium, about one mile southeast of the station of Placerville, is attracting considerable attention. The discovery was made by Mr. A. B. Frenzel, who is now engaged in the extraction of several thousand tons of the deposit for shipment to Europe. The deposit occurs near the top of a stratum of light-colored sandstone overlying the "red-beds," and is being produced mainly for the vanadium it contains. The development of the deposit is as yet quite superficial, but its presence along the face of the stratum may be traced by its peculiar greenish color for considerable distance. It appears to more or less thoroughly impregnate the sandstone, and is generally accompanied by thin seams or bands of uranium minerals, noticeable on account of their bright vellow color. The apparent supply is large. Mr. Frenzel, who has given much time to the study of rare minerals, is very sanguine as to the extent of available tonnage of the deposit and its value. The market demand for vanadium and uranium ores has been very much restricted, but the development of these ores in commercial quantities may open a new and valuable industry.

The importance of San Miguel county as a precious metal producer is shown by the following annual production. Mining operations during the past two years have been seriously impeded by an unusual number of casualties and somewhat extended labor troubles. The production for 1902 will, however, doubtless compare favorably with preceding years :

Yea	r. Gold.	Sil	ver.	Lead.	Copper.	Total.
1897	\$1,458,144	48 \$ 518,	405 62 \$	140,059 32 \$	37,252 00 \$	2,153,861 42
1898	1,572,676	95 1,240,	190 27	243,199 55	43,299 72	3,099,366 49
1899	1,376,704	68 719,	961 74	175,174 07	28,218 09	2,300,058 5 8
1900	1,827,352	02 698,	042 56	158,617 00	51,384 63	2,735,396 21
1901	2,049,471	84 540.	126 43	143,434 47	51,042 72	2,784.075 46

SAN JUAN COUNTY.

San Juan county is one of the smallest subdivisions of the state, having an area of about 480 square miles. It was the initial county in this section and bears the name now commonly applied to a group of counties in the southwest part of the state, viz., the "San Juan country." In form San Juan county, as now constituted, is similar to a triangle, having the greatest width along the southern boundary, the east and west boundaries meeting in a point in the northern limit. The adjoining counties are Dolores, San Miguel and Ouray on the north, Hinsdale on the east, La Plata on the south, and Dolores and San Miguel on the west.

Silverton is the county seat and main commercial center. It occupies a north-central position in the county and is located in Baker's park. It is the terminal point of a branch line of the Denver & Rio Grande Railway system from Durango, in La Plata county. Also the terminal of the Silverton and Red Mountain Railroad extending to Ironton in Ouray county via Chattanooga and Red Mountain. Short branch lines also extend north to Howardsville, Eureka and Gladstone from Silverton.

The territory embraced within the county boundaries is very mountainous. The San Juan mountains on the north and Needle mountains in the south, with their numerous spurs, cover the entire county. The intervening valleys are quite narrow in the main, but occasionally widen out into small park-like areas. Baker's park is the largest and has a mean altitude of about 9,200 feet above sea level. Through

it flows the Animas river in a southerly course, affording the main drainage of the county. The narrow valleys adjoining Baker's park are traversed by mountain streams that find source in large oval basins or cirques near the summit of the surrounding mountains. The mountains reach a maximum altitude of nearly 14,000 feet above sea level. The lower mountain slopes are covered with a heavy growth of spruce timber, which ceases to grow at an altitude varying from 10,-000 to 11,000 feet. The area above "timber line" in San Juan county is greater in proportion to the total area of the county, than in any other subdivision of the state.

The principal industry is that of precious metal mining. The early history of this section dates back to 1861. Mining practically began in 1870 with primitive appliances and was prosecuted with varying success until 1882. At this time the Denver & Rio Grande Railroad was completed to Silverton. Following the advent of transportation facilities mining operations were given an impetus that has since developed San Juan county into one of the most important mining sections of the state. At the present time nearly one-fifth of the entire area of the county is held by mineral locations. This fact demonstrates the prevalence of mineral deposition. The following table of production for the past several years illustrates the importance of the district as an annual contributor to the aggregate production of the state.

Year.	Gold.	Silver.	Lead.	Copper.	Total.
1897	\$ 694,325 97	\$657,287 53	\$271,123 79	\$150,696 32	\$1,773,433 61
1898	1,132,591 98	610,750 68	532,157 96	270,290 52	2,545,791 14
1899	996,273 33	710,108 40	715,721 96	210,908 10	2,633,011 79
1900	757,204 11	418,396 77	831,495 07	325,788 77	2,332,884 72
1901	962,973 96	462,296 51	670,607 92	453,613 95	2,549,492 34

The geology of this section is in a general way comparable to that of San Miguel, which is outlined at some length in the following chapter. The greater portion of San Juan and parts of San Miguel and Ouray counties are now receiving the careful consideration of the United States Geological Survey, and the publication of the folio with the usual maps and descriptive matter may be expected to appear in the near future. A report upon the economic geology of the Silverton quadrangle has already appeared as "Bulletin No. 182," "Series A, Economic Geology, 12," of the United States Geological Survey. This report was compiled by Mr. Frederic Leslie Ransome, and is one of the most complete and comprehensive published by the geological survey. It treats not only of the ore deposits, structure and ores of the lodes of the district in general, but a large portion of the report is devoted to a detailed description of special areas and individual mines. The mines and prospects mentioned being a large proportion of those most active in this immediate vicinity. The bulletin also contains an outline of the geology by Mr. Whitman Cross, geologist in charge. This work should be in the hands of every mine operator in the district and may be obtained from the office of the Survey at Washington at the nominal price of fifty cents.

San Juan county is deservedly noted for the great number and continuity of its fissure veins. Considering the district as a whole the fissures traverse the rugged mountains at all points of the compass and are generally filled with ore bearing veins having commercial value. The veins are, as a rule, easily traced on surface for quite long distances. Locally they have withstood the influences of erosion that have removed the adjoining country rock, and now stand out boldly, presenting the appearance of a long stone wall. In width the veins vary from a few feet to that of sixty feet or more. The dip of the veins varies from 40 degrees to 90 degrees, those nearer the vertical predominating. The continuity of mineral deposition in the veins, in many of the sections, is a marked characteristic. The commercial ores are mainly gold and silver bearing sulphides of iron, copper, lead and zinc, intimately associated in a matrix of quartz. Other gangue minerals such as heavy spar (Barite), pink spar (Rhodonite) and lime (Calcite), and others, are common in varying amounts. The metallic sulphides are, as a whole, low grade and require some system of ore dressing prior to sending to market. High grade ores are by no means of uncommon occurrence. Free gold, wire silver, silver glance (Argentite), gray copper (Tetrahedrite), bismuth silver (Sulphobismuthite) and others, occur in varying amounts at individual mines. The proportion of gold, silver, lead and copper produced in the ores of the county is shown by the production above, wherein it is reduced to dollars and cents at the average market price for each year.

The structure of the veins or lodes and the ores is described by Mr. Ransome in bulletin above referred to, as follows: "The larger structural features of the various lodes

depend mainly upon the character of the fissures in which they were deposited. Where the original fracture was a simple, clean dislocation, the resulting lode is a fissure vein. Most of the lodes of the Silverton guadrangle are of this character-nearly vertical plates of gangue and ore confined between definite walls. They sometimes show local irregularities and may divide into numerous branching stringers (stringer lodes) at their edges, but in the essential character of their workable portions they are veins, in the original sense of Von Cotta. Such are the veins of the Empire group on Sultan mountain; the New York City, Stelzner, Royal and Iowa veins, of Silver Lake basin; the Green mountain vein; most of the veins of Galena mountain; the Hamlet vein, and many of the lodes in the northeast portion of the quadrangle. The width of the workable veins usually varies from a few inches up to ten or twelve feet. Lodes attaining grater width than these are rarely simple veins, although some of those near Sunnyside basin, with widths of from twenty to fifty feet, appear to have filled simple open fissures. A width of two or three feet is perhaps a rough characteristic average of the productive veins of the Silverton region. The vein filling usually fits snugly to the fissure walls and is frequently adherent to them-"frozen,' as the miners say. Quite commonly, however, there has been sufficient movement along the fissure to cause the ore to come away readily from one or both walls, and sometimes there is a gouge or selvage present. This is rarely thick or extensive. Fissures sometimes contract, or pinch, and the vein then becomes much reduced in width and may be entirely absent. Such pinches, where the fairly solid walls are separated by a mere crack, were encountered on the New York City, Stelzner, and other veins, and on the Camp Bird lode. It is often difficult, when such a pinch is passed through by a cross-cut, to believe that it really represents a lode which is elsewhere wide and productive. Many cross-cut tunnels have on this account overshot the vein sought for. Careful systematic surveying and mapping is the safeguard against such mishaps, and is the prerequisite of all intelligent and extensive prospecting.

"As a rule the country rock adjoining the veins is not strikingly altered and retains practically the original form of the fractured surfaces. In some veins in rhyolite, however, there has been some replacement of the rock by ore, as may be seen in the Tom Moore mine.

"Veins of the simple type described are connected by many transitional forms with lodes occupying closely spaced sheeted zones and consisting really of several parallel veins. Such are the small lodes of the Micky Breen and the important lodes of the Camp Bird and Tombov mines. In both the Camp Bird and Tomboy, however, the parallel veining resulting from sheeting of the country rock is associated with the less regular linked-vein structure, in which the lode is made up of nearly parallel or slightly diverging veins connected by linking stringers (Trummer), and with the yet more irregular stringer-lode structure, in which the lode consists of a mass of stringers without noticeable parallelism among themselves. In these mines the more regular structure in usually found with the gold ore separated from the hanging wall by a little gouge, while the more irregular structures characterize the foot-wall portion of the lode, carrying a low-grade galena ore and sending off irregular stringers into the country rock, and being thus without regular foot-wall.

"The stringer-lode structure is perhaps best exemplified in the North Star (Solomon) lode, in portions of the Royal Tiger, and of the Pride of the West lodes, in the upper part of the Forest lode, and in the Alabama lode. But it may frequently be well studied in surface outcrops, notably those which stand out on the steep slopes of Dome peak, north of Howardsville, and in particular near the head of Mill creek, west of Chattanooga, where the Silver Crown lode is beautifully exposed in the bed of the stream, and the details of its structure may be seen through the clear water.

"Massive Structure.—The quartz, galena, sphalerite, chalcopyrite, pyrite, and other minerals are all crystallized irregularly in the fissures without external crystal form and without definite arrangement. As a rule the constituent minerals appear to have crystallized practically simultaneously.

"The structure is exceedingly common and is the characteristic one of the quadrangle. It is typically exhibited by the ores of the Silver Lake, Royal, Stelzner, New York City, Iowa and East Iowa lodes of the Silver Lake basin. The quartz sometimes encloses empty spaces, either as minute interstices between interlocking quartz prisms or as small vugs lined with quartz crystals. Occasionally, instead of being perfectly massive, the ore exhibits indistinct traces of the structure next to be described. The two are connected by intermediate forms.

"Branded Structure by Deposition.—The ore and gangue minerals have been deposited in more or less parallel sheets, distinguishable from each other by the fact that they contain the constituent vein-forming minerals in different proportions.

"This is far less common than the preceding, but it is found in many small and unproductive veins and in some of the more important lodes, such as the Gold King, where the pyrite has been deposited in bands alternating with white quartz. On the large scale, it is perhaps exemplified in the Sunnyside lode, where the ore streaks, themselves of massive structure, consisting of galena, sphalerite, chalcopyrite, pyrite, tedrahedrite, and free gold in a gangue of quartz, rhodonite, and a little fluorite, are separated by plates or lenses of relatively barren rhodonite.

"In the smaller veins and stringers carrying galena and quartz the galena frequently fills the medial suture former by the opposing pyramidal ends of the quartz crystals which have grown out from the walls of the fissure. This is well seen in some of the veinlets of the Silver Lake basin. Even the larger lodes, with prevailingly massive structure, not infrequently reveal a tendency toward a final crystallization of the galena in the middle portion of the vein, as may be seen in parts of the Iowa lode and in the Idaho claim, on the Titusville lode.

"Remarkably fine and regular banding was observed in the ore thrown out on the dump of a small deserted tunnel. on what is probably the Osceola claim, in Cunningham gulch, about half a mile above Stony gulch. In its most perfect form this banding consists of dark sheets of finely crystalline sphalerite and galena about one-half millimeter in thickness, separated by plates of vitreous quartz about two millimeters in thickness. The result is a remarkably regular and strikingly fine banding. The little sheets of quartz frequently show comb structure and have apparently crystallized in open spaces. In some facies with rather wider banding chalcopyrite occurs, chiefly in the quartzose bands. The cause of such fine and regular banding is not known, but is probably connected with metasomatic replacement. The ore is apparently of too low grade for profitable working, and was not seen in place.

"Cellular Structure.—The quartz or other vein material has crystallized as a mass of irregularly intersecting septa, leaving numerous drusy cavities separated by relatively thin walls.

"This is not a structure characterizing any important ore deposit, and was not seen in place. But it is of interest in view of the possible light that it may throw on the processes by which the vein-forming materials are deposited. The structure is best exemplified by fragments on the dump of the Pride of Syracuse mine, and on an upper dump of the Empire group, Sultan mountain. In the latter case the septa are composed chiefly of sphalerite and galena, and the cells are lined with drusy quartz and, in some cases, filled with rhodochrosite. Beautiful little crystals of ambercolored sphalerite and of tetrahedrite were observed in some of the cells, implanted upon quartz. It is possible that this cellular structure may have resulted from some kind of pseudomorphous replacement coupled with the solution and removal of some unknown mineral.

"Spherulitic Structure.—The quartz of a vein has crystallized in prisms, often imperfectly formed, which show a tendency to group themselves in radial fashion about local centers of crystallization. It is not intended to treat specially under this head such minerals as tremolite, which exhibits characteristically a radial structure.

"A rough spherulitic crystallization, previously described by Purrington, was noted in the gold quartz of the Tomboy mine, and, in connection with banding, in the Camp Bird lode. It is also a notable feature of the North Star lode, where worked in the Dives mine, and of the Magnet lode. The quartz in this case has often grown radially outward from kernels of tetrahedrite. Less conspicuous radial structure was noted in the Silver Queen, at the head of Placer gulch."

In common with other mining districts embracing rugged mountain sections, the mines of San Juan county are operated through cross-cut or adit tunnels. The terms "crosscut" and "adit tunnels," as generally used by miners and mine operators, are distinctive. The term "adit tunnel" applies to an adit started and driven on the ore vein or lode. The term "cross-cut tunnel" signifies the lode is reached by an adit driven across country to intersect the vein. The advantages incident to mine operations through tunnels are obvious. Mines thus opened are at all times free from water and require no expensive pumping plants and maintenance of same. In sections where snowfall is heavy, danger from snowslides or avalanches may, to a great extent, be guarded against by tunnels, and they further afford depth upon the vein, and, being located nearer the mountain base, save expense for transportation of supplies up and ores down. In this connection, the counties comprising the San Juan region are among the few sections of the state where long and expensive cross-cut tunnels have proven good investments, and encountering the vein at great depths is the general result.

The veins of the San Juan are generally but a few feet in width, occur in fissures somewhere near the vertical, and between comparatively solid vein walls. The veins are opened by drifts at vertical intervals varying from fifty to a hundred feet or more, and timbered with stull timbers set in hitch or notch cut in the foot-wall and leaning across the drift against the hanging wall. These stulls are covered with poles, and the waste rock removed is used to fill in the open spaces left by the extraction of the ore. In the event that the entire vein is extracted as ore, the vein walls are generally blasted sufficiently to fill the space and afford a working floor for the miners. The latter method, which is quite common, also demonstrates that parallel ore veins are not being overlooked or practically lost.

San Juan county may be justly credited as the pioneer of metallurgy in this region. Following the installation of the Mexican arastras in 1871-'72, came the "blowing in" of the Greene smelter, in 1875. This was one of the first successfully operated water-jacket furnaces in the state. This period was followed by the erection of several lixiviation plants that were operated more or less successfully. During late years, however, milling plants of the ordinary types for amalgamation and concentration have replaced all others. The use of canvas tables below the ordinary belt or rotating tables was a general practice in this section before its adoption in other districts. The mechanical appliances for crushing the ores are at present about equally divided between stamp and Cornish rolls, the selection being made according to mine product. The largest operative mills at present are locally known as the Silver Lake, Gold King, North Star, Sunnyside, Sunnyside Extension and Hercules. . The names are common to the mines with which they are connected. A number of milling plants are under construction or contemplated in the near future. The Kendrick-Gelder pyritic smelter, a plant having a normal daily capacity of about one hundred and fifty tons, was thoroughly overhauled during the winter and was successfully operated during the summer months. This plant affords a home market for ores too low in value to permit of shipment and charges at regular lead smelters. The construction of the plant was primarily for the reduction to matte of the ores from mines owned and operated by co-ordinate companies. Durango furnishes a good market for all ores and concentrates produced in the county.

The county is locally divided into mining districts having somewhat indefinite boundaries and varying names. Those most commonly used are Red mountain, in the northwest, tributary to Mineral creek; Animas, in the extreme northern end and that portion east of the Animas river; Eureka, the drainage of Cement creek and west tributaries of Animas river; Anvil mountain, embracing the spur from Red mountain between Cement and Mineral creeks; Ice lake and San Juan in the southwest part of the county.

During the past year there has been a greater activity in mining than ever before in the history of the county. Numerous transfers have been made, and a number of new companies been organized. The apparent tendency is to consolidate minor holdings into companies competent to mine on a large scale. The most prominent and best developed group of mining properties is that known as the Silver Lake mines. Since the purchase of this group of twenty or more claims, the Titusville group of fourteen claims and the Scranton groups have been added, together with a number of new locations, the whole comprising a large and compact acreage. The Silver Lake mines are equipped with all modern appliances, and the electrical plant on the Animas, which is utilized to full capacity, is supplemented by steam plants. The development work on the group aggregates several miles, and two tunnels are under way to open greater ore reserves. One of these tunnels will cut 1,000 feet and the other 2,300 feet below the apex of the vein. The latter tunnel, when completed, will have a length of about 11,000 feet from the portal. In the same vicinity, the Iowa and Tiger group have been under extensive development. The production, however, from these properties has been restricted for reasons best known to the management.

On Sultan mountain the North Star, of the Silverton Mining Company has an aggregate development of about 22,000 feet. This company is erecting a 100-ton concentration plant. The King group of the Royal Mining and Investment Company has about 3,000 feet of development and is employing an average force of twenty men. The Champion group of the Notaway G. & C. Co. stopped production in July, 1902, and development is concentrated on crosscut tunnel. The Little Dora of the Hercules Consolidated Mining Company is largely developed, well equipped, and employs an average force of about twenty-five men. The Idaho, on Kendall mountain, has about 4,000 feet of development and employs an average force of ten men.

In the Gladstone section the Gold King group of the Gold King Consolidated Mines Company has been a large producer, and improvements are under way to double present capacity. The developments on this group have been on a large scale and highly satisfactory. In addition to mining plant, this company operates the railroad between Gladstone and Silverton. The Grand Mogul Mines Company is employing a large force on development work, and have opened large ore reserves, with about 4,000 feet of drifts, etc. A large milling plant is a contemplated addition in the near future. The properties controlled by the Natalie Mining and Milling Company and the Big Colorado Mining and Milling Company are under systematic development. About three miles from Gladstone the Henrietta, one of a large group of claims, has been extensively developed during the year, and the favorable results of this work will doubtless soon add another profitable mill to this section.

The development work on the Utica group of 12 claims, in Deer park, is proving satisfactory. These properties are, as yet, but promising prospects. The Western States Gold Mining Company have under way an 1,800-foot cross-cut tunnel to develop the Montana group of 19 claims.

In the southwest portion of the county, among the active properties may be mentioned the Brooklyn, New York group and the Silver Ledge group. The latter company has recently added a 100-ton concentration mill, new houses and equipment for operating to full capacity. An increased number of old and new properties have been developed to a greater or less extent during the past year, and several sales of valuable groups are reported as virtually closed. These latter are properties that have been practically idle for a number of years.

In Minnie gulch the development work and production of the Esmeralda have proven highly satisfactory, and the mine is being equipped with hoisting plant for development at greater depth. The Bessie, in same gulch, was also a producer, and is under bond to an Eastern syndicate. The Silverton Girl, in Maggie gulch, reports the encountering of a body of high-grade ore.

In the vicinity of Mineral point, in the north end of the county, there has been a marked revival of interest, and a number of properties that have been idle for a number of years have been prospected with a view to extensive operations. This section is about equally distant from Ouray and Silverton, and the county boundary is somewhat indefinite.

The Highland Mary group, in Cunningham gulch, has been under extensive development for the past year or more, and the Gold Tunnel and Railway Company, controlling same, is erecting a large mill on the property. This plant is to be operated by water power, but a steam auxiliary plant is also installed.

The North Star group, on King Solomon mountain, has been actively operated during the past two years by the Contention Mining Company. A mill for treatment of the ores has been erected, and an average force of 80 men employed in mine and mill. The Black Prince is extending Contention tram to mine, and making other important improvements.

The Sunnyside group, in the north branch of Eureka gulch, has been extensively exploited and increased milling capacity added. This property is located on one of the large veins, or a series of parallel veins; the predominating ore value is in gold, and it bids fair to be one of the best producing mines of the county.

Tributary to Eureka, the Scotia, in Picayune gulch, noted for its rich gold ores, is operating under lease. The San Juan Queen group is developing by shaft from lower tunnel level. The Hidden Treasure group, in Mastodon gulch, is extending development. The Independence has developed good body of milling ore. The Early Bird group has been among the regular producers. The Silver Queen group, on

Treasure mountain, has devoted energy to development, aggregating about 1,200 feet, and marketed small amount from ores produced in development work. The Sioux Mining Company has 14 men engaged in development. The Silver Wing and Fredrica groups are operated by the Eureka Exploration Company, and have an aggregate development of about 4,000 feet. The Silver Wing mill, a 50-ton concentration plant, is operated in connection with mines. The Tom Moore has an average force of 16 men on development work. The Washington, about four miles above Eureka, is developing with small force. The property of the Tobasco Gold Mining and Milling Company consists of a large group in San Juan and Hinsdale counties. The aggregate development amounts to several thousand feet, and there is a 100-ton concentration plant in connection with claims.

The foregoing is a brief and necessarily unsatisfactory mention of some of the operative mines of the county. The district may be summarized as one that has a bright future, especially so where mining operations will be conducted on a scale of some magnitude. The ores, as a whole, are low grade and require some system of dressing or reduction. The apparent tonnage supply is large, and, with proper equipment and management, long continued profits may be confidently expected.

SUMMIT COUNTY.

This county was one of the original subdivisions made by the territorial legislature in 1861. As first organized it embraced the whole of northwest Colorado, but has subsequently been segregated in six county divisions, of which Summit is the smallest, embracing but a small portion of the southeast part of its original territory. It now has an area of about 690 square miles, and the adjoining counties are Grand on the north, Grand, Clear Creek and Park on the east, Park, Lake and Eagle on the south, and Eagle on the west.

In form the county is very irregular, being almost wholly embraced within boundaries that are outlined by the crests of mountain ranges, viz., the Williams River mountains on the east, the Continental divide on the south, and the Park range on the west. The included territory lies wholly on the Pacific slope and embraces the valleys of the Blue, Swan, Snake and Ten Mile rivers, with the drainage basins of their tributaries, all of which unite with the Blue and form one of the large tributaries of Grand river, which it joins near the north county boundary.

This region is almost strictly a mining county. Its mining history practically begins with the summer and fall of 1859, when nearly all sections of the state were entered by the overflow from the so-called "Pike's peak" excitement. The placer beds on the Blue river and its tributaries are credited with a production of many million dollars' worth of gold, to which may be added the later production of the lode mines. These latter have been constant producers since 1879, which may be said to be the result of prospecting by the overflow from the Leadville excitement.

The placer deposits in this section are in most respects common to those of other mountainous sections of the state. They occur in low flats and bars along the stream beds, or in ridges or benches above the level, but adjacent to the streams. The latter, generally designated as "bench diggings," have been those most operated until within the last few years. The gold in these beds is generally bright and clean, and ranges from 800 to 900 in fineness. It generally occurs in the form of nuggets and coarse grains, or "shot gold," the latter predominating, and is comparatively easy to recover. The amount of flour gold is relatively very small. These conditions caused Gold Run, Georgia, American, Humbug, Galena, Nigger, French, Illinois and Mayo gulches, and Yuba Dam, Delaware and Buffalo "flats" to be well known districts early in the history of the state. These beds could be attacked at comparatively small expense for equipment, and have been constantly worked each summer in a more or less active manner. To recover the rich deposits of gold along and under the stream beds proper is a proposition that requires large outlay in equipment, and skillful management. Prospect work has demonstrated a number of favorable conditions, viz. : The beds are composed mainly of a rather coarse gravel, with a few large boulders, and not enough clay to materially retard recovery by the ordinary methods of sluicing; the bed rock, although of variable texture, is generally hard enough to afford a good working floor; the gold is comparatively coarse, bright and clean, yields quickly to amalgamation, and the loss from fine gold is relatively small. The better values appear to be near the upper ends of the valleys and to gradually decrease

in value as distance from the stream head is gained. There is also an increase in the occurrence of large boulders near the upper end of the valleys. The beds vary in thickness, but will probably average about sixty feet. The unfavorable conditions are mainly shortage of water, except for a limited time each summer or spring, and the lack of dump space for material removed, necessitating a handling of same to a great extent after sluicing. The results at present being attained in this section, by the extensive operations in vogue by several large companies, is being watched with great interest. Detail may not at this time be given, but the latest and most approved appliances have been installed, and operations are reported as being largely satisfactory.

During the past season one of the large dredges has been operated to near its normal capacity, and the returns appear satisfactory to those most concerned, although not given to the public. This system overcomes the shortage of water, but it is urged by those using the open pit system that the most valuable product, viz., the gold that naturally concentrates in the small cracks and fractures in the bed rock, is not recovered. The operators, however, claim that the bed rock is not only cleaned, but is actually removed by the elevator buckets to a depth beyond where any concentrated gold could exist. In the open pit system the rock is removed to sluices by hydraulic elevators, which are protected from large boulders by a grizzly. The boulders are either broken up or removed by rock boats or elevators to dumps. This system affords an opportunity to carefully clean up the bed rock and crevices and recover all the gold washed down to bed rock by the nozzles, but not elevated to the sluices. The shortage of water or the short season when the water supply is ample is urged against this system, together with the expense incident to pumping seepage and excess water from the pit. Both systems, however, have been operative and report favorable returns. The field for future operations is quite extensive and demonstrated to be of great value.

The topography of the county may be generalized as that of mountain ranges surrounding somewhat restricted valleys, with streams whose drainage basins are below the mountain summits. Breckenridge is the county seat, located in the valley of the Blue, at an altitude of about 9,100 feet. The surrounding mountain ridges culminate in a number of peaks varying from 12,000 to 14,000 feet above sea level. This section is traversed in part by two railway systems. The Colorado & Southern enters from Denver via Breckenridge pass, thence winds down the mountains to Breckenridge and follows the Blue river to Dillon, thence up Ten Mile creek, via Frisco, Curtis, Kokomo and Robinson, to Leadville. The Denver & Rio Grande Railroad parallels the other line between Leadville and Dillon. From Dillon a wagon road extends north down the Blue river valley to Grand county, and a railroad grade has been constructed a considerable portion of the distance.

What is known as the Ten Mile mining district occupies the southwest part of the county. The geology and mineral deposition of this section has received the careful consideration of Mr. S. F. Emmons and his able corps of assistants. The results of this investigation are embodied in Mr. Emmons' report to the United States Geological Survey and published in folio No. 48, entitled "The Mile District," to which reference for detail is made. Mr. Whitman Cross gives a "general sketch" of this district, which in part is as follows:

The Ten Mile district adjoins the Leadville district on the north. It lies on the west flank of the Mosquito range, and just to the north of the continental divide, as it crosses from the Mosquito to the Sawatch range. The mapping of this district was carried out by Ernest Jacob, under the direction of S. F. Emmons. The present writer examined and collected specimens from the greater number of the eruptive masses after they had been traced out by Jacob. For permission to make a statement of the general geology the writer is indebted to Mr. Emmons. The area studied in detail is only about $8\frac{1}{2}$ by $7\frac{1}{4}$ miles in extent. Along its eastern border is the great Mosquito fault, separating the rugged Archean range from the area of Carboniferous and Triassic beds on the west.

While the Archean area is higher and more rugged than the sedimentary, there are still important mountain masses made up of the latter rocks and the eruptives which have penetrated them. The stratified rocks, have, in general, a slight easterly dip, with a shallow syncline near and parallel with the Mosquito fault.

The main sedimentary formations of the Ten Mile district are the Trias, and the Upper and Middle Carboniferous, the lower formations being shown to the westward in Eagle River vailey. The Middle Carboniferons, or Weber grits, consists of shales, sandstones, grits and thin limestones, in a thickness of about 3,000 feet. The Upper Coal-measures are mainly sandstones and fine conglomerates, with some shales and limestones, reaching a thickness of 1,300 feet. The Trias is here a series of sandstones and conglomerates, much like the Upper Coal-measures, and with a thickness of 1,700 feet now remaining.
Throughout the 6,000 feet of this sedimentary section are many masses of porphyrite, occurring principally in sheets nearly or quite conformable with the bedding of the strata and in a few small dikes. More than sixty different bodies are represented upon the map, and they are about equally distributed in the three great divisions of the strata.

Occurrence of the eruptive rocks.-The porphyrite sheets of the Ten Mile district are very regularly intruded on certain stratification planes, which they follow for several miles in many cases. They are of varying thickness, from twenty to 200 or more feet, and in some sections a dozen or more sheets are seen separated by sedimentary layers of nearly the same average thickness. In tracing out a given sheet it is usually found to have a more or less irregular contact with the strata, and in some cases cut across from one horizon to another, slightly higher or lower. The forking of a sheet may occasionally be observed, and several of the larger ones include considerable slabs or lenses of sediments. Dikes appear at various horizons, the rock resembling the contact zones of the sheets in some cases, and in others being like the main sheet rock. Contact phenomena are usually confined to the eruptive, and consist merely in the development of a narrow band of finer texture for a few inches from the contact. The effect is the same on the upper as on the lower contact.

One mass at the head of Eagle river is a great lens, to be compared with a laccolite. Its maximum thickness is about 2,000 feet, and certain arms of it cut more or less sharply across the stratification. Sheets of just the same rock type occur above this large mass.

Several of these porphyrite sheets extend southward into the area of the Leadville map, and it is claimed by Mr. Jacob that one of the lower sheets of the Ten Mile district is continuous with the main sheet of "gray porphyry" found at Leadville some fifteen miles distant. The rock is of the same type, certainly.

The intrusive rock.—The different intrusions of this district are all porphyrites, and there is much less diversity in their composition than in the main Mosquito range. The "Lincoln Porphyrite," characterized by phenocrysts of plagioclase, biotite quartz, and a variable number of large orthoclases, with a granular groundmass of quartz and orthoclases, is the rock of the Eagle river laccolite and of several important sheets near it, as well as of dikes in various parts of the field. The same type occurs in dike form in the Archean, and in small sheets in a remnant of Cambrian quartzite left on one point just east of the Mosquito fault. Two sheets and several dikes of this type are found in the Trias.

The greater number of the sheets of the Ten Mile district belong to a type distinguishable from the preceding only by the absence of orthoclase phenocrysts. Chemical analysis shows that the two types are identical in composition and that the development of the large orthoclase is a question of conditions of consolidation. The significance of this point in connection with some theories of porphyritic structure are pointed out in a later section of this article. These quartz-mica-porphyrites shade almost insensibly into forms carrying some hornblende and a little less quartz, and pass into a hornblende-mica-porphyrite with quartz in very small amount and restricted to the groundmass. Some of these are almost identical with the prevalent type of the plateau laccolite groups.

Allanite is more abundantly present in the Ten Mile rocks than in the Mosquito range, and it serves as a peculiar link, and a strong one, in the writer's estimation, to prove that this great series of eruptives are all most intimately connected in origin.

The rocks composing the remainder of the county may be generalized as fragmental beds of the sedimentary strata, as recorded in chapter on Park county, resting along the flanks of the granite-gneiss mountain ranges. This section originally formed a part of the existing open area that included South, Middle and North parks, and the sedimentary rocks are therefore the same. Since the uplift separating what is now the valley of the Blue river and South park, a large part of the stratified rocks have been removed by erosion and now locally exist as detached remnants.

Summit county, since the advent of Leadville, has never regained the supremacy it maintained for some years over other sections. It possesses large reserves, both in lode and placer mines, and during the past few years the general appreciation of that fact is being evidenced by increased activity in all of the various mining districts. Among the most active properties are the following: The Gold Pan Placer and Gold Pan Engineering Mines and Supply Company, the Tyra placer in the vicinity of Breckenridge, known as the Spaulding district; the French Gulch Placer Mining Company, in the Bevan district; the American Dredging Company, four miles north of Breckenridge, in the Swan River district, equipped with Bucyrus dredge, and the Gold Run, formerly the Peabody placer, owned by the same company. The Ora Grande, near Dillon, in the Wilkinson district. This company has installed Evans hydraulic elevators and has a plant similar to the Gold Pan Company. The Salt Lick placer, in same district. During the past season several sensational gold nuggets have been recovered, the largest being by the Bucyrus dredge, on Swan river. It weighed twentyeight onnces, and had a value of \$499.82. This is one of the largest placer muggets ever found in the state. While placer territory is being gradually absorbed by large companies, there still remains a number of smaller tracts or claims that

are operated in a desultory manner by individuals. Some new companies have been organized and will doubtless appear in the producing column next season.

The ore deposits of this county occur both as fissures and as "contact" veins. The contact veins occur in the lime beds, which have been locally replaced wholly or in part by the ores and gangue minerals. While these are comparable to the Leadville and Park county deposits, they occur at different geological horizons, and are generally not in direct contact with the intrusive porphyry sheets. The fissure veins occur both in the sedimentary strata and the granite areas. The latter are comparable to the Clear Creek county veins, and the former occupy fracture planes, or are in conjunction with dikes. The ores are mainly sulphide of lead, iron, copper and zinc or their oxidized products, carrying gold and silver values.

In the Ten Mile district there has been a large amount of new development work done, and the district as a whole shows increased activity. Among the active properties are the Michigan group on Sheep mountain; Colonel Sellers group, a large producer of iron sulphide ore; Delaware; Eagle Mining Company, on Elk mountain; Summit Mining and Smelting Company, with concentration plant; Conners Bonanza Mining Company. This tunnel is started near Kokomo and projected to cut Robinson vein in 2,500 feet. The Uthoff tunnel, Nettie B., on Sheep mountain; Free America, on Jacques mountain; Bird's Nest, Queen of the West, Tenmile Leasing Company, Half Moon, Snow Bank, Wheel of Fortune, Free Coinage Mining Company, Kimberly group, Michigan group, Boyce Gold and Silver Company, Gold Cord Mining and Smelting Company, Crown Point and Iolanthe. The Mountain Pride, in Bald Mountain district, is operating mine and twenty-stamp mill. Silver King reports strike in lower workings. Carbonate, operated by lessees. Dunkin, driving tunnel.

In the Farncomb Hill section, work is prosecuted almost entirely by lessees. This section is noted for its crystalline gold specimens, and the frequent occurrence of small pockets of high grade ore is very seductive to small operators. Among the properties operated are the Grouse, Fountain, Teller, Gold Flake, Silver, Townsend, Boss, Ontario, Key West, Geventa tunnel and Mulberry. In the Bevan mining district the Minnie is again under development. The Junita has been a spasmodic producer. The Agasta Mining and Milling Company, Colorado and Wyoming Company, and the Dunkin Mining Company have been prosecuting development.

The Hamilton mine and twenty-stamp mill, at head of Summit gulch, are working to capacity. The Cashier Mining and Milling Company is also operating twenty-stamp mill in connection with its property in Brown's gulch. The June Bug mine, on Gibson hill, is working small force on high grade silver ore. The Lightburn tunnel, in Gold Run gulch, is working small force. The Carrie, on Mt. Wise, twelve miles east of Breckenridge, near Swandyke, is operating small cyanide plant in connection with mill.

In the Snake River district there has been more activity than for many years. At Montezuma business has been greatly increased and lodging at times is difficult to procure. This section lies west of Clear Creek county, and until the past few years has been practically dormant. The California group has become a regular producer. The Bullion group is likewise producing regularly and operating concentration mill in connection with mine. A new company, known as the Ohio Mining Company, has revived the properties of the Pennsylvania Mines Company, and produced about 1,000 tons of silver-lead ores; a mill in connection with mine. Among others in this section are the Witches Head, Silver Cord, Hunkidori, Sunburst and Eureka.

Near the extreme north part of the county there has been considerable activity and excitement during the past year. The early reports indicated a section liable to become productive in short time, but these have not been confirmed beyond that of fair looking prospects with low grade gold-copper ores.

In the production for 1897-'01, inclusive, given below, the gold exceeds the silver on account of product from placer beds. Nearly all the lode veins carry small percentage of gold in their ores, but the predominating value is silver.

Year.	Cold	t.	Silve	r.	Len	d.	Copp	· a ·.	Total.
1997		0 13	\$306,664	83	\$ 59,108	12	\$14,015	61	\$653,438 69
1898		1 78	242,137	6S	177, 478	11	1,179	00	764,619 57
1899		6 02	157,810	74	180,249	67	11,540	01	610,166 44
1900	338,18	87	247,684	95	265,386	58	8,760	56	860,013 96
1901		9 29	217,458	89	188,201	()+) be be	2,824	62	717,204 02

TELLER COUNTY.

•This great gold producing county was created by the Twelfth General Assembly, the act receiving executive approval March 23, 1899. Its territory was segregated from El Paso, Fremont and Park counties, principally the first mentioned. As constituted, it embraces about 535 square miles and occupies a central position in the state. The adjoining counties are Douglas on the north, El Paso on the east, Fremont on the south and Park and Jefferson on the west.

Teller county is perhaps better known throughout the country at large as the Cripple Creek mining district. So much has been written of the early history of this section "when it was a cow-camp," etc., and its rapid development during the past few years into a great gold-producing district has occupied so much space in periodicals of all description, that it need not be repeated here. In only one particular will this oft-repeated and interesting story of the early mining history be referred to, and that briefly. One feature always given prominence in the numerous historical reviews, especially of the Cripple Creek district, is, that the "mining expert," "men of great experience" in metalliferous mining who were employed to report on properties in the "early days" consistently made adverse reports and pronounced the section "worthless." This claim is only true in a minor degree. With no desire to in any manner lessen the credit due the indefatigable energy, wisdom and keen observation of the prospectors, for they are entitled to great credit, the fact is that many mining engineers made most favorable reports upon the district. These, however, were not given to the press, but submitted to mining and business men, who, in contemplating new enterprises, rarely sought notoriety, and left the public ignorant as to their approval or disapproval of the section for mining purposes. The conditions surrounding ore deposition was in a restricted sense new to the Colorado mining field, and few, if any, engineers were granted sufficient time to substantiate their favorable reports with desired data. That these reports were favorable in a large degree, and so far interested capital as to exert itself in procuring the services of the United States Geological Survev is practically unwritten history. Prior to and while the

survey was making, mining territory was being quietly procured. The later and permanent development of the district followed one of the so-called "excitements" that had subsided and many had left the district. The subsequent revival was immediately preceded by the appearance of the Cripple Creek Folio publication of the Geological Survey. The demand for advance sheets of this publication was unprecedented, and to it more than any other one factor was due the revival of interest. The clearness of deductions therein given was appreciated by the mining engineers, and the later developments of the district are due to its intelligent guidance and advice. The great work incident to a geological survey of a district is beyond the individual, and must be undertaken by corps of engineers ably trained in the work of their several branches. The combined result of this work, described in detail and illustrated by a series of maps, provides the mine operator, through his engineer, an accurate base for individual effort. The United States Geological Survey and its able "experts" require no defense. The great value of its work, however, is little appreciated except by those who attain practical results in mining through its use. Public sentiment is, to a great extent, shaped by the press, and the constant discrediting of scientific research and attainment is derogatory to the best interest of the state. The United States Geological Survey, like all state departments, must be conducted in accord with the financial support granted by Congress and the various state legislatures. If the legislators assume their respective duties, ignorant of the benefits to be derived by scientific research, and more or less prejudiced against so-called "experts," the result, when appropriations are under consideration, is obvious. Again, the prospector can not be granted too much praise for his work at Cripple Creek and all other sections of the state, but writers for periodicals should ever bear in mind that the work of the prospector practically ceases where the work of practical mining and metallurgy begins.

The importance of the Cripple Creek district as a precious metal producer is evidenced by the following production table:

Year.	Gold.	Silver.	Lead.	Copper.	Total.
1899	\$16,058,564-31	\$19,033-74		\$18-43	\$16,107,616 51
1900	18,147,681-21	49,611-37		22 14	48,197,317 75
1901	17,232,692 35	52,786 78			17,285,469 13

The following table shows the total production of the entire state, Cripple Creek district included, for a like period :

Year.	Golđ.	Silver.	Lead.	Copper.	Total.
1899	\$26,508,675 57	\$13,771,731 10	\$ 6,170,765 53	\$ 1,295,610 85	\$47,746,783 05
1900	28,762,036 29	12,488,774 84	7,770,196 24	1,293,011 98	50,314,019 35
1901	27,679,445 04	10,901,365 89	6,419,131 61	1,303,297 17	46 303,239 71

The above tables show a slight decrease in production during 1901, as compared with preceding year. The main cause of this decrease is attributable, in part, to restricted production in certain properties, pending the completion of reduction works, but is due, in the main, to the change in grade of ores marketed. The tonnage in 1901 was greater than in the preceding years, and the product was largely obtained from a grade of ore that a few years before had no market value. In the "early days" ores having a value of \$100 per ton and over were required to yield a profit. Later, ores having a gross value of \$75, \$50, \$25, \$20 and \$15 per ton have, through the erection and successful operation of chlorination and evanidization plants, been marketed at a profit. The lowest grades above mentioned have only been made to yield a profit above operating expenses during the past few years. At the present time low-grade ores and increased tonnage is given preference over high-grade ores and small tonnage by a greater number of producers. The complete data for the completion of the production for 1902 is not, as yet, obtainable. The tonnage and general activity of the district would indicate that the aggregate result would for 1902 be equal to, if not in excess, of that of the preceding year. No estimate, however, is at this time given by the Department.

The Cripple Creek district has been the subject of many, papers. The following, by Mr. T. A. Rickard, formerly State Geologist of Colorado, is here reproduced because of its concise and yet comprehensive description :

Situation and Appearance of the Region.—The known gold-bearing portion of the district covers an area of about ten square miles, occupying a group of hills which rise from 300 to 1,000 feet above the general surface, and attain an average altitude of 10,500 to 11,000 feet above the sea. The drainage of the district flows into the Arkansas river, whose gateway into the plains is at Canon City. The general slope is southward, and the sunny aspect incident to this configuration of the surface has caused the hillsides to be clad with sufficient grass, and enabled them, at one time, despite the high altitude, to yield good pasturage.

Few mining camps have so picturesque a situation, and Cripple Creek is further notable because the picturesque is not obtained by any sacrifice of accessibility. The beauty of the panoramic view to be obtained from most of the mines is not due to mere ruggedness or to the ordinary grandeur of a mountanous country; it is traceable to a position upon the slopes flanking Pike's peak, which permits of an uninterrupted view of snow-clad ranges a hundred miles away. It is a panorama rather than a picture. In front are hills like giants tumbled in troubled sleep, whose feet touch the plateau of the South park. To the left are the Arkansas hills that confine the river of the same name to its tumultous gorge; further south is the Wet Mountain valley, and beyond that the long, magnificent, serrated range of the Sangre de Christo. * Turning northward, the valley of the Arkansas can be seen dividing the mountains which overlook Leadville. Further to the right are the beautiful Kenosha hills, at the head waters of the Platte, and beyond them are further peaks ennobled with coronets of snow. The details of the view are lost in the vastness of it, which impresses the observer no less because he may be surrounded by a noisy murmur of trains, steam whistles, wagons and machinery, which tell of the activity going on about him. Nor should he feel annoyance with his surroundings, for there is a nobility of human endeavor and successful achievement no less impressive than the beauty of the snow-clad peak and sunlit plain.

The physical condition on the surface had much to do with the checkered history of the district. Owing to a southern exposure and the comparative absence of a protecting growth of trees, the rocks, which mostly possess a fissile structure, have been shattered by frosts so as to overspread the solid formation with a thickness of debris, to which the tufted grass has given a further covering. Water, owing to its expansion between 4 degrees C. and the freezing point, is a ceaselessly destructive agent. When it penetrates the cracks and crannies of the rocks it serves as a wedge, shattering their stony substance with resistless power. The heat of the day and the cold of night, the warmth of summer and the snows of winter, alike aid this disintegrating process. A high altitude and a southerly slope afford the conditions most favorable to such action. Thus it came about that the district of Cripple Creek is largely covered with the shattered rock which the miners call "wash," incorrectly, however, because it is not composed of rounded waterworn material, but of angular fragments which, if not in place, are not far from their original position, having slid down the hill-slope in obedience to the laws of gravity. This shattering of the rock surface has caused one very important and, in Cripple Creek's case, far-reaching result. There are no outcrops. Ordinarily, the veins of gold ore stand above the surface with that boldness which caused the Australian miner to term them "reefs," and the Californian to call them "ledges." The ore, as will be seen when discussing the geology of the gold-field, is essentially altered and enriched rock.

comparatively devoid of the quartz composing the typical lodes of other districts in America and Australia, and consequently it shares with the rock the tendency to undergo easy shattering. Solid vein-stone, therefore, rarely survives amid the general disintegration, the outcrop of the Independence being a very notable exception.

The first discoveries in mining are usually due to the finding of outcrops; in the absence of them, deep explorations are seldom undertaken. Deep ravines often afford good natural sections of the rock formation. The Cripple Creek district was as deficient in one feature as in the other. The absence of steep declivities and abrupt rock-faces was characteristic of the pastoral landscape, and the angular debris covering the rounded hillsides made digging difficult. For these reasons, although the district was traversed by many thousands of prospectors at successive epochs, the existence of rich lodes was not surmised until a very recent date, and many experienced miners failed of success at first because they encountered conditions unfamiliar to them. Among the early arrivals, in 1891 and 1892, were the miners from Gilpin, Leadville and Aspen, men of knowledge in their own habitat, but unable to understand the peculiar vein-structure which they saw at Cripple Creek. It was the adverse opinion of these men, rather than the views of geologists or scientific observers, which injured the reputation of the gold-field in the beginning of its development.

The Geology of the Gold Field.—The Cripple Creek district occupies the ground-floor of a volcano, the superstructure of which has been removed by erosion. This interesting fact is responsible for many of the peculiar features of the region. The mines are situated amid a complex of volcanic rocks lying upon the southern slope of the mass of granite whose culminating point is Pike's peak. These volcanic rocks found a passage through the underlying granite during the comparatively recent period known to science as the Miocene, an early part of the last three great subdivisions of geological time. The granite was formed in the very beginning; out of the substance of it the foundations of Pike's peak were upbuilt and the crest of the mountain was chiseled. It is the basal rock of the region and at one time probably formed the bed of the ancient seas which received the sediments now composing the sandstones and limestones flanking the Front range. The granite is of a particular type, known, because of its prevalence in this locality, as Pike's peak granite. It is coarsely crystalline, and its three ingredients, the minerals quartz, mica and feldspar, are easily distinguishable by the unaided eve. A beautiful red tint, mainly due to the color of the feldspar, characterizes it and renders it recognizable by the least observant.

Long subsequent to the formation of the granite, and also that of the sedimentary rocks which were laid down upon it, there began an elevatory movement supposed to be traceable to the readjustment of the earth's exterior to its cooling and shrinking interior. Accompanying this movement there occurred a general fracturing of the rocks thus affected, so as to permit volcanic matter to force a way upward, after the manner

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of water rising through cracks in the overlying ice. The volcanic matter thus brought to the surface of the granite slowly filled the hollows of its uneven surface, and spread over a large area since then diminished by the patient forces of atmospheric erosion, which, during the long period of time separating the Miocene from the present day, have slowly sculptured the hills and valleys of the district.

A glance at the geological map of the gold-field exhibits a great variety of volcanic rocks. The principal of these is andesite breccia. The very nature of the breccia suggests the violence of the volcanic action which brought it to the surface of the granite. The miners call the breccia "porphyry" from its apparent resemblance to the rocks of that class with which they were previously familiar in the Leadville and in the Gilpin county mines. The porphyry of Leadville is quartz-felsite; that of Gilpin is quartz-andesite. Porphyry is an adjective-noun and refers to the structure rather than to the composition of a rock, so that there is "granite porphyry," "diorite-porphyry," "andesite-porphyry," etc., the term being applied to rocks of igneous origin in which particular minerals are distinguishable amid the groundmass of the rock so as to give it a speckled appearance. The Cripple Creek breccia has this appearance, but it is due to the fact that it is made up of a heterogeneous mass of rock particles of every size, from the most minute powder to fragments as large as a man's head. These consist mainly of andesite, but the other rocks are also included, especially near the edges of the volcanic vent. Some of this material is mere volcanic dust, called "tuff," which, when consolidated under pressure and cemented by silicious waters, becomes compacted into a dense, hard substance difficult to distinguish from a true crystalline rock; so that it is not to be wondered that the miners often label it with an incorrect name.

The breccia lies in the uneven hollows of the granite and probably fills a large part of the crater formed by the energies of the volcano. The thickness of the breccia has not been proved, nor has the exact position of the original vent of the volcano been discovered. There is evidence, of a general kind, chiefly in the composition of certain masses of eruptive rock, which indicates that there were two vents, at least—one near Goldfield and the other near Guyot hill. The mine workings which happen to be near the rim of the central basin have penetrated through the breccia into the underlying granite. A depth of over 1,000 feet has thus been proved by the sinking of shafts. There is, however, evidence to indicate that the maximum depth of the breccia formation, in the vicinity of the vent, must be several times 1,000 feet.

The breccia is penetrated and traversed by later volcanic rocks, of which phonolite is the most important in its relation to the occurrence of ore. Until recent years phonolite was not known as a rock species save as forming the Wolf rock in Cornwall, and, therefore, its association with great mineral wealth at Cripple Creek has been one of the most interesting features of the development of that district. The phonolite occurs for the most part in dikes; that is to say, in approximately vertical sheets

which traverse the older formations, the granite and the breccia, in various directions, and are probably united, at depths far beyond the reach of human exploration, to larger masses of rock having a similar composition, just as the cracks in ice are filled with a liquid similar to that beneath.

These dikes follow such lines of weakness in the older rocks as were developed into fractures at a time when the rocks underwent strains, the latter being considered to be the result of the slow wrinkling of the earth's crust due to its readjustment over a cooling and shrinking interior.

The phonolite rose in a mobile, if not molten, condition through the fractures thus formed, after the manner of water rising through the cracks in the overlying ice. The structural conditions thus created gave a direction to the subsequent circulation of underground waters. The deposition of ore is the result of such circulation, the underground waters being the vehicle by which the metals are leached out of the rocks at one place and laid down at another in such a concentrated form and within such a distance of the surface as to render them valuable to man. The place of ultimate origin is surmised, but vaguely, as being deeper than our deepest mines, and the place of deposition of the ore is not always the place where the miner finds it. Lines of weakness, healed and strengthened by the cementing effects of hot igneous rock, in the form of dikes, afford new lines of lesser resistance, parallel to the old ones and along the contact of the two rocks of unlike hardness and texture. For this reason ore-bearing veins so often accompany dikes. They do so at Cripple Creek.

It is well to begin the discussion of a subject by defining the terms employed. A "lode" is something which leads a miner, the words "lode" and "lead" having an identical Saxon origin. Australian miners designate a small, continuous vein connecting larger ore bodies as a "leader." "Lode" is therefore a comprehensive term covering many diverse forms of ore occurrence. The word "vein" has a more restricted usage, and describes those lodes in which the ore is supposed to occur in a tabular form, occupying continuous planes which are approximately vertical, and traversing the rocks like interminable sheets of paper set on edge; that is, they are supposed to fill simple fractures made in a perfectly homogeneous material. This term was originally borrowed from the human anatomy, and the oldest writers have used the simile of the rock veined with the precious metal. Nature does not recognize the definitions of the technical dictionary, and in mining practice it has been found that regularity of structure is the exception rather than the rule. The geologist of fifty years ago, when the science of geology was more the product of the library and laboratory than of actual observation underground, conceived the ore as having filled gaping fissures in the rock, comparable to the crevasses of a glacier; and when he had noted the dissimilarity between the ore and the encasing rock, he imagined the former to have been due to an upwelling of molten metallic matter. The ideas of the

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present day are still slightly tainted by the imaginations of the past, and the terms of an obsolete philosophy continue to cling to our nomenclature.

Modern investigations, based on accurate chemical knowledge, as well as geological observation, have all gone to prove that gold ores are not the product of direct volcanic action, but that they have been conveyed to the place where the miner finds them through the medium of water, the metals having been dissolved in various chemical combinations, by underground solutions, and precipitated along those fractures in the rocks which have been first lines of least resistance, and then lines of maximum circulation. The mineral solutions can not have come from indefinite depths, because the increasing pressure encountered would finally tend to close the channels of circulation, and also because the increase of heat (1 degree Fahrenheit for every forty-eight feet of descent), observable in the sinking of shafts and bore-holes, indicates that at a horizon of about 20,000 feet below the present surface a temperature (the critical point, 773 degrees Fahrenheit) would be attained, at which water, in spite of the pressure to which it would be subject, becomes disassociated into its constituent gases. It is considered probable, from the evidence yielded by certain classes of lodes, particularly those of nickel ores, that volcanic action serves to bring the metals from these great depths to that zone of the earth's exterior wherein solvent waters can circulate. The experience of gold mining corroborates this view, the association of volcanic rocks with bodies of valuable ore having become almost proverbial.

It is not surprising, therefore, that this very fact has tended to cause a confusion of ideas between volcanic action and lode formation.

In a railway cutting between the towns of Cripple Creek and Anaconda there is a bit of nature's testimony which will be of service in getting a clear idea of the essential characteristics of gold-bearing veins as compared with dikes of volcanic rock. The accompanying drawings will help the description. In Fig. 3 there is afforded an excellent illustration of simple dike structure. The dike in this case is composed of basalt; it is from nine to fifteen inches in width, and can be easily traced as an irregular dark band traversing the coarse-grained pink granite. The dike is very well defined, exhibiting clear-cut lines of demarcation from the enclosing granite, and it is evident from the contour of the walls that it occupies a fault-fissure. The outline of the east wall corresponds exactly to that of the western one, the movement of the latter having been upward, causing a displacement equal to about fourteen inches. It is a clean-cut fissure in the granite, filled with foreign materlal, a basic volcanic rock, which probably welled upward in a mobile condition, filling the fissure as it was formed, so as at no time to permit of a vacuity. Compare this with Fig. 4, which is a sketch of a gold-bearing vein, situated at a distance of a few yards from the dlke illustrated in Flg. 3. The country is the same, viz., granite, but in this instance the vein filling is not foreign matter, but essentially rock in place; it is granite, altered indeed, but easily recognizable, in splte of the kaoliniza-

tion of the feldspar and the partial removal of the mica. There are no clearly defined boundaries between the decomposed vein matter and the enclosing country, nor is there any evidence of faulting. The lines of fracture shown in the granite are the joints of that rock, and those which are observable in the vein itself are not continuous, but rather a closelyknit series of little breaks, which have afforded a passage for a liquid more subtle than the basalt. The vein occupies a line of maximum porisity along which water, more searching than any molten lava. has found

Fig. 3.

Fig.4



a way, decomposing the soluble ingredients of the rock, and depositing a minute quantity of gold, insufficient to make the decomposed granite of the vein differ essentially from the outer country, but rendering one gold-bearing ore, and leaving the other barren rock.

Here we have a dike compared with a vein and volcanic agencies brought into strong contrast with aqueous action. The faulting along the fissure followed by the dike is easily seen, but no evidence of such movement can be discerned along the seam of altered granite, which forms the gold vein. Nevertheless there must have been some movement, however slight, because a crack or break, not made evident, can be considered as only latent, until the two faces of it are caused, by that very shifting, so to disagree as to produce the irregularities which, when linked together, form the visible line of fracture. Even the joints in the solid granite require such an explanation, and however insignificant the shifting may be, it marks the adjustment of the rock to the effects of stresses, traceable in this case, probably, to the volcanic energies which extruded the large masses of breccia forming the characteristic feature of the geology of Cripple Creek. Permit me to repeat, however insignificant this shifting may have been, it made the rocks pervious to underground mineralbearing solutions, and where it occurred it developed a series of united passages, which afforded a line of maximum porosity, permitting the circulation of gold-bearing waters.

The mines afford illustrations of a great diversity of lode-structure. This diversity is traceable to the complexity of the enclosing rocks. The variations in ore-occurrence due to this fact explain the vicissitudes which marked the early history of the district, and the recognition of them should contribute toward the success of future exploratory work.



BRECCIA BASALT. WEIN MATTER

ORE ALONG SHEETED ZONE .

Many of the lodes are essentially dikes which have undergone fracturing, thereby affording an opportunity for their impregnation with gold through the agency of circulating solutions. The Moose vein will exemplify this type. The accompanying sketch, Fig. 5, was made at the 350foot level. From D to F is the width of the dike, which is composel of nepheline basalt. It traverses the andesite breecia, which is indicated at AA. The pay-ore extends from E to F, with a width of ten inches, and is distinguished from the remaining and comparatively barren portion of the dike, ED, a dark bluish gray rock, by being iron-stained and seamed with brown threads in which free golds and tellurides occur. The multiple fracturing, parallel to the walls of the dike, is a characteristic feature of this and similar lodes, experience having also shown that there

is reason to expect the lode to consist of rich ore when it becomes threaded with minute seams following these lines of fracture. This feature can be described as a sheeting of the rock; it is a very important factor in ore deposition.

An example of the latter is exhibited in Fig. 6, which represents a lode in the Moon-Anchor mine. This type of ore occurrence is thoroughly characteristic of the mines in that part of the district known as Gold Hill. The breccia is fine-grained. The partings are about a quarter of an inch apart. They are followed by minute seams of red, gritty clay, in which the tellurides can be distinguished. The individual seams are united by



OXIDATION. SHADING MARKS WIDTH

traverse impregnations which collectively make a pocket or small body of ore, in which it is not unusual to encounter patches consisting of an almost solid aggregate of crystalline sylvanite. The sheeted structure dies out into the enclosing country by the process of a gradual widening of the space intervening between each successive parting.

The occurrence represented in Fig. 7 is a peculiarly suggestive illustration of the manner in which a gold vein may be formed. It exhibits the Independence lode in the Washington claim, which is a portion of Stratton's Independence property. The lode, which further north traverses the breccia and is closely associated with a phonolite dike, is seen here as a band of decomposed granite subdivided equally by a central thread of quartz. The ore is essentially granite. The enclosing rock is also granite. The portion AC, DF is four feet wide and carries a little over three ounces gold per ton. The width of four feet which carries

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gold, and is therefore ore, has no parting or wall separating it from the outer rock which carries none, and is therefore regarded as waste, but it is distinguishable from the latter in many ways. The outer granite is fresh and unaltered, exhibiting its constituent minerals, white quartz, black biotite mica and pink orthoclase feldspar, with great clearness. The inner gold-bearing rock is much altered by decomposition and replacement; the orthoclase alone appears to have survived the general metamorphism: the mica has been removed and, in its stead, chlorite can be seen in green patches; the original crystalline quartz is largely gone and the presence of purple fluorite suggests that hydrofluoric acid may have been a primary agent in that removal; secondary, hydrous quartz fills many of the interstices between the crystalline constituents of the rock; in iron-stained cavities free gold can be seen by the aid of a pocket lens and the gold is observed to have the dark, lusterless appearance which characterizes it when derived from the oxidation of tellurides. The entire width of this gold-bearing, decomposed granite is heavily iron-stained by the oxides resulting from the disintegration of the small crystals of iron pyrites which can be seen in an unaltered condition disseminated throughout the same lode at lower levels. In the center of the band of ore there is a distinct parting, BE, which is separated from a persistent thread of white quartz, only about a quarter of an inch in width, by a slight selvage of red clay. At a distance the lode appears as a distinct broad band of iron-stained granite, and it is only by closer examination that the boundaries of it are seen to consist, not of "walls" or of any such evident demarcation, but merely of a transition from decomposed into undecomposed granite.

The lodes which have been described will exemplify the extraordinary variety of structure to be observed in the district. Much evidence has been accumulated in support of the most recent theories of ore deposition which are based upon a study of the underground water-circulation. An idea has been voiced by those not having authority, such as the scribes of the daily press, that Cripple Creek, both in its earlier stages and now, has set at naught the accepted teachings of geological science. It is a fantasy, born of the necessity of filling newspaper space. On the contrary, it has always been insisted, by the writer, among others, that no mining region yields so much corroborative evidence in support of those views on ore deposition which have won general acceptation, namely, that the formation of ore is due to the precipitation of the matter curried in solution by underground waters which have circulated in obedience to the conditions created by the structural relations of the rocks.

Reference to the production tables above discloses the fact that the commercial ores of this section are mainly goldbearing, and that the aggregate value in other metals is very small in proportion. The gold occurs mainly in the form of a telluride (Calaverite), although other tellurium compounds are not uncommon. Development work of the past two years

has locally demonstrated a marked decrease in the amount of telluride ores, and as greater depth is gained a large increase in amount of pyrite and other sulphides present. This change has been noted by the daily press and some technical journals, and appears to be generally accepted as evidence of "secondary enrichment" of the ore veins, and as having an important bearing upon the future of the district. The term "secondary enrichment" has been more or less prominent in the Colorado mining vocabulary since August, 1901. At that time Prof. C. R. Van Hise delivered an address before the geological section of the American Association for the Advancement of Science, at Denver, on the genesis of ore deposits, and made the term "secondary enrichment" somewhat prominent in his discussion. As is often the case with a newly adopted term, the true meaning of "secondary enrichment" as used by Prof. Van Hise has suffered much misinterpretation and misapplication. The theory of secondary enrichment may be of great value in the pursuit of ore, and especially in the Cripple Creek district. It should, however, be newly presented and in such a form as to render it more easily comprehensible to those practically interested in mining. A carefully prepared paper along these lines. broadly applicable to all mining of the state, but largely based on recent investigations in the Cripple Creek district, was expected to be received from Mr. J. W. Finch, State Geologist of Colorado, to be herein incorporated. It is hoped, however, that the same may appear in the forthcoming Bulletin of the Department, on the "Precious Metal Production of 1902."

Space in the present publication will not permit a detailed description of the rapid development of this district. At the present time the district is traversed by the lines of three railroad corporations, and crossed by one electric line. A description of the numerous and almost contiguous camps near the base of the various hills affords little conception of the actual conditions and apparent numerous railroad lines. The transportation facilities are almost equal to that of a large city, and employes at the various mines may use their choice of roads going to and from work and reside in one of the many inhabited centers. The city of Cripple Creek maintains the prestige as the most important commercial and resident center; Victor, the most important mining center. The adjoining and intervening towns are Goldfield, Independence, Elkton, Altman, Anaconda and Lawrence. The combined population is estimated at from 30,000 to 40,000.

The various reports of the mining companies and the mine inspectors show that mining operations are conducted on from 100 to 300 different properties. Owing to the fact that operations on many are more or less spasmodic, the average number in constant operation is difficult to obtain. The average number of men constantly employed is 6,000. The major portion of these are employed by the larger companies. The leasing system is, however, much in vogue, and a large number are employed as or by lessees. Leases of all kinds are granted and may include an entire property or a small section or "block" of ground in a developed mine. The royalties exacted vary from twenty to eighty per cent., and are generally based on a sliding scale comparable to the grade of ore produced.

The numerous mines are with few exceptions developed by shafts. A number of these have passed the 1,000-foot mark in depth, and are equipped with mechanical plants of the latest and most improved design. A number of small operators utilize electrical energy, which is furnished by two different companies. The Colorado Electric Power Company plant is located at Canon City and transmits power a distance of twenty-four miles. The La Belle plant at Independence manufactures both electrical energy and compressed air. The surplus of both are furnished various patrons. The great advantage of being able to rent both equipment and power by small operators is apparent. The rates charged are little if any in excess of the interest and maintenance of individual plants. Both of the above companies generate electrical energy from steam. One of the auxiliary companies of the Woods Investment Company has a large electrical plant on Beaver creek. Water is utilized by this company and the power generated is transmitted to various plants for power or light purposes. All of these plants are thoroughly modern in every particular and represent heavy investments.

The principal reduction plants of the district are the Economic, at Victor, and the Arequa, Brodie and Ironclad, at Cripple Creek. The main ore production is shipped to the reduction works at Colorado City and Florence. Only

about twenty to twenty-five per cent. of the aggregate ore produced is shipped to the smelters direct.

The future of the Cripple Creek district has been portrayed in a carefully prepared paper by Mr. Charles J. Moore, a well-known mining engineer of the district, published in the New Year's edition of the Cripple Creek *Times*, which is as follows:

Every mining district in the western portion of the United States has its alternation of "boom" and quietude, activity and dullness, until the permanent average production is reached, and the problems of supply and demand finally settled on business lines.

In Cripple Creek district a feature of fluctuation entirely outside of the question of the ore production, labor, transportation, treatment facilities and charges has had more influence than anything else on the general prosperity of the district—the mining stock market.

This influence has at times been quite detrimental to the interests of the district. It is difficult to make the ordinary investor understand that the actual condition of the mining industry is not directly reflected in the stock market. In fact, the two are completely separated as the Chicago grain market and the actual production of cereals.

The great depression of the stock market here for the past two years has caused a false impression through the country that there is a constant and serious decrease in the amount and valuation of the ore production. The stock market is merely a field of speculation, and the quotations on any stock is in no degree based upon the indications at the mine upon which the company is nominally organized. This is certainly wrong, but appears as though no reform will ever occur unless all promoters and brokers were held by law to strict accountability for all statements made in reference to the properties whose stock they may be offering, or the enterprises promoted.

In looking at the future, there are several questions to be considered.

1. Are the mines permanent, and for how long will they continue to produce payable ore?

2. Will the present ore-producing territory be enlarged, and if so, in what direction?

3. Will the treatment facilities continue in the present state, improve or deteriorate?

4. Will the transportation facilities continue, improve or lessen?

It would seem that the consideration of the first two questions includes an answer to the last two; if, for instance, the district will enlarge, the transportation and treatment facilities will be enlarged at an equal rate, and charges for both decrease as the supply becomes larger. REPORT OF COMMISSIONER OF MINES

From the numerous developments that have been made in the territory outside a circle, say, six miles in diameter, having the summit of Iron Clad hill for its center, it would appear that no further extension of the ore-bearing district can be expected beyond the limits we now have.

This does not mean that all the mines are already opened, for very large tracts of territory within this circle remain undeveloped, in some of which certainly new mines will be opened up. We have certainly not reached the end of new discoveries within the district.

A large impetus in this direction will be given by opening the properties of the Stratton Mining and Development Company to lessees, which is now expected very shortly.

The main question remaining is that of the permanency of the mines, and of this, during the past year, we have received very promising evidence.

The deepest mines now being worked on the different hills are as follows:

BATTLE MOUNTAIN,

Portland, at 1,100 feet in the Burns shaft to 1,260 feet below surface at shaft No. 2.

	r eet.
Granite	. 1,000
Ajax	. 1,000
Stratton's Independence	1,460
Strong	. 900
Gold Coin	. 1,100
Modoe	. 800

BULL HILL,	Feet.
Last Dollar	. 1,218
Blue Bird	. 1.371
Logan	. 1,400
American Eagles	. 1,500
Wild Horse.	. 1,050
lsabella	. 900

EAST SPUR BULL HILL.	Feet.
Independence T. & M. Co	. 1,160
Vindicator	. 1,200
Lillie	. 1,510
Gölden Cycle	. 900

All but one of these shafts have good bodies of ore and excellent indications for the future at the lowest levels to which they have thus far attained. Certain of these shafts, to wit, the Last Dollar and Blue

Bird, show some of the richest ore ever mined in the district at their lowest levels. It has lately been asserted that this great enrichment of these veins is due to secondary deposit. By this is meant that the gold values have been largely leached from the upper portions of these veins and redeposited at a lower level, thereby enriching the original ore deposit of the vein by this amount.

It is still an open question whether this enrichment extends to every ore-bearing vein in the district, but it would certainly appear probable that those veins which have shown lean or poor zones of ground in their upper portion carry enriched ore bodies at greater depths; this would be especially true of those veins which at the surface and for some distance below yielded good ore followed by poorer ground in greater depth.

A special feature of these rich ore bodies at 1,200 and 1,300 feet below surface is the presence of copper, which is entirely absent from the upper or oxidized portion of the Cripple Creek vein. Another change in the mineral contents of the veins at the greatest depth thus far attained is the presence of lead, zinc and antimony in sulphide form and increase in the iron sulphide generally called "pyrites."

None of these changes coming in the veins at depth indicate any decrease of gold or silver values, but, on the contrary, in the immediate future, a great increase from a plane about 9,100 feet above sea level downwards. The thickness or depth of this rich zone is purely a matter of conjecture, but probably not less than 300 feet. Underneath this may be expected poorer ground, but still carrying payable ore. Deeper than this, neither practical experience or theories can guide us as to what to expect in the future, nor can the life of the district be reasonably predicted, though it would appear to be safe to reckon on the present average production for at least seven years to come.

The most menacing question which has arisen during the past year is that of the water, which must be pumped in order to work the veins deeper. The investigations made during the past year have clearly proved that the underground water is not in the nature of streams fed from perpetual springs, but rather an accumulation from many cycles of past rain and snowfalls upon the ground surface which has penetrated to some distance below the surface and there found a reservoir contained within the granite walls of the Cripple Creek volcano.

Now as pumping is continued in such a reservoir, it follows that the permanent level is being continually lowered and that as the sides of the crater flatten and slope towards its center the total area to be pumped will be less as greater depth is attained. To shorten the time and expense required for such pumping, various tunnel projects have been proposed during the past year, and the plans for one are now definitely settled, which will be started shortly after the beginning of the year 1903 by the co-operation of half a dozen mining companies most vitally interested.

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By the driving of a tunnel 10,000 feet it is estimated that the reservoir will be tapped and the water drained in a short time to a depth of 250 feet below the present level, or to a level of \$,775 feet above the sea. This will at once enable the El Paso, Mary McKinney, Work, Anaconda, Elkton, Moon-Anchor, Midget and probably many other mines to sink 250 feet deeper than their present workings. Doubtless long before this tunnel will have accomplished all that is expected of it, another one at the co-operation of a much larger number of mine owners, possibly those greater depth on a more comprehensive scale will be well under way by of the entire district.

In view of all the statements of fact above, it will be seen that successful future of the district is certain, and that the average grade of the ore produced during the next two years will in all probability be higher than at any time during the past, except the years 1894 to 1897.

THE BUREAU OF MINES.

The statute establishing "The Bureau of Mines of the State of Colorado," providing for its maintenance, and prescribing the duties of its officers, is susceptible of varying construction. The evident intent of the law was the establishment of a department for the purpose of advancing the welfare of the mining industry of the state, and to provide for the safety of those engaged therein. The present statute is the outcome of two separate "bills" introduced in the Tenth General Assembly. One of these may be summarized as providing for the legitimate advertising of the resources of the state. The other for inspection of the metalliferous mines. The consolidation of both measures into one was deemed best by the assembly, and was so enacted.

The wisdom of placing under one management affairs that have so little in common is questionable. Practical results show that the Commissioner of Mines could do much more effective work in collecting data, minerals, and the publication of bulletins on various mining sections, etc., were he not compelled to arbitrate differences between mine operators and mine inspectors. Farther, that mine inspection could be much improved were it separate and alone. In a broad sense, mine inspection belongs to a labor bureau, and the major duties of the Commissioner of Mines, as now provided, to a Of the latter, the State Geologist should technical bureau. be a prominent officer, if not placed in control. At present, the office of State Geologist is an honorary position, but is usually filled by persons of technical knowledge and ability.

In the conduct of the affairs of the Department an earnest effort has been made to discharge the dual duties imposed in an impartial manner. These duties, however, are so intimately related to questions that involve the employer and employe that only by somewhat arbitrary decisions has the Bureau of Mines kept out of controversies between labor and capital. Complaints from both sides have received careful consideration, and conclusions were reached without prejudice, discussion, or expression favoring either side of the controversy. As in nearly all official positions, the decisions of the Commissioner of Mines have pleased neither the employer or employe, and the reward of vilification has not been wanting.

The policy of the Department regarding publicity of its acts has been subjected to severe criticism. The consistent refusal to supply the press with information gained in transacting the business of the office may have been too strictly enforced. This, however, is a matter of opinion, subject to individual judgment. The duties of the officers, as prescribed by statute and construed by the Commissioner of Mines, forbids making public the information officially gained, except through official reports and bulletins, likewise provided for. The officers of the Department have opportunity, and are granted special privileges for gaining information, but this knowledge is gained in pursuit of prescribed duties, and is not intended for publication. Mine operators, as a rule, are satisfied to conduct their business in a conservative manner, and desire all the benefits accruing from ore deposits by them developed and demonstrated to exist in adjoining properties. The Bureau of Mines could provide much news of interest, but it could, likewise, precipitate much trouble and consequent litigation. The daily press is not always the best medium for the diffusion of reliable information. Articles submitted are subject to re-editing and lack of conception of the nature and intent of the same, the original generally appears in a much altered and abbreviated form. That the Bureau of Mines has not been to the general public a more prominent factor is entirely due to lack of suitable provision for a printing fund for official bulletins, and not to lack of desire of its officers. Without this provision one of the main objects aimed to attain by the framers of the law governing the Department is defeated. The information gained by the officers in discharge of their duties is, therefore, of greater benefit to them personally than to the general public, by reason of inability to issue publications.

The detailed and accurate description of the varying methods of mine timbering, mechanical handling of the ores, mechanical equipment, and the many different mills and metallurgical plants might display a general marked uniformity and be largely a repetition of the same thing in many chapters. They would, however, in detail, call attention to practices common to one district that were unused in another, and each operator would get the benefit of the practical results attained by all. That such work would materially advance mining and metallurgical methods there can be no doubt, and suitable provision for their publication should be made.

ACKNOWLÉDGMENTS.

The statute controlling the Bureau of Mines makes no provision for mileage or transportation of its officers from place to place in discharge of official duties. Through the courtesy of the Colorado railroads this difficulty has been met and transportation gratuitously furnished, of which acknowledgment is here made.

The Department is under added obligations to Dr. William P. Headden, chemist at the State Agricultural College, for many courtesies extended. A number of samples have been forwarded the bureau with the request for varying determinations. When the requests were within reasonable limits the samples were forwarded Dr. Headden, who promptly complied with all the demands made.

The thanks of the Bureau are extended the various newspapers and periodicals that have generously donated their publications, the same being on file in the Department.

Due acknowledgment is made for the various state and governmental reports supplied the library of the Bureau gratuitously or in exchange for like courtesies. The library is fast becoming a valuable collection for reference, but should be endowed with a small annual appropriation for purchase of new and needed publications as they appear.

THE MINERAL COLLECTION.

During the past two years the mineral collection has been materially improved. Not as many additions to the collection have been made as in former years, but many specimens have been replaced by better ones. The main reason for retarded advance in this line is due to the failure of an appropriation by the last general assembly for incidental expenses of the Bureau. Many mine operators are willing to contribute valuable specimens, but their enthusiasm rarely goes so far as to be willing to incur the expense for transportation. This item of expense could only be met from the incidental fund appropriated for the Commissioner, and this fund has been utilized for this purpose as far as possible.

The direct advantages to be derived from a mineral collection for public use are in no way determinable. That the collection is a great attraction and constantly growing in popularity there is no question. The present display appears to satisfy the popular demand and to meet the expectations of thousands who visit Colorado during the year. Whether or not this attractive, visible evidence of the state's great mineral wealth aids in eventually adding to its material welfare is a matter for individual conjecture, but it is a well known fact that all successful business enterprises maintain standing and attractive advertisements.

Appreciation of the value of the collection is fast increasing among the mining operators and scientific men. The latter, especially those who visit the state for the purpose of determining the value of a mine under consideration, not only visit the collection, but utilize the library and records of the Department. The commercial ores upon exhibition from every section of the state afford a good idea of their general character and what may be expected when the proposed section is visited. These ores, while labeled and properly marked with values per ton, give a favorable impression by reason of being above the average mine product.

Pursuant to an executive order a small but rather choice collection of minerals was placed on exhibition at the South Carolina Interstate and West India Exposition at Charleston, South Carolina. This exhibit was installed January 28, 1902, and returned to the department June 16, 1902. The exhibit was displayed during this time and was awarded a gold medal by the exposition commissioners.

En route to Charleston, the Commissioner of Mines, through the courtesy of the officers of the United States Geological Survey and the Smithsonian Institute at Washington, D. C., secured a complete set of the various Colorado rock types collected and classified by the Department. These are a most valuable acquisition and are used to a great extent by mining engineers and mine operators. Among the latest acquisitions to the collection was a crystalline specimen of electrum, delivered in person by Mr. Arthur Collins the day before he left for Telluride, where he met his untimely death. A mineral collection is in many ways comparable to a library. Neither can long remain up to date without constant additions. Specimens from Colorado may, by proper effort, be obtained free, but rare minerals that are discovered in other sections usually pass into the hands of dealers and must be purchased. During the past two years a number of rare minerals have been presented for purchase, but, through inability of the Department, were later placed in the mineral collections of other states, at advanced prices. The aggregate amount required for this purpose would not exceed two or three hundred dollars per annum and should be provided.

Attention is again respectfully called to section nineteen of the statute creating the bureau, which reads as follows:

"Sec. 19. The mineral specimens heretofore collected by the Bureau of Immigration and Statistics and the World's Fair Commissioners, are hereby transferred to the custody of the Bureau of Mines."

This section refers to the collection of ores exhibited at the St. Louis exposition, and later loaned to the Pueblo mineral palace at Pueblo. This collection did contain a large amount of valuable material, and should be added to the present mineral collection.

The following extracts from the minutes of a meeting of the Board of World's Fair Managers, held in the office of the Governor at 1:30 p. m., June 1, 1901, are self-explanatory:

"Present, Governor John L. Routt, A. B. McKinley, J. A. Thatcher and O. C. French. The secretary read a communication from John Livezey, secretary of the Colorado mineral palace, dated Pueblo, Colorado, May 25, 1891, 'making application for the use of ores and specimens which were collected by the different counties of Colorado for the St. Louis exhibit.' After full discussion of the matter, the following resolution was offered by Mr. Thatcher and unanimously adopted:

"Resolved, That the secretary is hereby instructed to inform Mr. John Livezey, secretary of the Colorado mineral palace at Pueblo, that the ores and specimens now stored in Denver, known as the St. Louis exhibit, are yet under control of the State Bureau of Immigration; that before the World's Fair Board can receive them it will be necessary to classify and check them off with the records of the State Bureau, and that this board is unable to provide for the taking over of said exhibit at this time, owing to the fact that no part of its appropriation has yet been paid over.

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"And that the secretary in said communication is further authorized to propose to the Colorado mineral palace that if it will defray all the expenses of all the necessary employes in opening, classifying and arranging the said St. Louis exhibit in the warehouse where the same is now stored, in shipping it to Pueblo, in caring for it while on exhibition and returning it to Denver to this board, that said exhibit may be displayed on such terms."

The above proposition was accepted by the officers of the mineral palace, and the collection removed and arranged in the building of the Mineral Palace Company at Pueblo.

In pursuing this matter, the services of an attorney were required to look up the condition and ownership of the mineral palace, and the courtesy extended the Bureau by Hon. W. L. Hartman, of Pueblo, is here acknowledged, the following being self-explanatory:

"Pueblo, Colorado, March 21, 1896.

"HON. HARRY A. LEE, "Commissioner of Mines, "Denver, Colo,

"Dear Sir: In answer to your favor of the 18th inst., will say that I have just concluded examination of the records and making inquiries regarding the mineral palace property, and especially the exhibits.

"I find that a deed of trust was given on the real estate only and the franchises to the Stockgrowers' National Bank, April 1, 1891, recorded in book 107, page 208, to secure an issue of bonds amounting to \$50,000. This deed of trust was foreclosed and conveyed to John T. Higgens by trustee's deed, dated June 4, 1894, recorded in book 155, page 259. It simply conveys the real estate by proper description, and the franchises to the company. A careful examination of the indexes fails to show that any mortgage or other lien or conveyance of exhibits, or of any personal property of the company, was ever given by the Mineral Palace Company.

"Mr. John T. Higgens died about a year ago and, though the real estate still stands of record in his name, we are reliably informed that he gave a declaration of trust at the time he received the title, and afterwards executed a deed. We understand that the property is now really owned by the First, the American, the Pueblo and the Stockgrowers' National Banks, or possibly by the officials of those banks; and they claim to own all the specimens and exhibits, with a few exceptions of minor importance. These we understand are cabinets of specimens belonging to individuals. Mr. D. R. Green, president of the Pueblo National Bank, is in charge and control of the property.

"I will be glad to be of any service to you.

"Very truly yours,

"(Signed)

W. L. HARTMAN."

The amended statute in the Session Laws of 1899 recites the following, on page 287 :

"Sec. 19. The mineral specimens heretofore collected by the Bureau of Immigration and the World's Fair Commissioners are hereby transferred to the custody of the Bureau of Mines, and if found necessary the Attorney General shall bring suit to recover the same."

It was confidently expected at this time to be able to report the completion of the purchase of the mineral collection of Dr. John Elsner. Considerable time and energy have been devoted to this matter, but sufficient contributions to complete purchase have not been obtained. This collection is recognized as one of the most valuable in the state, and contains many rare minerals that were discovered early in the history of the state, and can not now be duplicated. It should remain in the state and in the Bureau of Mines, where it now is. The present arrangement with Dr. Elsner guarantees the state against any financial loss, and should the collection be removed, the amounts paid must be first returned to the Department. The legislature, by making an appropriation to complete the purchase of this valuable collection, would do much to advance the welfare of the Bureau of Mines and the state at large.

NUMBER ENGAGED IN MINING, MILLING AND SMELTING.

The following represents the average number of men engaged in mining, milling, smelting and hauling ore during the whole year, but does not include employes in general offices of the corporations, mining brokers or promoters of mining sales, mining and consulting engineers, who maintain their own offices, United States deputy mineral surveyors, or those owing or operating properties, but devoting their time principally to other vocations.

COUNTY.	1896	1897	1898	1899	1900	1901	1902
Arapahoe	1,152	1,583	1,604	2,032	2,092	1,810	1,615
Archuleta	45	76	23	10	6	6	18
Boulder	1,353	1,653	1,687	1,539	1,597	1,610	1,556
Chaffee	482	707	722	938	944	792	725
Clear Creek	1,312	1,712	1,816	1,981	2.012	1,975	2,010
Conejos	27	46	7	35	15	23	18
Costilla	18	28	85	62	44	25	35
Custer	189	318	363	340	419	325	350

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COUNTY.	1896	1897	1898	1899	1900	1901	1902
Delta			• • • •			õ	5
Dolores	356	354	414	485	497	415	352
Douglas	135	77	86	43	õ	6	ī
Eagle	162	182	241	316	302	391	305
E1 Paso	3,575	5,386	5,764		\$5	162	830
Fremont	477	384	395	410	495	200	725
Garfield		27	12	10	6	5	15
Gilpin	2,160	2,473	2,517	3,017	3,124	2,664	2,322
Grand		15	53	24	35	26	75
Gunnison	704	787	624	560	555	450	630
Hinsdale	432	493	397	576	535	516	580
Huerfano	23	26	11	8	37	40	35
Jefferson	35	45	37	57	45	26	85
Lake	3,984	3,519	3,780	6,736	7,470	6,420	5,772
La Plata	410	544	419	360	307	387	475
Larimer	86	147	92	110	86	74	45
Las Animas		26	17	12	10		
Mineral	336	495	867	1,040	992	1,075	920
Montrose			22	162	115	204	152
Mesa			12	55	25	70	65
Montezuma	45	52	55	125	109	85	143
Ouray	1,167	1,185	1,214	1,878	1,897	1,918	1,609
Pueblo	1,660	1,685	1,712	2,054	2,084	1,975	1,485
Park	381	467	374	448	374	360	406
Pitkin	1,500	1,242	1,363	1,635	1,560	1,692	1,355
Rio Bianco		9.0 0 =	14	5	6	8	25
Rio Grande:	75	194	156	186	75	110	145
Routt	128	247	124	191	115	138	135
Saguache	268	264	247	315	378	425	310
San Juan	1,351	996	1,087	1,347	1,405	1,658	1,595
San Miguel	1,105	1,289	1,344	1,612	1,723	1,840	1,625
Summit	412	426	474	568	574	532	623
Teller				7,928	7,920	6,484	5,940
Total2	5,545	29,215	30,231	39,210	40,111	37,260	35,118

EMPLOYES, "ABOVE AND UNDER GROUND."

To accurately divide the number of men into "number employed above ground" and "number employed under ground" is practically impossible, for the reason that no small proportion employed, work both above and below ground each day worked. That is to say, on small properties the labor above ground is usually divided among the employes. All may work under ground while the holes for blasts are being drilled, and after blasting, one or two do the "top work" one day, necessary to remove the broken rock, sharpen tools, etc., and the others do the top work next day. From best information obtainable the following is an equitable division and practically correct.

1896.	1897.	1898.	1899.	1900.	1901.	1902.
Number of men engaged in mining, milling and smelting25,545	29,215	30,231	39,210	40,111	37, 260	35,118
Number of men engaged above ground	11,686	12,092	15,684	16,040	14,904	14,047
Number of men engaged under ground15,924	17,529	18,139	23,526	24,071	22,356	21,071

ACCIDENTS.

In 1902, eighty-two fatal accidents occurred in and about the mines and mills of the state. Compared with the previous year there is a decrease of thirty-nine in the fatal accidents, but an increase of fourteen in 1901 over that of 1900, owing to the unusual disaster at the Smuggler-Union mine, at Telluride.

CAUSE OF ACCIDENT.

		-1901		-1902.—
ABOVE GROUND.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.
Machinery accidents		15	1	20
Mill and smelter accidents	•••	85	3	24
Overwinding cage or bucket		1		
Falling from gallows frame or staging	s	3		1
Injured by windlass		2		•••
Falling from ore wagen		2		
Gravity tramway	. 2	2		2
Tramming or dumping cars	. 3	32		25
Handling rock or ore		3		12
Material falling down shaft from surface	- . 1	2	2	
Falls in ore chute or bin or caugh with running ore	t • •••	3	1	2
Falling into uncovered prospect holes.		1		
Operating hydraulic machinery			2	
Miscellaneous	• •••	27		15
Total	. 6	178	9	101

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		-1901	-1902		
SHAFT ACCIDENTS.	Fatal.	Non-Fatal.	Fatal.	Non-Fatai.	
Getting on or off cage or bucket in motion	3	S		7	
Falls from bucket or cage while being hoisted or lowered	S	13	9	13	
Material falling from overloaded bucket	1	1	1	5	
Material falling from level or side of shaft	4	16		ĩ	
Broken or detached cable	2	3		4	
Struck by descending cage or bucket	1	7		6	
Pushed car into open shaft, going down with same		1	1	1	
Fall of rock and earth in shaft	1	2	1	4	
Falling down shaft from level	4	9 2	4		
Miscellaneous	• • •	2		1	
Total	24		16		

		-1901.—	_	-1902.—
UNDER GROUND ACCIDENTS.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.
Falls of rock	. 29	158	13	168
Falls of timbers while timbering	. 4	17	1	20
Falls from ladder		16	4	14
Falls from overloaded staging		13	1	18
Falls in chute, winze, upraise or man way	- 5	9	9	11
Caught in ore chute with running ore	. 3	15	1	21
Injured by tram car		19	2	27
Struck by flying rock or steel from hammer or pick	n 	25		42
Struck with hammer by helper or by self	v	8		5
Falls while carrying tools or materia about mine	1	ĩ		9
Suffocation, burning shaft house o tunnel building	r . 27		•	
Suffocation, bad alr or powder smoke	1	1	11	16
Operating machine drills		-18		30
Miscellaneous	. 1	13		10
	-		-	
Total	73	349	-12	381

STATE OF COLORADO, 1901-2.

			-1902	
EXPLOSIVES.	Fatal.	Non-Fatal.	Fatal.	Non-Fatal.
Thawing powder over candle, in hot sand or water	3	2	3	1
Picking out missed shots	4	7	1	3
Drilled into hole that missed fire	3	4	1	7
Blast exploded while loading	2	Ţ	3	6
Remained too long after lighting fuse.	4	15	4	4
Returned before blast exploded		-4	2	1
Struck unexploded powder or cap with pick or shovel while cleaning away muck		9		2
Ohet analadad before beine beinted		0		2
Shot exploded before being holsted		2		1
Handling caps		3	•••	
Explosion of gasoline	1	1		
Electricity, live wire	1			
Explosion, cause unknown			1	2
Total	18	51	15	31
Grand total	121	633	82	561

SUMMARY OF ACCIDENTS-1896-1902, INCLUSIVE.

1	1896	1891.	7898.	1899.	1900.	1901.	1902.
Number of men engaged mining, milling, milling and smelting25	i,545	29,215	30,231	39,210	40,111	37,260	35,118
Number of accidents inves- tigated	210	279	292	584	633	754	643
Number of non-fatal acci- dents	107	169	184	481	526	633	561
Number of fatal accidents	103	110	108	103	107	121	82
Number non-fatal accidents above ground	10	27	12	150	156	181	106
Number fatal accidents above ground	8	7	9	15	15	11	13
Number non-fatal accidents under ground	97	162	172	341	360	452	455
Number fatal accidents under ground	95	103	99	88	92	110	69
Proportion non-fatal acci- dents per 1,000 men employed4	1.188	5.778	6.086	14.462	15.620	19.988	17.975
Proportion fatal accidents per 1,000 men employed. 4	1.032	3.765	3.572	2.626	2.667	3.247	2.306

1896.	1897.	1898.	1899.	1900.	1901.	1902.
Per cent. non-fatal acci- dents per 1,000 men						
above ground 1.039	2.311	.992	5.964	9.125	12.144	1.046
Per cent. fatal accidents per 1,000 men above ground	.599	.744	.956	. 935	.738	.925
Per cent. non-fatal acci- dents per 1,000 men under ground 6.091	9.242	9.482	14.532	14.955	20.218	21.593
Per cent. fatal accidents per 1,000 men under						
ground 5.966	5.876	5.458	3.743	3.823	4.919	3.274

SUMMARY OF ACCIDENTS-1896-1902, INCLUSIVE-Concluded.

There have been fewer fatal accidents in the metalliferous mines during the past year than during the previous years. That the Bureau of Mines has been the means through which this much desired result has been accomplished, there can be no doubt. Beyond that of being the agency through which the wisdom of the general assemblies has been exemplified by the enactment of laws contemplated to prevent accident, and prescribing the duties of its officers, the Bureau is entitled to no credit.

While the rate of fatalities is considerably reduced, as shown above, the accident rate of the metalliferous mines is still much in excess of what it should be, and may be still further reduced. To compare favorably with other mining sections where more rigid laws are enforced, the rate must be largely reduced.

The non-fatal accidents since 1899 show a marked increase over the preceding years. This is due to the law enacted by the Twelfth General Assembly, defining an accident requiring a report to be an "* * * accident serious enough in character to cause the injured party to stop work two consecutive days. * * *" Prior to the enactment of this definition, minor accidents were not reported to the Department or taken into consideration.

REVIEW OF ACCIDENTS.

In the table showing cause of accidents for the year 1901-1902, the casualties are so grouped and designated that a careful perusal will determine where remedies are most needed.

Each accident reported is a matter of record in the Bureau, and subject to examination.

The casualties are very small from machinery, mills and smelters as compared with the nuber of men employed. There were four fatal and 105 non-fatal accidents reported. Three of the fatal accidents occurred in mills, and one at pipe-dipping machine. On April 2, at the Florence Dorcas Reduction Works, Walter R. Martin fell through the framework into a reloving shaft. On April 29, Andrew W. Ramsev, foreman of the Humphreys' mill at Creede, fell from a platform twenty feet high to the floor. On February 19, August Campbell, while assisting in erecting the Bonanza mill, in Gilpin county, fell about eight feet, striking on a girder, and on January 15, at the Gold Pan placer, Breckenridge, Edward Varney was caught with a guy rope and thrown about fifty feet against an engine. The non-fatal accidents are from varied causes that naturally arise in and about mills and smelters.

Detail mention of the numerous accidents will not be given, the same being rarely considered beyond aggregates above given. The accident at the Smuggler-Union property on November 20, 1901, was carefully investigated and a full and complete report filed. The evidence in this matter alone would, if reproduced, be equal to at least one-half of this report. This great casualty calls attention to the necessity of mine tunnels being so equipped at the portals that loss of life from fire be impossible. The Bullion tunnel at the Smuggler-Union was equipped with two doors, one near the portal and one near the shaft conecting the various levels. Had these doors been both tightly closed, the loss of life would have been prevented. The result was, however, that, in the excitement, and through fear of lives being lost, those who went to the rescue of their brother workmen and to sound the alarm, forgot the doors, and the sad result followed. Since this accident, a number of doors have been placed in tunnels and a number of buildings over tunnel portals removed. The best design for doors were those placed by the Tomboy mine, in San Miguel county, and the Big 5 Company, in Boulder county. . The doors are of steel, hung from the top and placed well back in the tunnels. The supports are solid masonry cemented in the tunnel sides and having a broad, smooth surface in front for the door to close against. The door is raised and maintained by a rope over

pulleys extending into the buildings over tunnel and so adjusted that the rope may be detached and the door instantly dropped. In the event of this being forgotten, the rope would soon burn off and permit the door to drop to place. At mines located at high altitudes the snowfall is heavy and the tunnel portals must be covered. This may be done without direct connection to large buildings in which steam furnaces and blacksmith shops are maintained. The sad accident at the Liberty Bell mine, whereby twenty-six men were killed by snowslides, may be classed among the unexpected. The mine buildings were generally supposed to be amply protected, and, never having been before injured by avalanches, although many had occurred and had been warded off by the protection provided, no thought of impending danger was entertained by the management or the employes. The result, however, emphasizes the necessity of greater care in the construction of these houses in a safer manner.

MINE INSPECTION.

* Acknowledgment is here made of the uniform courtesy extended the mine inspectors in the discharge of their official duties by the mine operators throughout the state. Only in a few instances have the duties of mine inspection been resented by operators and accepted as "official meddling with personal affairs." The almost universal rule has been the reverse, and mine inspectors have not only been extended every courtesy, but have been materially aided in the discharge of their official duties.

It has been the enforced policy of the Department to, as far as possible, avoid a vulgar display of authority; to do what should be done, by suggestion if possible, by order if necessary. As a rule, suggestions were sought rather than evaded, and improvements advocated were promptly complied with. The pursuance of this policy has been productive of good results. This method, however, fails to make a large proportion of the recommendations made matters of record, but the end to be considered is that of the safety of employes, and co-operation to that end has been demonstrated to be generally more effective than compulsion.

As stated in previous reports, the inspectors have encountered more antagonism from the lessee or miner when working for themselves than from any other source. They, as a rule, fully appreciate the risks incurred, but neglect
the expense incident to safety appliances either from a desire to make greater earnings or from inability to purchase the needed material to insure safety. The last condition is one of the most trying that may be met by the inspectors, and in a number of individual cases material assistance has been rendered in procuring required supplies.

Two classes of complaints are still of common occurrence, viz.: one, the mine owner who has leased his property and the lessees have developed rich ore bodies. The other, that of discharged employes. Both complaints are common in so far as alleging the existence of "unsafe conditions" and a desire to do all in their power to "prevent a disaster." As a rule, these complaints are found, upon investigation, to be ill-founded and to result from avarice or a desire for revenge.

The investigation of accidents in various sections of the state seriously retards systematic inspection. By systematic inspection is meant the examination of every working property in a district visited before going to another. A number of accidents occur that are not granted a personal investigation by the inspectors. These are investigated by reports and affidavits or statements of disinterested parties. These investigations, however, very often result in the obvious necessity of personal examination, and the inspectors are being constantly moved from one section of the state to another, thereby greatly destroying their efficiency through loss of time consumed in travel.

The general effect of mine inspection is good, and the result of the work of the Department in this line is highly satisfactory. That the safety of the underground workmen is receiving more consideration than prior to the establishment of the Bureau there can be no existing doubt. No claim is made however, that all that should be has been done, or that mining accidents are reduced to the minimum. The direct result of mine inspection is good as far as it goes, but it should go further and be more thorough. Each operating property should be examined at least twice a year, and the advancing standard of safety be still further encouraged or enforced. This may be accomplished only in two ways, viz. : An increase in the number of mine inspectors or a decrease in the number of operative properties. In the event of an increase in the number of inspectors, they could best discharge their duties by being assigned districts which they could effectually cover twice a year. The result would be better service and a proportional reduction of incidental expense. The object to be considered is a most sacred one, that of saving human life, and should receive the support of all legislators, whether they be from mining or farming sections of the state.

The legislator whose natural affiliation is with the mine operator or the miner, and honestly desires to advance their interest through legislation, too commonly loses sight of the desired end through personal prejudice.

It is a well-established fact that reports from the various state departments receive but little careful consideration at the hands of the general assemblies. From the day of assembly to the close of the session matters of seeming more pressing moment naturally postpone a careful perusal of results attained by the departments, and action is therefore in the main in accord with preconceived ideas. The matter of providing protection for workmen is one deserving serious consideration. It is not a so-called labor question, designed to advance the welfare of the employe at the expense of the employer. The safety of employes is recognized as one of the important economic problems by all large mine operators, and is a question that should be carefully considered and discussed by both miner and mine operator.

ORDERS.

During the fiscal years of 1901 and 1902 the following orders were issued by the Department and complied with:

19	001.	1902.
Regarding timbers and timbering	15	23
Regulating explosives	GS	90
Regulating the amount of powder kept in stores	1	5
Storing oil and inflammable material	27	24
Use of steel or iron tamping bar	20	21
Removing old timbers from the mine	2	
Regarding employment of holsting engineer commentation and the second se	1	1
Regarding indicator on hoisting machinery	35	37
Employing cage tender	1	5
Posting uniform code of signals.	13	40
Regarding fire protection	19	33
Prohibit riding on loaded enge, skip or bucket	9	3
Giving false signals	1	1
Partitioning shaft for ladderway and repairing ladder	60	SS

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1901.	1:002
Making exit to surface	14
Provide tunnel or adit with connections to surface with suitable ladders	16
Provide chain ladder in shaft or incline while sinking	21
Providing shaft collar with cover or bonnet, and cage equipped with safety clutches and steel hood or bonnet	24
Making passage-way around shaft and providing guard rails 28	27
Leave pillar of ground standing on side of shaft	3
Cover or fence abandoned mine shafts 24	12
Penalty for removing shaft coverings 2	
Shall report to the Bureau of Mines118	163
Notice of number of men permitted to ride upon cage, skip or bucket. 26	2
Sanitary condition 4	2
Place fire door at mouth of tunnel 1	34
Repair or replace cable	14
Miscellaneous	2

RECOMMENDATIONS.

To the end that the Bureau of Mines may better promote safety of employes in metalliferous mining, and be made a more useful agent in advancing the material welfare of the state, the following recommendations are respectfully submitted:

Providing for a material increase in the number of mine inspectors for reasons assigned on page 239, and making their term of office four instead of two years.

Providing an incidental fund sufficient to meet the requirements for printing official bulletins, approved by the Governor; maintenance of mineral collection and library, and for payment of court fees incident to suits entered to enforce the statutory mine regulations. No appropriation having been made for the latter purpose, no suits have been instituted. Under existing conditions the expense incident to enforcing the statute through the courts must be borne by the Commissioner of Mines, and any fines that might be imposed and collected would be placed to the credit of the school fund.

Providing for all fees collected and fines imposed to be paid in to the state treasurer and by him placed to the credit of the Bureau of Mines fund.

Providing an appropriation for the completion of purchase of the Elsner mineral collection. Providing for the segregating of the Bureau of Mines into two departments, to be designated as the Bureau of Mines, and Metalliferous Mine Inspectors, departments, for reasons assigned on page 239.

Providing mileage for the officers of the Department when traveling in discharge of their official duties, similar to that now granted the coal mine inspectors.

Providing for the publication of the Bureau of Mines report on or before July 1, 1905, and biennially thereafter. This will afford the best results in obtaining required data, and the work of the Department may be carefully considered prior to the meeting of the general assembly.

APPOINTMENTS.

- April 27, 1901, P. H. Clifford, Inspector for term of two years beginning June 1, 1901.
- May 29, 1901, Fred H. Nye, Inspector for term of two years beginning June 1, 1901.
- May 29, 1901, J. C. Langley, Clerk and Assistant Curator for term of two years beginning June 1, 1901.
- May 29, 1901, Iva C. Brawner, Stenographer, for term of two years beginning June 1, 1901.

STATEMENT OF DISBURSEMENTS OF THE BUREAU OF MINES AP-PROPRIATION, FOR THE FISCAL YEARS 1901-1902.

Appropriation		\$22,333 3
Commissioner of Mines, salary\$	5,000	00
Commissioner of Mines, expense account	1,769	14
Inspector D. L. Griffin, salary	850	00
Inspector D. L. Griffin, expense account	342	65
Inspector F- H. Nye, salary	2,150	00
Inspector F. H. Nye, expense account	1,525	80
Inspector P H. Clifford, salary	3,000	00
Inspector P. H. Clifford, expense account	1.821	16
Clerk and Assistant Curator, salary	3,000	00
Stenographer salary	2,000	00
Printing, incidental and operating expenses	333	34
Balance	540	96

ALTITUDES IN COLORADO.

THE FOLLOWING ALTITUDES ARE COMPILED FROM BULLETIN NO. 160 OF THE UNITED STATES GEOLOGICAL SURVEY, BY HENRY GANNETT.

ALTITUDE OF CITIES AND TOWNS.

CITY OR TOWN	Feet	CITY OR TOWN	Feet
Akron	4,650	Dillon	8,859
Alamosa	7,531	Dolores	6,942
Alma	10,240	Dumont	8,000
Antonito	7,873	Durango	6,551
Aspen	7,853	Eaton	4,834
Berthoud	4,959	Elizabeth	6,445
Black Hawk	8,044	Empire	8,259
Boulder	5,347	Evans	4,647
Breckenridge	9,524	Fairplay	9,898
Buena Vista	7,955	Fall Creek	7,466
Burlington	4,160	Florence	5,185
Canon City	5,329	Florissant	8,177
Caribou	9,905	Forks Creek	6,892
Castle Rock	6,220	Fort Collins	4,994
Central City	8,515	Fort Crawford	6,168
Cheyenne Wells	4,279	Fort Morgan	4,319
Colorado City	6,064	Fountain	5,535
Colorado Springs	6,098	Frisco	9,071
Como	9,787	Fruita	4,510
Conejos	7,880	Garfield	9 496
Creede	9,000	Garland, Fort	7,996
Crisman	6.287	Georgetown	8,587
Cripple Creek	9,396	Gleneye	6,500
Dallas	6,911	Glenwood	5,743
Del Norte	7,865	Golden	5,667
Delta	4,980	Goldhill	7,200
Denver	5,309	Grand Junction	4,594
		1	

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CITY OR TOWN CITY OR TOWN Feet Feet Granite 8,930 Ophir 9,221 4.639 Ouray Greelev 7.640 Pagosa Springs Gunnison 7.648 7.095 Gypsum Pinkhampton 6.310 8 000 Havden 9.141 Pitkin 9.192 6.630 Placerville Hermosa 7.306 Pueblo Hesperus 8.135 4.690 3.745 Red Cliff Holvoke 8.656 Hotchkiss ____ 6.395 Rico 8,737 Rocky Ford Howardville 9,700 4.177 Rollinsville 5.662Huerfano Rosita 5.0528.932 Hugo St. Vrains Idaho Springs 7,550 5,256 Jamestown 7,123 Saguache . 7,740 Iulesburg 3,560 Salida 7,035 Salina Kit Carson 1.284 6.560 Kokomo Sedgwich 10.654 3.573 Lajara 7.909 Silver Plume 9.188 3.592 Silverton 9,285 I,amar 5.069Sterling . 3.918 Laporte ... Las Animas Sunshine 3,892 12.945 Telluride Leadville 10,185 8,741 Longmont 4,935 Trinidad 5,990 Twin Lakes Loveland 4.984 9.012 1,903 Unaweep 1,621 Lupton_ _ 3 910 Vance Junction 8,101 Lyon, Fort _ Villa Grove Magnolia 5,330 7,956 6,960 Victor 9,734 Mancos _ _ Wall Street 6 309 6.865 Maniton Walsenburg 6.182 6.170 Meeker___ 7.650 9,217 Monte Vista Ward 5.511 Westcliffe ____ 7,819 Montrose_ Whitewater 4,651 8.263 Nederland _ 3,512 Needleton 8,126 Wray 1.119 Newcastle 5,547 Yuma 8,558

ALTITUDE OF CITIES AND TOWNS-Concluded.

MOUNTAIN PEAKS AND PASSES OF COLORADO AND THEIR ELEVATIONS ABOVE SEA LEVEL.

NAME	Feet	NAME	Feet
Abeyta Pass	9,300	Breckenridge Pass	11,503
Agency Knob	12,274	Buckeye Peak	12,873
Aeolus	14,054	Buckskin Mountain	14,296
Alpine Tunnel	11,608	Buffalo Peak	13,541
Altar Peak	13,254	Byers, Mount	12,778
Anchor Mountain	12,092	Calico Mountain	12,056
Autelope Pass	8,050	Cameron Cone	10,685
Antero, Mount	14.245	Canby, Mount	13,466
Arapahoe Peak	13,520	Capitol Mountain	13,997
Argentine Pass	13,286	Carbon Mountain	12,000
Arkansas, Mount	13,807	Cascade Mountain, Elk Mts	11,707
Augusta Mountain	12,615	Castle Peak	14,259
Avery Peak	12,659	Cement Mountain	12,212
Axtell Mountain	12,012	Chama Peak	12,248
Bald Mountain	13,974	Chicago Lake	11,50 0
Baldy Mountain, Elk Mountains	12,809	Chief Mountain	11,833
Baldy Peak	14,176	Clark Peak	13,167
Banded Peak	12,860	Cochetopa Dome	10,000
Basalt Peak	11,906	Comanche	11,929
Bear Creek Pass	12 600	Conejos Mountain	13,183
Bear Mountain	12,950	Corral Peak	11,333
Beckwith Mountain	12,371	Crested Butte, Elk Mountains	12,172
Belleview	12,350	Crestone Peak	14,233
Bison Peak	12,426	Cuerno Verde Peak	12,341
Blackhead	12,514	Culebra Peak	14,069
Blaine, Mount	14,249	Cunningham Pass	12,090
Blanca Peak	14,390	Daly, Mount	13,193
Boreas	11.482	Del Norte Peak	13,084
Boulder Pass	11.670	Derby, Mount	12,253
Boulder Peak	12,417	Devil's Head	9,348
Boundary Peak	12,840	Double Top Mountain	12,192

MOUNTAIN PEAKS AND PASSES OF COLORADO-Continued.

NAMĘ	Feet	NAME	Feet
Dunn Peak	13,502	Guyot Mountain	13,565
Eagle Peak	12,130	Hagerman	11,495
East Cement Mountain	12,047	Hague Peak	13,832
East River Pass	11,163	Hamilton Pass	12,370
East Spanish Peak	12,708	Hancock Pass	12,263
Eighteen Mile Mountain	12,278	Handies' Peak	14,008
Elbert Peak	14,421	Hanz Peak	10,906
Elliott Mountain	12.361	Harvard, Mount	14.375
Emmons, Mount, Elk Mount ins.	12,414	Hayden Divide	9,182
Engineer Mountain	13,190	Helmet Peak	12.042
Ethel Peak	11,976	Hermano Peak	9,014
Evans, Mount	14,330	Hesperus Mountain	13,135
Farnum Peak	11,400	Holy Cross Mountain	14,006
Fisher Peak	9,586	Homestake Peak	13,227
Flora, Mount	12,878	Hoosier Pass	11,627
Freeman Peak	11,627	Horsefly Mountain	10,504
Fremont Pass	11,313	Horseshoe Mcuntain	13,912
French Pass	12,044	Hunchback Mountain	13,755
Frustum Mountain	13,893	Hunt Peak	12,333
Galena Mountain	13,290	Hurricane Peak	13,565
Garfield Peak, Elk Mountains	12,136	Indian Creek Pass	9,803
Georgia Pass	11,811	Jacque Peak	13,215
Gibson Peak	13,729	Jaines Peak	13,283
Gilpin Peak	13,682	Jones Mountain	13,851
Glacier Mountain	14,243	Kendall, Mount	13,480
Golden Peak	9,650	Kenosha Cones, East	12,350
Gothic Mountain	12,646	Kenosha Cones, West	12,310
Grand Mesa	10,000	Kit Carson Peak	14,100
Grayhead	10,994	Lake Creek Pass	12,226
Gray's Peak	11,341	Lamborn, Mount	11,337
Greenhorn Mountains	12,230	I,a Plata Peak	14,342
Green Mountain .	10,530	La Veta Peak	11,654
Griffith Mountain	11 273	I,eon Peak	10,954
Grizzly Peak, San Juan Mts	13,718	Lillie Mountain	11,433
Grizzly Peak, Sawatch Range	13,956	Lime Creek (or, White Earth) Pass	11,314
Gunnison, Mount	12,688	Lincoln, Mount.	14,297

MOUNTAIN PEAKS AND PASSES OF COLORADO-Continued.

NAME	Feet	NAME	Feet
Little Scraggy Peak	9.640	Pagosa Peak	12.674
Lizard Head, Depot	10,235	Park Cone	12,021
I,one Cone	12,761	Park View Peak	12,433
I,ong's Pass	7,660	Parry Peak	13,133
Long's Peak	14,271	Pass Mountain	11,200
Lookout Peak	13,674	Pearl Pass, Elk Mountains	12,715
Lost Knife Pass	8,400	Pearl Peak, Elk Mountains	13,484
Lost Park Mountain	11,800	Peeler Peak, Elk Mountains	12,219
McClelland Mountain	13,423	Pidgeon Peak.	13,928
Macomb Peak	13,154	Pike's Peak	14,108
Marcellina, Mount, Elk Mts	11,349	Pike's Peak, timberline	11,720
Marleston Peak	10,874	Pilot Knob	13,750
Marmot Peak	11,600	Pintado Peak	13,176
Maroon Mountain	14,003	Pisgah, Mount	10,322
Marshall Pass	10,841	Pole Creek Mountain	13,400
Massive Mountain	14,424	Potosi Peak	13,763
Mayo Springs	10,174	Powell, Mount	13,398
Mear's Peak	13,008	Princeton, Mount	14,196
Meigs Peak	13,394	Prospect Mountain	12,618
Mesquite Pass	13,308	Prospect Peak	9,909
Mineral Creek Pass	11,098	Ptarmigan Peak	13,746
Mineral Point, Elk Mountains	12,541	Pyramid Peak	13,885
Monitor Peak	11,270	Quandary Peak	14,266
Mosca Pass	9,713	Rabbit Ears Mountain	10,719
Mosquito Pass	13,188	Ralston Butte	10,593
Mosquito Peak	13,974	Raton Pass	7,893
Muddy Creek Pass	8,772	Red Cloud Peak	14,092
North Italian Mountain, Elk Mts.	13,225	Red Mountain	13,333
North Mam	11,973	Rhyolite Peak	10,400
Ohio Pass, Elk Mountains	10,033	Richmond, Mount, Elk Mts	12,542
Ohio Peak	12,251	Rio Grande Pyramid	13,773
Ormus Mountain	12,185	Rito Alto, Mount	12,989
Oso, Mount	13,640	Riga Spar	11,306
Ouray, Mount	13,956	Rolling Mountain	13,694
Owen, Mount, Elk Mountains	13,102	Rosa Mountain	11,427
Pagoda Peak	11,251	Rosalie Mountain	14,340

MOUNTAIN PEAKS AND PASSES OF COLORADO Continued.

NAME	Feet	NAME	Feet
Round Mountain, Elk Mountains	10,881	Telescope Mountain	12.231
Round Mountain, Elk Mountains	13,422	Teocalli, Mount, Elk Mountains	13,220
Round Peak	12,946	Tetons	14,195
Rowter, Mount	13,750	Tilton Mount, Elk Mountains,	12.633
Ruby Peak, Elk Mountains	12,749	Torrey Peak	14,336
Saddle Mountain	10,815	Tower Mountain	13,444
San Francisco Pass	8,560	Treasury Mountain	13,200
Sangre de Cristo Pass	9,454	Trinchera Mountain	13,546
San Luis Peak	14,100	Troublesome Peak	11,500
Schuylkill, Mount, Elk Mts	12,188	Trout Creek Pass	9,346
Shavano, Mount	14,239	Tumichi Dome	11,384
Sheep Mountain	12,559	Twin Creek Pass	9,612
Sherman Mountain	14,048	Twin Sister Lake	13,43%
Shingle Mountain	12,072	Uncompaligre Peak	14,289
Silesia Butte	13,699	Ute Peak, Middle Park	11,968
Silverheels, Mount	13,855	Velie Peak	13,456
Simpson, Mount	14,055	Venado Peak	12,800
Slate Peak, Elk Mountains	12,989	Vermilion Peak	13,870
Smith Peak	13,093	Veta Pass	9,375
Sueels, Mount	14,158	Virginia Peak	10,600
Snowmass Mountain	13,970	Vulcan Crest	13,971
Sopris Peak	12,823	Wasatch Mountain	13,551
South River Peak	13,160	Weeminuche.	10,670
Spanish Peaks	13,620	West Elk Peak	12,920
Squaw Mountain	11,733	Weston Pass	12,109
Star Peak	13,562	West Spanish Peak	13,623
Stewart Peak	14,032	Wetterhorn	14,069
Stoll Mountain	10,915	Whale Peak	13,104
Stony Monntain	12,677	Wheatstone Monntain	12,545
Stormy Peak	11,748	Whiteface Peak	11,493
Storm Ridge	11,859	Whitehead	10,817
Sultan Mountain	13,366	White Rock Monutain	13,532
Summit Peak	13,323	Wildflax Pass	\$,900
Tarryall Pass	12,176	Wilkinson Monutain	11,687
Tarryall Peak	12,466	Williams, Monut	11,413
Taylor Peak, Elk Mountains	13,419	Willow Creek Pass	9,683

MOUNTAIN PEAKS AND PASSES OF COLORADO Concluded.

NAME	Feet	NAME	Feet
Wilson, Mount	14,280	Yellow Jacket Pass	7,493
Wood Mountain	13,640	Yellow Peak	13,618
Yale Mountain	14,187	Zenobia Peak	9,297
Yampa Peak	8,022	Zirkel Mountain	12,126

ELEVATION OF PARKS AND LAKES.

NAME	Feet	NAME	Feet
Allen Park	8,513	Manitou Park	8,464
Bergen Park	7,643	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 Lake	7,592
Chicago Lake	11,500	San Luis Valley (Mean)	7,500
Columbine Lake	8,788	San Miguel Lake	9,720
Crane Park	10,184	Sheridian Lake	4,065
Crystal Lake	9,317	South Park	8,000 to 10,000
Eagle Park	9,212	Trout Lake	9,700
Elk Park	8,868	Twin Lakes	9,012
Grand Lake	8,153	Twin Sister Lake	13,438
Hughes' Lake	7,453	Union Park	9,655
Jerome Park	8,290	Weiserhorn Lake	5,238
I,ake Moraine	10,268	White River Plateau	11,000 to 12,000

POPULATION OF COLORADO. (TWELFTH CENSUS OF THE UNITED STATES.)

Colorado was organized as a territory February 28, 1861, and admitted as a state August 1, 1876. The population of Colorado at each census from 1860 to 1900, inclusive, together with the increase by number and per cent. during each decade.

TABLE I—POPULATION (OF COL	LORADO—	1860 TO	1900.
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		Increase	
CENSUS YEARS	Population	Number	Per Cent.
1900	539,700	127,502	30.9
1890	412,198	217,871	112.1
1880	194,327	154,463	387.4
1870	39,864	5,587	16.2
1860	34,277		

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COUNTIES	1900	1890	1850	1870
The State	539,700	412,198	194,327	39,864
Arapahoe	153,017	132,135	38,644	6,829
Archuleta	2,117	826		
Васа	759	1,479		
Bent	3,049	1,313	1,654	592
Boulder .	21,544	14.082	9,723	1.939
Chaffee	7.085	6,612	6,512	
Cheyenne	501	534		
Clear Creek	7,052	7,184	7,823	1,596
Conejos	5,794	. 7,193	5,605	2,504
Costilla	4.632	3,491	2,879	1,779
Custer	2,937	2 970	8,0°0	
Delta	5,457	2,534		
Dolores .	1.134	1,495		
Douglas	3,120	3,006	2,4×6	1,355
Fagle .	3,008	3 725		
Elbert	3,101	1,856	1,705	
El Paso	31,602	21,239	7,949	987
Fremont	15,636	9 156	4,735	1,064
Garfield	5,835	4,478		
Gilpin	6,690	5,867	6,489	5,490
Grand	741	604	417	
Greenwood		Same and	dana d	510
Gunnison.	5,331	4,359	8,235	
Hinsdale	1,609	862	1,457	
Hueifano	8,395	6,882	4,124	2,250
Jefferson	9,306	8,450	6,804	2,390
Kiowa	701	1,243		
Kit Carson	1,550	2,472	Same	
Lake	1.8,054	14,663	23,563	522
I,a Plata	7,016	5,509	1,110	
I,arimer	12,168	9,712	4,892	838
Las Animas	21,842	17,208	8,903	4,276
Lincoln	926	689		
Logan	3,292	3.070		

POPULATION OF COLORADO BY COUNTIES. 1870 TO 1900.

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POPULATION OF COLORADO BY COUNTIES Concluded. 1870 TO 1900.

COUNTIES	1900	1890	1880	1870
Mesa	9,267	4,260		
Mineral	1,913			
Montezuma	3,058	1,529		
Montrose	4,535	3,980		
Morgan	3,268	1,601		
Otero	11,522	4,192		
Ouray	4,731	6,510	2,669	
Park	2,998	3,548	3,970	447
Phillips	1,583	2,642		
Pitkin	7,020	8,929		
Prowers	3,766	1,969		
Pueblo	34,448	31,491	7,617	2,265
Rio Blanco	1,690	1,200		
Rio Crande	4,080	3,451	1,944	
Routt	3,661	2,369	140	
Saguache	3,853	3,313	1,973	304
San Juan	2.342	1,572	1,087	
San Miguel	5,379	2,909		
Sedgwick	971	1,293		
Summit :	2,744	1,906	5,459	258
Teller	29,002			
Washington	1,241	2.301		
Weld	16,808	11,736	5,646	1,636
Yuma	1.729	2,596		

268 REPORT OF COMMISSIONER OF MINES

INCREASE IN POPULATION OF COLORADO BY COUNTIES. 1890 TO 1900.

	Iucr	ease
COUNTIES	Number	Per Cent.
The State	127,502	30.9
Arapahoe	20,882	15.8
Arehuleta	1,291	156.2
Baca	* 720	* 45.6
Bent	1,736	132.2
Boulder	7,462	52.9
Chaffee	473	7,1
Сћеуеппе	* 33	* 6.1
Clear Creek	* 102	* 1.4
Conejos	1,601	20.2
Costilla	1,141	32.6
Custer	* 33	* 1.1
Delta	2,953	116.5
Dolores	* 364	* 24.2
Douglas	114	3.7
Eagle	* 717	* 19.2
Elbert	1.245	67
El Paso	10,363	48.7
Fremont	6,480	70.7
Garfield	1,357	30.3
Gilpin	\$23	14
Grand	137	22.6
Gunnison	972	22.2
Hinsdale	747	86.6
Huerfano	1,513	21_9
Jefferson	856	10.1
Kiowa	* 542	* 43.6
Kit Carson	* 892	* 36
Lake	3,391	23.1
La Plata	1,507	27.3
I,arimer	2.456	25.2
Las Animas	1.634	26.9
Lincolu	237	34.3

* Decrease.

STATE OF COLORADO, 1901-2.

INCREASE IN POPULATION OF COLORADO BY COUNTIES-Concluded, 1890 TO 1900.

	Inci	ease
COUNTIES	Number	Per Cent.
Logan	222	7.2
Mesa	5,007	117.5
Mineral	1,913	
Montezuma	1,529	100
Montrose	555	13.9
Morgan	1,667	104.1
Otero	7,330	174.8
Оитау	* 1,779	* 27.3
Park	* 550	* 15.5
Phillips	* 1,059	* 40
Pitkin	* 1,909	* 21.3
Prowers	1,797	91.2
Pueblo	2,957	9.3
Rio Blanco	490	40.8
Rio Grande	629	18.2
Routt	1,292	54.5
Saguache	540	16.2
San Juan	770	48.9
San Miguel	2,470	84.9
Sedgwick	* 322	* 24.9
Summit	83 8	43.9
Teller	29,002	
Washington	* 1,060	* 46
Weld	5,072	43.2
Yuma	* 867	* 33.3

*Decrease.

AVERAGE MARKET VALUE OF METALS PER ANNUM.

YEAR	Gold Per Ounce	Silver Per Ounce	Lead Per Pound	Copper 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	1 275	0601	225
1875	20 67	1 246	0585	21
1876	20 67	1 156	0613	186
1577	20 67	1 201	0549	156
1878	20 67	1 152	0361	165
1879	20 67	1 123	0414	171
1550	20 67	1 145	0504	201
1841	20 67	1 138	0481	181
1582	20 67	1 136	0491	185
1883	20/67	1 11	0432	1585
1%4	20 67	1 13	0374	1385
1885	20 67	1 065	0395	1112
18-6	20 67	995	0463	11
1887	20 67	978	0450	1225
1885	20 67	94	0442	1666
1989	20 67	936	0393	1375
1890	20 67	1 016	0448	1575
1891	20 67	988	0435	1262
1892	20 67	876	0409	1155
1893	20 67	792	0373	1075
1×94	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	0173	1652
1901	20 67	5895	04334	16555
1902	20 67	5216	01069	11887

THE BUREAU OF MINES OF THE STATE OF COLORADO. PRECIOUS METAL PRODUCTION OF COLORADO TO DECEMBER 31, 1901.

5,828,341 20 S,743,906 S0 5,478,710 20 22,035,241 20 22,465,713 40 23,473,526 00 25,291,631 30 23,237,608 50 27,583,081 00 3,695,000 00 .693,009 00 ,711,464 00 .092.340 42 5,280,220 40 5.380.352 00 7,372,425 24 22,271,794 00 21,687,362 **FOTAL** 69 89,000 00 S4,000 00 276,390 00 50 278,800 50 44,990 00 10,000 00 00,000,00 30,000 00 5,000 00 55,000 00 90,197 00 00.000.06 70,000 00 93,796 64 31,000 00 61,000 00 182,750 27,435 Value COPPER 200,000 906'06 55,172 28,172 100,876 504,253 539,393 766,052 915,422 ,146,000 97,088 128,571 376 244 589,503 ,494,000 .153,000 2,013,000 109,000 Pounds 37,502 40 5,000 00 7,078 40 00 00,706 00 98,490 60 181,501 80 ,960,207 20 3,595,939 20 40 00 000,101,000 00 8 ,724,742 00 ,345 000 00 5,463,400 00 81.774 1 3,900,621 5,096,124 Value LEAD 80,000 112,000 624,000 ,334,000 000,491,000 17.348,000 71,348,000 81,094,000 110,000,000 (11,111,000 26,330,000 111,000,000 118,000,000 636.000 3,338,000 Pounds ,029,058 00 2,015.001 00 3.086,926 00 2,873,591 00 1 180,138 00 10,162.503 00 5,104.092 00 330,000 00 660,000 00 2,185,014 00 2,950,256 00 L.807,001 00 5.055,302 00 14,436,136 00 4,912,756 00 3,984,066 00 3,014,927 00 12,313,404 00 Value SILVER -250,000 779,590 524.207 2,415,435 2.306,253 2,552,125 3,480,548 2.375.280 500,000 ,683,370 4,172,744 9,049,424 3,148,735 3,272,488 12,375,280 2,707,866 3,434,915 2,220,589 Fine Ounces 27,213,081 00 3,015,000 00 3,633,951 00 2.646,463 00 835,248 00 2,065,595 00 2,321,055 00 2.726.311 0.0 3.000.000 00 3,366,404 00 3,225,000 00 360,000 00 4,450,000 00 200.000 00 3,300,000 00 100,000 00 250,000 00 200,000 00 Value GOLD -99,932 156,023 131,897 145,138 159,652 198,355 205,612 ,316,550 145,864 175,808 128,034 88.788 12.291 162,864 154,814 162,554 203,193 215,288 Fine Ounces Previous to 1870 YEAR 1873. 1875. 1879 1883. 1870 1871 1872 1876 1877 1878 1880 1881 1882 1884 1886 1874

STATE OF COLORADO, 1901-2.

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PRR	Value	\$ 226,350 00	270,058 60	426,250 00	915,000 00	883,400 00	837,375 00	765,535 12	624,097 26	659,050 00	820,269 86	960,917 13	1,304,504 28	1,295,610-85	1,293,011 98	1,303,297 17	\$ 14,634,087 10
COP	Pounds	2,012,000	1,621,000	3,100,000	6,000,000	7,000,000	7,250,000	7,121,157	6,528,214	6,125,000	7,539,245	9,151,592	10,870,869	7,357,245	7,826,949	7,872,529	108,982,515
AD	Value	\$ 5,670,000 00	5,790,200 00	5,423,400 00	4,883,200 00	5,568,000 00	5,030,700 00	3,147,970 80	3,200,000 00	2,954,714 00	2,321,109 40	2,731,032 49	4,117,043 24	6,170,765 53	7,770,196 24	6,419,131 61	\$107,491,551 31
I,F	Pounds	126,000,000	131,000,000	138,000,000	109,000,000	128,000,000	123,000,000	84,396,000	97,264,000	91,477,214	82,018,000	80,799,778	113,417,168	138,048,446	164,274,762	148,111,020	2,579,958,388
VER	Value	\$ 11,345,608 00	13,813,906 00	17,199,486 00	19,665,245 00	20,906,554 00	23,082,600 00	20,205,785 00	14,638,696 00	11,683,232 00	14,458,536 00	12,692,448 00	13,690,265 15	13,771.731 10	12,458,774 84	10,901,365-89	\$363,614,403 98
SIL	Fine Ounces	11,600,826	14,695,645	18,375,519	18,800,425	21,160,480	26,350,000	25,838 600	23,236,025	17,891,626	21,547,743	21,278,202	23,502,601	23,114,688	20,336,712	18,492,563	424,470,504
01,D	Value	\$ 4,000,000 00	3,758,000 00	3,883,859 00	4,150,000 00	4,600.000 00	5,300.000 00	7,527 000 00	9.549,731 00	13,559,954 00	15.267 234 00	19,579,637 00	23, 534, 531 28	26,508,675 57	28.762.036 29	27,679,445 04	\$ 279,565,211 18
	Fine Ounces	193,517	151,809	187,898	200.774	522.545	256,410	364,151	462,009	656,021	738,618	612.249	1,138.584	1,282,471	1,391,487	1.339.112	13,525,312
	YEAR	1887	1548	1×19.	1.90	1.91	1-92	1~93	1×94	1895	1×96	1897	1898	1 - 99	1900	1901	Totals

NOTE-In the above table the calculation is on the average market price of the metal for each year. See page 270,

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REPORT OF COMMISSIONER OF MINES

COLORADO.	THE YEAR 1897.
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STATE OF COLORADO, 1901-2.

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COLORADO		GOLD	SII	L'VER	H.)	U.A.D	CO	PPER	
Name of County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	TOTAL
Hinsdale.	\$ 136	\$ 168,171 12	243,437	\$ 145,210 17	5,550,058	\$ 187,591 96	8,085	\$ 848-93	\$ 501,822 18
Huerfano	35	723 45	167	99 62	1,067	36 06	92	99 6	808 10
Jefferson	399	S.247 33	1,611	962 75	10,093	341 14	1,602	168 21	9,719-13
I,ake	99 - 15	2,063,558 16	5,451,317	3,251,710 59	23,700,908	801,090 69	3,146,802	330,411 21	6, 117,073 65
La Plata	1.426	29,475 42	1,409	840 47	857	28 97	420	44 10	30,388-96
I,arimer	144	2,976 45	97	57 86					3,034 34
Las Animas.	31	640 77	9	5 37					646 14
Mineral	2,967	61,327 89	3,070,576	1,831,598 58	6,080,673	205,526 75	1,500	157 50	2.098,610 72
Montrose	317	6,552 39	8.11	507 62				*	7,060 01
Mesa									
Montezuma .	371	7,668 57	105	62 63					7,731 20
Ouray	26,746	552,839 52	2,776.394	1.656,119 02	7,754,212	263,106 37	2,185,084	229,433 82	2,701,499_03
Park	7,432	153,619 44	199,945	119 267 19	4,517,614	152,695 35	58,002	6,090 21	131,672 19
Pitkın	7,955	161 429 85	4.599,946	2,743 867 79	4,456,478	150,628 96	8,360	05 215	3,059,804 40
Rio Grande	1,093	22,592-31	8,168	4,872-21	12,006	105 80	627	65 84	27,936-16
Routt	473	9.776 91	7,805	4,655 68	58,736	2,999 28	928	62 001	17,532.46
Saguache	665	13,745 55	2,482	1,480 51	9,266	313 19	2,975	312 38	15,851 63
San Juan	33,591	694,325 97	1,101 907	657,287 53	8,021,414	271,123 79	1,435,203	150,696 32	1,773,433-61

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San Miguel	70,544	1,458,114 48	869,079	518,405 62	4,143,767	140,059 32	354,781	37,252 00	2,153,861 42
Summit	13,239	273,650 13	514.107	306,664 83	1,748,761	39,108 12	133,482	14,015 61	623,438 69
Totals	947,249	\$ 19,579,636 83	21,278,202	\$ 12,692,447 47	80,799,778	\$ 2,731,032 49	9,151,592	\$ 960,917 13	\$ 35,964,033 92
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NOTE-In the above table the calculation is on the average market price of the metal for the year. See page 270.

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REPORT OF COMMISSIONER OF MINES

Huerfano	L+	144 69	40	23 30			2 0 0 9 5 0 9 5 0 0		167 99
Jefferson	89	1,839 63	102	59 42	8 8 8 8 9 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8				1,899 05
Lake	100,292	2,073,035 64	7,068,727	4,117,533 48	35,945,006	1.304.803 72	5,543,954	665,274 48	8,160,647 32
I,a Plata	1,470	30,384 90	4,348	2,532 71			2,568	308 16	33,225 77
L'arimer	240	11,161 80	60	34 95			24,484	2,938 08	14,134 83
Las Animas	9	124 02							124 02
Mineral	2,244	46,383 48	4,177,184	2,433,209 68	5,453,104	197,947 68	14,729	1,767 48	2,679,308 32
Montrose	131	2,707 77	6,290	3,663 93			34,664	4,159 68	10,531 38
Mesa	8	165 36	20	11 65					177 01
Montezuma	400	8,268 00	871	507 36	8,407	305 17			9,050 53
Juray	41,246	852,554 82	1,420,330	827,342 23	2,799,936	101,637 68	1,035,562	124,267 44	1,905,802 17
Park	7,716	159,489 72	198,711	115,749 16	1,953,001	70,893 94	20,957	2,514 84	345,647-66
Pitkin	3,435	71,001 45	3,977,270	2,316,759 78	15,903,682	577,303 66	4,553	546 36	2,965,611 25
Rio Grande	180	3,720 60	1,568	913 36	2,393	86 87	9,794	1,175 28	5,896 11
Routt	617	12,753 39	2,173	1,265 77	15,477	561 82	600	72 00	14,652 98
Saguache	952	19,677 84	2,618	1,524 99	132,462	4,808 37	21,711	2,605 32	28,616 52
3an Juan	54,794	1,132,591 98	1,048,499	610,750 68	14,659,999	532,157 96	2,252,421	270,290 52	2,545,791 14
san Miguel	76,085	1,572,676 95	2,129,082	1,240,190 27	6,699,712	243,199 55	360,831	13,299 72	3,099,366 49
Summit	16,634	343,824 78	415,687	242,137 68	4,889,204	177,478 11	9,825	1,179 00	764,619 57
Totals	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	\$ 12,646,343 95

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NOTE-In the above table the calculation is on the average market price of the metal for the year. See page 270.

STATE OF COLORADO, 1901-2.

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269 90 128-97 212 66 96 98 127 00 733 58 12,203 05 1,816.410 80 19,958 66 20 319,302 97 26,678 65 13,463 57 220,027 58 508.493 21 150,473 14 2,440,371 21 612,561 38 881 131 TOTAL. 13,879 50 36 1 179 52 31 72 03 8,133 35 8,747 94 22,695 21 82,659 84 51,591 : 7,838 (1,034 162 Value COPPER -78,816 5,876 6,698 696,736 292,966 44,509 46,186 49,676 923 1,037 421 Pounds 82 172,584 18 1,253 52 53,330 41 37,409 16 91,466 57 511 50 58,660 35 62,550 32 53,100 47 322,566 Value I,FAI) 2.046,232 28,043 836, 894 11.443 7,216,260 1.187,930 1.312,312 1,399,336 10.572,353 1,193,074 Pounds 25 62 70 67 1 19 5 96 14 30 10 13 895,427 82 13,695 65 3,577 18 53,151 59 26,449 35 2 98 15,501 84 S7,784 58 2,367 70 202,960 16 79,231 27 92,856 41 {--Value SILVER 4 01 43 76,371 147,339 22,987 126 6.004 10 257,052 11,393 3.974 340,652 13 132,983 155,902 ,502.900 57 Fine Ounces 103 35 6,263 01 206 70 \$2 68 02 723 45 E 547,858 35 216.662 94 546,824 85 806 13 71 400,1 66.846 75 16.094 10 9.404 85 090.060 56 0,112 64 34,342 85 268 124 VALUE 10 -Fine Ounces 26.505 10.482 26.455 2.2303,392 303 9 155 10 10 3,224 96,565 35 1,555 Vame of County COLORADO Clear Creek Chaffee Archuleta Arapahoe Gunnison Hinsdale Huerfano Boulder . Conejos Costilla Douglas Fremont Garfield Dolores Delta .. Gilpin. Eagle . Grand Custer

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REPORT OF COMMISSIONER OF MINES

Jefferson	99	1,364 22	351	209 13	022	34 42	127	11 73	1,652 50
L,ake	106 265	2,196,497 55	7,230,118	4,307,704 30	48,598,720	2,172,362 78	3,202,828	564.018 01	9,240,582 64
La Plata.	1,242	25,672 14	3,162	1,883 92	3,176	141 97	211	37 16	27,735 19
L,arimer	100	2.067 00	135	80 43	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		2 474	135 67	2,583 10
I,as Animas	. 10	206 70	50	1 79					208 49
Mineral	4,435	91,671 45	3,796,899	2,262,192 42	5,677,162	253,769 14	20,223	3,561 27	2,611.194 2>
Montrose	35	723 45	46,119	27,477 70			75,006	13,208 56	41.409 71
Mesa	9	124 02	4,120	2,454 70			4,650	818 87	3,397 59
Montezuma	746	15,419 82	227	135 25					15,555 07
Ouray	82 000	1,694,940 00	2,346,194	1,397.862 39	7.556,386	337,770 45	305,177	53,741 67	3,484,314 51
Park	7,404	153,040 68	72,137	42,979 22	540,849	24,175 95	7,903	1,391 72	221,587 57
Pitkin	2.527	52,233 09	4.158,708	2,477,758 23	25,458,380	1,137,989 59	19,351	3,407 71	3,671,388 62
Rio Grande	929	19,202 43	2,718	1,619 38	1,635	73 08	336	51 65	20,954 06
Routt	559	11,554 53	1,271	757 26	. 3,405	152 20			12,463 99
Saguache	188	3,885 96	14,306	8,523 51	441,095	19,716 95	35,319	6,219 68	38,346 10
San Juan	48,199	995,273 33	1,191,657	710,108 40	16 011,677	715,721.96	1.197.661	210,908 10	2,633,011 79
San Miguel	66,604	1.376,704 68	1 205,395	719,961 74	3,918.8~3	175 171 07	160.239	28,218 09	2,300,058 55
Summit	12,606	260,566 02	264,872	157,810 74	4.032, 431	180,249 67	65,531	11,540 01	610,166 44
Teller	776,902	16.058,564 34	82,299	49,033 74		-	275	18 43	16,107.646 51
Totals	1,282,471	26,508,675 57	23,114,688	\$ 13,771,731 10	138.045,446	\$ 6,170,765 53	7,357.245	\$ 1,295.610 85	\$ 47.746.753 05

NOTE-IN the above table the calculation is on the average market price of the metal for the year. See page 270.

STATE OF COLORADO, 1901-2.

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76 75 248 04 163 12 1.963 65 13 1,636 27 369,419 37 113,572 52 576,035 32 4,306 41 2,277 51 05,495 44 1,031 06 63,861 59 81,082-92 11,162 45 ,967,550 71 3,774 84 255,934 85 524 TOTAL -747 86 380 13 17 68 1,470 28 3,365 29 24,507 44 10,324 00 5,948 69 59,315 72 1,110 97 32.073 77 7.068 90 Value COPPER 44 8,900 211,092 36,009 6.725 799,478 42,790 20,371 153,677 359,054 4,527 107 2,301Pounds 104 06 12 22 391 74 39 236,228 64 9,950 97 174,055 86 34,802 06 74,891 04 3,598 3 39,422 33,552 2 Value I, I & A D 2,200709,349 210,3%0 8.282 533 462 1,583,320 76,076 ,994,263 3,679,828 Pounds 14 74 12 90 90,116 72 43 6 83 65 10 44,113 30 98 55,469 80 76,965 15 34,035 62 97,837 18 1.350 40 64 45,173 24 195 18 3 622 727 59 ι~ Value 00 SILVER -82,605 159,318 30 102 2.199236,400 90,327 125,330 ,358,143 1,014 314 10 234,674 5 13 146,746 Fine Ounces 516 75 65,417 06 2,831 79 2,067 00 20, S35 36 62 01 83,858-19 69 35 307,015 89 72,677 18 49 50.124 75 1,963 65 04 103,598 04 5,309 34 655.501 64 3,761 94 248 144 103 971 Value G01,D ÷, 5,012 Fine Ounces 22,518 2.42580,092 12 1-10 29,367 137 100 ,005 1- \mathfrak{r} 35 402 182 5 100.4 5,354 Name of County COLORADO Baca Delta Clear Creek Archuleta . Custer Gunnison Arapahoe Boulder .. Chaffee Gilpin Grand Conejos . Douglas . I²remont Garfield Eagle Costilla Dolores El Paso

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REPORT OF COMMISSIONER OF MINES

\$ 50,314,019 35	\$ 1.293,011 98	7,826,949	\$ 7.770,196 24	164,274,762	\$12,488,774 84	20,336,712	\$28,762,036 29	1,391,487	'l'otals
18,197.317 75	22 14	134			49,614 37	80,792	18,147,681 24	877,972	'l'eller
860,013 96	8,760 56	53,030	265,386 58	5,610,710	247,684-95	403,330	338,181 87	16,361	Summit
2,735,396 21	51,344 63	311,045	158,617 00	3,353,425	698,042 56	1,136,692	1,827,352 02	88,406	San Miguel
2,332,884 72	325,788 77	1,972,087	831,495 07	17,579,177	418,396 77	681,317	757,204 11	36,633	San Juan
35 291 29	2,664 50	16,129	14,949 69	316,061	9,698 48	15,793	7,978 62	386	Saguache
4,531 84	952 38	5,765			292 93	477	3,286 53	159	Routt
112,179 70	1,420 55	8,599	1,242 10	26,260	1,888 36	3,075	107,628 69	5,207	Rio Grande
253 57					5 53	6	248 04	12	Pueblo
3,842,501 96	1,004 75	6,082	1,298,491 90	27,452,260	2,529,549 14	4,119,116	13,456 17	651	Pitkin
177,790 84	2,478 00	15,000	32,263 66	682,107	26,491 05	43,138	116,558 13	5,639	Park
3,163,612 68	58,211 19	352,368	44S,340 48	9,478,657	1,219,152 46	1,985,267	1.437,908 55	69,565	Ouray
9,884 85				8 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	63 25	103	9,921 60	480	Montezuma
793 00	355 18	2,150			313 80	511	124 02	9	Mesa
18,991 92	5,290 70	32,026			12,068 29	19,652	1,632 93	61	Montrose
2,317,217 79	431 83	2,614	707,227 52	14,951,956	1,400,171 34	2,280,038	209,387 10	10,130	Mineral
									I,as Animas
3,991 06	2,280 75	13,806			- 77 38	126	1,632 93	79	I,arimer
20,100 37	57 82	350	685 85	14,500	4,350 28	7,084	15,006 42	726	I,a Plata
10,219,838 54	450,756 96	2,728,553	2,960,963 63	62,599,654	4,278,606 03	6,967,279	2,529,511 92	122.376	Lake
734 10		* * * * * * *			31 32	51	702 78	34	Jefferson
136 30					12 28	20	124 02	9	Iluerfano
600,309 35	4,820 54	29,180	343,535 03	9,377,062	95,483 34	155,485	56,470 4.1	2,732	Hinsdale

Norm-In the above table the calculation is on the average market price of the metal for the year. See page 270.

STATE OF COLORADO, 1901-2.

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Name of County	Fine Ounces	Value	Fine Ounces	Value	Pounds	Value	Pounds	Value	10101
Arapahoe	16	\$ 330 72							\$ 330 72
Archuleta .	9	124 02	18	\$ 10.61					131 63
Baca	4	52 68	80	47 16			590	\$ 97.67	227 54
Boulder	37 460	774.298 20	113,782	67,071 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
člear Creek	26.172	\$540,975 24	1,271,227	749,388 32	3,890,216	163,601-96	374,534	62,004 10	1,520,969 62
Conejos	10	1,178-19	102	60 13	1,200	52 01	210	34 77	1,325 10
Costilla		91 150	153	90 19			235	38 90	1,100 58
Custer	266	11,120.46	50.394	29,707 26	400,481	17,356 85	40,528	6,709-41	64, 593 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	13	103 35	10	5 89					109 24
ljagle	4.711	97,376 37	175,181	103,269-20	2,775,291	120,281 11	157,914	26,112-66	317,069 34
1-1 Paso	5-	1.612 26	15	8.84					1,621 10
l remont	312	6,449 04	933	00_00	33,945	1,471 18	15,907	2,633 40	11,103 62
Gilpin	202,97	1.63~,965 64	271,635	160,130 60	670,018	29,038 58	731,194	121,049 17	1,949,183 99
(,arfield	17	351 39	13	2 66					359 05
(,rand	20	1,033 50	30	17 65					1,051 18
(,nnuison	4,037	S3 444 79	93,243	54,966 75	656,631	28,458 39	53,396	8,839 71	175,709-64

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17.285,469-13					52,786-78	89,515	17,232,682 35	833,705	
747.204 02	2,824 62	17,062	188,201 22	1,342,437	217,458 89	368,887	335,719-29	16,387	
2,754.075 46	51,012 72	308.322	143,434-47	3,309,517	540,126 43	916,245	2,049,471 84	99,152	uel
2,519,492 34	453,613 95	2,740,042	670,607 92	15,473,187	462.296 51	784,218	962,973 96	46,588	
104,S03 64	2,525 13	15,253	10,217 40	235,750	12,088 88	20,507	79,972,23	3,869	e
4,762.75	82 77	200	95 0 1	2,193	140 89	239	4,414 05	215	
11 000 11	10,860 58	65,603	29 34	677	4,082 88	6,926	32,927 31	1,593	
230 78	34 77	210			30 65	52	165 36	20	
3,515,086 26	8,407 62	50,786	1,419,363 81	32,749,511	2,082,622 74	3,532,863	1,692 09	722	
156,987 11	1,598 72	9.657	18,257 53	421,955	40,778 66	69,175	96,322 20	099'1	
2,960,088 05	108,093 72	652,937	342,590 74	7,901,724	963,080 89	1,633,725	1,546,322 70	74,810	
3,652 62					35 37	60	3,617 25	175	uma
3,428-16	1,290 46	7,795			91 37	155	2,046 33	66	
70,562 90	9,261 52	55,944			59,751 13	101,359	1,550 25	75	e
1,629,457 10	166 71	1,007	455,932 25	10,519,895	1,070,545 56	1,816,023	102,812 58	4,974	
3,976 26	3,003 08	18,140			43 03	73	930 15	15	
30,750 91	21 85	132	268 58	6,197	3,258 76	5,528	27,201 72	1,316	
8,564,699 56	319,603 55	1,930,556	2,442,629 74	56,359,708	4,026,334 51	6,830,084	1,776,131 76	85,928	
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496,792 04	2,074 67	12,532	328,893 17	7,588,675	89,675 92	152,122	76,148 28	3,684	e

STATE OF COLORADO, 1901-2.

NorB-In the above table the calculation is on the average market price of the metals for the year. Gold, 20 67. Silver, .3835, Lead, .04334, Copper, .16555.

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Mining Law

Relative to

Bureau of Mines

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Mining Law Relative to Bureau of Mines

AN ACT

TO AMEND AN ACT ENTITLED "AN ACT TO CREATE A BUREAU OF MINES, TO DEFINE THE DUTIES OF THE COMMISSIONER OF MINES AND PROVIDE FOR THE GOVERNMENT THEREOF, AND MAKING AN APPROPRIATION THEREFOR; AND TO REPEAL AN ACT ENTITLED 'AN ACT DIVIDING THE STATE OF COLORADO INTO METALLIFEROUS MINING DISTRICTS, AND APPOINTING AN INSPECTOR OF METALLIFEROUS MINES,' APPROVED APRIL 1, 1889, AND PORTIONS OF OTHER ACTS IN CONFLICT HERE-WITH."

Be it enacted by the General Assembly of the State of Colorado:

Section 1. That section 1 of an act entitled "An act to create a Bureau of Mines, etc., approved March 30, 1895," be and the same is hereby amended to read as follows:

Section 1. There'shall be and is hereby established in this state a department to be known as "The Bureau of Mines of the state of Colorado," the principal office of which shall be maintained at the state capitol, in the city of Denver.

Sec. 2. That section 2 of said act be and the same is hereby amended to read as follows:

Sec. 2. It shall be the duty of the Governor to appoint a citizen of this state, having had not less than seven (7) years practical experience in mining in the state of Colorado, together with a practical and scientific knowledge of mining, metallurgy, mineralogy and geology, to the office of Commissioner of Mines, to hold the said office for the term of four (4) years, or until the appointment and qualification of his successor, as provided in section 1 of article XVI of the Constitution of the state of Colorado, who shall take and subscribe the oath of office prescribed by the Constitution; and he shall give bond to the state in the sum of \$20,000, to be approved by the Governor of the state, conditioned upon thee faithful discharge of his duties.

The Governor shall have power at any time to remove from office the Commissioner of Mines, for incompetency, neglect of duty or abuse of the privileges of his office.

Sec. 3. That section 6 of said act be and the same is hereby made section 3 of this act and amended to read as follows:

Sec. 3. The Commissioner of Mines shall, with the consent of the Governor, appoint two inspectors of practical experience in mining, citizens of the United States and legal voters of the state of Colorado, and having had not less than seven (7) years pracitcal experience in mining in the state of Colorado, who shall hold their office for the term of two vears, and whose duties shall be as hereinafter specified and , he shall appoint a clerk who must have a general knowledge of mineralogy and shall act as assistant curator for the state mineral collection; and before entering upon the discharge of their duties they shall subscribe to the oath required by the Constitution, and each give bond to the state in the sum of \$5,000, to be approved by the Governor, coditioned upon the faithful performance of their duties, respectively; said bonds shall, together with the Commissioner's bond, be deposited with the Secretary of State. The Commissioner of Mines may appoint a stenographer, who shall act as assistant clerk, and such other competent assistants as he may deem necessary for the carrying out of the object of this act; Provided, appropriation be made therefor, and shall have the power, with the consent of the Governor, at any time, to remove the inspectors, clerks or other assistants for incompetency, neglect of duty or abuse of the privileges of his office.

Sec. 4. It shall be the duty of the inspectors to examine and report to the Commissioner the condition of the hoisting machinery, engines, boilers, whims, cages, cars, buckets, ropes and cables in use in all the metalliferous mines in operation in the state, the appliances used for the extinguishment of fires, the manner and methods of working and tim-
bering the shafts, drifts, inclines, stopes, winzes, tunnels and upraises through which persons pass while engaged in their daily labors, all exits from the mine and how the mine is ventilated, together with the sanitary condition of the same, and also how and where all explosives and inflammable oils and supplies are stored, also the syste mof signals used in the mine. He shall not give notice to any owner, agent, manager or lessee of the time when such inspection shall be made.

Sec. 5. That section 5 of said act be hereby made section 5 of this act and amended to read as follows:

Sec. 5. The Commissioner of Mines may, as appropriations may be made therefor, from time to time, appoint deputy inspectors in the various mining camps or districts to investigate or report on accidents, or appoint such other competent assistants as he may deem necessary and proper for the carrying out of the object of this act; for the purpose of making more extended geological researches and surveys concerning the mineral districts of the state; the appointments of said deputy inspectors or assistants to become void upon the performance of the specific things or acts designated by the Commissioner in their said appointment; but the entire expenses of the bureau must not in any one year be greater than can be paid out of the fund or appropriation provided therefor.

Sec. 6. That section 4 of said act be hereby made section 6 of this act and be amended to read as follows:

Sec. 6. The secretary of the State Board of Capitol Managers shall provide suitable and ample rooms in the state capitol building for the use of said bureau, and shall provide the necessary fuel, lights and appurtenances to the proper and creditable management of said office; said office shall be deemed a public office, and the records, books and papers thereof, or on file therein, shall be deemed public records of the state; all books and documents and all other articles whatever in the office of the Commissioner of Mines shall be transferred by him to his successor in office, who shall give him a receipt for the same. The Commissioner shall keep and maintain a complete list and record of all articles, papers and documents received by him and belonging to the said office. Sec. 7. That section 3 of said act be hereby made section 7 of this act and amended to read as follows:

Sec. 7. That it shall be the duty of the Commissioner of Mines, as he has opportunity and means, aided by the other officers, except the inspectors, of the bureau, working under his instructions, to collect and preserve for study and reference specimens of all the geological and mineralogical substances, including mineral waters found in the state, especially those possessing economic or commercial value, which specimens shall be marked, arranged, classified and described, and a record thereof preserved, showing the character thereof and the place from whence obtained; to collect and in like manner preserve in his office minerals, rocks and fossils of other states, territories and countries; to collect and make a part of the records of his office the geological surveys and reports bearing upon the mining industry heretofore made by other officers of the state or by the United States government; to collect and record all data and records giving the history and showing the progress of the mining industry of the state from the earliest date up to the present time; to examine, report and record the geological formation of each important mining district and each important mine, giving the name of the mine, altitude, location, name of owners, character of vein development, character of walls or enclosing rocks, character and extent of ore veins or deposits, methods of ore extraction, power used. fuel used, water used in boilers, pressure carried, cost of fuel, cost of timbers, cost of transporting supplies to mine, cost per ton for transporting ore to market, method of treatment, cost of treatment per ton, average cost of sinking per foot, average cost of drifting per foot, average number of men employed, wages paid and hours worked, and all other information that will tend to give a correct idea of the expense and serve as a guide to profitable mining and milling of ore; to investigate and report and record the successfully used methods for the recovery of the precious metals, describing in detail mechanical operations of all important milling and reduction plants and results obtained; to investigate, report and record the advancement made in the application of electricity, compressed air, water power and steam as labor-saving devices to all branches of mining operations; to collect statistics upon smelting, concentrating, milling and dressing of metalliferons ores, and upon

all the mineral products of the state for reference and study: to distribute reliable information regarding the product. available supply, location, character and adaptability for economic purposes of the resources of Colorado in coal, coal oil, asphalt, iron, building stone, slates, marble, fire clavs, cements, pottery and porcelain clays, asbestos, mica and the various mineral waters, and such other items within the province of this bureau as in the judgment of the Commissioner of Mines may be advisable; to procure standard works on the mining industry, smelting, concentrating, milling and dressing of metalliferous ores, mining engineering, geology, mineralogy and other subjects which can aid in the study and promote knowledge of all who are interested in mining or manufacturing of any of the mineral products of this state; and the Commissioner of Mines shall give receipt, when demanded, for all enumerated herein to the persons from whom he receives them; to make or cause to be made, with the approval of the Governor and under the direction of some officer of the bureau, exhibits of the mineral resources and products of the state, at such industrial exhibitions held in this or other states or countries, as may be deemed advisable or desirable, and for which due appropriations shall have been or may be provided.

Sec. 8. Section 7 of said act be and the same is hereby made section 8 of this act, and amended to read as follows:

Sec. 8. The Commissioner of Mines, inspectors, or either of them, shall not act as manager, or agent or lessee, for any mining or other corporation during the term of his office, but shall give his whole time and attention to the duties of the office to which he has been appointed. No officer of this bureau, nor any agent or person in any way connected therewith, shall make a report of any mine or mining property with the intent to promote or aid in the sale or other convevance thereof, and any such officer, agent, or person violating this provision shall, upon conviction thereof, pay a fine of not less than five hundred dollars (\$500.00), nor more than five thousand dollars (\$5,000.00), or be imprisoned in the State Penitentiary not less than one (1) nor more than three (3) years, or both, in the discretion of the court. The Commissioner shall, on receipt of reliable information relating to the health and safety of the workmen employed in any metalliferous mine, mill or reduction plant in the state, or whenever he deems such inspection necessary, examine or instruct one of the inspectors to examine and report to him the condition of the same. The owner, agent, manager or lessee shall have the right to appeal to the Commissioner on any difference that may arise between such parties and the inspector. On receipt of notice of any accident in a mine, mill or reduction plant, whether fatal or not, the Commisssioner shall inquire into the cause of such accident.

Sec. 9. It shall be the duty of the Commissioner of Mines to biennially make report to the Governor, showing the amount of disbursements of the bureau under his charge, the progress made, and such statistical information in reference to mines, mining, milling and smelting as shall be deemed important, and shall transmit copies of said report to the general assembly at the biennial session. There shall be printed at least one thousand (1,000) copies of said report for distribution, and said report shall contain a review of the work of the bureau.

The Commissioner may, from time to time, with the consent of the Governor, as appropriations may be made therefor, compile, publish and distribute bulletins upon subjects, districts and counties; such bulletins, when treating of a district or county, shall give in detail the history, geology, mines, mills, process of treatment and results, together with a classification and location of mines and prospects, together with maps of the same; one thousand (1,000) copies shall be distributed free to state and county officers, public libraries, newspapers, magazines and exchanges of the bureau, and the remainder sold at cost of printing.

Sec. 10. That section 9 of said act is hereby made section 10 of this act and amended to read as follows:

Sec. 10. Every owner, agent, manager or lessee of any metalliferous mine or metallurgical plant in this state shall admit the Commissioner or inspector on the exhibition of his certificate of appointment, for the purpose of making examination and inspection provided for in this act, whenever the mine is in active operation and render any necessary assistance for such inspection. But said Commissioner or inspector shall not unnecessarily obstruct the working of said mine or plant. The refusal of the owner, agent, manager or lessee to admit the Commissioner or inspector to such mine or plant to lawfully inspect the same shall, upon conviction, be deemed a misdemeanor, and shall be subject to a fine of not less than fifty dollars (\$50.00), nor more than three hundred dollars (\$300.00), or be imprisoned not less than one (1) nor more than three (3) months, or by both such fine and imprisonment.

Sec. 11. That section 11 of said act be and the same is hereby made section 11 of this act and amended to read as follows:

Sec. 11. The Commissioner and inspectors shall exercise a sound discretion in the enforcement of this act, and if they shall find any matter, thing or practice in or connected with any metalliferous mine or metallurgical plant to be dangerous or defective, so as to, in their opinion, threaten or tend to the bodily injury of any person, the Commissioner or inspector shall give notice in writing thereof to the owner, agent, manager or lessee of such mine or plant, stating in such notice the particulars in which he considers such mine, or plant, part thereof or practice to be dangerous or defective, and he shall order the same to be remedied. A copy of said order shall be filed and become a part of the records of the bureau of mines, and said owner, agent, manager or lessee shall, upon compliance of said order, immediately notify the Commissioner of Mines in writing. Upon the refusal or failure of said owner, agent, manager or lessee to report within reasonable length of time, said owner, agent, manager or lessee shall be subject to a fine of not less than fifty dollars (\$50.00), nor more than three hundred dollars (\$300.00), for each and every such refusal or failure.

Sec. 12. That section 10 of said act be and the same is hereby made section 12 of this act and amended to read as follows:

Sec. 12. If the Commissioner, inspectors, or either of them, shall reveal any information in regard to metallurgical processes, ore bodies, shoots or deposits of ore or location, course or character of underground workings, or give any information or opinion respecting any mine or metallurgical process, obtained by them in making such inspection, except in the way of official reports filed for record, as hereinbefore provided, on conviction thereof he or they shall be removed from the office and fined in a sum not less than one thousand dollars (\$1,000.00), nor more than five thousand dollars (\$5,000.00). Sec. 13. That section 12 of said act be and the same is hereby made section 13 of this act and amended to read as follows:

Sec. 13. In case the owner, agent, manager or lessee, after written notice being duly given, does not conform to the provisions of this act, or disregards the requirements of this act, or any of its provisions, or lawful order of the Commissioner or inspector made hereunder, any court of competent jurisdiction may, on application or information of the Commissioner of Mines, by civil action in the name of the people of the state of Colorado, enjoin or restrain the owner, agent, manager or lessee from working the same until it is made to conform to the provisions of this act; and the costs of action paid by defendant, and such remedy shall be cumulative, and shall not affect any other proceedings against such owner, agent, manager or lessee, authorized by law for the matters complained of in such action.

Sec. 14. That section 13 of said act be and the same is hereby made section 14 of this act and amended to read as follows:

Sec. 14. Any owner, agent, manager or lessee having charge or operating any metalliferous mine or metallurgical plant, whenever loss of life or accident serious enough in character to cause the injured party to stop work for two consecutive days and connected with the workings of such mine or metallurgical plant, shall occur, shall give notice immediately and report all the facts thereof to the Commissioner of Mines. The refusal or failure of the said owner, agent, manager or lessee to so report within reasonable length of time shall be deemed a misdemeanor, and shall upon conviction be subject to a fine of not less than fifty dollars (\$50.00), nor more than three hundred dollars (\$300.00), or be imprisoned not less than one or more than three months, or by both such fine and imprisonment. The Commissioner of Mines, upon receipt of notice of accident, shall investigate and ascertain the causes and make or cause to be made a report, which report shall be filed in his office for future reference.

Sec. 15. The Commissioner of Mines shall receive for his services a salary of twenty-five hundred dollars (\$2,500.00) per annum, to be paid as other officers of the state are paid, and shall also receive his necessary traveling

expenses when traveling on the business of his office, not to exceed the sum of one thousand dollars (\$1,000.00) per annum. The inspectors shall each receive the sum of fifteen hundred dollars (\$1,500.00) per annum and actual traveling expenses, not to exceed the sum of one thousand dollars (\$1,000.00) per annum. The clerk or assistant curator shall receive the sum of fifteen hundred dollars (\$1,500.00) per annum; the stenographer or assistant clerk shall receive one thousand dollars (\$1,000.00) per annum. The whole of said salary and expenses to be paid out of the bureau of mines fund hereinafter provided for, and not otherwise.

The Commissioner of Mines shall have at his disposal the sum of two thousand dollars (\$2,000.00) for the fiscal years of 1899 and 1900, and shall, in his annual report, itemize the expenditures made from this fund.

Sec. 16. That section 14 of said act be and the same is hereby made section 16 of this act and amended to read as follows:

Sec. 16. The Commissioner of Mines is hereby authorized, with the approval of the Governor, to draw upon the funds appropriated by this act, from time to time, to pay the salaries and traveling expenses of himself and inspectors and the salary of the clerk and other assistants, and printing of bulletins hereinbefore provided, and to defrav the necessary expenses of his office; and the State Auditor is hereby required to issue his warrant on the State Treasurer for such payments or expenses as they may accrue, and in all accounts rendered or presented for payment, on account of the bureau of mines, the Commissioner shall be required to make vouchers in duplicate, one of which shall be filed in his office. He is hereby authorized to procure such instruments and apparatus from time to time as may be necessary to the proper discharge of the duties under this act, not to exceed the amount appropriated for incidental and operating expenses.

Sec. 17. That section 15 of said act be and the same is hereby made section 17 of this act and amended to read as follows:

Sec. 17. For the purpose of carrying out the provisions of this act there is hereby appropriated out of the funds in the state treasury, not otherwise appropriated, the sum of twenty-four thousand dollars (\$24,000.00) for the fiscal years 1899 and 1900, said amounts, including the sum of two thousand dollars (\$2,000.00) for printing, incidental and operating expenses, to be at the disposal of the Commissioner of Mines, as otherwise provided for.

Sec. 18. That section 18 of said act be and the same is hereby made section 18 of this act.

Sec. 18. It shall be the duty of the Commissioner of Mines to furnish as far as practicable, to the proper officials of the State School of Mines, such information, plats, surveys, etc., resulting from the researches of his department, from time to time, as said officials may ask or deem advantageous to the advancement of the interest of the State School of Mines.

Sec. 19. That section 19 of said act be and the same is hereby made section 19 of this act and amended to read as follows:

Sec. 19. The mineral specimens heretofore collected by the bureau of immigration and the World's Fair Commissioners are hereby transferred to the custody of the bureau of mines, and, if found necessary, the Attorney General shall bring suit to recover the same.

For the purpose of providing the necessary rules and regulations for the government of metalliferous mining in this state, the following section, to be known as section 20, is hereby enacted and made a part of this act:

Sec. 20. First—That explosives must be stored in a magazine provided for that purpose alone; said magazine to be placed far enough from the working shaft, tunnel or incline to insure the same remaining intact in the event the entire stock of explosives in said magazine be exploded; that all explosives in excess of the amount required for a shift's work must be kept in said magazine; that no powder or other explosive be stored in underground workings where men are employed; that each mine shall provide and employ a suitable device for thawing or warming powder and keep the same in condition for use; that oils or other combustible substances shall not be kept or stored in the same magazine with explosives.

Second—That the Commissioner of Mines shall have authority to regulate and limit the amount of nitro powder stored or kept in general supply stores in mining camps or

mining towns where there is no municipal law governing the storage of same.

Third—That oils and other inflammable materials shall be stored or kept in a building erected for that purpose, and at a safe distance from the main buildings, and at a safe distance from the powder magazine, and their removal from said building for use shall be in such quantities as are necessary to meet the requirements of a day only.

Fourth—That no person shall, whether working for himself or in the employ of any person, company or corporation, while loading or charging a hole with nitroglycerine powder or other explosive, use or employ any steel or iron tamping bar; nor shall any mine manager, superintendent, foreman or shift boss, or other person having the management or direction of mine labor, allow or permit the use of such steel, iron or other metal tamping bar by employes under his management or direction.

Fifth—That all old timber removed shall as soon as practicable be taken from the mine and shall not be piled up and permitted to decay underground.

Sixth—That no person addicted to the use of intoxicating liquors or under eighteen years of age shall be employed as hoisting engineer.

Seventh—That all hoisting machinery, using steam, electricity, air or hydraulic motive power, for the purpose of hoisting from or lowering into metalliferous mines employes and materials, shall be equipped with an indicator geared positively to the drum shaft, and so adjusted with dial or slide as to move a target or indicator and thereby at all times show the exact location of the cage, bucket or skip, said indicator to be so placed near to and in clear view of the engineer and to be free of gong, bells or other automatic attachments.

Eighth—That all mines employing steam and other hoisting power, and equipped with cage or skip, shall, when hoisting material from two or more levels, employ a man to be known as a "cager," whose duties shall be to load and unload said cage or skip at said levels and to give all signals to the engineer.

Ninth—That there shall be established by the Commissioner of Mines a uniform code of signals, embracing that most generally in use in metalliferous mines, and the Commissioner shall have the power to enforce the adoption of such code of signals in all mines using hoisting machinery. The code of signals shall be securely posted, in clear and legible form, in the engine room, at the collar of the shaft and at each level or station.

Tenth—That all mines having but one exit, and the same covered with a building containing the mechanical plant, furnace room, and blacksmith shop, shall have fire protection. Where steam is used, hose of sufficient length to reach the farthest point of the plant shall be attached to feed pump or injector, and the same kept ready for immediate use. In mines where water is not available, chemical fire extinguishers or hand grenades shall be kept in convenient places for immediate use.

Eleventh—That all persons shall be prohibited from riding upon any cage, skip or bucket loaded with tools, timber, powder or other material, except for the purpose of assisting in passing same through shaft or incline, and then only upon special signal.

Twelfth—All persons giving or causing to be given false signals, or riding upon any cage, skip or bucket upon signals that designate to the engineer that no employes are aboard, shall be deemed guilty of a misdemeanor under this act.

Thirteenth-That all shafts more than fifty (50) feet in depth equipped with hoisting machinery shall be divided into at least two (2) compartments, and one compartment to be partitioned off and set aside for a ladderway. The ladders shall be made sufficiently strong for the purpose demanded. and in vertical shafts landings shall be constructed not more than twenty (20) feet apart, said landings to be closely covered, except an opening large enough to permit the passage of a man; said ladders shall be inclined at the most convenient angle which the space allows, and shall be firmly fastened, and kept in good repair. In all incline shafts the landings shall be put in as above described, but a straight ladder on the incline of the shaft. Ladders in upraises and winzes shall be likewise provided and kept in repair, but where winzes connecting levels are used only for ventilation and exit, only one such winze on each level need be equipped.

Fourteenth—That hereafter shafts equipped with buildings and machinery, with only the working shaft for exit, shall be divided into at least two (2) compartments, one of which shall be tightly partitioned off and used for a ladderway as hereinbefore provided for; said ladderway shall be securely bulkheaded at a point at least twenty-five feet below the collar of the shaft, and below this bulkhead a drift shall be run to the surface, if location of drift is upon side hill, or wall without the building and upraised to the surface if upon a level. Said ladderway and landings shall be kept at all times in good repair and afford easy mode of escape in event of fire.

Fifteenth—That hereafter all tunnels or adit levels at safe distance from mouth of same shall connect with the surface, and be provided with safe and suitable ladders, and thus afford a means of exit in case of fire destroying buildings over the mouth of tunnel or adit level.

Sixteenth—That employes engaged in sinking shaft to incline shall at all times be provided with chain or other kind of ladder, so arranged as to insure safe means of exit.

Seventeenth—That all shaft collars hereafter constructed shall be covered and so arranged that persons or foreign objects can not fall into the shaft. Where a mining cage is used a bonnet, which raises with the cage and falls back into place when the cage descends, shall be used. This bonnet or shaft cover need not be tight beyond what would exclude anything from falling into the shaft that would endanger life, and the cage shall also be equipped with safety clutches and a steel hood, or bonnet, oval in shape, if solid, and, if divided in the middle and hinged at the sides, the angles of the sides when closed shall not be less than fortyfive degrees, nor the steel less than three-sixteenths (3-16) of an inch thick.

When wooden doors are used the shaft must be housed in and covered, and said doors so constructed as to stand at an angle of not less than forty-five degrees pitch, when closed, hinged at the lower sides, and opening upward, or outward, and said doors shall not be less than four inches in thickness.

Eighteenth—That all stations or levels shall, when practicable, have a passageway around the working shaft, so that crossing over the working compartment can be avoided. At all shaft stations a guard rail or rails shall be provided and kept in place across the shaft, in front of the level, so arranged that it will prevent persons from walking, falling or pushing a truck, car or other conveyance into the shaft. All winzes and mill holes extending from one level to another shall be covered or surrounded with guard-rails, to prevent persons from stepping or falling into the same.

Nineteenth—That where any shaft is sunk on a vein, ore shoot or body, a pillar of ground shall be left standing on each side of the shaft of sufficient dimensions to protect and secure the same, and in no case shall stoping be permitted up to or within such close proximity to the shaft as to render the same insecure, until such time as the mine is to be abandoned and said pillar withdrawn.

Twentieth—That all abandoned mine shafts, pits or other excavations endangering the life of man or beast shall be securely covered or fenced.

Twenty-first—That any person or persons removing or destroying any covering or fencing placed around or over any shaft, pit or other excavation, as hereinbefore provided, shall be deemed guilty of a misdemeanor under this act, and upon conviction thereof in any court of competent jurisdiction shall be fined in a sum of not less than fifty dollars (\$50.00), or more than three hundred dollars (\$300.00), or imprisonment in the county jail for six (6) months, or by both fine and imprisonment.

Twenty-second—That any person or persons operating any metalliferous mine or mill and employing five or more men shall report the same to the bureau of mines and state when work is commenced and when stopped, and mines working continuously shall report on or before December 1 of each year, together with the names of the owners and managers or lessee in charge of said work, together with the postoffice address, the name of the claim or claims to be operated, the name of the county and mining district, together with the number of men employed, directly or indirectly, the same being classified into miners, trammers, timbermen, ore assorters, mill men, teamsters, etc. The necessary blanks to carry ont the provisions of this section shall be furnished upon application by the Commissioner of Mines.

Twenty-third—That any owner, lessee, manager, superintendent or foreman in charge of any metalliferous mine who shall wilfully misrepresent or withhold facts or information from any inspector or other officer of this bureau re-

garding the mine, such as length of time timbers have been in place, or making any misrepresentation tending to show safety when the reverse is true, shall be deemed guilty of a misdemeanor, and upon conviction thereof in any court of competent jurisdiction shall be fined in any sum not less than one hundred dollars, nor more than three hundred dollars.

Twenty-fourth—That strangers or visitors shall not be allowed underground in any mine, unless accompanied by some owner, official or employe deputized to accompany same.

Twenty-fifth—That strangers or visitors shall not be permitted to ride upon or in the cage, skip or bucket, at one time, shall be posted at the collar of the shaft and at each level. All men or employes riding upon or in an overloaded cage, skip or bucket, as provided in notice so posted, shall be guilty of a misdemeanor, and upon conviction in a competent court shall be fined not less than five dollars nor more than fifty dollars for each and every offense.

Twenty-sixth—The Commissioner of Mines or inspectors under this act shall have power to make such examination and inquiry as is deemed necessary to ascertain whether the provisions of this act are complied with; to examine into and make inquiry respecting the condition of any mine, mill or part thereof, and all matters or things connected with or relating to the safety of the persons employed in or about the same; to examine into and make inquiry respecting the condition of the machinery or mechanical device, and if deemed necessary to have same tested; to appear at all coroners' inquests held, respecting accidents, and if deemed necessary, call, examine and cross-examine witnesses; to exercise such other powers as are necessary for carrying this act into effect.

Twenty-seventh—Any person, owner, agent, manager or lessee operating a metalliferous mine or mill in this state, who fails to comply with the provisions herein set forth, shall be deemed guilty of a misdemeanor against this act, and, when not otherwise provided, shall be liable to the penalty prescribed in section 13 of this act, or to a fine of not less than twenty-five dollars (\$25.00), nor more than three hundred dollars (\$300.00), for each and every provision not complied with, or both, at the discretion of the court. Sec. 21. The Secretary of State shall provide the bureau of mines with a seal, the same to be marked "The Bureau of Mines of the State of Colorado," and bear the coat of arms of the state. The Commissioner of Mines is hereby empowered to affix seal to all certified copies of sections of record and shall charge the legal rate allowed for such service. Any and all moneys thus collected shall be transferred to the proper officer and by him credited to the bureau of mines fund.

Sec. 22. All justices of the peace and county courts, in their respective counties, shall have original jurisdiction in prosecution for the violation of sections nine (9), ten (10), thirteen (13), nineteen (19) and twenty (20) of this act, with the right to appeal from judgment of justices of the peace to county courts in their respective counties, under the same conditions as in civil cases; and in all trials before justices of the peace and in county courts the defendant shall be entitled to a trial by jury as in other misdemeanor cases. District courts in their respective districts shall have original jurisdiction upon information or indictment in all prosecutions for violations of this act.

Sec. 23. That sections eight (8), sixteen (16) and seventeen (17) of said act be and the same are hereby repealed.

Sec. 24. That section 20 of said act be and the same is hereby made section 24 of this act.

Sec. 25. An act dividing the state into metalliferous mining districts and appointing an inspector of mines, approved April 1, 1889, and all other acts inconsistent herewith are hereby repealed.

Sec. 26. That section 21 of said act be and the same is hereby made section 26 of this act.

Approved this 10th day of April, A. D. 1899, at 9 o'clock a. m.

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