REPORT

ON THE

DEVELOPMENT

OF THE

Mineral, Metallurgical, Agricultural, Pastoral,

AND OTHER

RESOURCES OF COLORADO

FOR THE YEARS 1881 AND 1882.

J. ALDEN SMITH,
STATE GEOLOGIST.

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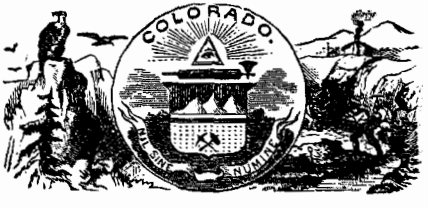

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LETTER OF TRANSMITTAL.

STATE OF COLORADO,
OFFICE OF STATE GEOLOGIST,
DENVER, January 1, 1883.

To His Excellency, Hon. F. W. Pitkin, Governor of the State of Colorado:

SIR:—I have the honor to submit herewith my biennial report, as State Geologist, for the term ending December 31, 1882, together with a general economic report of the principal resources of the State. The object of the writer has been rather to present in brief form an epitome of the principal economic and industrial resources, and their progress, together with the causes that have led thereto, than to attempt a technically scientific report.

Very respectfully,

J. ALDEN SMITH,
State Geologist.

REPORT OF STATE GEOLOGIST.

As a producer of the precious metals, Colorado, three years ago, by virtue of the largest returns, assumed the headship of the mining States of the world, and has maintained that position to the present time. It is also true that for the past two years, something over one-half of the total lead product of the United States has been taken from our mines. This enviable precedence has not been attained, however, without long and persistent effort. The fruitage of these endeavors, begun by the trail blazers and carried on by their successors, is seen to-day in the successful establishment of a permanent and steadily profitable industry which will endure for ages, with, it is believed, constantly increasing yields. The field is very large; embracing nearly all the mountain ranges, and extremely inviting alike to the capitalist, the artisan, the miner and the common laborer. No quarter of the Union offers better advantages to those who enter it with the courage and determination to wrest success from the conditions presented, by acting in the spirit which has advanced our commonwealth to its present stage.

Beginning with the discovery of gold in Gilpin County twenty-three years ago, which drew vast numbers from all the Western States to search for hidden treasure, the development was for a considerable period wholly crude and spasmodic, confined almost entirely to the rapid exhaustion of the more valuable deposits found at the surface here and there in the various mineral belts, where the decomposed outcroppings gave promise of immediate rewards to unskilled effort, and to the gulches and placer grounds. The earliest settlers, and the few who followed them up to the year 1865, came for gold only, with no expectation of being

called to solve the deeper problems of lode mining and metallurgy. Yet the major part of the great fortunes thus far acquired came from this pursuit. The areas containing gold were nearly as well known then as they are now, for most of the sections from which the present supplies of that metal are drawn, were very thoroughly prospected by the pioneers. The tracts bearing free gold being extremely limited, and each crowded at the outset by hordes of men impatient to dig out their fortunes as soon as possible, the interest excited by the realization of heavy gains subsided by degrees with the gradual decrease of earnings, when the crowds emigrated to other fields, leaving the further development of the country to the few whose pluck and faith seemed equal to the task. Constantly recurring discoveries in the Northern and Western territories, together with numerous enlistments in the army, ultimately swept away the floating element, and as the war demanded about all the able-bodied men that could be spared from the States, the exodus was not supplemented by fresh immigration. Therefore, from 1863 to 1870, there was a gradual but certain decrease of population, the official census of the latter year giving us a little over 37,000. The small amount of solid wealth accumulated meanwhile, was due rather to hard work and the closest economy than to the productiveness of the resources under operation.

Legitimate exploitation of the fissure veins which constituted the principal sources of production, proceeded slowly because of the universal ignorance of the perfected methods of mining and the reduction of refractory ores. Science and skilled labor had not then filled the land with potent aids for the proper extraction of ores and their precious contents. Consequently, underground work was unskillfully prosecuted and unfairly rewarded. The mineral broken by hard struggling with adverse conditions, however rich in gold or silver, returned meagre profits to the producer, because no one had applied the better knowledge of milling or smelting employed with powerful effect in the

older mining States and Territories. The beds of streams into which the crushing mills poured their refuse, were choked with concentrates bearing the enormous wastage of imperfect appliances. Excepting two or three districts in Gilpin, Clear Creek and Boulder counties, very little beyond the determination of the permanency of the lodes was accomplished during the first decade. The remoteness of our industrial centres from the bases of supply east of the Missouri river, and the total absence of railways, compelled the transportation of all commerce, including heavy machinery, across the plains at a cost for freightage of ten to forty cents per pound. Wagon trains were frequently harrassed by roving bands of hostile Indians, who destroyed them, appropriated their animals, and in many cases killed the attaches.

In the foregoing hasty summary of events, the reader will find sufficient cause for the lack of progress during the first eleven years of settlement in the Rocky Mountains. We now begin the pleasing contrast of the second period.

THE INTRODUCTION OF RAILWAYS.

Undeniably, the influence which operated most effectively for the adjustment of Indian difficulties and the inauguration of a better era, was the coming of railways in 1870. With the first locomotive appeared the change which subsequently wrought momentous consequences in the new West. In order to convey a proper estimate of them, it is necessary to enter upon a brief epitome of railway history.

The Union Pacific, though originally intended to cross the mountains via Denver, finally discovered a more feasible route through the Black Hills west of Cheyenne, and so passed within a few miles of our northern boundary line, leaving us as completely isolated as if it had never been conceived, because it sapped the little strength we possessed, instead of bringing the aid and comfort which was sorely needed. It drew off our population, and diverted our commerce to points in Wyoming and Utah. This exhaustive drain soon compelled recognition of the fact by all who re-

tained property interests here, that something must be done to counteract it. Out of this sentiment finally grew the Denver Pacific Railway, which was completed on the 22d of June, 1870. And, strange to say, the impelling force of that enterprise came from one who after exciting the attention of two continents to his eccentric words and deeds, sank suddenly into nameless obscurity—George Francis Train, who also claimed with some degree of justice to have originated the Union Pacific. But before Train was Thomas H. Benton, and after Benton our first Territorial Executive, William Gilpin, to both of whom a large share of the credit is due.

The first President of the Denver Pacific was General Bela M. Hughes, under whose vigorous administration, ably seconded by F. M. Case and John Pierce as engineers, the project assumed definite form. Hughes resigned in February, 1868, and was succeeded by Major W. F. Johnson. In September of the same year, sufficient funds for the work having been raised by subscription, grading began at Cheyenne. March 5, 1869, Major Johnson died, and Ex-Governor John Evans became President of the Company by unanimous vote of the Directors. After a long battle with opposing circumstances, it was brought to a successful conclusion on the date above mentioned.

It is written of John Jacob Astor, the wealthiest American of his time, that it cost him more toil, hardship and privation to accumulate his first thousand dollars from small savings than all the remainder of his great fortune. Leaving the details of its accomplishment to the historian, it may be said that their first railroad cost the people of Denver greater anxiety, more money, labor and sacrifices than all that have since made this city one of the most prominent and prosperous railway centres of the West. It was a desperate and at times well nigh hopeless endeavor to make this gigantic stride in creative progression. When opened to commerce, the power of rapid transit began to be manifest. Colonies were founded upon the

fertile lands traversed by the iron rails. More extended schemes of like character and influence followed in quick succession, and through them appeared the dawn of Statehood.

THE KANSAS PACIFIC,

or, as it was originally designated, the "Eastern Division of the Union Pacific," after a protracted stoppage at Pond Creek beyond our Eastern boundary—the Western limit of its bonded privileges—was completed to Denver under the superintendence of General Wm. J. Palmer on the 15th of August, 1870, when this new line, 639 miles in length, assumed its part in the general development. We then had two standard gauge roads to the Mississippi Valley and the heart of the nation, which laid the foundation whereby Colorado six years later was enabled to enter the Union as a State. The Kansas Pacific brought a resident also, whose later interest in our affairs evolved the grand results now observable in the southern half of the State. During the same year the first link in the

COLORADO CENTRAL

system united Golden with Denver. Though third on the list of partially constructed lines, it was in reality the first ever instituted here, dating its inception from the year 1861, when W. A. H. Loveland and Capt. E. L. Berthoud made the first surveys and explorations. The Company was organized in due form, and chartered by the Territorial Legislature in 1865. Grading began at Golden in 1868, and the rails were laid in the fall of 1870. This cleared the way for further connections with the mining districts of Gilpin and Clear Creek, which were in a semi-paralytic stage, from causes previously recited. But the plans formulated embraced a dual mission; first, the development of agriculture along the base of the mountains northward to Boulder, Longmont and Fort Collins; and, secondly, the penetration of the gold and silver fields on North and South Clear Creeks to the westward. Pursuing these aims, the

broad gauge was extended to Boulder and Longmont in 1872, where this division rested for a time. Simultaneously a narrow gauge was put under construction from Golden to Black Hawk, with a branch four miles in length from the junction of the streams above mentioned to the western base of Floyd Hill, or the entrance to the valley of South Clear Creek, thus opening an outlet to the exceedingly valuable mines of Idaho, Spanish Bar, Georgetown and Empire.

The possession of railway facilities caused immediate restoratian of confidence, and the re-opening of all the channels of productive activity. They brought new life blood, with skilled labor, improved machinery, increased demand with higher prices for ores, and accessories for the extraction of the precious metals. The necessities of the people, following the exhaustion of timber on the mountain sides, were met by cheaper and better fuel brought up from the coal beds of the plains. Golden having by this time become not only an active railway center, but a strong point for the reduction of ores, competing markets were opened to the miners, and the unsatisfactory returns of the stamp mills, which up to 1868, when the Boston and Colorado Smelting Works became a competitor, were the sole arbiters of the gold product, were supplemented, or rather for the higher grades of mineral wholly superseded by the more perfect method of reduction in reverberatory and blast furnaces. The change became a revelation to the despondent workers underground, since it brought the promise of substantial gains for the present and future.

Then began the practical demonstration of the character and value of the fissure veins at great depths, which has been prosecuted to this time. Many shafts have been carried downward to the depth of 1,000 feet, and two are more than 1,300 feet deep. Hundreds of others are being pushed to the same destinations. The systems of milling the sulphuret bearing gangues, from which the heavier mineral had been previously assorted for treatment by fire, advanced briskly under the improvements rendered

by science to the work of amalgamation and concentration. Every advance step in these directions augmented production from the deeper mines, and opened many others which had only been prospected. The smelters were soon enabled to pay higher prices for the grades best adapted to their use, and to multiply their facilities to the extent of the growing demand. This branch of the subject, however, will be treated more at length in a subsequent chapter.

In 1877, the Floyd Hill branch was extended to Georgetown, which gave the inhabitants of Clear Creek Valley communication with the plains, the mercantile depots, manufacturing and other systems there firmly established. Then, instead of a few hundred thousands as formerly, there began a regular annual output of millions from well conducted operations, which is still maintained. When these lines were projected, experienced local engineers who had been railway builders years before in the States, declared that they could not be made to pay. This opinion was shared by many others, yet the mountain combination soon became one of the most active and profitable in the country, through the developments following its completion. Passing down to a recent period, the standard gauge was extended northerly to Cheyenne to a connection with the Union Pacific (and under its control) in November, 1877, skirting the base of the mountains through established towns, and causing immense areas of rich farming lands theretofore wholly idle to be put under irrigating canals and tillage. In addition, many large deposits of superior building and paving stone, from which Denver and other points are receiving a considerable portion of their supplies of these materials, have been opened, giving employment to hundreds of laborers and contributing a new feature to the arteries of industry and trade. Until quite recently this connection was employed for the transfer of passengers and freight to and from Wyoming, Utah and California, and for a time brought to our smelters large quantities of ore and, later, of copper matte from the Territories of Montana and Idaho.

Still later (November, 1881), what is known as the Julesburgh cut-off, was extended from the town of Evans on the Denver Pacific (using the latter for connection with Denver), 200 miles down the valley of the South Platte river to a junction with the main trunk of the Union Pacific at a point about five miles east of Julesburgh Station, at or very near the eastern boundary of Colorado, creating a line to Omaha seventy miles shorter than via Cheyenne, and the most direct route, over the lightest and smoothest grades, to the Missouri River. While it has added but little to the developed resources of the State, it opens a very desirable outlet to Eastern centers by an independent line.

In 1877 a coal road was built from Boulder to the Marshall coal banks, six miles distant, by T. G. Lyster and others of this city, and was christened the Golden, Boulder & Caribou. A year or so afterward it was sold to the Union Pacific.

In 1878 the gap between Black Hawk and Central City was filled by a remarkable achievement of engineering skill, resulting in the construction of a switch back over what a few years earlier would have been considered insurmountable difficulties. At the present time another division of the Georgetown line is being carried over the Snowy Range via Loveland Pass to Dillon, in Summit County (thirty miles), and to Leadville, in Lake. When finished to this point, it will form the shortest and most direct route to the carbonate mines. From Dillon it is to be carried to Salt Lake City. But assuming that only the Dillon and Leadville divisions will be constructed in the near future, they will penetrate and render tributary to Denver several extensive and very important mineral sections, and bring their ores here for treatment in our great reduction works. It is proper to state, in conclusion, that all the lines of the Colorado Central, as also the Denver Pacific, Kansas Pacific, South Park, Boulder Valley, Golden, Boulder & Caribou are now embraced in the Union Pacific combination.

THE BOULDER VALLEY

Railway, an offshoot of the Denver Pacific, was opened to the coal mines at Erie in 1871, and to Boulder January 1, 1874. It became necessary through the need of fuel supplies for Denver and the railways centering here, and was constructed by John Evans, Cyrus W. Fisher, W. S. Cheesman, Wm. N. Byers, D. H. Moffat, jr., and others who had been associated in the Denver Pacific. This line traverses some of the finest lignite fields yet discovered in the northern part of the State, affords ample markets for all that may be produced, and gives material aid to the farmers and other settlers. Prior to the acquisition of these facilities, all the coal consumed here was transported from these mines by wagons at a cost to the consumer of $10 to $15 per ton. The retail price of the same fuel at once dropped to $4 and $5 per ton when the locomotive superseded horse and mule power, and has not since risen above these figures.

Next in the regular order of progression, we are brought to the invasion of the South by General Palmer, Ex-Governor A. C. Hunt and Col. W. H. Greenwood (chief engineer), who devised

THE DENVER & RIO GRANDE

Railway, now the most extensive system of narrow gauge (three feet) roads in the world, with more than 1,400 miles of track under constant operation. When these gentlemen organized their company, October 27, 1870, and in March, 1871, began the difficult task of carrying it across the "Divide" to Colorado Springs, seventy-five miles distant, with the intention of occupying the entire region beyond, it seemed to the casual observer the most extravagant and altogether Quixotic venture ever conceived by man. Excepting the small village of Littleton, twelve miles away, and a few scattering inhabitants on the Fountain qui Bouille, there was nothing to invite or give promise of traffic for an undertaking of this magnitude. The fine Colorado resort

of to-day was then but an open plain, designed for a quiet, peaceful and industrious colony town, when settlers could be persuaded to come there. The primitive town of Colorado City, for a few weeks the capital of the Territory in early days, had declined until scarcely enough remained to keep the place alive, and Pueblo, the second point of attack, was but a struggling village which hoped to achieve prominence some day in the distant future. Worse than all, there was not an important industry on the route surveyed, and little apparent material for the creation of enterprises, agricultural or otherwise. True, parts of the Divide furnished admirable grazing ranges for sheep and cattle, and something might be made out of the timber growing there. Still the idea of building a railroad through such a country for the gains in sight, seemed wholly absurd. The passenger traffic may be illustrated by saying that the single stage line from Denver to Pueblo carried an average of three passengers daily, while the trains of the present transport from 400 to 500 daily. Besides, the projectors were without practical knowledge of the scheme, because there were no well defined precedents for it. One or two small coal and iron tramways were operated in England and on the Continent, but these were insufficient models. No road of the gauge proposed had ever been constructed for the general carrying trade, therefore the entire system had to be created, from the grade to the rails, embracing every detail of equipment, and involving plans and specifications for countless new patterns for locomotives, wheels and cars. Yet the task was undertaken, and on the 27th of October, 1871, completed to Colorado Springs. Viewed from the present, it forms one of the most extraordinary events in the history of railway building.

When the first train passed out of this city southward, hundreds of interested spectators were there to see this wonderful novelty, and the scene was both instructive and amusing. It resembled, with its tiny locomotive and cars, a toy outfit for children to play with rather than the begin-

ning of a colossal revolution. Year by year the designs were enlarged and otherwise perfected until the trains, both freight and passenger, became equal to the vast traffic imposed by the growth of the country. No one then dreamed of the elegant sleepers, luxurious reclining chairs or the tremendous tonnage since supplied. Like the Territory, it was in its swaddling clothes and had to grow to the full strength of perfect manhood before such improvements as are now seen were possible. It is no discredit to the builders of the mountain sections of the Colorado Central and of the South Park to say, that their equipments were furnished from the model thus provided, if not directly from the improved patterns. It has effected much for the internal development of Utah, Montana and Old Mexico, since its inauguration here, and has exerted great influence upon the commerce of several American States, and in Europe.

Pursuing its course southward, the Rio Grande Company, within ten years, completed lines to Pueblo (1872), thence through the splendid coal deposits of Fremont County to Cañon City; thence, after a long and hotly contested battle with the Atchison, Topeka & Santa Fe for possession of the Grand Cañon of the Arkansas to Leadville (July 20, 1880); thence to Robinson and Kokomo in the famous Ten Mile District, where it rests for the present. From Leadville Junction (Malta) an arm passes northwesterly across the range thirty miles to the valley of Eagle River, where, in the vicinity of Red Cliff, large deposits of lead ore (bearing from ten to fifty ounces silver per ton) have been opened, and whence the main supplies of this valuable flux are obtained for the dry ores of the Leadville region.

The Blue River branch has been extended from Kokomo to Frisco and Dillon within the past year, and the grade for a fourth extension to Breckenridge and Montezuma established. Thus all the principal mining towns in Summit County are placed in communication with the leading

ore markets and supply depots of the State, enabling them to produce and sell at profitable margins grades of material hitherto of no value to the producer.

From Poncho on the main line (Arkansas Valley), a branch runs northwesterly six miles to Maysville for the encouragement of the miners of Monarch District. From Salida the road crosses the Continental Divide via Marshall Pass to Gunnison, whence an arm proceeds northward to Crested Butte, thirty-two miles to the great bituminous and anthracite coal mines, with, in the near vicinity extensive beds of valuable iron ore. The advantages of this connection are shared by Ruby District, Gothic, Elko and Scofield. From the bituminous coals of Crested Butte the finest coke manufactured in the world is produced (determined by comparison with the best English and Pennsylvania products), fifty ovens being in operation, and fifty more under construction to be completed in a short time. The gas companies at Leadville and Denver are now using this coal for illuminating purposes, because of its great superiority over all others in the State.

From Gunnison the main trunk is extended down Gunnison River through the Black Cañon to the Utah line; thence to Salt Lake City and Ogden to a junction with the Central Pacific of California, and the Utah Northern now penetrating the mining centers of Montana Territory. According to existing arrangements, this division will be completed and in full operation on or before March 1, 1883, which will give the country at large a third transcontinental line, with Denver as its initial point. The reader will comprehend the importance of this connection to the interests of Colorado, when it is stated that hitherto this State has derived no benefit whatever from the direct intercourse of the Eastern States with San Francisco. The Union Pacific avoids us on the north, and the Atchison, Topeka & Santa Fe passes across our southern boundary merely as a matter of convenience in reaching its objective terminals on the Pacific Coast. Therefore, so far as our relations to these

trunk lines are concerned, we might as well be as far removed as Texas or Louisiana. On the contrary, the new line will undoubtedly carry a considerable percentage of the continental tourists, because it traverses the great scenic region of the Rocky Mountains, presenting attractions unequaled by any other section of the American Continent, in about the same time now occupied by the other trunk lines, with equal comfort in the matter of accommodations. Besides, it will afford us cheaper transportation for the heavy trade in fruits and other products of the Pacific, which of itself will furnish large revenues annually to the company and reduced rates to the consumers. Grand Junction, where Gunnison and Grand Rivers unite, opens to the agriculturists and stock growers one of the most fertile tracts of land thus far occupied in Colorado, and will in a short time effect a heavy lodgment of settlers there. Like conditions prevail in the broad delta at the confluence of the Gunnison and Uncompahgre. In the La Salle Mountains, where the Utah and Colorado lines unite, a belt of silver lodes has recently been discovered, at a point about fifteen miles south of the Denver & Rio Grande Railway.

Returning from our digression westward, we again take up the Colorado lines, and follow them to their conclusion.

From Mears Station, a few miles west of Poncho Springs, a branch runs southeasterly to Villa Grove, in Saguache County, within a short distance of the developed mines of Kirber Creek (Bonanza District). Connection with the latter point will probably be made during 1883. The mines about Bonanza and in the neighborhood of Villa Grove, are becoming quite productive in silver, and give unquestioned promise of very large yields when more thoroughly explored.

From the town of Nathrop, a branch twelve miles in length, built by the Denver & South Park Company, and occupied jointly by the Rio Grande, runs to Alpine, traversing the western half of Chaffee County via Chalk Creek,

at the foot of the Continental Divide, which affords an outlet to the extensively operated mines of that quarter, whence the ores are conveyed to smelters at Leadville, Pueblo and Denver. To obtain an intelligent idea of these otherwise puzzling ramifications, and the advantages derived by the producers of mineral, since nearly every camp is united with the main trunk by a series of arms jutting out in all directions where needed, the reader should have before him a perfected map of that division of the State. As I am not authorized to supply the omission, recourse must be had to the map makers, of whom there are quite a number, or to the company which publishes them periodically for the use of its patrons.

Returning now to Cañon City, at the base of the mountains, or at the debouchure of the Arkansas River, in July, 1880, a branch was constructed through Grape Creek Cañon, an extremely difficult and expensive undertaking, thirty-one miles to West Cliff, in Custer County, and put under operation March 15, 1881, which closes the series in that direction. The mines of Silver Cliff, Rosita and Querida, were thus provided with an outlet.

From Pueblo there is a line directly southward to Cuchara and to El Moro, near Trinidad, which was opened for business April 15, 1876, when the fine bituminous coal beds of that section were extensively opened, and, later, a large number of coke ovens erected for the purpose of furnishing the smelters of Leadville, Pueblo and Denver. The various gas companies, by an admixture of the dense bituminous coals of El Moro and the somewhat lighter coals of Labran, near Cañon City, until recently produced from them a superior illuminating gas, whereby those cities were lighted. As stated elsewhere, Denver and Leadville now receive most of their supplies from Crested Butte. The like admixture is much used for smelting gold, silver and copper ores, and separately for steam and domestic purposes.

From Cuchara a line runs southwesterly across La Veta Pass in the Sangre de Christo Range to Alamosa, whence a branch northwesterly connects Del Norte, situated near the base of the San Juan Range, and gives ready access to the exceedingly rich gold mines of Summit District, twenty-five miles beyond. This is rapidly becoming one of the most prominent gold producing centers of the State, and, next to Gilpin, yields the largest returns of that metal. This branch of the road is to be carried on to the hot springs in Wagon Wheel Gap, which is already a favorite summer resort, owing to the salubrity of the climate and the curative properties of the fine mineral springs situated there.

Again, putting out from Alamosa, in Conejos County, is a long arm, which runs southwesterly two hundred miles to Durango, in La Plata County, with an extension directly north forty-five miles to Silverton, the seat of San Juan County (completed in 1882), which develops the coal mines of the former, where veins of unusual thickness and of excellent quality exist, and the productive silver bearing lodes of the latter. While these counties have been sparsely settled for many years, progress had been slow and unsatisfactory for the want of the facilities now provided. The mines about Silverton are among the largest and best in the San Juan Range, and were developed to a considerable extent long before the arrival of the railway, but owing to the high cost of labor, supplies and transportation, the absence of suitable machinery and competing markets, such as are now at their command, at reduced cost, it was impossible to maintain active settlements. Now, however, the mines are sending out large shipments of high grade ores, with some bullion from local reduction works. Numerous discoveries of extremely valuable mines have occurred during the last few months; the principal veins are in constant operation, and the people are enjoying an era of prosperity hitherto unknown. This point is attracting, by the activity everywhere manifest, and by the

results secured to well directed effort, a larger share of immigration than any other in the southwest.

In the Animas Valley, near Durango, immense veins of superior bituminous coal have been well opened and are now furnishing fuel to the railroad and all settlements within reach. Movements are in progress for the extension of the Silverton branch to Rico, the seat of Dolores County, and the mines there under development. A second branch is projected from Montrose—on the main line to Utah—southeasterly to Ouray, where the miners are impatiently awaiting its arrival.

A second arm runs immediately south from Antonito, near the southern boundary line, to Espanola, on the Rio Grande River in New Mexico, whence it is soon to be connected with Santa Fe by a branch thirty-five miles in length, now nearing completion. Various other short lines to different points in the mountains have been surveyed, some of them partly graded, notably the branch from Gunnison to Lake City, in Hinsdale County, and all to be constructed as soon as practicable after the connection with Ogden shall have been made. The series of lines under operation in Colorado alone (including the Espanola Extension) cover one thousand two hundred and eighty-one miles, and, with the completion to Ogden, three hundred and eleven miles will be added, making a grand total of one thousand five hundred and ninety-two miles. All this vast combination of roads is under the general management of D. C. Dodge, who assumed this position January 1, 1879. The benefits derived by the country thus invaded, may be measured by a brief comparison of the conditions prevailing before and after the accomplishment of these gigantic enterprises. Southern Colorado, as already stated, was little more than a barren waste, with stock growing for its chief industry, and though possessing ample resources, they had been but feebly prospected, and their extent and value were undetermined problems. Agriculture was at no period advanced beyond the primitive

stage. The valuable coals which now constitute an important factor in our domestic and manufacturing economy, if known, were unimproved. Though many divisions contain iron and other minerals, they were of no value, hence were untouched. While the mountains of the San Juan, Gunnison, Chaffee, Pitkin and Summit were settled by thousands in later years, isolation rendered their best efforts practically abortive. Mining at Leadville was conducted under great difficulties, and at an expense for all manner of supplies which nothing but the excitement created, the immense influx of people and capital, and the richness of the first mines operated, could have justified. The facts may be clearly defined by saying that if the railway were to be suddenly removed and the primitive expenses restored, it would close nearly every mine and smelter in Lake County. Because it is from the medium and low grade ores, and the economic systems introduced with the railway, that the profitable millions are now derived. These ores were wholly valueless under the rule of wagon transportation, and had to be thrown into the waste dumps. The Iron Silver Mine, for example, has for the past year or two, paid regular dividends on its capital stock from ores which yield an average of only 20 ozs. silver per ton, a result wholly impossible two years earlier. Like illustrations might be adduced from many other sources, but this is sufficient.

The change from past to present is nothing less than a marvellous transformation scene, begun but not to be completed in our day and generation. If the unexplored regions beyond those inhabited are found worthy of settlement, they too will be occupied, when the iron lines must be extended to them as to those of the present day, and for the same reasons. Without them no mining district, however great its capabilities, can be permanently prospered. Hauling supplies by wagons over lofty mountains on roads, which a single storm, an avalanche of snow, or a land slide may at any time destroy, and the shipment of

ores by the same method to distant markets, forbids prosperity. The railway offers the only means of relief from otherwise paralyzing obstructions. The wide difference between the annual returns from the camps intersected by them and those yet isolated, is a sufficient verification of this statement.

Yet all that has been thus far outlined, is only an incident in the chapter of railway progress, composing the annals of our second decade, and the two years of the third just finished. We are now to consider the bearings of

THE DENVER & SOUTH PARK

Railway upon the development of history. In 1874, Ex-Governor John Evans, supported by the leading business men of Denver, which then had a population of six to eight thousand, came to the front again, with a project intended to strengthen and perpetuate the ascendency of this city in State commerce, through a direct line to Park and Lake Counties. Leadville and the country to the north and west were comparatively unknown, their richest treasures undiscovered. The mines which have since poured out their millions, were wholly unknown. Park County had long been a producer of placer gold, and of some silver. The systematic development of these regions, and of the large belts of timber fringing the mountains on either side of the South Platte River, as also the stone quarries, limestone ledges and gypsum beds, with other available resources, it was believed would furnish ample traffic for a narrow gauge railroad. Beginning with their own capital, and $300,000 in bonds voted by Arapahoe County, the first step was taken in June, 1873, a fateful year for railway builders. Ground was broken in the following autumn about the time of the financial crash that destroyed millions of values and wholly checked railway ventures of all kinds throughout the country. Nevertheless, the first division was completed to Morrison, sixteen miles distant, at the base of the mountains, July 1, 1874. Residents of that

period will recall the doubts then and for some years afterward entertained of the public necessity for a road to Morrison. It seemed to have no practical bearing whatever upon the main object, and therefore gave rise to much criticism. Passing over the few intervening years, and looking at this matter by the light of present intelligence, it is seen that this line actually developed latent resources of incalculable value. Three years of slow and expensive labor were required to extend the rails to Webster Station, at the eastern base of Kenosha Hill, involving also an incessant struggle for funds to meet the heavy cost of grading through the rocky cañon. Meanwhile, the discoveries at Leadville quickened the pulse of industry all over the State, reviving confidence and bringing thousands of immigrants, with unlimited capital to our aid. This being the most direct route to the new Eldorado, the finished portion was crowded with freight and passengers. The unexpected traffic soon provided all the funds required to push the road to its destination on the South Arkansas. In the fall of 1879 it crossed the "Divide" and entered the South Park, whence the way to Leadville offered no serious difficulties. By mutual agreement the Rio Grande built the link to Leadville from Buena Vista, and gave the South Park joint use of its track to that point. This connection occurred early in 1880.

From Garo Station a branch completed in 1881 runs to Fairplay. During the past year, the London Mining Company constructed an independent connection up Mosquito Gulch to the base of the Range near the London mine for the better, more rapid and cheaper conveyance of its ores to established markets. Still later in the same year, a branch was carried from Como across Hamilton Pass to Breckenridge, which in 1883 will be extended to Dillon and Montezuma.

No lengthy narrative is necessary to show what has been accomplished by this road. In addition to the developments at Morrison, it has opened the timber belts, from

which a considerable part of our domestic lumber is obtained. It enables the settlers on the rich grazing lands of the Park to ship great numbers of fine beef cattle to profitable markets. It has developed large deposits of excellent coal and iron, and becomes the only natural outlet for the silver mines of Hall's Valley and Geneva Gulch. It has stimulated all classes of mining in the mountains about Buckskin, Alma, Montgomery and Breckenridge, and affords easy access to inexhaustible quarries of valuable limestone flux for the smelters at Leadville, and, finally, resulted in the location here of the Grant Smelter, one of the largest of its class in the world. It has built westward from the South Arkansas through Chalk Creek; cut a tunnel through the Continental Divide, at Alpine, nearly 3000 feet in length, opening the way to Pitkin Gunnison, and the Ohio Creek coal fields beyond, and affording a competing line to that important section of country. With each new arm thrown out, it has brought within its regenerating influence all the needed accessories for the successful prosecution of manifold industries. The greater part of this work has been accomplished within four years, and it is not improbable that through it Colorado will soon be given a second connection with the Pacific via Salt Lake City. It will be understood that all the mountain lines thus far described are parts of the narrow gauge system, and that it has cost millions to build them.

The South Park, together with all the railway lines centering here, with the exception of the Rio Grande, the Denver, Utah & Pacific, and Denver & New Orleans, are under the control of the Union Pacific. A standard gauge road of recent origin, begun in 1881, called the Greeley, Salt Lake & Pacific, runs from Greeley, thirty-eight and a half miles up the Cache la Poudre, through Fort Collins to to Stout stone quarries beyond. At Collins it unites with the Colorado Central and runs over the latter's track to Boulder, whence a narrow gauge traverses the town, and passes up Boulder Cañon to Four Mile Creek, thence up

Pennsylvania Gulch, crossing Sugar Loaf Range just east of Williamsburg; thence southerly to Nederland, along Middle Boulder Creek southwest of Caribou to the foot of the range, whence it is to reach Middle Park by tunneling through the mountains. It is ironed for a distance of twelve miles up the Cañon, and much of the grade beyond is completed. The Denver, Western & Pacific is another of the enterprises of 1881, and was designed to connect Boulder and Longmont with Denver by a narrow gauge, but after ironing twelve miles from this city and bridging and grading the remainder, fell into litigation and is now in the hands of a Receiver.

The Colorado Central connection with the Union Pacific at Cheyenne was some months ago discontinued, as after the purchase of the Denver Pacific it was rendered obsolete beyond Fort Collins.

Embracing all its lines and branches, the Union Pacific is now operating about one thousand and fifty miles of railway in Colorado, with, as already stated, numerous other projects in the way of extensions surveyed and several under construction.

THE ATCHISON, TOPEKA & SANTA FE

Railway crossed our State line en route to New Mexico January 1, 1873, and was extended to Granada, a town of its own creation twelve miles beyond, July 4th of that year, where it rested for a time. In December, 1875, it was carried forward to La Junta. Meanwhile, the Pueblo & Arkansas Valley Company was organized to make connection with Pueblo, sixty-four miles distant, and this branch being completed February 26, 1876, was immediately leased to the Santa Fe for a long term of years. At the same time the main trunk was pushed southward to and across the Raton Range, first by an ingenious switch-back for temporary use, and subsequently by a tunnel two thousand feet in length penetrating the range, thence to the Rio Grande River, whence a branch is carried to Santa Fe,

while the main line is continued to Albuquerque and Deming, and thence to San Francisco via the Southern Pacific. In 1882 a third rail was laid by the Denver & Rio Grande Company on their line from Pueblo to Denver, which enabled the Santa Fe to run its broad gauge trains into Denver, and thereby enter into competition with the Union Pacific for the general carrying trade. These trains were withdrawn, however, late in the fall, and the Santa Fe retired again to Pueblo.

In 1878 the Rio Grande lines were leased to the Atchison, Topeka & Santa Fe Company, which operated them for about one year.

This line has but one branch in Colorado—a coal road thirty-five miles in length from Pueblo up the Arkansas to the Rockville mines, which are operated exclusively to supply its locomotives with fuel. The main trunk within this State is one hundred and eighty-two miles long, which, with the Pueblo & Arkansas Valley branch and that to the coal mines just referred to, gives it a total of two hundred and eighty-one miles. The great stock growing interests of that region, the largest we have, are fostered by this road, which furnishes transportation for thousands to Eastern markets. The Pueblo branch gives it a considerable share of the Colorado trade, and Trinidad is almost wholly supplied by the main artery. With these exceptions it is, in the development of local resources, of rather less importance to the State than those which center here.

THE DENVER & NEW ORLEANS.

Having sold the South Park to the Union Pacific in 1880, Governor Evans and most of his associates in that enterprise soon afterward conceived the idea of building a broad gauge from Denver to Canadian River, there to connect with the New Orleans & Fort Worth, then and now building actively northward. This plan has been executed to the construction of a line to Pueblo, with surveys and grade lines established to the Canadian terminus; but, as

the projectors have been obliged to rely solely upon their own capital, it is assumed that no further advance will be made before next spring, when it is expected the requisite funds will be raised in Eastern or foreign markets for its completion. During December last, a branch, nine miles in length, connected Colorado Springs with the main line, which will give it considerable additional support. Its principal development has been the opening of coal measures at Franceville, near the base of the mountains, about seventy-five miles from this city, and the introduction of these coals to the towns on its line. If completed according to the designs, it will become an extremely important enterprise, as it will penetrate a section now almost wholly unoccupied, and bring the capital of the State, as well as Pueblo and Trinidad, into direct commercial intercourse with Texas and the principal cities of the Southern seaboard. Though environed with difficulties from the beginning, there is no doubt that it will accomplish the purpose of its creation in due time, and take its place as one of the most important factors in the commercial progress of Colorado.

THE DENVER, UTAH & PACIFIC

Is a narrow gauge road having its origin in this city, with a route surveyed from the Platte River at the foot of Nineteenth Street, northwesterly through Jefferson and Boulder Counties via South Boulder Cañon to Rollinsville, in Gilpin County, with the intention of crossing the Range to Middle Park and proceeding thence to a connection with the Union Pacific. This line is ironed and equipped to Hallack Junction, nine miles distant, whence a branch runs north to the Mitchell Coal Mines, fourteen miles, where connection is made with the Denver, Longmont & Northwestern (operated under lease by the Denver, Utah & Pacific) to Longmont, seventeen miles, also narrow gauge. The president of the road is George M. Miller, of New York; general manager, John W. Smith, of Denver. Its chief purpose is to reach and assist the development of various resources known to

exist in Middle Park, notably the coal and asphalt beds of that region, together with the mineral districts of the Rabbit Ear Range, besides materially benefiting several intermediate points, where gold and silver mining has been carried on for many years. The road brings large quantities of coal to market from the extensive mines opened in Boulder County, and affords the people of Longmont an independent connection with this city. Portions of the main line are graded to Rollinsville, to which place the rails will probably be laid next summer.

THE BURLINGTON & MISSOURI.

This constitutes the most prominent addition to the railway influences operating for the general advancement of State interests that has been furnished for several years, because it gives us a fourth trunk line to the Missouri River and the Atlantic Coast. It forms a part of the Chicago, Burlington & Quincy System, and was completed May 28, 1882. The first freight train arrived June 1st, and on July 1st the road was opened to passenger traffic. It crosses our eastern boundary at a point one hundred and seventy miles east of Denver, is thoroughly constructed, mounted with sixty-pound steel rails, and splendidly equipped. Immense herds of cattle are fattened upon the nutritious grasses of the plains traversed, and preparations are in progress for putting large tracts under tillage. To this end the Greeley & Beaver Ditch Company are digging a large canal to convey the waters of Beaver Creek over the fine virgin lands near Brush Station, eighty-five miles to the eastward. At Akron, one hundred and twelve miles distant, the United States Government is sinking an artesian well, with the expectation of discovering unlimited subterranean waters, which may be utilized for the dual purpose of promoting stock growing and agriculture. If these hopes are realized, it will result in numerous other efforts in the same direction, whereby millions of acres now utterly valueless, may be reclaimed and made enormously productive. It is assumed that the

Burlington Company will heartily support these endeavors. Excepting at the stations above mentioned, their line passes through an uninhabited desert. If artesian water is found at Akron, it may be opened at many other points, and thus, by rendering this vast region available for settlement, add greatly to the population and industrial resources of the State. In my judgment, the mission of this road does not, and was never intended to, terminate with its entry into Denver. While its plans for the future are sealed to the public, it has not escaped the eyes of speculative conjecture that its part in our affairs is just begun. What further remains is for time to reveal.

THE DENVER CIRCLE RAILWAY.

This enterprise being of purely local interest, only the principal features need to be mentioned.

The Company was organized November 16, 1880, with a capital stock of $1,000,000; Hon. W. A. H. Loveland, President, H. D. Perkey, General Manager. Like the Belt Railway of Indianapolis, it is designed to completely encircle the city, passing just beyond the present outskirts, where it is hoped that the cheaper lands will induce large numbers of people to locate homes. It is also expected that the manufacturing establishments of the future, and, possibly, extensive stock yards, will be located on this line. Several handsome parks for the public accommodation, with race tracks and other attractions, are to be laid out at various points, lands for the same having been secured.

Within the past year the Company has built and put in operation something over six miles of track—three foot gauge. Contracts for extensions have recently been let, among them one from Curtis Street to Larimer, along Cherry Creek. Here the permanent depot is to be erected. A commencement has been made which will in a few years make this a necessary convenience to many people, and will operate for the extension of the city far beyond its present boundaries.

Having epitomized the general development of the country through the facilities provided for cheaper and more rapid transit, let us now turn to the present condition of the mines, which supply a large part of their traffic, and are furnishing the principal export commerce of the State. The counties and their resources will be considered in alphabetical order for greater convenience, and such facts presented in regard to each as will lead to a comprehensive idea of what is being accomplished in this great field.

At the beginning of this work it is proper to state, that in order to make the reports of the State Geologist especially valuable to the mining interest, some provision should be made whereby the sphere of their usefulness may be enlarged. For example, he should be authorized to prepare suitable maps and drawings of certain geological sections of the principal mineral belts, and sectional drawings of such mines as present important geological phenomena, and illustrating the extent and character of the developments where such phenomena occur. It would be well, also, to include such new methods for the more efficient reduction of gold and silver ores, and the saving of their precious contents, as may have been practically and successfully introduced, together with any improvements in established systems, with text descriptions. This would invest these publications with a value not hitherto attained, because the miners and workers of ores are constantly searching for new light on all matters pertaining to their vocation. It is undeniable that the Leadville miners were greatly benefited by reference to Professor Hague's admirable and exhaustive illustrated account of the system of timbering in the Comstock mine, Nevada, printed by the general government several years ago, under direction of Mr. Clarence King. These descriptions were so complete in detail as to enable less experienced managers who were called to explore the peculiar deposits found at Leadville, to proceed understandingly from the beginning, and, by the knowledge thus obtained, to protect themselves and their employes from disastrous cavings.

From the date of its creation in 1872 to the present time, this office has been conducted wholly without expense to the State. The work thus far performed has, therefore, embraced only a hasty resume of the notes gathered from time to time in the regular course of my practice as a mining engineer. I believe, however, that it would be false economy to allow the office to remain longer unaided by the State Government, when the appropriation of a small sum biennially would make it of undoubted benefit to the interest it seeks to promote. The importance of the subject demands something further, and I know of no more effective aid to the general information than the additions herein suggested. The cost would be small in comparison with the benefits acquired. One or two thousand dollars applied to these purposes would be worth many times these amounts to the class more particularly addressed, in assisting them to a clearer understanding of conditions with which they are unfamiliar.

BOULDER COUNTY.

The mines of this county are at present in quite as healthy a condition as they have been at any time within the past ten years. They are very generally operated for actual profits, rather than for the purpose of creating a fictitious value for the stocks of the various companies. The "new process" craze has had, and is still having, a very extended influence, greatly to the detriment of the county's development at home and of its reputation abroad. Within two years several mills have been erected at a cost of hundreds of thousands, containing "processes," the principles of which were tested and condemned many years ago, and, if the parties who furnished the capital for these enterprises (it is assumed that no one familiar with metallurgical science would have embarked in them), had consulted metallurgists of ability and integrity, they would have saved themselves much annoyance and expense, and the country would have escaped much ridicule and consequent loss of prestige.

While the failure of these schemes has not injured the mines, they have, nevertheless, prejudiced capital against the districts where they are located, because the want of success is almost universally charged to the refractoriness of the ores, or to their poverty, rather than to the true causes.

Several excellent mills, constructed upon correct principles, have been established in localities where high grade ores are abundant, but where it was impossible for the owners to obtain all the varieties necessary to form self-fluxing mixtures. These errors, to give them no harsher name, have seriously retarded progress here and elsewhere. These monuments of folly standing in the form of deserted and decaying mills and smelting furnaces, may be seen in all the mining counties, from Boulder to the distant San Juan, representing the darkness of ignorance and millions of capital wantonly squandered. No district of prominence is without one or more of them. But this is not the worst feature of the case; they are being duplicated even at this late day, generally at the expense of innocent but misguided investors, and often for the personal advantage of those whose only interest is in the salvage that may be secured by superintending their erection.

For ten years Boulder County has produced gold and silver in large quantities and in about equal proportions. In 1881 the bullion product was $535,482.88 made up as follows:

1.—Value of silver bricks, product of the Caribou mine, shipped through the express office at Boulder	$227,982 88
2.—Value of ores shipped to Argo from the Boulder Sampling Works of the Boston and Colorado Smelting Company . .	100,000 00
The above is from the books of the company, with an estimate for the last ten days.	
3.—To the 1st of December the Boyd Sampling Works had shipped to the Golden Smelting Company, $50,000; estimated for December, $8,000, making	58,000 00
4.—Value of ores shipped to Omaha and other smelting points not mentioned above, as estimated from the books of the railway office	60,000 00

5.—Product of the 50-stamp gold mill of the Resumption Mining Company at Ward District, shipped through the Denver Mint and banks	40,000 00
6.—Product of the Golden Age Stamp Mill, product of other stamp mills, arastras and gulches shipped through the National banks of Boulder	37,500 00
7.—Value of bullion, the product of 1881, yet in the hands of the producers or sent East by channels not indicated above, estimated	10,000 00
Total for 1881	$533,482 88

The return for 1882 is $550,000.

A very complete description of the principal mines having been given in my report of December, 1880,* it is considered unnecessary to repeat it here. It is sufficient to say that as a rule the veins are true fissures in granitic rocks, continuous and well-defined to the greatest depths thus far attained.

Caribou District, situate in the southwestern corner of the county, yields the major part of the silver, the main sources being the Caribou and No Name mines, both quite extensively developed. These veins cross each other, and being owned by the same company, are operated through one common shaft. The strike of the Caribou is nearly due east and west, while that of the No Name is about northeast and southwest. The crossing above mentioned, occurs in the main workings of the mine, which have reached a depth of one thousand feet, where the vein is still distinct, regular and well-defined, and the ore quite as abundant and valuable as it was in the openings near the surface. The ore is a mixture of zinc blende, galena, iron and copper pyrites, interspersed with a considerable per cent. of silver glance and native silver. The solid, or smelting ore, yields in large lots from one hundred to twelve hundred ounces per ton, and the milling material from twenty to sixty ounces.

Among the other productive mines of this locality may be mentioned the Native Silver, Seven-Thirty, Ten-Forty,

* Copies of this report may be obtained of Stone & Co., booksellers, Denver, who published quite a large edition for their own use.

Poorman, Sherman, and others, all of which have been developed to depths varying from one hundred to five hundred feet. The mines of

Ward District, with the single exception of the Ni Wot, have sent out very little bullion for two years, not through any fault of the mines, but because they have not been operated. There are several superior mines in this district, notably the Ni Wot, Nelson, Stoughton, Celestial, Humboldt and Morning Star, which have been opened by shafts, levels and tunnels, from two hundred to four thousand feet in extent. The ores are chiefly gold-bearing, with very little silver, and are of the class denominated "free milling." The stamp rock yields from six to fifty dollars per ton, averaging not far from twelve dollars. The smelting product yields fifty to one hundred and sixty dollars, averaging about ninety dollars.

Central District, embracing the hamlets of Jamestown, Ballarat and Springdale, returns a lighter product this year than formerly, because of indifferent work upon its mines. The somewhat famous Smuggler, as well as the John Jay, Last Chance, Longfellow and Golden Age, have not been continuously worked, and no productive new discoveries have been made.

Gold Hill, Sunshine, Sugar Loaf and Magnolia Districts, are still yielding about the usual quantity of ore and bullion. The Prussian, Slide, Alla Makee, Mountain Chief, Victoria, Cold Spring and a few others in Gold Hill, have been steady, and some of them large producers. In Sunshine the Emancipation, Inter-Ocean and Ingram are the most prominent. In Sugar Loaf the Yellow Pine, Melvina, Goldsmith Maid, Emerson and Logan, are under continuous operation. In Magnolia the Senator Hill, Kekionga, Keystone, American Eagle and some others, have contributed considerable bullion. A large number of valuable mines in these districts which have yielded largely in past years, are from various causes, none of them due to the poverty of the lodes, however, wholly unproductive at this time.

Some have quite recently been put under operation, and it is hoped that many others will be in like condition within the next year. The mines of Boulder County, if steadily worked under competent direction, are capable of returning from six to ten times as much as they are now doing.

The placers have not been extensively worked during the past two years, and for this reason have added but little to the general output. Some effort has been made on Four Mile Creek, Left Hand, etc., but with these exceptions they have been wholly idle.

The following statement of the material wealth of the county is taken from the books of the County Assessor for the year 1882:

	VALUE.
Lands and improvements	$2,050,610 00
Improvements on Public Lands	218,605 00
Lots	945,640 00
4194 horses	228,875 00
414 mules	31,595 00
7770 cattle	128,970 00
148 sheep	295 00
488 swine	2,920 00
29 other animals	565 00
1103 watches	18,720 00
341 musical instruments	22,160 00
1285 carriages	58,905 00
Moneys and credits	214,255 00
Capital in manufacturing	42,360 00
Capital in merchandise	269,700 00
Stocks and shares	97,600 00
Household furniture	18,100 00
Jewelry, gold and silver plate	2,760 00
All other property	125,495 00
Grand total	$4,477,130 00

CHAFFEE COUNTY,

Though contending with the trials and obstructions incident to all the more recently explored sections of country, has made considerable progress. In 1880, its return was about $90,000 from all sources. The following year it advanced to $196,400, and in 1882 this amount was increased to $225,500.

The districts of South Arkansas, Chalk Creek, Cottonwood, Granite and Hope, are the most extensively developed. The general formation is granitic, with numerous great dikes of eruptive rocks of different varieties. One interesting example occurs on the east side of the Arkansas River, half a mile from Nathrop Station, on the Denver & Rio Grande Railway. A large part of it is composed of cellular pumice, of a light gray color. In the cells or cavities are beautiful crystals of topaz, of a delicate pinkish yellow color, perfectly transparent and free from flaws. They are quite small, however, the largest yet found being only half an inch in length and one quarter of an inch diameter. Associated therewith are many small dark red garnets. On the easterly side of the mass there is a large dike of smoky brown spherulitic pitchstone.

In the district of South Arkansas there are many excellent prospects, with a few largely productive mines, notably the Columbus, located about two miles above the town of Garfield. It has about 1,000 feet of levels and winzes, all said to be in ore that will yield an average of 100 ounces silver per ton, and the vein is very large. At and near the surface the ore body was composed of carbonate and oxide of lead, carrying silver in the form of chloride, with some silver glance and native silver, but latterly its character has changed, assuming more of the sulphide structure. The owners have a complete and well-appointed amalgamating mill, with capacity for the reduction of 40 tons per day, which is connected with the mine by a Halliday wire tramway, some 5,000 feet in length.

Chalk Creek District contains many fine lodes, most of them in the prospective stage as yet, with a few developed mines. The Murphy, situated on the mountain which bears its "milesian" name, above St. Elmo, has been quite extensively explored, and has shipped large quantities of valuable ore to the various markets. It is claimed to have sufficient resources for the production of 50 tons daily during the next two years, worth an average of $60 net per

ton, if reasonable rates for its transportation to the smelters could be obtained. A wire tramway of the Halliday patent, with a capacity of 100 tons per diem, runs from the mine to the company's ore bins, on the line of the Denver & South Park Railway, at Murphy's Switch. It is understood that the owners will erect a mill for the treatment of their ores at a point near the mine.

For the past two years it is probable that the Hortense, located on Mt. Princeton, has returned a greater aggregate of bullion than any other property in the district. It is thoroughly developed, has immense reserves exposed, but the bulk of the ore is of rather low grade—25 to 40 ounces per ton—and of the free milling variety, which, with proper reduction works near at hand, could be made substantially profitable. The owners have this project in contemplation.

Cottonwood District, embracing South, Middle and North Cottonwood Creeks, seems destined to assume a prominent station among the active and steadily productive sections. It has many fine prospects, but none of them have been explored to any considerable depth, therefore the bullion returns have been light.

Granite and Hope Districts constitute the chief centers of placer mining, and have contributed quite freely of gold. The free gold-bearing lodes in the neighborhood of Granite have not been largely or continuously operated during '82. The same may be said of those of like character situated near Buena Vista.

Chaffee County appears to be rich in mineral resources, of great extent and variety, but it has never been favored with the stimulus of excitement and abundant capital accorded its neighbor at Leadville. Yet the results, secured to patient endeavor, encourage the belief that it will at no distant day become a formidable rival to the great carbonate camp. While the exhibits of bullion are comparatively small, they are increasing as the prospects are converted into mines. From the number in process of development

it may be assumed that heavy yields will mark their future operation, and that two years hence a much better report can be made.

CLEAR CREEK COUNTY

Is almost exclusively devoted to the pursuit of mining, there being only a few narrow strips of tillable land within its limits. The geology is quite simple: the rocks are generally granitic, with occasional patches and dikes of the eruptive varieties here and there in different sections. The granitic series embrace all the diversified forms, from the true massive granite, running, through all the gneissic grades, down to highly stratified mica schist. The veins are mainly true fissures, having a strike approximately northeast and southwest, though there are isolated instances where the strike is nearly north and south, and others east and west.

This county has been quite thoroughly prospected, and valuable lodes bearing gold or silver, and in many instances both of these metals, found in nearly all the districts, some of which have been worked to greater or less extent since 1859. The annexed table sets forth the yearly product collated from the most authentic data obtainable, with the proportion per capita to the miners engaged and to the whole population:

YEAR.	Population.	Per Capita.	No. Miners.	Per Capita	Total Product.
1859 to 1864 (Inclusive)	1,500	$1,333	1,000	$2,000	$2,000,000
1865 to 1868 do	1,000	141	700	365	182,823
1869	2,000	200	800	500	400,354
1870	2,500	192	1,500	320	481,354
1871	3,000	287	1,500	579	869,046
1872	3,500	429	1,700	884	1,503,391
1873	3,500	357	1,700	741	1,259,761
1874	4,000	500	2,000	1,101	2,203,947
1875	4,000	482	2,000	964	1,928,161
1876	4,500	440	2,000	991	1,982,544
1877	4,500	490	2,000	1,103	2,206,577
1878	5,000	465	2,000	1,130	2,261,105
1879	5,000	393	2,000	983	1,967,000
1880	7,000	427	2,500	1,198	2,994,728
1881	7,000	314	2,250	980	2,204,980
1882	7,000	.....	2,250	.....	2,001,629

Total product of the County to January 1, 1883, $26,447,400.

From 1859 to 1864 the yield was almost wholly derived from the placer mines, and from the decomposed surface ores of the gold veins, as the silver mines were not operated until 1865. The first noteworthy discoveries of silver lodes occurred in the vicinity of Georgetown in the fall of 1864, which created much excitement the following year. Some of these veins have been constantly and very successfully worked, with a steadily increasing output from that time to the present. Yet, as a whole, the district has been at the best only skimmed, very few of the veins having been penetrated to the water level of the mountain streams. Less than half a dozen pumps are employed, and there are none of large capacity. Beside the many older workings, conducted from five to fifteen years, several new discoveries have been made and partially developed, creating new sources of wealth, and furnishing the greater part of the bullion crop. The deeper mines, as a rule, show no diminution in the quantity or quality of their ores. The Terrible mine has reached a depth of about 1,200 feet—the deepest in the county—and is said to carry a crevice and ore vein quite as large and well-defined as at any point above, with a little better average grade. The silver in this, as in most others in the district, is largely carried in the gray, yellow and purple sulphurets of copper; lead, zinc and bismuth sulphides, with smaller proportions of ruby silver, argentite, native silver, etc., intermixed. Its average value is not far from 200 ounces silver per ton.

The milling facilities consist of several sampling establishments, where the ores are purchased for the smelters at Argo, Denver, Golden, Pueblo, Omaha and other points, and two concerns where they are bought and reduced to bullion on the ground.

Empire District has been settled since 1861 and was the scene of no little excitement for three or four years later, owing to the gains derived from sluicing the surface dirt or quartz decompositions on the slopes about North Empire. But for some years past it has been an insignificant

factor in the general scheme of gold and silver production. A number of mines have been opened, but none of them very extensively, from the causes which follow. The ores are almost wholly auriferous, but generally of too low a grade to bear transportation to distant markets, and there are no local works adapted to their economical reduction. The results of reduction by the stamping process have averaged about the same as in Gilpin County, but the per cent. of smelting ore is not as great nor of as high a grade. A large and well constructed mill, with methods for cheap roasting and amalgamation, would shortly give this district exalted standing among the productive sections of the State.

Dailey and *Atlantic Districts* are still in the embryonic stage, but with encouraging prospects for the future. The ores found here are argentiferous, and the veins generally very large. The mineral is usually quite rich, but much of it scattered in specks through the entire gangue matter of the veins, which prevents the miners from shipping to market, as it would be impossible to realize a satisfactory profit after deducting the cost of transportation and treatment. Like those of Empire, they need cheaper works placed near the sources of supply.

On Red Elephant Mountain and vicinity, several mines have been extensively worked under leases, and large quantities of valuable ore extracted for smelting. It is true, however, that these properties have yielded only a small part of what might have been realized through a broader system of development and supervisory direction. The Stephens concentrating mill has been of great assistance to the successful conduct of these mines, by providing a cash market with remunerative prices for grades of material which, without its aid, would remain a worthless item in the waste dumps. The long inactive, and apparently lifeless, district of *Dumont* has for a year or two past exhibited something of its early vigor, and while the output is still meagre, many of the lodes which were formerly

very productive, but later to all intents and purposes abandoned, have been reclaimed, and the prospect is favorable that some of them will soon be made heavy contributors to the general prosperity.

Trail Creek is in better condition than at any previous time since 1861-2. In addition to the large number of mines vigorously operated, a smelter has been erected and put in blast, and the Freeland concentrating mill engaged upon the low grade gangue matter of the lode whence its name is derived. The Freeland is explored by about one and a half miles of levels, shafts and winzes, and has vast reserves of ore in sight. The Gum Tree and Lone Tree also have been quite thoroughly developed, but without reference to the production of ore, the main purpose of the management being to open stoping ground for future results. Several new discoveries have occurred, some of which are said to promise extremely well. A considerable amount of development work has been performed in the *Fall River* and *Chicago Creek Districts.* Material advances have occurred in *Idaho District.* The network of veins in Virginia Cañon, Gilson Gulch, Hukill Gulch, Spanish Bar and other quarters, have been worked with gratifying regularity, and the results achieved form an important part of the bullion returns for the county. The placers, though not exhausted, are virtually abandoned.

CUSTER COUNTY.

The return for this county in 1881 was $755,600. That for 1882 shows a decline to $705,116. Those familiar with the situation will readily understand the cause. The better mines are in the hands of corporations who do not work them, owing to the failure of conclusions drawn from false premises respecting the character and value of the principal deposits, and the course of treatment required for the profitable extraction of the precious metals. Having reached the limit of speculation in stocks, the projectors have no further use for the works, and therefore, with a few excep-

tions, the whole mining interest of this county has fallen into decay. The Bassick is still a great mine, and since its character is rather phenomenal, it is worthy of a brief description. Originally it appears to have been an active geyser, and the spaces between the boulders and angular fragments of rock, after the subsidence of the thermal waters, were filled with rich auriferous and argentiferous ores, mixed with a calcareous gangue. It is well known that most of the ore occurs in the form of shell-like coatings on boulders, varying from a mere scale to an inch or more in thickness, and it is asserted that the coating increases in thickness as depth is gained in the mine. The body of boulders forms a circular "chimney," "well hole" or minute crater, from 20 feet to 80 feet in diameter, with apparently no well-defined, continuous vein extending from it in any direction. The ore consists of the sulphides of zinc, iron, lead and copper, with, it is said, some tellurides, but I have seen none of the latter species. They are usually rich in gold and silver, some extraordinarily so, running up to thousands per ton, chiefly gold.

The Bull Domingo, near Silver Cliff, is another example of the class, but the "chimney" is much larger, and the ore of lower grade.

Several great and costly mills have been built in the neighborhood of Silver Cliff, but for some unexplained cause, either the extreme poverty of the ores, or the inadaptation of the methods employed, have been idle for a year or more. Two or three so-called "new processes" have been introduced with painful results to the investors, but without other or better effect upon the bullion crop. It is unquestionable that the mines about Silver Cliff contain enormous resources in the lower grades of milling material, but they must remain unproductive until means shall be found to reduce them on a large scale, and by the accumulation of small savings render them reasonably profitable. Let us hope the day is near at hand when the right measures will be rationally applied.

DOLORES COUNTY.

This county was created by a division of Ouray in 1880. It has but one mining district, and of this Rico is the seat. It is the center also of great possibilities. Because of its isolation from railways, ore markets and supply depots—the nearest being Silverton—and the intervening ranges of mountains, the splendid mineral resources found there develop slowly. The people are moving, however, unitedly and vigorously for relief, and it is not unlikely that the Denver & Rio Grande Railway will afford them the desired connection during the current year.

The formation in which the mines are located is principally sandstone and limerock, much disturbed and broken by numerous dikes and overflows of the eruptive rocks. The mineral lies in contacts between these stratifications, and in fissures penetrating or cutting up through them from below the contacts. The ores consist of the argentiferous sulphides, carbonates and oxides of lead, iron, zinc, copper and a little bismuth, having an average value of about $125 per ton, as indicated by assays and the returns of numerous large shipments to the smelters.

The Newman group of eight claims, owned by the Marrs Consolidated Mining Company, has attained the greatest development, which comprises about 2,000 feet of levels and other openings. The production of ore from these workings, without recourse to stoping, will aggregate $50,000. The value of the reserves exposed is variously estimated, from $500,000 to something over $1,000,000. The greater portion of the ores are free milling, composed of earthy oxides of iron and manganese, mixed with a little lead carbonate, sulphate, sulphide and oxide, carrying silver in the form of sulphide, chloride, and native, in a calcareous, sandy gangue. Its value ranges between 20 and 60 ounces silver per ton. Intermixed therewith is a considerable quantity of smelting ore in the form of the sulphides of zinc, iron, lead and copper. Some 70 tons of this class have been extracted from the different workings, which

gave by assay about $300 per ton, netting at the smelters, after the customary deductions, $243.77 per ton.

The Johnny Bull, Puzzle, Puzzle Extension and a few others, have marketed several consignments of high grade mineral. Others are in condition to do likewise, but are awaiting facilities for cheaper and more direct transportation, as existing rates consume too much of the gross valuation. Distributed through the district are many excellent prospects, which only require the encouragement of favorable markets to render them highly productive and profitable. When these shall be supplied, Rico should become one of the most prosperous sections in the San Juan country.

Three establishments for the reduction of ores have been located there, namely: The Grand View Smelter, the Santa Clara (lead smelting) and Warren's Lixiviation Works. The first of these has produced the major part of the bullion, because put in blast in the fall of 1881, and operated much of the time during '82, while the others being of recent construction have yielded only small amounts.

FREMONT COUNTY

Has been chiefly noted for its superior coal mines, beautiful fruit orchards, agricultural and stock growing advantages, all of which will be considered in a subsequent chapter. Mining was added to its resources during 1881, when its first bullion returns were reported in the table for that year. The product was $14,535.50, principally derived from two mines—the Cotopaxi, in the district of that name, and the Gem, in Grape Creek cañon. The latter contains much nickel associated with the silver, the only instance of the occurrence of this metal in quantity thus far reported in Colorado. During the past two years several discoveries of veins bearing gold, silver, copper, nickel, etc., have occurred. Fine samples from sixty-five distinct prospects were shown at the National Mining and Industrial Exposition held in Denver last August. In the month of Decem-

ber some excitement was created by surprising discoveries of copper ore in the Green Mountain Mine, located on the Divide between Pine and Copper Gulches, five miles west of Grape Creek. The vein is twelve feet wide, and the whole mass shipped to market gives by assay about 22 per cent. of copper, and carres from $10 to $12 in gold and silver. We may confidently anticipate, therefore, that the yield of $19,960 reported for 1882, will be largely increased during '83.

GILPIN COUNTY.

A glance at the map of Colorado will show that Gilpin is the smallest of all the counties, but in the record of production it is the greatest save one—Lake County. Its dimensions are somewhat less than twelve by fifteen miles. The gold mines are clustered in groups, within a space of less than four miles diameter, and they have been under development for twenty-three years. In that period the product has been $41,000,000, of which $37,500,000 was gold, and $3,500,000 silver, the whole constituting more than one-fourth of the entire bullion output of the State, and nearly two-thirds of all the gold. The history of Colorado had its beginning here, and from it all the other sections have taken their most instructive lessons in mining and milling. From various causes, readily explainable, the yields since 1880 have suffered some decline. This was due to the suspension of work on several of the more extensively operated mines, rather than to the lack of paying ores. In some instances the suspension was caused by the necessity of erecting heavier machinery for raising ore and water from the great depths attained, while in others development work only was performed, pending the completion of negotiations for their purchase. The majority of these, however, have lately resumed active operations, and it is expected that the usual number will be engaged in the same direction next season. To all depths thus far penetrated, the quantity and quality of ore remains near the old standard. The average assay value of the stamp rock, as indicated by the results

of some thousands of assays by the writer and others during the past eighteen years, is about one ounce, or $20 per ton in gold, and not far from six ounces silver. The average amount extracted by the stamp mills proper, from the best information obtainable, is about 60 per cent. of the gold and 7 per cent. of the silver, or about $12.50 per ton, coin. The silver saved is only that which is in alloy with the gold, and the per cent. varies quite perceptibly in the ores of different mines. There is a further saving by concentrating the tailings from the stamp mills, equal to about one dollar per ton, average, for the crude material, at the prices generally paid for the concentrates during the past seven years. This gives a total average yield of $13.50 coin, per ton, or about 73 per cent. of the assay value. From a few of the mines a much higher per cent. is saved, and from others less, but I am convinced that the above is very near the general average. From the nature of the ore, it being very heavy in sulphurets, it is scarcely possible to obtain much better results from the present stamping process.

The sulphuret or smelting product, comprising the sulphides of iron, zinc, copper, lead, etc., is usually separated from the stamp rock by hand picking, and then sold for smelting. The average assay value of this class of ore, as shown by the practical results of twelve years' continuous operation, is about $100 (coin) per ton. Delivered at the smelters, the producer receives from $70 to $74 net per ton. At the present cost of labor, fuel, freights, etc., this is regarded as very fair, and even liberal, compensation.

All the later approved systems of mining and stamp milling are employed, and considering the character of the ores, which are very heavy, it is assumed that these mills are doing as perfect work as those of any other section in the United States. About 500 stamps are engaged in crushing, most of them for miscellaneous customers.

Among the enterprises recently inaugurated, which promise large benefits to the county, is the British-American Tunnel. Having its initial point on South Clear Creek, a

short distance below the mouth of Fall River, it is projected in a northerly direction through the great mineral belt of Quartz Hill to the silver district beyond on North Clear Creek, a few miles above Black Hawk. It is designed to cut the Champion group of lodes at a depth of nearly 3,000 feet (on the incline of the veins); the White Cloud at 2,300; the Pewabic at 1,500; the Leavenworth, 1,600; the Alps, 2,000; the California and Kansas at 1,600 to 1,800; the Prize and Gunnell at 1,200 to 1,500; the Winnebago and others at 1,000 feet. The first 5,000 feet from the entrance the tunnel will penetrate ground on which there are no developed mines, though many prospects have been discovered at the surface, and doubtless some of them will eventually become valuable. Within the succeeding three miles, however, it will intersect more than sixty well-known lodes, which have been well explored and their value established, besides many of lesser present importance. To all who are familiar with the territory to be traversed, the benefits derivable from an enterprise of this nature will be at once apparent. It will open and drain a vast series of fissure veins to depths which cannot be attained by sinking in the ordinary course, without infinite difficulty and expense, and furnish a general outlet for the economical delivery of all grades of ore to reduction works driven by water power. These advantages will enable the miners to obtain a profit from material that is now essentially worthless to them, and add millions annually to the general bullion crop of the county.

The Union Tunnel is another project, though of less magnitude, calculated to achieve similar results. It begins on North Clear Creek, with the purpose of cutting through Maryland Mountain on the north and Casto Mountain on the south. About 1,000 feet have been driven, and contracts let for 2,000 feet additional. The openings on either side are situated near good wagon roads, with easy grades for the conveyance of ores to the mills and the railway station.

The European-American Tunnel begins on the south side of North Clear Creek, one mile below Black Hawk, and is projected westerly to intersect the mines of Bobtail and Gregory Hills. Though recently started, it is in the hands of men who declare their intention to drive it with all possible energy to its destination above mentioned.

Recurring to the original subject, it may be stated that outside of this large cluster of gold-bearing fissures, and virtually surrounding it on all sides, there is a belt of highly productive veins, in character of gangue matter and mineral, quite similar to those already mentioned, excepting that the precious metal is almost exclusively silver. These veins first attracted my attention in 1864, and several were located during the summer of that year. But as there was then no market for such ores nearer than Newark, New Jersey, and as these were not rich enough to bear transportation seven hundred miles by wagon, and two thousand miles by rail, they were abandoned until five years ago, when many were relocated and have since been steadily worked, with in some cases very gratifying results.

The District of Gold Dirt was practically deserted from 1865 until about two years ago, when a general revival took place. The Rollins Gold and Silver Mining Company—John Q. A. Rollins, manager—have been exploring by methodical direction the Perigo and Gold Dirt lodes with admirable success. From August 1, 1881, to November 1, 1882, a period of fifteen months, after performing a large amount of dead work for the exposure of its better ores, the yield of the Perigo alone was $67,000, the stamp rock averaging $14.50 per ton, and the smelting product $72 assay value.

To illustrate the permanency of the veins, it is stated that many of them have been opened to depths of 700 feet to 1,380 feet, without any appreciable reduction in quantity or quality of the ores; indeed, there seems to have been some increase on the whole in both, probably sufficient to compensate the additional expense of mining at great depths.

*There are no present indications that they will deteriorate in these respects within any limit where practical operation is possible.

The placer mines have added but little to the bullion returns for several years. Excepting a few companies engaged in the gravel beds between Black Hawk and the Junction, several miles below, the placer diggings are in the hands of Chinamen, whose industry and habits of economy enable them to secure a living from very lean ground. Russell, Lake, Leavenworth and Illinois gulches are almost wholly occupied by Chinese, as well as most of the smaller areas long since abandoned by white labor.

I am averse to dismissing this subject without elaborating certain facts and opinions respecting the future progress of this splendid mineral bearing zone, already touched upon. In consideration of the fact that many of its mines have been sunk to depths where hoisting and pumping have become very expensive, and that in addition to the available grades of ore there are immense quantities too lean for profitable handling, which carry only one to two ounces gold per cord, yet still sufficiently rich to yield a fair profit under more favorable conditions, it seems to me that the time has arrived when a project should be devised for the largest practicable utilization of this now, to all intents and purposes, waste product. I am fully satisfied that a tunnel

*While it is true that an apparent decline in the value of both smelting ore and stamp rock is shown, it may be thus accounted for. A few years since the smelters purchased on the following scale: First, deduct 10 per cent. of the assay value; second, $35 per ton for treatment. Under this schedule of rates, it did not pay to send ores to them worth less than $50 per ton. Hence, everything under that grade went to the stamp mills, which naturally augmented the grade of the stamp rock. Recent reductions of smelters' charges, enable the producer to derive as great a margin from ores assaying $33.33 per ton as could formerly be realized from that worth $50. The result is, that while the quantity of smelting product is increased, the grade is much lower, and the stamp rock by the abstraction of the richer material, becomes less valuable for milling. Again, the reduced cost of crushing in the stamp mills, and the general decrease of expenses following the introduction of railways and improved devices, has made it possible to reduce, profitably, much leaner stamp dirt than before, which caused the miners to take great quantities from their stulls and dumps to be milled. Therefore, on the whole, I see no reason for receding from the opinion expressed above, that no material decline in quantity or quality has occurred in the deep mines of this county. The only appreciable difference is in the grading, as above defined.

from some feasible point on South Clear Creek, would do more toward the solution of the problem than any other enterprise that can be instituted at this time. Under capable management it may be made a profitable investment for the amount of capital required for its completion, and the benefits to the mining interests would be almost incalculable. The end in view would be best accomplished, and with least expense, by starting at some desirable point between Idaho Springs and Fall River, and running directly under the principal lodes of Belleview, Quartz, Prize and Winnebago Hills. It would then cut all the important groups heretofore mentioned, at vertical depths ranging between 900 and 2,000 feet, and on their dips from 1,200 to 3,000 feet, effectually draining them to these depths, and doing away with the heavy expense of pumps and the power to operate them. The tunnel should be of sufficient dimensions to admit of a double track, with a water way beneath, and for the passage of underground locomotives for the conveyance of ores to mills containing from 100 to 200 stamps each, located on South Clear Creek, near the mouth of the tunnel. They could be operated by water power eight to nine months in the year, thus materially reducing the cost of crushing. The present cost of mining, hauling and milling stamp rock, according to the voluminous notes I have collated, is about $35 per cord, average, or $5 per ton, distributed as follows:

	Per Cord.	Per Ton.
Breaking and passing ore to shaft	$ 9 00	$1 30
Hoisting and pumping	6 13	87
Hauling to mills	7 87	1 12
Crushing in custom mills	12 00	1 71
	$35 00	$5 00

What is termed "two ounce stamp dirt,"—containing two ounces gold per cord,—yields about the following average:

Two ounces gold retort, value $17 per ounce	$34 00
Half a ton of concentrated tailings, @ $5 per ton	2 50
	$36 50

It will be seen that this leaves a margin of only $1.50 per cord, or 21 cents per ton, on two ounce rock, too little to make it an object to mine and reduce it.

Now let us see what reductions may be made with a tunnel as suggested, and large water power mills contiguous to its outlet:

	Per Cord.	Per Ton.
Breaking and passing ore to cars, 10 per cent. . .	$ 90	$ 13
Hoisting and pumping above tunnel level, 90 per ct.	5 52	79
Hauling to mills	84	12
Crushing	6 00	86
	$13 26	$1 90

This would effect a saving of nearly 38 per cent. and leave a margin of profit:

	Per Cord.	Per Ton.
On two ounce ore	$14 76	$2 10
On one and a half ounce	6 26	89

It is, therefore, quite clear, that if by the use of improved devices and appliances we can reduce the cost of mining to 89 cents per ton, and the cost of crushing to 45 cents, as is now accomplished in the Black Hills of Dakota, according to the certified statement below, we should realize a profit of $3.12 per cord, or 44 cents per ton, from ore containing only *one* ounce, and still allow $7 per cord, or $1 per ton, for conveyance out of the tunnel, which would be a very liberal tariff. This being admitted, we should have a larger margin by more than 100 per cent. on *one* ounce ore than is now obtained from the two ounce. But we cannot expect to reduce the cost of crushing to the Dakota standard, for two reasons: First, because the gold in most of our mines is much finer, consequently finer pulverizing is required. Second, owing to the high per cent. of sulphides, the pulp becomes very heavy, therefore must be passed over the amalgamating plates in a thinner body than is necessary with a pulp of lighter material. Hence, each stamd has far more work to perform to produce these conditions.

The following statement from Superintendent McMasters shows the yields, together with the cost of mining and milling, at the different mines in the Black Hills:

They embrace, as we understand it, the product of all the properties from the outset of their exploitation up to the 31st July, 1882, as understated:

Homestake Mining Company produced	$4,367,180 48
(Tons of ore milled, 684,733; average per ton, $6.37.)	
Highland Mining Company produced	1,175,632 45
(Tons of ore milled, 234,081; average per ton, $5.02.)	
Deadwood-Terra Mining Company produced	1,221,946 57
(Tons of ore milled, 249,329; average per ton, $4.90.)	
Deadwood Mining Company produced before consolidation of Deadwood-Terra Mining Companies	834,192 28
Golden Terra Mining Company produced before consolidation of Deadwood-Terra Mining Companies	788,054 62
Giant and Old Abe Mining Company produced before consolidation with Homestake Mining Company	72,469 34
Father De Smet Mining Company, from January 1, 1878, to August 1, 1882, produced	1,974,640 36
(Tons of ore milled, 343,394; average per ton, $5.74.)	
Total product	$10,434,116 10
(Average of 1,512,037 tons, $5.78 per ton.)	

In connection with the central enterprise of this group, the following figures are significant:

Up to December 31, 1879, the gross bullion yield of the Homestake Company was	$1,051,265 58
For January, 1880	78,569 65
For February, "	84,868 20
For March, "	90,159 23
For April, "	104,281 13
For May, "	118,463 31
For June, "	123,413 03
For July, "	128,768 96
For August, "	144,980 43
Total to September 1, 1880	$1,924,769 52

Thus we see a steadily increasing production, while Superintendent McMasters is able to show that the cost of mining has diminished from $1.98 down to 89 cents per ton, and the cost of milling from $1.59 down to 64 cents in the 80-stamp mill, and from $1.22 down to 45 cents in the 120-stamp mill. Further: "The average gross yield of the ore to June, 1879, was $9.69 per ton. Since then it has been found of advantage to extract and mill all the rock between the walls of the veins. This has lowered the grade of the ore somewhat, but the gross amount milled has been increased in great proportion, while the cost of mining has been correspondingly reduced. The yield of the ore from September, 1879, to February, 1880, varied from $4.25 to $5.60 per ton. Since that date it has been increased by the ore of higher grade extracted from the 100-foot level, and now averages $7.95 per ton."

From the dividend standpoint the showing is as follows:

DIVIDENDS PAID.

Homestake—47 dividends	$1,512,500
Father De Smet—21 dividends	540,000
Deadwood-Terra—20 dividends	740,000
Deadwood before consolidation	275,000
Terra before consolidation	75,000
Dividends of the group	$3,142,500
Total assessment	400,000

It is estimated that 1,000 tons at least, of one to two and a half ounce ore, averaging say one and a half ounces, could be produced daily from mines already developed along the course of the proposed tunnel. This would provide employment for not less than 1,000 men, besides adding more than $1,000,000 annually to the general product, from material which, without the aid of some such enterprise, must remain in the mines and waste dumps. It is from these grades that the county must in the near future derive a large proportion of its bullion returns, and the sooner some enterprise is inaugurated to this end, the sooner its internal condition will be materially improved.

In a subsequent division of this report, I shall reproduce at length the admirable paper discussing the important subject of milling gold ores by the stamping process, prepared by A. N. Rogers, Esq., superintendent of the Bobtail Company's mines and mills, read before the American Institute of Mining Engineers at Central City, in August, 1882. Mr. Rogers has had very large experience, with ample opportunities for the closest and most careful observation, which he has improved with infinite care and skill; therefore his deductions and comparisons, as presented, are entitled to the highest consideration.

GRAND COUNTY.

Thirteen years ago this division of the State was the favorite reservation and hunting ground of the Northern Ute Indians, and of all the country they have surrendered to the monarchs of civilization this was most reluctantly

parted with. Though released according to treaty stipulations, it was not until quite recently wholly abandoned by these wandering tribes. Though long opened to settlement, it is still but sparsely populated, and but for the valuable hot sulphur springs on the Grand, and the mines discovered a few years since in one or two of the mountain ranges, would be even now only an inviting field for the hunter and trapper. It is used, also, to a considerable extent, for stock grazing.

The principal mines are situated in the Rabbit Ear Range, near the geographical center of the county. The Wolverine lode, from which the best reports have come, has a vein about two feet in width, with a streak of paying mineral from six to twelve inches thick. The ore is a combination of the sulphides of iron, lead, zinc and copper, said to give by assay an average of $100 per ton. The dumps of the mine now contain about 100 tons of this ore. The Endomile is another extensively developed lode, from which considerable ore, said to be worth from $30 to $40 per ton, has been extracted. The vein is reported to be from twenty to thirty feet wide. Because there are no reduction works adapted to the proper treatment of these minerals nearer than Denver, with the continental divide intervening, which is heavily covered with snow more than half of each year, only a few small lots have been marketed.

There are some good placer mines on each side of the Rabbit Ear Range, but they have never been opened to the profitable stage. Discoveries of rich mines are reported from the southern part of the county, near Cozzen's camp, which, if equal to the accounts given, will find a market in Georgetown until supplied with sampling works on the ground. But until reached by railways, these districts, however filled with resources, cannot make any decided advancement. Two or three roads are now pointing in that direction, but the difficulties before them are great, and not to be overcome without the expenditure of large sums, consequently the miners will have to be patient until these measures of relief come to them.

Grand Lake, the county seat, is a town of about fifty inhabitants. Hot Sulphur Springs is another hamlet of about the same dimensions. The valleys are chiefly devoted to stock growing.

GUNNISON COUNTY.

Three years ago thousands of enthusiastic prospectors whose hopes were the basis of their faith, ventured the prediction that a greater than Leadville would be found somewhere in the Gunnison, then a comparatively unknown quantity of our territorial area. The tales of the Arabian Nights present no more extravagant imageries of hidden wealth than haunted the dreams of the almost innumerable host who waited for the gates of spring to open and let them into the Promised Land. When it came, the flood rushed in and overspread the mountains and valleys like a cloud. A year later it had disappeared, leaving only a few substantial fragments here and there, and it is to those we owe the discovery and development of whatever is good in this old Indian hunting ground.

Whilst the glowing expectations of the pioneers have not been realized here or elsewhere, for no equal of the magnificent carbonate field has been located, sources of boundless treasure have been unearthed and will endure for ages to come. If nothing further than the marvellous deposits of iron, anthracite and bituminous coals, had rewarded the search, the effort would have been amply compensated. As these will be treated at length elsewhere in this work, no further mention is necessary at this time.

Notwithstanding the universal disappointment which followed surface explorations, there is cause for congratulation in the fact that several large and very promising tracts of mineral land have been occupied and put under profitable development. While the yields of silver and gold have not amounted to millions, there is no doubt whatever that these results will be attained in the early future. The Gunnison has been but imperfectly prospected as yet, and, in my judgment, only a small fraction of its resources

brought to light. Each succeeding year will inevitably add to the number, and the search will be continued long after the present generation has passed away.

The mining industry at large is assuming decided importance with the advent of railways and suitable reduction works. As a rule the ores are of medium or low grade, but the quantity is practically unlimited, and there are instances in nearly all the districts where one or more mines have produced ores of extraordinary richness.

The revenue derived from coal, iron, building stone, etc., will soon equal and perhaps exceed the aggregate of the precious metals.

Tin Cup District is situated near the extreme eastern boundary of the county, forty miles northeast of Gunnison. It is the oldest settlement in the Elk Mountain region, and up to this time the largest producer of bullion. The geological formation is widely varied in different sections, giving essentially different characteristics to the lodes. On Gold Hill, the Gold Cup Mine is a bedded vein in limestone. The Tin Cup, which is an extension of the same, is of like character. The Drew, Iron Bonnet, El Capitan and several others, present similar general features.

The Jimmy Mack, on the same mountain, but further westward, is a contact between limestone and porphyry.

The formation of Anna Mountain is principally granitic. The Mayflower and Anna Dedricka, with some others located here, are fissures in eruptive granite. Thus far the ores of this district have been of the altered surface varieties, giving evidence of the existence of considerable iron, copper, lead and some silver glance, native silver, etc. These yield, in large lots, from 50 to 500 ounces silver, and $5 to $30 per ton gold.

It is manifest that if well conducted reduction works with processes adapted to the peculiar constitution of the ores, and of a capacity equal to the demands of the mines were established here, Tin Cup would be able to produce $700,000 to $1,000,000 per annum from the veins already

developed, with a large prospective increase from further developments.

The placers of Union Park, Taylor Park, Bertha Gulch, West Willow and Tin Cup, have added much to the general output. With extensive and more systematic operation, the yields may be materially enlarged.

Quartz Creek District is the especial hope and pride of Pitkin, one of the most picturesque and beautiful mining towns in the Rocky Mountains. The mines of this locality have assumed something more than mere local importance during the year just closed, through the disclosures made in a number of its free gold veins situated near Ohio City, and the later discovery of the Silent Friend group, five miles north of the town. No less than five crushing mills have been erected in the gold belt, and they are said to have turned out bullion to the amount of $35,000 in the last few months since their completion. The shipments of ore to other markets are given at $200,000, which is probably an over-statement. It will be remembered that until near the close of last summer, this district had no other than long and rough wagon-road communication with outer centers of trade. The advent of the South Park Railway came like a blessing to the isolated workers in mineral, and they immediately began to show their appreciation of it by sending out hundreds of tons of ore, which many bidders were eager to purchase. As a consequence, there has been a steady increase of population and trade, of mining and milling appliances, and capital for the more rapid expansion of all internal pursuits.

Elk Mountain District includes Copper, Rock, Brush and several other creeks where the business of mining is carried on. Gothic, the principal town and center of supplies, has several productive mines, and numberless prospects. From the somewhat celebrated Sylvanite and Virginius large consignments of exceptionally rich ore have been marketed, with, from the former, a great deal of native silver in rare and beautiful forms. The Eureka, Buffalo, Lake View,

Luona, Painter Boy, Whopper and a few others, have acquired substantial value through development, but further exploration is necessary to the exposure of the best reserves. This whole region, like so many others in the border counties, needs the advantages afforded by cheap transportation and well-devised reduction works, suited to the various mineral combinations.

Some excitement was created in the early part of last season, by the alleged discovery of large deposits of carbonate ores near Snow Mass. The most authentic advices lead me to the conclusion that thus far they have only developed an immense deposit of ferruginous quartz and earth, with some iron pyrites, zinc and lead intermixed, all containing a small amount of gold and silver. I am not aware that any large quantity of rich ore has yet been found there.

Ruby District, with Irwin for its principal town, has some really valuable and productive mines, as demonstrated by rather limited exploration, and the customary per centage of prospects, some of which will doubtless prove valuable mines when developed. The veins generally are fissures, cutting sedimentary rocks—with occasional occurrences in eruptive rocks—and of contacts between the eruptive and sedimentary series. The ores comprise the sulphides of iron, zinc, lead and copper, with a noteworthy per centage of ruby and native silver, argentiferous gray copper, etc. The average value of the ores sent to the smelters was about 200 ozs. silver per ton, but selected lots have run up into the thousands. The Forest Queen is regarded as the greatest in the camp, from the remarkable richness and productiveness of its surface minerals. The Ruby Chief, Lead Chief, Bullion King, Durango and some others, have a prominent standing from similar causes.

In O-Be-Joyful Basin, Redwell, Poverty Gulch, Wolverine and tributary sub-divisions, there are many prospects, some of them having piles of valuable ore on their dumps, with ample reserves in the mines, awaiting the time

when they can be disposed of at rates which will afford the owners a reasonable margin for their labor.

The Pioneer Mill at Ruby, with its roasting and amalgamating process, has been operated with satisfactory results the past summer. Its construction is in some respects defective, but at the time of my inspection appeared to be intelligently and skillfully conducted, though laboring under serious difficulties. Several smelting furnaces have been established in the surrounding region, but, unfortunately, not calculated for the successful treatment of the ores produced in their vicinity. A concentrating mill was erected at Elko in 1882, which, when in complete order, will be, or is expected to be, of great advantage to the mines of that section, which are mainly of low grade.

Tomichi District has exhibited much activity the past year. Several mines have been regular shippers of ore, and others have prepared their lower grades for the concentrators recently established near at hand. The geological formation on the west side of Tomichi Creek is granitic; on the east, granitic, eruptive and sedimentary at different points. A majority of the veins are quite large, and their contents of medium grade. The North Star group, David H., Montgomery, Bill Short, Defiance, Gypsey, Fort Scott, Twin Lakes, Lewiston and Sleeping Pet, have for two years been producers of bullion. Some extremely rich ore has been taken from the Pet and Lewiston. Under the favorable conditions which prevail in districts reached by railways, Tomichi, with present development, would be able to market from 20 to 30 tons daily, besides furnishing indefinite quantities for the concentrators.

HINSDALE COUNTY.

This county, organized in 1874, simultaneously with La Plata and Rio Grande, was, up to that time, part of an area covering 15,000 square miles, and indeterminately known as the "San Juan Country." It is mountainous to the last degree, and its only resource gold and silver mining. Hins-

dale forms, however, but an inconsiderable part of this immense territory.

Lake City, the county seat and the only town of importance, is situated in a broad and beautiful valley, on the Lake Fork of Gunnison River, far below the mines, and closely resembling the site of Georgetown in Clear Creek. The general formation is eruptive, and the veins true fissures, excepting possibly a few located on the great flat near the summit of Engineer Mountain, which was the scene of no little interest last year by reason of remarkable revelations made in the Frank Hough Mine. As to the character of those opened in this particular section, opinions differ. Some insist that they are fissures, while others contend as obstinately for the bedded, or deposit form. As I have not been favored with an opportunity for careful examination, I am unable to determine which of these views is correct. Cursory examination of the surface indications incline one to support the fissure theory, but the evidences underground, if correctly reported, are diametrically opposed to this conclusion. But whatever its true character, the ores are chiefly black oxide of copper, resembling furnace matte, and contain from $200 to $600 per ton in gold and silver.

The Ute and Ula were the first mines opened in the county and still maintain their early position as the most productive and thoroughly developed. In 1876 they were purchased by the Crooke Brothers, of New York, who erected the necessary buildings, let contracts for sinking shafts and driving levels, and built a concentrating mill. In the fall of 1877 a smelter was completed, when the whole concern began vigorous operations, the mines furnishing full supplies for the reduction works. Later, these were enlarged to meet the increased production. The present owners have added many improvements, and are conducting the business with great energy and success.

The Hotchkiss (lately relocated as the Golden Fleece) has acquired a marked reputation from the richnes of its

ores, which are tellurides. While they bear little outward resemblance to those of Boulder County, they are extremely high grade, yielding, by specimen assays, from $100 to $100,000 per ton, and by mill runs in bulk, from $100 to $4,000 per ton.

Again, the Palmetto, located on Engineer Mountain, near "Rose's cabin," has a working shaft 350 feet deep, showing a vein from two to five feet wide, carrying pay ore from ten to twenty-four inches thick, which mills 60 to 120 ozs. silver per ton. Assays of selected samples gave 1,000 ozs. It is owned by the Palmetto Mining and Milling Company, Robert Burnham, superintendent. They have a well constructed stamp mill, supplemented by one of Howell's roasting and chloridizing furnaces, with combination amalgamating pans and settlers. At the time of my visit it was running regularly, and, as I was informed by Mr. Burnham, saving an average of 91 per cent. of the assay value of the ore. The vein is a fissure in fine grained porphyry, the ores being the sulphides of iron, zinc and copper, mixed with a notable per cent. of ruby, brittle and native silver in a siliceous gangue matter. At that time it was producing about 15 tons of milling ore daily.

In the other districts, Lake, Park, Sherman and Cimmaron, there are a few good mines and some prospects which give promise of excellent results when thoroughly opened.

Some idea of the growth of Hinsdale county may be had from the assessor's valuation. In 1875 the taxable property aggregated $18,349.50. In 1881 it was $757,265. The bullion returns and ore shipments at the close of '81 gave a total from this source of $187,375. Those of 1882 were $275,000. With increased development and the enlargement of facilities for the treatment of ores, there is no doubt that the product of '83 will largely exceed that of any previous year.

LAKE COUNTY.

The fame of Leadville, the dominant factor in Lake County and in the bullion tables of our State, has been

published in all languages, and it is assumed that nothing can be added to it in a work of this character. In point of universal interest, it is the natural successor of Australia, California and Washoe. Having passed the effervescent stages of excitement, speculation and boundless expectations, it has settled down at last into a substantial, well ordered and prosperous mining district, without a rival in the extent and productiveness of its resources. According to the most accurate data at command, the yield of the county from all sources, from 1860 to 1877 inclusive, was $7,298,330, principally gold, from the placers and gulches. This brings us to the Leadville period, which has returned the following, chiefly in base bullion:

1878	$ 3,152,925 00
1879	10,333,740 69
1880	14,187,697 00
1881	12,738,902 00
1882	16,531,853 00
Total	$56,945,117 69

From the gross return for 1882, I have deducted $600,000, the estimated value of consignments of ore from Summit, Park, Chaffee, Gunnison and other outside sources, brought to Leadville for reduction, and included in the statements from that place. The subjoined table was compiled from the books of the different smelters and mills, and of the placers, etc., etc.:

Harrison Reduction Works	$1,944,383
August R. Meyer and Company	118,681
La Plata Mining and Smelting Company	2,380,489
Tabor Milling Company	280,616
Arkansas Valley Smelting Company	2,476,366
American Mining and Smelting Company	1,098,914
Cummings & Finn	2,073,008
Leadville Gold and Silver Mill Company	451,709
Shields Mining and Milling Company	80,005
Robert E. Lee Mine	368,343
Grant Smelting Works	1,338,913
Eddy, James & Co.	3,867,232
Grant Smelting Company (Elgin)	581,194
Mike and Starr Mine	4,500
Oro Mill	4,000
Placers and other sources	63,500
Total	$17,131,853

The following statement shows the relative proportions of each metal, and the amount of ore shipped in bulk to other cities for reduction, beginning with 1877:

YEAR.	Tons Lead.	Oz. Silver.	Oz. Gold.	Tons of Ore.	Value of Ore Shipments.
1877	175	376827	2750	3300	$ 400000
1878	2324	450476	897	16840	2360503
1879	17650	6004416	1100	18540	2851850
1880	33551	8999399	1687	12410	1460363
1881	38101	7162909	13192	15630	1016044
1882	39864	8376802	12615	22416	1872604
Total	131665	31370829	32241	88145	$9961364

In this connection, it is deemed advisable to reproduce the salient points of an editorial in the Leadville *Herald* reviewing the work accomplished during 1882, because some of the facts presented confirm certain opinions expressed in my last report respecting the probable discovery of further ore bodies in bedded veins and fissures beneath the workings of that period—1880:

"Leadville has every reason for satisfaction in the contemplation of the work and results of the past year. Not only has the yield of her mines and smelters been unprecedented, but the number of new and producing mines that have been opened up during the past year is much greater than during 1881, and the promise that the more recent discoveries hold out for the future is most reassuring. During the year a number of localities that were not previously productive or considered promising have developed shipping mines, and the developments thus made have added largely to the knowledge of the limits and course of the mineral belt. They have also stimulated the work of prospecting not only the territory in their immediate neighborhood, but have encouraged similar work in other localities, which have also been considered unpromising, but which now promise to become equally valuable. The tendency of these discoveries is to show that the mineral belt on which the mines of this district is located is much more

extensive than hitherto supposed, and that it will prove a far more enduring field for mining operations than even the most sanguine believers in the permanence of our mines have ventured to predict. On Carbonate Hill, for instance, many of the oldest mines, which showed signs of exhaustion, have during the past year not only resumed their places as shippers, but have better prospects to-day than they have had at any time during the past two years. The developments in the Waterloo, Henriette and other properties, indicate that the ore deposit from which the great production of the past has been made is to be duplicated at a greater depth, giving to old mines a new lease of life and affording promise of the opening up of new ones. On Iron Hill, the developments of the year have established the continuity of the great ore chutes that traverse the hill, and recent discoveries reported to have been made in the lower workings of the great Iron Mine are prophetic of deep shafts and rich discoveries to be made through them. With every fresh development new possibilities open out, and no one longer ventures to assert that Leadville is a camp of a year or a decade. The new fields opening up to the north, south and east of the territory thus far principally worked are full of promise, and will in time no doubt add their contributions to the general yield of ore. West of the city, in a locality heretofore but little heard of, in Little Frying Pan and Sugar Loaf Gulches, leading down from the main range, a district that, for the development it has received, makes a showing sufficient to cause a "boom" in any outside camp, has been opened up and promises to produce largely during the coming year."

It is a fact that fissures and bedded deposits have been found in a few instances below the first contacts, in the regular course of developments. Two years ago (see report for 1880) I ventured the prediction, based upon a careful examination of several leading mines, that such veins and deposits would be exposed by deeper workings, and I am now more than ever convinced that further discoveries of

like nature await a resolute effort to reveal them. When disclosed, they will take the place of those near the surface and perpetuate the supply of ores and bullion.

The geological problems of this district are being gradually solved by practical mining, which is constantly upsetting assumptions by the unchangeable force of material facts. Multifarious theories have been advanced respecting the true sources of carbonate ores. I am not disposed to discuss them separately or collectively, nor to add another to the list.

That which appears to have received the highest endorsement, is extracted from the report of Prof. S. F. Emmons, of the United States Geological Survey, as follows:

"The principal ore deposits of the region are found at or near the contact of the blue limestone with the overlying porphyry. The ore is not confined to the surface of the limestone, but often extends into the mass, pinching out, however, in depth. Sometimes the bodies thus developed show no visible connection with the surface, but it is evident that they originally came from it. From the present investigations it has been proved of the ore deposits, as regards their origin—

1. That they have been derived from aqueous solutions.
2. That these solutions came from above.
3. That they derived their metalic contents from the neighboring eruptive rocks.
4. That in their original form they were deposited not later than the Cretaceous epoch.

And as regards their mode of formation—

1. That the metals were deposited from their solutions mainly as sulphides.
2. That the process of deposition of vein material was a chemical interchange, or actual replacement of the rock-mass, in which they were deposited.
3. That the mineral solutions or ore-currents concentrated along natural water channels and followed by preference the bedding planes at a certain geological horizon;

but that they also penetrated the mass of the adjoining rocks through cross joints and cleavage planes.

And with regard to distribution—

1. That the main mass of argentiferous lead ores is found in calcareo-magnesian rocks.

2. That the siliceous rocks, porphyries and crystalline rocks contain proportionately more gold and copper.

The deposits of this region are peculiarly exposed to the action of surface waters, and that they have had considerable influence upon the deposits in their original composition is certain.

The prevailing, and by far the most important, ore from an economical point of view, is argentiferous galena, and its secondary products cerussite, or carbonate of lead, and kerargyrite, or chloride of silver. Lead is also found as anglesite or sulphate, as pyromorphite or phosphate, and occasionally as oxide in the form of litharge, or more rarely minium.

Silver frequently occurs as chloro-bromide, less frequently as chloro-iodide, occasionally as sulphuret, and very rarely in the native state. Chemical investigation has failed to detect sufficient regularity in the proportions of chlorine, bromine and iodine combined with the silver, to justify the determination of distinct mineral species. Gold occurs in the native state generally in extremely small flakes, and is also said to have been found in the filiform state in galena.

As accessory minerals are—

Zinc blende and silicate of zinc or calamine, arsenic, probably as sulphide and as arseniate of iron.

Antimony, probably as sulphide.

Copper as carbonate or silicate.

Bismuth as sulphide and its secondary product, a double carbonate.

Tin has been detected in furnace products.

Iron occurs as an ore, though in the Leadville deposits it may be considered as an essential part of the gangue or matrix in which the valuable ore is found. In the former

case it occurs in considerable bodies as pyrite or sulphide and anhydrous oxide, or red hematite with a little magnetite. The gangue may be regarded as including silica, either as chert or a granular cavernous quartz, and chemically or mechanically combined hydrous oxides of iron and manganese; a great variety of clays, or hydrous silicates of alumina, generally very impure. Sulphate of baryta, carbonates of iron, pyrite and sulphate of lime, are comparatively rare. A substance, locally termed "Chinese Tallow," occurs with singular persistence along the main ore channe as the dividing plane between the white porphyry and underlying limestone or vein material, and also at times within the body of the deposit. It is composed of silicate, and a varying amount of sulphate, of alumina, to which no definite composition can be assigned. It is compact, semi-translucent, generally white and very soft, and easily cut with the finger-nail."

The varieties of minerals exhibited in the Denver Exposition from Lake County, given by the commissioner in charge, are as follows, and are regarded as approximately correct, and embracing about all thus far noticed:

Carbonate and sulphate of lead ores.

Granular ores or sands in fifteen stages of disintegration, nine varieties showing every grade of color from gray and black, three varieties of yellow and three varieties of red ores.

Hard Ores—1. Siliceous carbonate ores. 2. Sulphate of lead ore (blue). 3. Compact carbonates. 4. Compact carbonate, encrusted with embolite. 5. Specimens showing stages of decomposition from sulphide to carbonate. 6. Crystallized cerussites and pseudomorphs. 7. Resin carbonate. 8. Leadhillite.

Galena Ores—1. Steel-grained. 2. Coarse-grained (bluish). 3. Coarse-grained (silver bright). 4. Compact granular. 5. Galena nodules covered with carbonate, Vanadinite, Descloizite, Dechenite.

Iron Minerals—Hematite, limonite, siderite, gossans, pyrites.

Copper Minerals—Chalcocite, malachite (stains), azurite (stains), chalcopyrite, native leaf copper.

Silver Ores—Argentite, kerargyrite, usually disseminated through a ferruginous siliceous rock, embolite, native silver.

Manganese Ores—Pyrolusite, Wad (or Bog Manganese, with some talcose matter associated), native sulphur, halloysite, wavellite, kaolin, flint nodules, dendrites, calamine, calcite (in remarkably fine concretions), zinc blende, quartz crystal, iron ochres—all colors, pyrites banded with galena and blende, granulated pyrites, free-gold quartz.

It is not practicable, nor is it necessary, to name and describe in this condensed report, all the productive mines, but it is entirely proper that the more prominent in the list should receive due attention. To the Evening Star, Chrysolite, Robert E. Lee, Matchless, Iron Silver, Little Chief, La Plata, Morning Star, Little Pittsburgh, Amie, Leadville Consolidated, Henriette, Dunkin, Carbonate, Hibernia, Climax, Catalpa, Glass-Pendery and several others, the district is indebted for its great prestige, and for much the greater part of the grand aggregate of nearly $57,000,000 it has added to the metalic wealth of the world in the last four years.

The present output is about 1,500 tons per diem, of ore having an average value in silver and lead not far from $30 per ton, netting the producer, after deducting smelters' charges, from $17 to $21, the difference in price depending upon the amount of lead or zinc, irrespective of the silver contents; also to some extent on the nature of the gangue, whether it contains much iron and lime, or is highly siliceous, with very little iron.

Since the beginning of 1881, many important discoveries have been made on Iron Hill, east of the territory belonging to the Iron-Silver Company; north of Fryer Hill on Prospect Mountain, in Big Evans Gulch and in some other localities. These have, in a measure, replaced the partially exhausted deposits in the older mines.

In closing, I am impelled to reiterate the opinions heretofore expressed, that the ore deposits of this district came from below, through fissures originating in the granitic rocks, and extending upward penetrated the limestones and quartzites to the contact with the overlying porphyry; that these fissures lead to many bedded veins in the limestone and quartzite, and to contact veins of more or less value between the formations last mentioned, and between those and the granitic formation; and that these fissures and deposits will be extensively and profitably worked for centuries after the contact deposits now operated are exhausted. This belief is supported by the fact that fissures and deposits of the character named, are known to exist both in the limestones and the quartzites. It is equally well established that the fissures have their origin in the granitic rocks, forcing their way upward, through the sedimentary series to the overlying porphyry, and, in some instances, of rare occurrence, through the porphyry to the surface. It has been confirmed by developments that the veins and deposits in these underlying rocks contain argentiferous ores, in quantity, of a commercially valuable grade. So far as my knowledge extends, founded upon the results of numerous personal tests, and those of other competent assayers and chemists, the overlying porphyry —when the samples were taken at a considerable distance from known deposits of rich ore between it and the limestone—has in no instance yielded more than barely appreciable traces of the precious metals. My own investigations, supplemented by the reports of others whose statements are widely respected, have utterly failed to elicit any conclusive evidence that they have ever existed there in any considerable degree. With these facts before us, it is more reasonable to assume that the ores came from a source known to carry their elements in positive quantity, than from one which bears only traces at best, and in some cases not even these.

Finally, I am convinced that this belief is shared by experienced miners and geologists who have familiarized themselves with the whole "carbonate formation," from Leadville eastward to the South Park. If it be true, as asserted by a few theorists, that the source of these ores was in the overlying porphyry, and that they have no existence in paying quantity in the underlying formations, it follows as an unavoidable sequence that the days of extensive and profitable mining in this locality are numbered, and unless surprising new discoveries occur, the many fine and costly buildings of Leadville, at a period less than fifty years distant, will be only "hiding places for bats and owls."

LA PLATA COUNTY.

This county forms the extreme southwestern division of the State, bordering on New Mexico and Utah Territories. Though rich in natural resources, mineral, agricultural and otherwise, its development has but just begun. Its principal industries at present are confined to coal mining, agriculture and stock raising. The gold and silver mines located there have attracted but little attention until within the past two years, or since the advent of the Denver & Rio Grande Railway, and the founding of the brisk and progressive town of Durango as its capital and center of supplies.

The mines are situated in the Needle Mountains—Junction Creek and La Plata—where a considerable amount of prospecting and development work has been done, and about $25,000 in bullion produced therefrom. The population of the county is placed at 6,000, and the property valuation for 1882, as shown by the books of the Assessor, at $2,162,668. Durango has a population of 3,000. The town is very pleasantly situated on the Animas River, at one of the principal gateways to the great San Juan mineral region, with vast tracts of fine arable land, much of it under tillage, tributary to it. An extensive smelting establishment has been erected here, designed to treat the ores

from the neighboring mines. It has railway communication with Denver and all points east and south, and northward to Silverton, 45 miles distant. Wagon roads lead to Rico, on the Dolores River; to the Needle Mountains, Junction Creek, Parrott City, the lower Animas and San Juan in New Mexico. There are some very fair placer grounds on the Rio de las Animas and on the La Plata, which are said to be valuable, but have been worked to only a small extent.

The metaliferous deposits which are most interesting to the scientist, and which give promise of future value when properly opened, are the telluride veins at the head of the La Plata and on Junction Creek. The major part of the mineral is sylvanite, distributed in small needle-like filaments through a greenish compact quartz, more rarely as plates in seams or fractures. They differ from the lodes of other telluride districts, in being confined—with few exceptions—to sedimentary rocks of the Triassic age, whereas this character of ore is usually found in granitic or eruptive formations.

OURAY COUNTY.

Dolores County was shorn from Ouray in 1880. The latter, named in honor of the late distinguished Chief of the Ute Nation, extends from the boundary lines of Hinsdale and San Juan Counties to the Utah line, embracing an area of 1,635 square miles, 200 of which may be regarded as mineral lands. The remainder is divided between timber, agricultural and grazing sections. Its population in 1880 was 2,670, which has since been increased to about 4,000. Ouray, the county seat, is situated near the head of the Uncompahgre River, and has a fixed population of about 1,000.

The mineral area is mainly confined to the southeastern division, along the western slope of the Uncompahgre Mountains, which contain the sources of the San Miguel and Uncompahgre Rivers, the former flowing westward into the Dolores, and the latter northwesterly into the Gunnison.

Excepting the "Mineral Farm," lying in sedimentary strata, and a few undeveloped ore streaks occurring in metamorphic rocks, the mineral product is derived from veins in eruptive rocks, belonging to the great Tertiary overflow of the San Juan Range. A portion of these veins carry argentiferous ores only, with but a slight per cent. of gold; others are auriferous, containing little or no silver. The latter, generally, are of a more recent period and intersect the others. Among the productive mines representing the former species, are the Cimmaron, Mendota, Ajax, Alta, Summit, Nevada, Silver Bell, Caribou, Santa Cruz, Virginius, Terrible and Royal Albert; while the Smuggler, Pandora, Big Elephant, Argentine, Champion, Gold and Silver Chief, Gold King, Osceola and Nellie, represent types of the latter.

The average value of these ores, as shown by a large number of mill runs, in large and small lots—some 800 tons in all—is about $225 per ton. Most of the veins have a banded structure, and the gangue matter is highly crystalline, more especially in barren ground. Following are the minerals of common occurrence, in the order of their abundance: galena, sphalerite, freibergite, chalcopyrite, pyrite, stephanite, bismuth-silver, pyrargyrite, native silver, free gold and argentite.

The general matrix is quartz, rarely sulphate of barya and exceptionally fluorite.

Besides the lode mines, there are some valuable and productive placers on the San Miguel and its tributaries, and on the Uncompahgre, all of which have been worked for several years, yielding, according to the best information obtainable, from $10,000 to $30,000 per annum.

Montrose, a station on the Denver & Rio Grande Railway, in Gunnison County, is the nearest rail connection—35 miles northwest of Ouray, 85 miles west of Gunnison, and 25 miles above the junction of the Gunnison and Uncompahgre Rivers. It is expected that a branch will be extended from Montrose to Ouray during 1883, since the

industrial development of this region gives encouraging prospects for the traffic necessary to support such line.

From 1876 to 1880 inclusive, this county has contributed, as nearly as can be ascertained from available records, about $52,000 per annum to the bullion output, or a total of $260,000. Since that period the increase is quite marked, that of 1881 being $78,000, and of 1882 $329,760. Only the richer ores, containing from $100 to $200 and $300 per ton, have been shipped to market, owing to the great expense of transportation to distant points. It is estimated by those familiar with prevalent conditions, that with the advantages afforded by the proposed railway connection, the mines of Ouray would be capable of sending to smelters and other markets from the sources already opened about 450 tons of ore daily.

The origin and pronunciation of the names of certain prominent streams in this region of country may be interesting. They are given by Prof. S. Richardson, of Gunnison, who received them from the famous Ute Chief, Ouray. The orthography is English, the pronunciation Indian :

Tomiche—*Tomit*, mountain; *Che*, stream—a mountain stream. To-mit-che.

Saguache is a Spanish name, *Sivat*, blue, and *che*, stream —the blue stream, Si-wot-che.

Cochetope (Ute) is pronounced Co-che-to-pa, signifying " the stream of the valley, or valley stream."

Uncapahgre—corrupted by settlers to " Uncompahgre," is the Ute for " hot water spring." *Unca*, hot ; *pah*, water ; *gre*, spring. Unca-paw-gre.

Unawippa is the name of a stream west of the Uncapahgre, and so designated from the color of the rocks near its source—a yellowish red.

Cebolla (Spanish) is a tributary of the Cimmaron, pronounced Ce-voy-ya, signifying in plain English, " Onion," a very remarkable vegetable.

Tierra Blanca (Spanish)—*Tierra*, earth; *blanca*, white; white earth, from the deposit of white alkali about the soda springs.

PARK COUNTY.

This sub-division is located in the geographical and metal producing center of the State, covers nearly 1,000 square miles and is about 10,000 feet above the level of the sea, having several peaks which rise to the height of more than 14,000 feet. In addition to the resources of gold and silver uncovered in the mountain ranges, it has very extensive tracts of agricultural and pastoral lands in the basin of the South Park, which form grazing lands for thousands of cattle and sheep. About 40,000 head of cattle were fattened upon its nutritious grasses during the past summer. The only saline springs of any importance are situated here. Geologically it embraces nearly all the formations from the archæan to the quarternary and recent. These are so intermingled, changing radically within short distances, as to render this region a very curious and interesting study for the scientist, and an inextricable puzzle to the prospector and miner. Scarcely two of the districts present the same, or even similar geological features. In Montgomery, Buckskin, Mosquito and Pennsylvania divisions the formations bear close resemblance to each other, the veins being fissures, contacts and bedded. The upper contact lies between porphyry and limestone. Lower down, we find contacts between lime and quartzite, porphyry and quartzite, and between quartzite and granite, or gneiss. The bedded veins lie both in the limestone and quartzite. The fissures originate in the granitic rocks, and break up through the quartzites and the limestone to the contact with the porphyry, in some rare instances through the porphyry to the surface. In the fissures of the archæan rocks, and at the contact with the quartzite, the ore is mainly composed of the sulphides of iron, zinc, copper and lead, the precious metal being largely gold. Above the quartzite, the lead is more abundant, with less of the other

base metals, the precious contents being almost exclusively silver.

High up on the slopes of Mounts Lincoln and Bross, we find some of the finest contact mines in the county, many of them extensively developed, among them the Moose, Dolly Varden, Russia, Wilson, Lime, D. H. Hill, and others of lesser note. For ten years past the Dolly Varden group, working but a small force, has returned about $660,000 in bullion, and it is estimated that the low grade ores on the dumps are worth $500,000. The Moose appears to have been equally productive.

In Buckskin District, both fissure and contact veins are operated, which carry gold and silver with about all the known base metals.

The majority of the ores are of medium grade, and include all the mixtures necessary for economical and successful matte smelting. In some of the mines there are very large bodies of the variety known as "free milling." The Fanny Barret, Criterion, Colorado Springs, Great West, Ten Forty, Ernest and other groups have been well, but not largely developed, and have marketed considerable ore. The Criterion yields heavily in free milling gold ores, with some high grades for smelting.

In Pennsylvania, Horseshoe and Sacramento Districts, most of the mines are contacts between limestone and porphyry. The Hock-Hocking in Pennsylvania, and the Sacramento, in the gulch of that name, have produced much high and medium grade, and are representative lodes of their respective sections. Those of Horseshoe are especially noted for ores low grade in silver but rich in lead.

Both fissure and contact veins are found in Mosquito District. In past years some of these have been quite productive. Both gold and silver occur in about equal proportions, or rather of equal value. The Orphan Boy, Senate, London, Forest Queen, New York and some others have acquired greatest prominence through exploitation. From the London, besides the smelting product, immense quantities of free milling gold-bearing ores are extracted.

Montgomery was settled in 1860, but after the exhaustion of the surface outcroppings of the lodes which carried considerable free gold, and it was discovered that the refractory minerals succeeding them, though valuable, would not yield their riches to the crude arastras and stamp mills of that period, the region was abandoned and remained so until within the past three or four years, when a revival took place. Under the stimulus of improved methods and better knowledge, Montgomery may yet become a leader. Late explorations show that excellent ores are there in abundance, and with reduction works suited to them, and above and beyond all, capable management, its original prestige may be restored.

Pulver, Fairmount and Weston Pass Districts are of comparatively recent origin, and hence but little development work has been done. The prospects for the future are, however, very encouraging.

Hall Valley is the center of a large mineral belt. The veins are fissures in granite, of more than ordinary strength, and the ores above the average grade. The Cashier, Whale, Leftwick and one or two others, are known to be extremely valuable properties. Parts of this section are rich in silver, copper, lead and iron ores.

The placers of Park County gave rise to its settlement, and to the subsequent discovery of other mineral resources. These have been worked continuously from 1860 to the present, and will probably last many years. The Alma Placer yielded about $27,000 gold last year, though, by reason of the refusal of the owners to state the exact amount of their product, it cannot be definitely ascertained. Their gravel bed is from 40 feet to 60 feet deep, and water for washing is ample for all their needs. The Clark and other properties of this class near Fairplay, with those of Beaver Creek and Tarryall, are operated to greater or less extent in the gulch mining season of each year. These grounds have not received the attention from capitalists which their merits deserve. There are thousands of acres

in the South Park that are unquestionably rich in gold, and should be contributing hundreds of thousands annually to the prosperity of the county and country. With few exceptions, those already developed are worked in a small way, and with little regard to system or economy, while the gravel deposits of California, though of less value, are made to yield profitable returns by the vigorous application of modern devices, which enable the owners to wash large tracts at insignificant cost. Like systems introduced here would give pounds, instead of a few ounces of gold, with each day's operation.

PITKIN COUNTY.

This county was created by Legislative enactment in 1880, through a division of Gunnison. Its prominence as a mining center dates from 1879, the year of the great hegira from Leadville. Several belts of superior lodes, both gold and silver, have been located and some of them opened. About $300,000 in bullion, besides large quantities of valuable ore shipped to market, and considerable amounts of medium and low grades lying in the dumps awaiting local reduction works, are the results of the developments thus far prosecuted.

The geological formation varies greatly in different sections of the county. At Independence, for example, the mines of the Farwell Company bearing gold, are in mica state, the gangue matter quartzose, and the ores a mixture of the sulphides of iron, zinc, copper and lead, while at Aspen it is largely limestone, and the lodes are contacts between lime and porphyry, and lime and quartzite, with, in some cases, bedded veins in the limestone. The ores are chiefly fine grained galena, intermixed with some copper and a little silver glance and native silver, in a gangue of limestone and heavy spar. At Ashcroft the formation is granitic and eruptive.

The Montezuma, one of the Tam O'Shanter group, is a fissure in eruptive rock.

Up to this time, the Farwell group of gold mines at Independence, the Spar and Smuggler at Aspen, the Tam O'Shanter, Unexpected, Philadelphia and the Yellow Boy groups at Ashcroft, have been the most prominent, and the main sources of production. Considering its isolated position, the want of any well-constructed lines of communication—the best being very rough wagon roads—the absence of local markets, and the excessive cost of transporting ores across the mountains by the most primitive means of conveyance, it is a matter of surprise that the settlers have been able to maintain a foothold there in any of the sections except Independence, which has an available outlet to the Arkansas Valley. But this district ships gold bullion only, its ores being reduced in mills on the ground. The remainder of the mining regions are as completely out of the range of all the advantages essential to progress and prosperity as it is possible to imagine. Yet few portions of the Rocky Mountain System are more prolific in mineral resources. It needs but the facilities enjoyed by the more favored localities, to make it one of the leading centers of productive industry.

Aspen, the county seat, is situated on the Roaring Fork of Grande River, at an altitude of about 8,000 feet, and has a population of 800, which is said to be rapidly increasing.

RIO GRANDE COUNTY.

This county is located on the western side of the San Luis Park, and takes its name from the Rio Grande River, which flows through its entire length from west to east. It is 48 miles in length from west to east, about 26 miles wide from north to south, and embraces nearly 800,000 acres. At present the resources are about evenly divided between agriculture, stock raising and mining.

Summit District, occupying the southwestern corner, about 30 miles from Del Norte, includes the only mineral-bearing section that has been developed. To this, attention was first attracted in the autumn of 1873, by the discovery of the Little Annie Lode by Brandt and Peterson, two

Swedish prospectors. Subsequently, the Little Ida, Aztec, Odin, Golconda, Golden Vault, Parole and others, were brought to light, and according to the reports of that period, produced about $1,000,000. In 1881 the total output of the mines was $280,000, and in 1882 $310,000, chiefly from the Little Ida, Little Annie and Aztec. Several others appear to contain resources of equal, if not even greater, extent than either of those above mentioned.

The geology of this district is quite intricate, and at the the same time highly interesting. To define it in detail, so that one unfamiliar with the phenomenal features exposed in the course of underground exploitation, would be able to comprehend it fully without illustrative drawings, would be very difficult. It is sufficient to state that the entire formation in which the mines are found is eruptive, and the gangue of the lodes wholly altered eruptive rock, not varying materially in composition from the enclosing country, though in physical appearance its characteristics are so distinctive as to render the precious metal zones readily traceable.

The contents of the ore is gold in the metalic state, with mere traces of silver, yielding readily a large per cent. of its value to the ordinary stamping mills.

The district is well supplied with mills, having nine altogether, with 155 stamps, nearly all of the most approved mechanical construction. The San Juan, Odin, Little Annie and Golconda Companies have gravitation tramways, which form convenient and cheap, because automatic, methods of transporting the ores from the mines to the crushing mills. The Iowa & Colorado Company have a wire tramway of the Halliday patent for like purposes. Hundreds of actual and alleged discoveries have been made, but excepting the lodes above mentioned, few, if any, have passed beyond the prospective stage.

The hamlet of Summitville is pleasantly situated in a small park at the head of Wightman's Fork of Alamosa Creek, at an elevation of about 11,300 feet. It is connected

with Del Norte by a good wagon road, over which, during the summer months, stages make daily trips between the two points. Further connection is made by telephone.

The surprising results achieved in the past eighteen months, both in the amount of bullion realized and the disclosures made in the few mines opened, give assurance that Summit will in a few years become one of our grandest mineral districts. The lodes are very large and extremely rich. The cost of extraction and treatment is insignificant when compared with the expense incident to most of the other gold belts. Consequently the profits are large. That it needs better economic systems is manifest from the wastage of the mills. It is undeniable that here as everywhere else, without the application of the best methods and skill to the work of mining the ores and their reduction, great loss will inevitably occur. But Summitville is in the chrysalis state as yet, and time will undoubtedly supply the needed improvements.

Rio Grande County now ranks third in the gold producing sections of Colorado, but I am of the opinion that it will rise to the second place within the year 1883.

ROUTT COUNTY

Was created by a division of Grand in 1877, and christened in honor of the first Executive of the State. It is 120 miles long by 45 miles wide, with an L-shaped tract, 18 miles by 30 miles, the whole comprising an area of about 3,825,000 acres, mostly agricultural and pastoral land. It includes Egeria and Twenty Mile Parks, the eastern portion of the great plateau known as Gilpin's Central Basin, and the fertile valleys of the Bear, Yampah, Little Snake and Green Rivers, Elk Head and Fortification Creeks, etc. Much of this area is admirably adapted to the cultivation of nearly all crops grown in the plains sections of Arapahoe, Jefferson and Boulder. The following table shows the property valuation for years 1877 to 1881 inclusive, the assessment roll for 1882 not being available at this writing.

The decrease of 1878 and 1879 was due to the Indian massacre, the settlers taking out their property:

YEAR.	VALUE.
1877—Horses, 221	$ 8,125
—Cattle, 6,504	26,490
Total assessment	84,698
1878—Horses, 168	5,044
—Cattle, 3,480	36,682
Total assessment	74,661
1879—Horses, 210	5,643
—Cattle, 1791	20,558
Total value	59,665
1880—Horses, 313	16,286
—Cattle, 5,332	16,720
Total assessment	85,864
1881—Horses, 403	12,175
—Cattle, 7,133	82,019
Total value	119,934

The pursuit of mining is confined to a small territory in the vicinity of Hahn's Peak, in the portion of the Continental Divide known as the "Park Range," where certain placers have been washed for their gold contents in the summer seasons for several years past. I am without data showing the actual yields, but the fact that the owners have operated them regularly from year to year, is evidence that they have gathered satisfactory results. Mr. France, of Rawlins, has been mining there the past season, and it is currently reported that he has taken out $100,000 in gold dust.

Early last season other discoveries, said to be surprisingly rich, were reported to have occurred at a point 35 miles southeast of Hahn's Peak. Having no further trustworthy information, I am unable to state the facts. Some lode mining has been done in different quarters, but without material returns. A few veins containing argentiferous lead and copper ores have been found, but not developed because of the distance from market.

The settlement of this inviting region has been retarded by the incessant hostility of the Ute Indians, who, until their rights to the land were extinguished by treaty, made

it one of their principal hunting grounds. Being at all times opposed to the encroachments of the white race, even long after they themselves had no rights there, frequent massacres occurred of those who, despite repeated warnings and threatening demonstrations, continued to hold their positions. But now that the savages have been removed to distant reservations, it is believed the better portions of the county will be occupied by stock growers, farmers and miners, and in time become strong enough not only to repel invasion, but to induce one or more of the many railways putting out from the plains with the intention of passing through Middle and North Parks *en route* to Salt Lake City, to unite them with the older and larger settlements at the base of the mountains.

SUMMIT COUNTY.

Until the reservation of the confederated Indian (Ute) tribes was vacated by treaty, this county was essentially, and almost exclusively, devoted to mining. There were a few hay ranches, some grazing and timber lands, with occasional indications of coal measures, but all were merely convenient and limitedly useful accessories to the main industry.

The opening of the reservation added a large tract of fine agricultural and grazing land, 66 by 108 miles square, embracing the Book (or Roan) and White River plateaus, and a portion or all of the fertile valleys of the White, Grand, Williams, Piney and Eagle Rivers.

For the past two years the county has ranked fourth among the bullion producing regions of the State, but I am convinced that its resources are sufficient, if perfectly developed, to raise it to the second position. Up to the present time the district of Ten Mile, 18 miles directly north of Leadville, and covering the mineral regions on each side of the upper portion of Ten Mile Creek, with the towns of Carbonateville, Robinson, Kokomo and Recen, has attracted greatest attention. The geological features are varied, being granitic, eruptive and sedimentary. The

veins are contacts, fissures and gashes, the characteristics varying with the different formations. The contacts lie between dolomite below, and metamorphic sandstone above, and generally are quite large. The principal mines are the Robinson, Aftermath, Milo, White Quail, Badger, Wheel of Fortune, Queen of the West and Mayflower. The veins range from two to twelve feet in thickness, and the ores are mainly carbonate of lead, with much oxide and carbonate of iron intermixed, carrying silver in variable proportions from 20 to 100 ounces per ton, in bulk, or large lots, and from 20 to 60 per cent. of lead. The fissures and gash veins contain the sulphides of iron, zinc, lead and copper, all carrying more or less silver, and usually a little gold.

The part of Eagle River District in the immediate vicinity of Red Cliff, has become an important mining camp, and for two years past has returned large quantities of base bullion. A dozen or more mines have been opened and energetically worked, among them the Belden, Little Chief, Eagle Bird, Crown Point, Casino, Kingfisher, Clinton and Rose. From these about 6,000 tons of ore were extracted during 1881, for which the owners realized, as nearly as can be ascertained, $160,000. I have no data at hand showing the exact returns for 1882, but it is estimated by authorities on the ground and familiar with the subject, at 400 tons of lead bullion, and about 10,000 tons of ore shipped by railway to Leadville, the net yield to the owners being not far from $285,000. The average net value of the ores delivered to the cars of the Denver & Rio Grande Railway, deducting cost of transportation to Leadville and smelters' charges, is placed at $22 per ton. Much of the ore yields a higher value than this, of course, but the great bulk of the carbonate variety is very low grade in silver.

The division of Summit County lying east of Ten Mile, comprising Breckenridge, Montezuma, Decatur and Chihuahua, and shipping from Breckenridge by rail via the

Denver & South Park, and from Frisco via the Denver & Rio Grande, according to the most authentic reports, have made a material increase of ore and bullion shipments over those of 1880 and 1881. Seventy-three silver mines are named as having shipped ore in bulk, the whole aggregating 4,491 tons, which yielded $459,550, an average of about $102 per ton. Besides, several gold mines are credited with $28,850 and the placers with $22,150, giving a total of $510,550.

With the exception of a few in the neighborhood of Breckenridge, the lodes are fissures in granitic rocks, and the ores consist of the sulphides of iron, copper, lead, zinc, bismuth, antimony, arsenic, etc., with some ruby silver, silver glance, native silver, etc. The region is filled with medium and low grade ores, with a fair per cent. of those which are exceptionally rich. Railways have already intersected the principal centers, and further extensions are projected for construction in 1883; therefore, the output will be considerably increased annually henceforward.

SAGUACHE COUNTY.

This sub-division of the State was organized in 1866, and embraces an area of 3,200 square miles, by far the greater portion being agricultural and grazing land. Numerous farms are under cultivation, yielding all the varieties of grain and hardy vegetables in abundance. The Sangre de Christo (blood of Christ) Range of Mountains forms the eastern boundary, and the Continental Divide crosses the northwestern quarter. In these mountains the mining districts are located. The principal towns are Saguache, situated in the San Luis Valley near the Cochetopa Mountains, at an elevation of 7,700 feet—the county seat—Bonanza, Villa Grove, Sedgwick and Exchequer, mining centers. The present population is about 6,000. In 1880 it was only 2,787.

In 1867 the assessed valuation of property was	$ 34,584
" 1881 it had increased to	300,000
" 1882 the estimated value was	550,000

The following statement taken from the Saguache *Chronicle* shows the products of agriculture and stock growing for 1881 :

150,000 lbs. wheat	$ 7,500
1,750,000 lbs. oats	35,000
1,500,000 lbs. potatoes	30,000
100,000 lbs. other vegetables	3,000
10,000 tons of hay	150,000
Total value of products	$225,500

The number of cattle owned in the county amounts to 12,000 head, valued at $310,000.

The number of horses broken and unbroken amount to 2,000 head, valued at $100,000.

The number of sheep owned in the county amount to 25,000 head, valued at $75,000.

The leading mines are located in Kirber Creek District, in the northern part of the county, and on the eastern slope of the Continental Divide. Most of the veins are of rather more than ordinary width ; the generality of the ores argentiferous and of medium grade. I have statements of the silver value of some 700 tons, which give an average of 70 ounces per ton. The copper contents range from a trace up to 15 per cent., and the lead to 65 per cent. It is probable that the ores thus far marketed contained in silver, lead and copper about $80 per ton.

In the matter of development and productiveness, the Empress Josephine, Whale, Antero, Boss, Mammoth, Townsend, Exchequer, Arkansas, Pacific and perhaps half a dozen others are prominent, and the prospects are almost without number. Nearly all these ores must be reduced by smelting, as most of them contain a considerable per cent. of lead or copper in combination with the precious metals. One lead furnace of twenty tons capacity was erected and put in blast during the summer of 1882.

In Crestone District but little beyond assessment work on a few mines has been accomplished. In the Sangre de Christo section, further south on the same slope, much more has been done and some bullion produced. The

claim known as Bonanza No. 1, with a five-stamp mill, is said to have turned out over $7,000 in gold from about 250 tons of rock containing $35 per ton—an average of $28, or a saving of about 80 per cent. of the assay value. The mine is developed by one shaft 110 feet deep, and has 300 feet of levels, showing a vein of milling ore 30 inches wide. It is stated that there are several other lodes in the immediate vicinity, which, when opened, will be equally productive.

The metaliferous zone about Bonanza appears to be well filled with mineral, and the miners need but the advantages of home markets and railway communication to make it a large producer.

The Empress Josephine, a leading representative mine, shows in the results already secured, what may be accomplished under more favorable conditions. The average value of its ores is $155 per ton, of which $10 is gold. The proceeds obtained in the regular course of exploitation amounted to about $40,000—the developments to 1,000 feet of levels, shafts and winzes. Many others are undoubtedly equal to it in strength of vein matter and value of ores. This will be determined as the work progresses. It is believed that the railway will be extended to Bonanza from Villa Grove before the end of the current year.

SAN JUAN COUNTY.

With a single exception (Gilpin) San Juan (San Whon) has the smallest area of any in the State, but its resources in medium and low grade ores are practically inexhaustible. It is situated in the heart of the great range from which its name is derived; is well watered and timbered, and at the present writing in the enjoyment of great prosperity. Geologically the general features are not materially different from those of Ouray County, its immediate neighbor on the north. The core of the range consists of metamorphic archæan rocks and granite, much of the latter possibly of igneous origin. All the metamorphosed series which still exhibit planes of bedding, are tilted at angles from 60° to

75°. Of the entire series comprising quartzites, hornblende schists, mica schists and slates, which constitute the mass of metamorphic strata, the quartzites largely predominate. On the western slope of the range, a series of conformable strata, included between the base of the carboniferous and the summit of the cretaceous, and in which red and gray sandstones predominate, are found to overlie unconformably the metamorphic nucleus.

A group of sedimentary rocks, which Hayden has referred to the Devonian or Silurian, are said to occur in the northwestern portion of the county. On the eastern slope, exposures of sedimentary beds are of rare occurrence, and we find only the eruptive rocks belonging to the tertiary overflow. These cover the larger portion of the main range, and in places aggregate in thickness 4,000 to 6,000 feet. In Ouray County adjoining, several hundred feet of conglomerate, doubtless of tertiary age, occur, sandwiched between the mesozoic beds and the eruptive strata.

The veins are fissures originating in the archæan rocks, and passing thence up through the eruptive to the surface, with exceptionally strong and distinct outcroppings, not infrequently traceable for miles. In width or thickness, they vary from a few inches to 100 feet, but averaging from 5 to 6, and carrying an ore vein or streak 3 to 4 feet wide, The ores are mainly adapted to smelting, and consist of galena, zinc blende, iron and copper pyrites, gray copper, massive enargite, bismuth, some ruby silver, brittle silver, silver glance and native silver. Their value, as demonstrated by the shipments of the past year from Silverton, averages not far from $75 per ton, though portions gave from $200 to $300, by carload lots.

The quantities sent to market may be illustrated by the fact that since the Denver & Rio Grande Railway was completed to that point, July 13, 1882, to the close of November, 4,620 tons were consigned to it for outside points. In addition, the local works have purchased not less than 2,000 tons, making a total of 6,620 tons.

Silverton, the county seat, is situated in Baker's Park, on the head waters of the Animas River, at an altitude of 9,400 feet, and is surrounded by lofty mountains, crowned with perpetual snows. It seems destined to become an important mining and commercial center, through the prosperity of its mineral fields. The North Star, Cleveland, Jennie Parker, Letter G., Aspen (the latter has already produced about $300,000), Susquehanna, Legal Tender, Green Mountain, Pride of the West, Columbia, Little Giant, Pony, Belle of the Animas, Argentine, Nevada, British Queen and Belcher, are among the more prominent mines, all, or most of which, have shipped ores to various reduction works. Howardsville, Eureka, Animas Forks and Mineral Point, are mining centers, each having a post office, and forming bases of supplies for neighboring camps.

The connection by rail afforded these sections last summer, exerted a remarkable influence upon the mining industry, as shown by the great increase of returns in the bullion table for 1882; and the completion of an excellent wagon road from Silverton to Ophir and San Miguel opened a fruitful source of activity in that direction. The county is noted for its fine thoroughfares and trails, which afford the isolated camps or towns direct communication with Silverton and the railway.

During the past summer four reverberatory smelting furnaces, with crushing and sampling machinery, have been erected under the direction of Dr. Beckwith, an experienced metallurgist. Several concentrating mills have been placed on the Animas river between Silverton and Animas Forks for the reduction of the low grades.

These substantial accessories, together with the many rich discoveries in which citizens of the county are directly interested, have inaugurated an era of progress and prosperity hitherto unknown in that quarter.

IMPROVEMENTS IN METHODS OF REDUCTION.

While no radical changes have been made in any department of reduction during the past twenty years, many im-

provements have followed the suggestions of experience from year to year, in the form of mechanical devices and chemical appliances. Let us discuss them *seriatim*.

Crushing.—For breaking hard rock and ore to the size of walnuts, the Blake jaw crusher is generally conceded to be the most efficient machine used in Colorado. The Dodge (new patent) and Alden inventions, however, do very effective work. Next in order, for reducing to the size of corn, are Cornish rolls. Following the jaw crushers, the rolls are employed for sampling in all the larger establishments, because, for this purpose, they are the best yet introduced here.

Pulverizing.—The stamp mill, though heavy and cumbersome, has stood the test of many generations, and for effectiveness and economy in fine pulverizing it is unequaled. Many inventions have attempted to supplant it, but unsuccessfully. It would be rash to say that it will not be superseded, but until something decidedly better shall be brought forward through all the experimental stages to a higher perfection, it will retain its position and prestige in all the mining districts where the ores are adapted to that method of treatment.

The following abstract of a paper on "Gold Milling in Gilpin County," prepared by Mr. A. N. Rogers, and read before the Colorado Session of the American Institute of Mining Engineers last August, contains much valuable information on the subject treated:

"Most of the gold ores are reduced by stamping, and amalgamated, both inside and outside of the batteries, after which blanketings are caught, to be panned, or returned to the batteries and put through a second time with the coarse rock. Below the blankets, suitable sluices and buddles are used to collect and concentrate the outflowing tailings, which, being reduced to a 10 per cent. gangue limit, become a marketable product for smelting, because of their fluxing qualities more than their value. The richer sulphurets are hand-picked and cobbed for the smelters, and

some grades of ore which are not free milling are concentrated and likewise sold; but the sands, or separating gangue, are then treated under stamps, after the manner of ordinary mill-rock.

The milling practice here is somewhat different from the methods employed on the Pacific Slope, and this has led to much unfavorable comment respecting the construction and mode of operating our mills. It is claimed that the mill-men of this section are slow, bound to old prejudices, and that the mills do neither good work nor much of it. This is a grave charge, which, having received the sanction of high authority, claims attention at this time, because of the opportunity furnished for a candid discussion of the subject. If the methods here employed are defective and wasteful, they ought to be abandoned, and the experience of others, if well founded, should be taken. It is of too serious moment, however, for hasty and inconsiderate action. While the customs of this section have been tenaciously adhered to in the face of adverse criticism, it has not been from lack of understanding the points at issue, but from convictions, based upon long experience, that the practice of other sections is not applicable to the circumstances of this. It is held that the milling ores of this district combine a larger per cent. of sulphurets than those of the Pacific Slope, and that the sulphurets are as a rule less valuable. In order to mill to any high per cent. of the contained value, very fine crushing and good battery amalgamation are essential. This, the underlying proposition, followed out, has, after the usual changes, mishaps and waste of money in processing, built up the present stamp-mill system, which is but little modified from an ancient custom, except in the matter of better construction and more attention to detail.

Fine crushing and battery amalgamation involve the necessity for holding the ore in the mortar until the work is thoroughly done, and this occasions all the points of difference between the mills of the two sections. The one

has a shallow mortar, short drop, coarse screen, and fast motion; the other, a deep mortar, long drop, fine screen, and slow motion, the very opposite in principle and construction, and with the very opposite aim in view; the one, to effect quick discharge and fast crushing; the other, to hold the pulp in the battery until its contents have become thoroughly reduced and a high per cent. of its value taken out. That each may do its work properly and with the best economy, should be easily conceived, if not frankly admitted; but to contrast, in units, the ore crushed per stamp in the two cases, as the basis of comparison between the efficiency of the mills, would be to misjudge the case entirely. Without considering the relative hardness of the rock to be crushed, the quality of the work done will be as the cube of its fineness, and this, in the two cases (if I am properly informed as to the California practice), will be as one to eight; that is to say, the California mill works to a 40-mesh screen, and the Colorado mill to an 80-mesh; the one reducing each cubic inch to 64,000 divisions, and the other to 512,000 divisions. The only authentic data at hand, from any California mill, by which a comparison may be made in respect to the fineness of crushing, is taken from a chapter of Raymond's Report for 1872, written by Mr. G. F. Deetken, of Grass Valley, in which he gives an elaborate and excellent description of the mills of that section. Relative to the matter of crushing, he says: 'The object being to liberate fine particles of metallic gold, disseminated through the quartz, so that they can be collected and subsequently amalgamated, a fine crushing is always desired. . . . . The fineness of crushing is found to be as follows: The battery sands, crushed through a No. 6 slot screen, contain an average of

"1. Slimes which remain suspended after three minutes' rest in still water, 19 per cent.

"2. Slimes passing through a sieve of 6,400 holes per square inch (No. 1 excluded), 51 per cent.

"3. Sands passing through 1,600 holes per square inch (excluding Nos. 1 and 2), 23 per cent.

"4. Sands not passing through 1,600 holes per square inch, 7 per cent."

This, by computation, would give, approximately, 468,000 particles to the cubic inch, and doubtless represents the finest crushing practice in that vicinity, as he states that "it is the work of one of the best mills in California." A test of the fineness of pulp from the Bobtail Mill of this place was made two years ago, on a ten days' run of one battery, which gave a computed result of not less than 700,000 particles to the solid inch, as follows:

	Per cent.
Caught on a 40-mesh sieve	1.17
Caught on a 60 mesh sieve	17.55
Caught on an 80-mesh sieve	13.08
Caught on a 100-mesh sieve	10.33
Passed through a 100-mesh sieve	57.87
Total	100.00

From this it will be seen that no proper comparison of stamp-work can be made without considering its quality, and the question is not what the mills will accomplish in the disposal of the rock, but whether it be expedient to reduce the same to the degree of fineness which is here practiced. This evidently depends upon the manner in which the gold is held in the rock; and respecting this it may be assumed that little is definitely and satisfactorily known. It is here believed to be very finely disseminated through the mass, as a rule, but there will be, no doubt, great diversity of opinion respecting the matter.

Mr. Melville Atwood, F. G. S., in a paper on the subject of the Microscope in Metallurgy, claims that as the gold is distributed in Grass Valley and Bodie ores, the gold is so associated in the rock as to render the loss by dead-stamping great.

As against the result of Mr. Atwood's investigations, I will state some facts, which have been gathered here, tending to show the manner of association of gold with the

rock of this section. I have a small quantity of gold which was taken, as amalgam, from the copper tables of a mill in my charge, for the purpose of examining its features and fineness. The amalgam was gathered and the quicksilver was dissolved out with acid, which left the gold, it is assumed, in substantially the same condition, as to its particles, as when it was taken from the tables. If they were bruised, beaten and laminated, these features would be shown under the microscope, as in the case reported by Mr. Atwood. Ninety-two per cent. of this gold was passed through a 100-mesh screen. It must therefore have exceeded in fineness 10,000 divisions to the square inch, and 1,000,000 particles to the cubic inch. A sample of this, under a microscope with a power of 600 diameters, does not show any flattening of the particles, but a granular structure, with the appearance of crystalline formation, tending to clusters. The gold and quartz, in some instances, were found still wedded to each other in bonds so intimate as to defy both stamps and quicksilver.

In one case, a prism of quartz had its surface dotted with granules about the tenth of its diameter in size, each covering $\frac{1}{100}$ of its exposed surface, thus forming, approximately, $\frac{1}{1000}$ of its mass. By computation, this would give it the bulk of $\frac{1}{100000000000}$ of an inch, more or less, solid measure. In the light of this revelation, it may not be claimed that the Gilpin County mills are doing too much work upon the ore by dead-stamping. Rugged as the stamp mill may appear, as a machine it has to do with a most delicate problem, and if we are to believe the senses, must work to a degree of fineness almost beyond human comprehension. The question, how this may be best attained, presents itself for consideration. The practical methods of this section have been the outgrowth of experience, finally resulting in the mills as we see them to-day, differing so widely from the California mills as to be the subject of adverse criticism. The point of departure between the practice of the two sections commences with the

seeming necessity for fine crushing to amalgamate the ores of this section, which, from the statement of Mr. Atwood, must differ widely from California ores. If we concede the necessity for fine crushing here, which is not expedient in the treatment of California ores, then we may account for what seems to be the best practice in each case, though it differs widely. Here, the doctrine of fine crushing is the underlying principle, and the methods of accomplishing the work are believed to be well founded and judiciously carried out. The stamp battery, as a reducing device, has stood the test of many generations, and is believed to be without a rival for economy and for fineness and uniformity of work, which may be graded to any degree of attenuation sought. A battery which would be best adapted to reduce to forty divisions can not be expected to attain to the fineness of eighty divisions to the linear inch merely by changing the size of the screen; it requires something more—a water dam to keep the disintegrated rock "*in chancery*" away from the screen, until the work upon it is completed; hence the deep mortar and high issue in the mill designed for fine crushing. This departure from the fast-crushing battery of the Pacific Slope is the direct cause of the other changes which follow in logical sequence, A high-water level in the battery is inevitably followed by the long drop of the stamp, and this, again, by a less number of drops in a given time, to do the same work or to develop the same number of foot-pounds, which is its expression. The effective duty of a properly-constructed stamp battery should be accurately measured by the foot-pounds developed by the falling stamp—the product of the weight, drop and speed, which are three elements of mechanical work. It is claimed, however, that this is not in accordance with observed results. In a recent paper by Professor Monroe (read at the Lake Superior meeting of the Institute, August, 1880), this subject has been elaborately discussed, mostly from data published in the reports of Prof. Raymond, as Commissioner of Mining Statistics.

The conclusions reached by Prof. Monroe seem to be unfavorable to the efficiency of Colorado mills, and are different from what would be expected by those familiar with their work. Yet they are supported by seemingly convincing testimony, all tending to the same verdict. It is admitted, however, that the data are not strictly reliable, since, as stated, "the capacity of stamp mills is directly dependent, in some degree, upon the nature and extent of discharge, fineness of screens and other peculiarities of the battery; and finally, the hardness and tenacity of the rock crushed varies so much that comparisons between the different localities can not be implicitly trusted." Very naturally, comparisons can only be made with safety when the conditions are the same. In this case, the comparisons can not be "implicitly trusted," and it will appear that they can not be justly made. To say nothing of the character of the rock, varying, perhaps, widely in hardness and tenacity, no discrimination is made respecting the quality of the work done upon it, which might vary still more, since the screens may vary from thirty to eighty meshes to the linear inch, not an unusual variation, according as the amalgamation is done inside or outside the battery. There is a margin for doubt here, which will more than account for the seeming paradox that the law of the velocity of impact is effective in the case of the steam stamp, but not in that of the drop stamp. Recurring to the previous statements respecting the relative fineness of the tailings of the Bobtail and Grass Valley mills, it will be observed that they are as 700,000 to 468,000, or as 3 to 2. If it be assumed that the work expended to attain this fineness is in the same ratio, then the Bobtail mill has done one and one-half times as much work on the rock as the other mill, if the quality of the rock be the same in both cases. The Bobtail mill has 500-pound stamps, dropping 16 inches thirty times per minute; thus developing, per stamp nearly 29,000,000 foot-pounds in twenty-four hours to crush one ton of rock. The Grass Valley mill has 700-pound

stamps, dropping 10 inches, and sixty-eight times per minute; thus developing, per stamp, 57,000,000 foot-pounds in twenty-four hours to crush $1\frac{6}{10}$ tons of rock, or at the rate of 35,700,000 foot-pounds per ton of rock crushed. If the ore should be held in the batteries until reduced to the Bobtail standard of fineness, one and one-half as much work, or 53,550,000 foot-pounds per ton of ore would be absorbed; thus showing an efficiency of 54 per cent. as compared with the Bobtail mill. This apparent difference is too large to be taken without question of doubt, though the data seem to be strictly reliable. The proof goes far enough, however, to show the fallacy of indiscriminate comparisons.

It is more than probable that, if a close comparison were made, taking into consideration the quality of the work as well as the quantity, it would appear that the foot-pound of power expended would render its equivalent in duty under any circumstances; and that, in every instance where the apparent advantage is in favor of the short drop, it is due to coarser crushing, naturally resulting from the low issue and quick, if not premature, discharge of the pulp from the battery. We must reason that, when a stamp is raised through a certain distance, there is a definite amount of energy stored in its mass which will be given out in its fall. If it is not expended upon the rock which takes the blow, what becomes of it? If it goes into the foundation or is wasted in any manner, by undue shocks and jars of the machine, its effects will at once be made manifest, and become visible in wear and waste. It is a living force, which cannot be taken out of the stamp without being put into something else, leaving its mark. It has been stated that it may be lost in "heat or packing," which, though vague, is evidently intended to mean that the blow has been given without its equivalent effect. If heat is the result of a blow, the blow has done its work, either upon the rock or upon the metal. If upon the metal, the metal will show its effects. It may be claimed, therefore, that the de-

struction of metal, per unit of work, will be inversely as the efficiency of the battery. In other words, the work expended in blows cannot be lost, and will have its normal effect upon the rock, or will occasion an abnormal wear of the metal surrounding it.

The proportionate waste of metal, then, should be an infallible test as to whether the power is properly expended.

The data at hand respecting this are limited to the working experience of two mills—those which have already been mentioned—the Grass Valley mill, of California, and the Bobtail mill, of Central City. These are taken to be representative mills of the two sections, and the only mills furnishing available data for comparison at this time. The proportionate wear of metal, per unit of work and per ton of ore crushed, will be shown by the appended table:

	Bobtail Mill.	Grass Valley Mill.	G. V. Mill reduced to Bobtail standard of fineness.
Work delivered by stamp.			
In millions of foot-pounds per pound of shoe worn	20.000	31.733	
In millions of foot-pounds per pound of die worn	92.900	59.500	
In millions of foot-pounds per stem broken	720,000	30,844.800	
Metal worn			
From shoe per ton of rock crushed	1.44 lbs.	1.125 lbs.	1.8 lbs.
From die per ton of rock crushed	0.31 lbs.	0.6 lbs.	0,9 lbs.
Quantity of rock.			
Crushed by shoe without removal	70.8 tons	79 tons	53 tons
Crushed by die without removal	578 tons	100 tons	67 tons
Crushed by stem before breaking	25,000 tons	864 tons	576 tons

It will appear, by inspection of the foregoing: 1st. That the Grass Valley mill wears out the most metal per ton of rock, and has the greatest proportion of wear on the die. 2d. That the Bobtail mill performs one and one-half times the work to each pound of metal worn from the die, and twenty-three times the work to the breakage of a stem, as the other mill. 3d. That the shoe of the Bobtail mill wastes four and six-tenth times as fast as the die, thus proving that the blow is taken by the rock and not passed through the rock to the die beneath. 4th. That while the Bobtail wears the shoe four and six-tenth times as fast as the die, the other mill wears its shoe but twice as fast as the die, which indicates that more of the work passes

through the rock into the die, employing the same as an anvil. 5th. That the relative endurance of the stems in the two cases must be taken as the most conclusive evidence that the blow of the Bobtail stamp, notwithstanding the velocity of the impact, due to a greater drop, has been absorbed in the rock, and the stem has not received the violent shock which would result from falling upon the metal of the die. 6th. That by careful analysis of these data, no undue wear can be detected in the battery or foundations of a long-drop mill, as compared with that of a short-drop, and therefore its work must have been properly expended upon the rock in the battery. In marked contrast to this, and pertinent to the subject, I will quote the remarks of Mr. J. M. Adams, of Silver City, Idaho, (in a a chapter entitled Hints on the Washoe Process, which will be found in Raymond's Report of 1873). In describing his practice with a stamp-mill, Mr. Adams says: 'Low feeding is the best; let iron *almost* wear on iron; under this system, a stem may break occasionally, but it does not take long to put in another. Even if three stems out of twenty are broken every month, the cost of repairing amounts to little compared with the increased production obtained by low feeding. The stem almost invariably breaks in one place—namely, where it comes out of the stamp-socket or boss. The broken surface of the wrought-iron stem shows the iron to be thoroughly crystallized, its fibrous condition having been destroyed by the constant jar.' This statement is presumed to represent fairly the effects of iron '*almost* wearing on iron,' and is given here without comment as pertinent to the discussion, and as an experience remote from our own practice.

Much stress has been laid upon the loss occasioned by the stamp working in the battery water. Its retarding effect cannot be an important element in the discussion; but, being easily disposed of, it seems proper to consider what may be its influence upon the crushing duty of the stamp. Its effect will vary as the depth of the water, and

will be greater in a deep mortar than in a shallow one. We will assume the outside limit in a high-drop mill to be about one foot of water, through which the stamp is expected to drop in doing its work. If the stamp has a diameter of 8 inches, its section will be about $\frac{35}{100}$ of a square foot, and the water displaced by its fall will be $\frac{35}{100}$ of a cubic foot, which, if it be considered as water alone, will weigh 21.7 pounds. Taking into account the solid matter held in suspension, it may be well to call it 25 pounds. Now, this displacement has commenced at the surface, where the pressure is zero, and has continued, with the pressure increasing in direct ratio with the depth, until the final pressure upon the bottom of the stamp is 25 pounds; the total resistance, therefore, expressed in units of work, will be 25 pounds x 1 foot — 2, or 12½ foot-pounds. If the weight of the stamp be 500 pounds and the drop 16 inches, when falling freely it will develop a blow of 667 foot-pounds; but, meeting a resistance during its fall of 12½ foot-pounds, the effect will be diminished about $1\frac{9}{10}$ per cent., which, if lost, is not of serious moment. But it is not lost, since the reactive buoyancy of the fluid assists in lifting the stamp, and the same amount is recovered, except the trifling friction due to a wave motion of the water, which is needed for other purposes. Again, the effect of fine screens has been claimed to be another source of loss, which interferes with the duty of the stamp. If the screen, by impeding the discharge, can affect the duty in the sense of absorbing any portion of the work, being of thin sheet iron, punched through with many slots, it would be battered to pieces in an hour; and yet the screens require changing but once in six weeks, after having discharged about 4,000 tons of battery slime through a single screen. The resistance to the outflow of the pulp, due to the screen, should be quite accurately measured by the pressure of water behind. Since this does not average, in head, more than half its width, or some five inches above its bottom, it is too small for serious consideration. If the loss be supposed to

occur from re-working the battery pulp after it is reduced to the requisite fineness for discharge, the reply will be that the rate of discharge may be increased by adding water to thin the pulp, and to raise the pressure behind the screen, thus increasing its outflow.

Whatever may be the effect of the deep mortar and fine screen, it is apparent that they have been intelligently chosen to retard the outflow from the battery; and any attempt to hasten the work by discharging more freely will defeat the purpose in view. Not unfrequently, by unskillful management, stamp-batteries are run with a very considerable loss in efficiency, but this loss is due to quite a different cause. When a mill "pounds," as the expression goes, by which is meant that the stamp falls through the pulp upon the die, it is certain that its work is wasted. In this case, it will probably be found that one end of the battery is empty and the other end banked with the surplus of dirt; part of the stamps will be going through to the bare metal and the others stopping at half-stroke on the accumulated pile, without making an impression upon it.

In this perplexing condition, no work will be accomplished, and not unlikely stems will be breaking at the rate of one or two a day. The experienced mill-man will remedy the difficulty by lengthening the drop, in order to give chance for the settlement of the stuff, under the pounding-stamps. The short drop, causing undue commotion in the battery, has prevented the settlement of sands, and the stamp has gone through to the die, churning the dirt to the other end of the mortar, where it has banked and shortened the play of the fellow-stamps; resulting in loss of work, injury to the mill, and defeat of amalgamation. These are the evils which have attended every attempt to shorten the drop and quicken the motion of mills with a deep mortar and high issue. It has been tried so often, with the same results, that this point has been settled beyond question.

If the excessive work (in foot pounds of power expended) which is shown to be done by the mills of this section is

not wasted in useless destruction of metal—of which we have no evidence—then it must go into honest blows upon the rock, and the question is narrowed to the consideration as to whether this is needless, in order to free the gold for proper amalgamation. Here, it is pertinent to remark that the custom of re-grinding and amalgamating in pans, and other kindred devices, is preached and practiced in connection with the California mills, and in other sections where the quick drop and low issue are used. This is a fair admission that more work is needed upon the quartz than is given by the stamps of such mills. What, then, is the advantage of multiplying machines and processes if as good work may be done in the battery? It is not because of cheapness; for it is patent that the stamp, as a pulverizer, is far superior to the muller, both in the quantity and quality of the work it will do with a given power and given wear of metal. It is not because the pan is superior as an amalgamator; for it has many defects not common to the battery, while the battery has no defects not common to the pan.

The gold taken in the battery is the "bird in the hand," and battery amalgamation is the rachet-wheel, in drilling, which holds to what you get. If 75 per cent. of the gold which a good mill will save can be caught in the battery without other attention than is given by the feeder, why should it be permitted to escape for the purpose of making a race for its recovery, with a multiplication of expensive devices beyond? All of these may be used later, in case they can be made to pay.

If so large a per cent. may be saved in the battery, the conditions favoring amalgamation are too valuable to be neglected. If neglected, it must be for the reason that the advantages are too poorly understood to be appreciated. The working of the battery would seem to be that both the gold, upon being released from its matrix, and the mercury, which is fed into the battery, tend to gravitate through the shifting sands to the bottom of the battery-box. Here, be-

neath the mass, they are continuously manipulated by the blows and pressure of the stamps. Freed from the earthy matter and mineral contaminations which float off from above, the surfaces of the gold become brightened by attrition of the sands, and the mercury, with lively affinity, readily unites with each particle thereof, forming amalgam.

It is difficult to conceive of circumstances more auspicious for their union, thenceforth they journey together. While either by itself could have passed the screen openings, and been lost, now united they can no longer run the gauntlet, but must find a lodgment on the battery coppers. The depth of the mortar and high-water line evidently perform important functions in preventing their escape, until they have had ample opportunity to unite, thus rendering their escape more difficult. This is conceived to be the ordinary happening with the coarse gold.

It is observed that the gold taken from the outside coppers is exceedingly fine, compared with that from the inside coppers. From this it is apparent that the fine gold is carried with the water-currents through the screens before it can be placed in bondage, after the manner described. We reason, therefore, that, by quickening the drop of the stamp, the greater commotion of the battery water and the stronger currents, which would be due to a shallow mortar and low screen, would aid this escape and be prejudicial to battery amalgamation. The combination, then, of the deep mortar, long drop, and slow motion, considered in respect to the purpose in view, is not chosen by caprice and upheld without reason; it is that most likely to secure the desideratum sought, namely, to extract directly and during the crushing as high a per cent. of the value as possible, giving but subordinate attention to any further treatment of the pulp. To accomplish this, the battery is chosen for the work, because:

It takes the place of more complicated and more expensive devices.

It is direct and continuous in its work.

It grades the material closely, pulverizing finely, evenly and cheaply, discharging the waste as soon as it is disengaged, thus ridding the amalgamation of a hinderance and the mill of an incumbrance.

It delivers its power in blows, which take advantage of the brittleness of the rock, crushing one fragment upon another with the least friction and abrasion of the metal.

It grinds the sands and gold by pressure and attrition of the shifting mass, rather than by rubbing and abrasion of metals, thus avoiding evils incident to the latter, among which may be named chemical reactions of the metals set free, flouring of the quicksilver, abrasion of the gold, and the interference of slimes, which absorb, waste and sicken the mercury, rendering it sluggish in its affinities.

The arguments against battery amalgamation seem to be limited to the claim that it interferes with the crushing efficiency of the battery.

The loss of quicksilver is an item which is highly important to consider, though the data for comparison between mills of this and other sections are not at hand. This loss has been claimed to be excessive in the battery; but it is thought to be far less than by pan amalgamation, and that statements heretofore made respecting the matter must have been erroneous, or else the milling must have improved very much in later years. In Mr. J. D. Hague's report, in 1868, it was spoken of as being from $\frac{1}{10}$ to $\frac{1}{20}$ of a pound of mercury to the ton of rock. In 1870 Mr. Reichenecker of this place, in a well-written article, copied into Raymond's Report, claimed the loss in the battery to be three times as much as is again recovered in the amalgam. The actual average loss in the Bobtail mill, in crushing 125,000 tons of rock, amounted to less than $\frac{2}{100}$ of a pound to one ton of ore—strictly 1 pound to 56 tons of rock crushed—and this covers the entire loss in and about the mill.

The remaining and most important topic which claims attention is the gold-saving qualities of the mills, or the percentage of value utilized. This is given in a statement by

Mr. George H. Gray, assayer and metallurgist. A brief synopsis of the working results, as shown by this statement, is as follows:

Of upward of 2,000 tons of ore, which was weighed, sampled and assayed, before treatment in the Bobtail mill, the saving, by amalgamation above the blankets, was fully 70 per cent of the contained value of gold the ore, and about 6 per cent. of the silver, of which latter the ore contained but $1\frac{3}{8}$ dollars in value per ton. This milling was done at an average cost of but little more than one dollar per ton, embracing all items of current expense, repairs, and removals of the plant, but not covering interest on its cost.

While disclaiming any intention to criticise the milling practice elsewhere, or to invite a controversy in respect to any claimed superiority of our own methods, it has been thought that a full and fair understanding of these methods and of the reasons for adhering to them, and of the results obtained therefrom, has been wanting, in order to give a fair impression of what the Gilpin County mills are doing, and that a more complete account of the same would be of interest on this occasion.

The fact is well-known that eighteen years ago stamp milling in Gilpin County barely escaped disastrous failure because of the refractoriness of the very heavy sulphide ores which succeeded the surface decompositions (gossans) in the mines. Stamp rock which contained $20 to $50 per ton, under the best skill and methods then at command, would rarely yield more than 50 per cent., and in some cases less than 25 per cent., of its value. Careful and intelligent supervision, together with systematic experimenting through a long period of time, have advanced it to the present high standard. In view of the difficulties overcome, and still in the way, it is doubtful if better stamp milling is done in any part of the world than here.

CONCENTRATION.

Though vast effort, supported by abundant capital, has been expended upon this intricate problem, it has not been

fully solved. While many new devices have been introduced from time to time, none have met all the requirements of the districts where located. I cannot discover that any remarkable advance upon the old established forms of concentrating machinery have been made, either in this country or in Europe. The object in view is the economical utilization of the low grade material which forms so large a part of the product of all mines, and which in its native state has no commercial value. While this has been accomplished to a limited extent, the inventions of later times have not materially changed the results attained fifty years ago. For concentrating the finely pulverized residuum of stamp mills, the Cornish Nicking Buddle, and a peculiar form of Rocker, have proven most economical and effective, when the cost of the plant, expense of operation, and relative per centage of saving are considered. Mills have been erected in different quarters of the State expressly for concentrating ores, but, with few exceptions, were closed in a few weeks after completion, or operated spasmodically without satisfactory results. The causes of failure in some cases is directly atttributable to ignorance of the essential principles involved; others to machinery calculated to work in direct opposition to natural laws. Still others had approved machinery, but of a capacity too limited for profitable conduct. Some were placed where there was no adequate supply of suitable ores, and many where the concentrates, when perfectly cleansed, were of too low a grade for existing markets.

The Hartz jigs and slime tables, Collom jigs, Rittinger tables, Krom dry jigs, Frue vanners, Rouse tables, etc., have all been subjected to crucial tests in our mining districts. Though each possesses more or less merit, not one is perfect, and few, if any, except the buddles and rockers, have been continuously and profitably operated. In some cases too much benefit is expected from concentration; in the majority the mills fail from the want o practical knowledge on the part of the managers.

Roasting. Reverberatory furnaces were first employed in Colorado for roasting pyritous ores, and, when skillfully managed, have always done excellent work. Several other methods, among them the Keith, Crosby & Thompson, Bruckner, Stetefeldt, Arey, Willard, Paul, White & Howell, Robinson, Bancroft-Walker, have been put through a long course of experiments, and at the close all but a few abandoned.

The Crosby & Thompson possessed certain valuable qualities, but from the want of practical skill in its supervision, it soon fell into disrepute. The Keith furnace failed for similar reasons. The Bruckner was well constructed, theoretically and mechanically, and has found favor throughout the mining States and Territories, where it is widely believed to perform the work required quite as thoroughly as the reverberatory, and at considerably reduced expense. The White & Howell bears much the same reputation. They are not materially dissimilar, excepting that the latter is a continuous roaster, in other words, feeding and discharging simultaneously, while the Bruckner takes a full charge and holds it until desulphurized, when it is discharged and again refilled. The Bancroft-Walker is the most recent addition. In construction and operation it is wholly different from the others named. The ore is passed through a series of four revolving cylindrical retorts, set in a brick furnace, in the manner following, as defined by the owners of the patent:

"The manner in which this system of ore reduction is carried into effect is as follows: The ore is dried, crushed and pulverized sufficiently fine to be passed through a 60-mesh screen, by any well known or approved means, into an automatic ore-roaster, consisting of eight fire-clay retorts, each 9 feet long and 18 inches inside diameter, placed in a furnace in two tiers of four retorts each, one above the other, and resting upon the ends of the furnace. Each retort is provided with a hollow shaft, with water connection so arranged that a small stream of water will pass through

the shafts to prevent overheating. Steel vanes or rakes are attached to the shafts for the purpose of constantly agitating and conveying the ore. The end walls of the furnaces are provided with flues at alternate ends, so as to make a continuous connection for the passage of the ore from one retort to the other, so that the ore, being made to pass in equal amounts into the upper one of each tier of retorts from a hopper which is provided with a right and left hand screw, is taken by the stirrers and conveyers, and while kept in constant agitation, is at the same time moved from one end of the retort to the other, where it enters the flue and falls to the next retort below, where it is subjected to the same treatment as above, and so on until it enters the lower retorts and passes out through a chute into an automatic ore cooler. The heat generated in the furnace is made to pass under and then over each pair of retorts in a zig-zag manner, until it reaches the pair at the top, where it enters the inside and passes down with the ore until it reaches the lower retorts, whence it goes off through a flue with the sulphur, etc , into the chimney."

"The advantages claimed for the above described mode of roasting ores are:

1. Automatic operation.
2. Economy of fuel.
3. Uniformity and perfection of the roast.
4. Perfect oxidization of the base metals by means of the large volume of heated air passing through the retorts and coming in contact with all the particles of the ores.
5. There is no probability of matting, as the lower retorts only are subjected to a high degree of heat, it gradually diminishing as it ascends to the upper ones.
6. Cheapness.

When wood is used for fuel the products of combustion, after passing over the top retorts, are conveyed through a flue directly into the chimney.

Air is admitted through openings in the ends of the retorts for oxidizing and promoting the combustion of the sulphur."

This process is comparatively new, but it has been repeatedly tested by competent metallurgists, and appears to be regarded as the best thus far introduced. It is now in constant operation on gold and silver ores, and excellent results are obtained. The Stetefeldt and Arey, though meritorious in some respects, were only successful when supplemented by reverberatory hearths at the bottom of the flues. The Willard, Paul and Robinson have made no striking advances. In the reverberatories, considerable saving in the cost of roasting has been effected by using a mixture of lignite and bituminous coals, instead of wood.

AMALGAMATION.

Aside from the regular amalgamation occurring in the batteries and on the copper plates of stamp mills, which it is understood secure only an average of about 70 per cent. of the gold contents, many attempts have been made to obtain a further saving without roasting the ore, but no great degree of increase has rewarded these efforts. The highest advance has followed the use of Bertola pans—a convenient form of iron arastra, with stone mullers or drags, but their capacity is very limited, and it is only in exceptional cases that much profit is realized. The large, rapidly-running pans, extensively employed on the Pacific coast, have not proven equally capable here, owing to the widely different composition of our ores.

For amalgamating silver-bearing minerals, either roasted and chloridized or raw, which contain silver in the form of chloride, iodide, bromide, sulphide or native, numerous inventions have been applied with varying success. The old Freiberg barrels and pans, Hepburn, Wheeler, Hepburn & Peterson, Varney, Wheeler & Randall, Excelsior and Combination pans have achieved more or less important results, but the Combination and Varney are in more general use than any of the others. Under ordinarily favorable conditions, from 85 to 92 per cent. of the silver is secured by their use; also a fair per centage of whatever gold may be associated with the silver.

SMELTING.

In this department gradual improvements have marked the course of experience in the construction of furnaces, and in the fluxing of charges, whereby considerable economy of fuel is realized. The reduction of nearly all gold and silver ores, save those rich in lead, is performed in reverberatory furnaces, where they are converted into copper matte. Lead ores are almost universally treated in blast furnaces, and the product shipped to Eastern cities in the form of lead bullion, very little refining being carried on except in the matting works.

OUR COAL MINES.

Many extravagant estimates of the area containing coal have been made, some placing it at 50,000 square miles, but deducting barren ground caused by faultings from various causes, together with that erroneously classed as coal land, I am convinced that they are much too high. That we have an immense territory filled with valuable fuels is undeniable, but its entirety cannot be even approximately ascertained until developed by the prospectors of future generations. Several discoveries have occurred during the past two years, and the yield has been very largely augmented in that time. The greater portion is a superior lignite, but numerous tracts, as will be hereafter defined, contain the denser bituminous and the anthracite varieties. The lignites are universally conceded to excel those of most other countries. They are exceedingly dense, generally jet black, with high luster and, as a rule, wholly destitute of fibrous or woody structure; specific gravity from 1.28 to 1.40, averaging about 1.33; rarely contain one per cent, of sulphur, and usually less than 0 4 per cent.; ash residue comparatively slight, ranging between 2 and 7 per cent., averaging about 4¼; heating power high, igniting readily, burning freely until the last fragment is consumed; are in general use for domestic purposes, roasting pyritous ores, for making steam in stationary and locomotive boilers,

blacksmithing, the burning of lime, and, to a limited extent for smelting, and the production of illuminating gas.

The age in which the different varieties of coal found here were deposited or formed, is still a matter of contention among geologists, some asserting the tertiary, others with perhaps equally good reasons that they are of cretaceous origin. My own view of it is that the northeastern fields are tertiary, and those in the southwestern part of the State partially, if not wholly, of the post-cretaceous period. Quite recently, beds of lignite were discovered in Routt County, near the Utah line, believed to be of carboniferous age, but as I have not examined them I am unable to determine. It is beyond dispute, however, that carboniferous rocks exist in that region. The deposits of lignite from which the greater part of our domestic supplies are drawn, lie in the northern fields, embracing sections of Jefferson, Boulder and Weld Counties. The principal veins are from five to sixteen feet thick, averaging eight to nine feet. The product of this region for 1882 was, in round numbers, 310,000 tons, distributed as follows:

Mines in the vicinity of Canfield and Erie	88,000 Tons
Jay Gould, or Welch, at Louisville	90,000 "
Marshall, at Langford	60,000 "
Fox	32,000 "
Those about Golden (about)	30,000 "
Other smaller mines and prospects (estimated)	10,000 "

Larimer and Grand Counties properly belong to the foregoing division, because in each, and especially the latter, promising surface indications of valuable deposits appear, but from the lack of railway facilities and large home demands, they have not been developed.

The middle subdivision includes El Paso, Park and Fremont. In the former but one mine has been opened, and this at Franceville, near Colorado Springs, on the line of the Denver & New Orleans Railway. The coal found here is nearly identical with that of Boulder and Jefferson, being of good quality, and though slacking rapidly by exposure, is nevertheless, an excellent fuel for household use. Dur-

ing the six or eight months of operation, 24,000 tons were extracted and consumed in Denver and by the locomotives of the road.

The South Park mines, near Como Station, have produced about 75,000 tons. It is more bituminous than the others above mentioned, and yields a good quality of coke.

The coals of Fremont County closely resemble those just named, but do not alone make a good article of coke, but by admixture with certain proportions of the variety obtained at El Moro, a superior article is obtained. From the three principal mines—Coal Creek, Oak Creek No. 1 and No. 2, 141,504 tons were produced last year. Others of lesser note, gave about 20,000 tons, the whole aggregating say 160,000.

The southern division, from bituminous mines in the neighborhood of Trinidad and El Moro, yielded 755,000 tons of coal, and about 12,225 tons of excellent coke. Until recently, all the gas companies used these coals for illuminating the cities of Leadville, Pueblo and Denver. The El Moro vein is from 10 feet to 12 feet thick, and is nearly horizontal. The productive capacity of the mine is about 2,000 tons daily, which might be greatly increased if required.

The Cuchara fields are situated near Walsenburg, in Huerfano County. Of the three veins discovered, but one has been developed. This is 7 feet thick, the coal similar to that of the Cañon mines, affording an excellent fuel for steam and domestic uses. Its capacity is said to be 700 tons per diem, and it has produced 96,200 tons in the past year.

I have not examined the deposits of La Plata County, but they are pronounced by competent authority to be among the largest and most valuable thus far discovered in the West. They are located near the town of Durango. I am informed, from trustworthy sources, that the Durango vein is 13 feet thick, the Railroad and Peacock 75 feet, and the California 110 feet; also that much of it produces a

fine quality of coke. The local demand during 1882 consumed about 6,000 tons. The yield of the Railway mines at Monero, asserted to be a part of the same field, though just outside of our State line, in New Mexico, was 12,000 tons, which, added to the Durango product, gives a total of 18,000 tons.

A few narrower veins have been opened near Rico, in Dolores County, and others prospected. These carry from 2 feet to 7 feet of marketable coal, of excellent quality, from which fine specimens of coke have been exhibited. For home consumption only some 2,000 tons have been extracted.

There are strong indications of large deposits in Conejos County, but they have not been developed. The same is true of Rio Grande, Costilla, Saguache and Ouray.

The northwestern division embraces Gunnison, Pitkin, Summit and Routt Counties. The more extensive developments are at Crested Butte, in Gunnison. Undoubtedly this is one of the most important fields in the State. The best coking coals, and the only anthracites yet found here or at any point west of the Alleghanies, are located in this region. The bituminous varieties are in veins respectively 4 feet, 5 feet, 6 feet and 10 feet thick. The principal openings, aggregating over a mile in length, are on the 10-foot vein. The total yield for the past year was 130 tons per day, about half of it converted into coke, mainly in the open air, by primitive methods. Now, however, the company have 100 beehive ovens completed, fifty of which are in constant operation, and the remainder nearly ready to be charged. Each of these ovens, in running order, turns out two tons every forty-eight hours, the whole capable of producing 36,500 tons per annum. I am informed by the managers of smelting works that this coke is not excelled by any other in the world, as demonstrated by repeated comparative tests. The mines and coking establishment give employment to 160 men.

The product of the ovens is mainly consumed in Leadville, though many tons are sent to various other points in the State.

It is reported that a vein of coking coal has been found on Ohio Creek, eighteen miles north of Gunnison, but it has only been prospected. Large deposits of the ordinary bituminous class have been discovered on Mount Carbon, Ohio Creek and at other points in that region. The yield of the county for the year was about 45,000 tons.

The better anthracites are situated on Slate River, three to four miles from Crested Butte, on Anthracite Creek, near Irwin, and on Rock Creek. But the larger deposits are on lower Anthracite Creek, near the north fork of Gunnison River. So far as determined by limited development, these latter coals are somewhat inferior to those first mentioned, which are said to be fully equal in all respects to the best Pennsylvania product, no material difference having been detected in chemical analysis or physical structure. Owing to their remoteness from prominent markets, no considerable traffic has been created, but it is expected that a steadily increasing demand will follow their general introduction at reasonable prices. Large hoisting plants, breakers, etc., are in process of erection, and extensive preparations made for active operations. The yield last year was about 2,800 tons, chiefly for local consumption, though a portion found sale in Leadville and Denver.

The entire production of coal for 1882, as nearly as can be ascertained, is thus tabulated:

	TONS.
Boulder, Jefferson and Weld	310,000
El Paso	24,000
Park	75,000
Fremont	160,000
Las Animas	755,000
Huerfano	96,200
La Plata	18,000
Dolores	2,000
Crested Butte (bituminous)	45,000
" (anthracite)	2,800
All other sources (estimated)	100,000
	1,588,000

The average value of these coals at the mines is $2.25 per ton, making a cash return of $3,573,000. Placing the value of 21,353 tons of coke at $4.50 per ton we have $96,088.50 from this source. Deduct value of coal consumed in its production, say 16,000 tons at $2, which should cover the whole cost, we have a net result of $64,088.50 for the coke, or a grand total realized from the industry of coal mining of $3,637,088.

The subjoined table will show the growth of the coal traffic at El Moro, Walsenburg and Crested Butte, (the latter for two years only) during the last decade:

1873	12,187 Tons.	1878	82,140 Tons.
1874	18,092 "	1879	120,102 "
1875	15,278 "	1880	221,378 "
1876	20,316 "	1881	350,944 "
1877	44,410 "	1882	511,239 "

The analyses below exhibit the character and value of coals and cokes of different districts, with their average composition and value:

The annexed analyses were obtained from two specimens of Canon coal:

Water	4.50	5.49
Volatile matter	34.20	9.33
Fixed carbon	56.80	51.01
Ash	4.50	4.17
	100	100
Sulphur		.35

CHUCHARAS COAL.

	4-ft. seam.	7-ft. seam.
Water	3.23	2.97
Volatile matter	40.93	40.08
Fixed carbon	49.54	48.67
Ash	6.30	8.28
	100	100
Sulphur	.62	.65

The subjoined analyses are of El Moro coal:

Water	0.26	1.66	1.34
Volatile matter	29.66	34.48	35.79
Fixed carbon	65.76	60.08	54.75
Ash	4.32	3.78	8.12
	100	100	100

Analyses of the Crested Butte bituminous coal are as follows:

Water	3.70	.72	1.10	.44
Volatile matter	30.97	23.44	23.20	24.17
Fixed carbon	61.07	71.91	72.60	72.30
Ash	4.47	2.93	3.10	3.09
	100	100	100	100
Theoretical yield of coke			75.70	75.39

Following is a comparison between an average of several analyses of Crested Butte coking coals, and an equal number of the Connellsville, Pennsylvania:

CRESTED BUTTE COAL.

Fixed carbon	72.60
Ash	3.10
Gas	22.80
Moisture	1.10
Per cent. of coke	75.70

CONNELLSVILLE (PA.), COAL.

Fixed carbon	65.00
Ash	6.50
Gas	24.00
Moisture	4.50
Per cent. of coke	71.50

These figures speak for themselves, and need no comment.

Analysis of Crested Butte anthracite made by Prof. Williams, of Philadelphia, last October:

	Per Ct.
Moisture (at 212 Fahr.)	1,588
Volatile matter (at red heat)	5,862
Fixed Carbon	89,780
Ash (red)	2,770
	100,000

The annexed table gives an average of many analyses of the above made by myself and others:

Water	1.20
Volatile matter	5.16
Fixed carbon	90.24
Ash (red)	3.40
	100.00

	Water.	Volatile Matter.	Fixed Carbon.	Ash.
Pennsylvania anthracite	1.92	2.78	88.39	6.54
South Wales "	3.33	3.59	91.50	1.58
Piesburg, Hanover, anthracite	1.98	0.80	89.83	7.39

Following are two analyses from the Anthracite Mesa Company's coal:

	3 ft. 6 in. Vein.	6 ft. Vein.
Water and volatile matter	5.17	6.29
Fixed Carbon	90.65	89.89
Ash	4.18	3.82

The average of a large number of analyses of Canon, Cucharas, El Moro, Crested Butte and Lechner coking coals give the following results:

Water	4.468
Volatile matter	32.703
Fixed carbon	57.353
Ash	5.517
	100.041

The following will be found an instructive comparison of the analyses of El Moro and Crested Butte cokes with the celebrated Connellsville of Pennsylvania:

	Water & Vol. Matter.	Fixed Carbon	Ash.	Sulphur.
El Moro	1.85	87.47	10.68	.85
Crested Butte	1.35	92.03	6.62	. . .
Connellsville	. . .	87.26	11.79	.75

PETROLEUM.

Although there are abundant proofs of the existence of this valuable staple at many points in the State, in oil and bitumen springs, and through the small quantities obtained

by boring, no large reservoir has been opened. Those which have attracted greatest attention are situated on Oil Creek, six miles north of Cañon City, from which considerable oil has been taken by skimming the brackish water at the surface which rises with it. In the crude state it is heavy and impure, containing about 50 per cent. of heavy oil, 12 per cent. of benzine, with much paraffine, and paraffine oil, and about 15 per cent. of coke and useless matter. Some years ago a well was bored near these springs to a depth of 85 feet, which produced a little oil.

Another well was sunk on the flat near Cañon City to a depth of 1,200 feet. I was informed by the manager that some indications of oil were found there.

Nine miles south of this well another has been put down nearly 1,500 feet, which is said to have yielded small quantities of oil of a fair quality.

It is the judgment of many who have had long experience in the Eastern oil regions, and are well versed in such matters, that extensive reservoirs may be discovered here, and also in the great bituminous coal basin near Trinidad, by deeper borings. It is likewise probable that they may be found in the Gunnison fields near Crested Butte.

The existence of oil springs has been established near Morrison, fifteen miles from Denver; near Bitter Water Fork, on Grand River, below the old White River Agency; on a tributary of Bear River, about one hundred miles northeast of the Hot Sulphur Springs in Middle Park; and at several other points. It is not improbable that borings intelligently directed would penetrate large reservoirs in one or more of these sections, and thus add another important feature to our already numerous developed resources.

IRON.

Accompanying and contiguous to the coal mines, as well as independently at many other points, both in the mountains, parks and on the plains, in nearly every section

of the State, vast deposits of iron ore of good quality have been discovered, comprising nearly all the known varieties. But until the past two years very little attention has been given to this branch of industry. As an indication of what has been accomplished in this short period, I cannot do better than to insert the statement of the operations of the Colorado Coal and Iron Company, which was organized January 23, 1880.

This corporation owns and controls the following properties: 99,376 acres of selected lands along the line of the Denver & Rio Grande Railway. Of these 13,971 acres are coal lands; 83,788 acres are in town sites, colony and agricultural subdivisions, including South Pueblo, the site of the steel works, part of Cañon City, and the town sites of El Moro, Cucharas and Labran; 1,057 acres are iron ore lands, embracing what is known as Iron Mountain, a large deposit of magnetic iron ore lying between Cañon City and Silver Cliff; also the Calumet and Hecla and Smithville iron mines near Salida, including about 300 acres of fine magnetic ore; also, at Hot Springs, over 100 acres containing large deposits of superior hematite. They have, in addition, a lease of the Placer iron mines, near Placer station, with a lease to work other mines in the Trinchera estate. Of coal lands, the company own 8,121 acres at El Moro; 2,390 acres on the Cucharas; in the Cañon fields 3,300 acres, and controlling by lease 360 acres more. At Crested Butte they own 160 acres, and lease 1,120 adjoining. At Irwin they hold by lease 240 acres. On the San Carlos, seven miles from their works, they own extensive lime quarries and beds of clay.

VALUE OF PRODUCTS FOR 1882.

(December estimated.)

Coal	$2,000,000
Coke	500,000
Steel, iron and nails	2,400,000
Iron ore	250,000
Total	$5,150,000

PRODUCTIONS FOR 1882.

(Fourth week of December estimated.)

COAL.

	Tons.
Coal Creek mines	91,072
Oak " No. 1	5,455
" " No. 2	44,977
Walsenburg mines	95,377
El Moro "	235,449
Crested Butte "	38,909
Total	511,239

COKE.

	Tons.
El Moro	83,642
Crested Butte	9,128
Total	92,770

IRON ORE.

	Tons.
South Arkansas Mine	14,202
Hot Springs "	29,190
Placer "	8,378
Silver Cliff "	854
Grape Creek "	801
Total	53,425

IRON AND STEEL.

	Tons.
Merchant bar, mine rail, etc	3,883
Pig iron	24,303
Castings	2,752
Muck bar (4 months only)	1,253
Nails " "	807
Spikes (6 " ")	251
Steel ingots (8 " ")	20,919
" blooms " "	18,068
Rails " "	16,139
Total	88,375

The first rail was rolled by this Company on April 12, 1882, and the nail mill was started September 15th following. It is confidently expected that their operations will be at least doubled within the next year. The following table shows the comparative productions of 1881 and 1882:

COAL:

1881.	1882.	INCREASE.
350,944 tons.	511,239 tons.	160,295 tons.

COKE:

1881.	1882.	INCREASE.
47,670 tons.	92,770 tons.	45,100 tons.

Besides the mines owned and controlled by this Company, many might be mentioned as of special importance, but I shall only name a few. One on the Cebolla Creek, a short distance above its junction with the Powder Horn, where there is an immense, and apparently inexhaustible body of valuable magnetic ore. The following analysis of

a sample of this ore, by Otto Wuth, an able analytical and consulting chemist, of Pittsburgh, Pa., tells its own story:

Water	.94
Allumina	.48
Per oxide of iron	38.66
Magnesia	.37
Sulphuric acid	.012
Silicic acid	1.87
Magnetic oxide of iron	55.63
Lime	1.02
Phosphoric acid	.019
Phosphorus	.0084
Metallic iron	68.06

"The analysis speaks for itself. There is no better ore to be found anywhere in the United States. Yours respectfully, OTTO WUTH.

It is also well known that there are immense deposits of bog ore of superior quality in Handcart Gulch, Park County, and of magnetic ore in the South Park.

The following comparative analyses of iron ores from iron furnaces of the Hanging Rock Iron Region, Ohio, with those from the iron mines near Como, Park County, Colorado, are of interest.

MUNROE FURNACE, OHIO.

	Average Ore.	Blue Limestone Ore.	Gray Limestone Ore.
Metallic iron	37.603	38.560	33.23
Manganese	.857	.637	2.82
Silica	1.08	4.844	11.75
Phosphorus	.132	.494	.32
Sulphur	.554	.355	.86
Lime	3.234	2.750	3.717

WASHINGTON FURNACE, OHIO.

	Ferriferous Limestone Ore.	Red Oxide Ore, raw.	Red Oxide Ore, roasted.
Metallic iron	47.81	55.885	60.89
Manganese	Trace.	1.029	1.068
Silica	7.00	2.643	1.437
Phosphorus	.980	.325	.356
Sulphur	.097	.02	.028
Lime	2.2	.400	.42
Alumina	.13		

ÆTNA FURNACE, OHIO.

	Red Limestone Ore.	Gray Limestone Ore.	Gray Kidney Ore.
Metallic iron	47.92	40.88	40.36
Manganese		2.35	
Silica	6.95	5.35	8.78
Phosphorus	.116	.232	.43
Sulphur	.172	.282	1.04
Lime		12.50	5.25

PITTSBURG, February 15, 1881.

W. J. Curtice, Denver, Colorado:

Dear Sir:—I have made a careful analysis of the sample of iron ore you sent me some days ago, and found it to be composed as follows:

Water	.94
Silicic acid	1.87
Alumina	.48
Magnetic oxide of iron	56.63
Per oxide of iron	38.66
Lime	1.02
Magnesia	.37
Phosphoric Acid	.018
Sulphuric acid	.012
	100.
Metallic iron	68.06
Phosphorus	.0084

There is no better ore to be found anywhere in the United States.

Yours truly, OTTO WUTH.

BUILDING STONE, MARBLES, ETC.

Within the past few years these industries have assumed considerable proportions through the constant demands of Denver builders and those of neighboring towns. This has resulted in the discovery and development of many quarries containing the different varieties of stone in all quarters of the State. Granite, lava, trachytic rocks, lime and sand stones, etc., are found in limitless abundance. The Railroad and St. Vrain quarries, near Fort Collins, which produce flagging stone in all desirable patterns, from two feet to twenty feet in length and breadth, and from two to ten inches thick, have been largely developed. About fifty men are employed here, and the products are shipped to

Denver, Greeley, Cheyenne, Boulder, Omaha and other points. This is a highly siliceous gray sand stone, very hard, the blocks smooth and clean, requiring little or no dressing beyond the end and side jointing, to fit them for immediate use in sidewalks. An excellent quality of granite may be obtained in the Cañons of Boulder, Clear Creek, Platte and Arkansas. Sand stones of superior grade for large buildings are abundant near Morrison, Cañon City, Manitou, Trinidad and elsewhere. Basaltic lavas, suitable for foundations and paving, exist in many localities. The supply of limestone is boundless in nearly all quarters. Castle Rock, on the Denver & Rio Grande Railway, furnishes much of the fine pink colored lava used here in dwellings, hotels and business blocks.

Marbles of many varieties and of very good quality are found along the bases and slopes of the mountain ranges. A beautiful species of *breccia* occurs in Boulder County, and one extensive deposit of white marble was recently opened in Chaffee County. Apple green and clouded of fine texture, susceptible of high polish, and very desirable for mantels and other household ornamentations, occur in Park County. Immense beds are said to exist near the head of Rock Creek, in Gunnison County. It is described as a clouded marble in all colors, and forming superior building material.

No special effort has been made to utilize any of these valuable deposits, but the time is near when they will become prominent features of our industrial forces.

In Boulder and Las Animas Counties we find a sharp-grit sandstone, from which excellent *grindstones* may be made. I am informed that Messrs. Chappell & John are about to establish a manufactory for this purpose at Trinidad. It appears that the stone has been thoroughly tested and its quality fully proven. The grit is sharp, the texture in every way suitable for the various desirable grades.

Fire, Pottery and Brick Clays, adapted to all local needs, abound in many sections, and large establishments in

Golden and Denver are employed in working them into merchantable forms—bricks, brown pottery, and terra cotta wares, crucibles, scorifiers, muffles, drain tiles, sewer pipe, etc.—meeting not only the local demand, but supplying, to some extent, other States and Territories.

Gypsum.—Heavy deposits of this mineral are found in the South and Middle Parks, and along the bases of the mountains east and west. Owing to the limited home demand, these have not been extensively developed.

Mica, of good quality, and in considerable quantity and medium sized plates, occurs in many places. The following extract from the Philadelphia *Mining Journal*, will be interesting to parties owning or prospecting for mica mines:

"The market value of mica is great, and at the present time the demand is such that it cannot be supplied. A piece of mica four inches by four inches, five-eighths of an inch thick, will weigh one pound, and has a market value of $4. A piece three by six inches, one-half an inch thick, will weigh one pound, and has a market value of $4.60, and like relative value exists, except in the smallest pieces—say one and a half by two inches, which have a relative value of 50 cents a pound, and all the refuse and trimmings of the mica are readily sold to parties who pulverize them for use in nitro-glycerine and other dangerous explosives."

Sulphate of Baryta, or *Heavy Spar*, is found in beds, and as gangue matter in many of our silver mines. Large quantities are extracted and used in the adulteration of, and not infrequently as a substitute, for white lead in the manufacture of paints. It is mined for these purposes in Nova Scotia, where the crude mineral has a market value of about $8 per ton.

Fluor Spar occurs in large beds at Jamestown, and in wide metaliferous veins near Bear Creek, Jefferson County, but thus far has been only limitedly utilized.

MINERAL SPRINGS,

Both hot and cold, containing salt, soda, magnesia, sulphur, lime, iron, oil, bitumen, etc., exist in the mountains, and near their bases, most of them possessing valuable medic-

inal properties. The more important have been improved, and the localities converted into popular summer resorts for tourists and our own population.

The waters of the Cold Springs are usually rich in the carbonates of soda and magnesia, with more or less iron, not materially different from the famous Seltzers of Germany, and very agreeable to the taste. There are some exceptions, however, in which the waters are heavily charged with sulphureted hydrogen, arsenic, etc., rendering them not only very unpalatable, but in some instances dangerously poisonous. As a rule, the hot springs contain much sulphur, and are highly efficaceous in scrofula and all diseases of the skin; many have marvellous curative powers in cases of rheumatism, secondary syphilis, etc. Those at Idaho attract throngs of visitors during the summer and autumn. These are both hot and cold. The others are thus enumerated: Springdale (cold), Manitou (hot and cold), Cañon City (hot and cold), Middle Park (hot and cold), Poncho (hot and cold), Hortense, Cottonwood and Haywood (hot and cold), Tomichi (hot and cold), Pagosa (hot). Others of less celebrity, though probably of equal value medicinally, are located in Boulder Cañon, Four-mile Creek, in Boulder County, Boulder City, Leadville, Wagon-Wheel Gap, White Earth River, Cebolla and numerous other places. The temperature of the water in the hot springs ranges between 80° and 115°, and that in the cold from 50° to 70°. Among the more noted of the oil and bitumen springs are those at Oil Creek, near Cañon City, Green River, near Bitter Water Fork, and on Grand River, below the White River Agency. Below is an analysis of the waters of hot sulphur springs, Middle Park. One pint contains:

	Grains.
Carbonate of soda	4.9217
Sulphate of soda	1.2310
Chloride of sodium	1.7459
Sulphate of potassa	.1195
Carbonate of Magnesia	.2412
Carbonate of lime	.4601

Free carbonic acid	1.1863
Silicic acid	.1642
Iron	trace
Ammonia	trace
Total	10.0719

Several saline springs exist at different points within the State, but none of them have thus far produced brine of sufficient strength and purity to render them valuable for the production of salt, excepting, possibly, those in the South Park, which are now being developed and tested.

SULPHATE OF SODA.

This valuable product occurs more or less abundantly at several points on the plains, and in the South and Middle Parks. Twelve miles south of Denver are located Burdsall's Soda Lakes, four in number. The waters of these lakes are very highly charged with soda, three and a half barrels yielding one barrel of crystalized sulphate of soda, as I am informed by Dr. Burdsall. The soil near the shores of these lakes, for twenty feet in depth, is heavily impregnated. Three pounds, when well leached, affords one pound of soda. In dry seasons the soda frequently lies four to six inches deep around the shores of the lakes, over an area of forty acres or more, and may be shoveled up in almost any quantity, sufficiently pure for metallurgical purposes, glass-making, etc., without redissolving and crystalizing. The salt, by analysis, contains sixty-three per cent. of soda—carbonate of soda, sulphate of soda, chloride of sodium, sulphide of calcium, and traces of manganese. By roasting, this salt can be converted into carbonate of soda, for which there is an almost unlimited demand. These deposits will, at no very distant day, form an important part of the industrial operations of Colorado.

TIMBER

of the softer varieties, such as pine, spruce, fir, aspen, etc., of the best quality, is abundant in the mountain regions all over the State, and cottonwood occurs in more or less

abundance along most of the streams on the plains, as well as in the mountains. Oak, maple, cherry, etc., occur in many places, but rarely, if ever, of sufficient size to be of much use for timber. Of pines we have three or four varieties; of spruce, at least three varieties; of fir, two varieties, one of which is the beautiful *silver fir*, highly prized here, as well as throughout the Eastern States, as an ornamental shade tree, and of cottonwood three varieties, all of more or less value for timber. Of native

ORNAMENTAL TREES AND SHRUBS

we have a considerable variety, among which may be mentioned the *ash-leaved maple*, or *box elder* (acer negunda), *flowering maple* (acer circinatum), *American aspen*, three varieties of *cottonwood*, *balm of gilead* (populus candicans), *American mountain ash* (pyrus Americana), a beautiful tree, growing from twenty to thirty feet high, flowering in June, and bearing beautiful flame red berries in clusters, some of them six inches across, which remain on the trees through the winter, making them highly ornamental throughout the year. *Silver* and *balsam fir*, *black* and *white spruce*, *hawthorn*, or *white thorn*, *snowberry* (symphoricarpus racemosus) *white flowering raspberry*, *common* and *staghorn sumach*, *red-berried* and *common elder*, *red cedar*, *red rose*, three varieties of *clematis*, or *virgin's bower* (c. virginiana, c. verticalaris, and c. pitcheri), and several others, all of which are found growing wild in abundance, and in a high state of perfection.

WILD PLUMS AND BERRIES

of many kinds are abundant, both in the mountains and on the plains, near the foothills. The *wild yellow*, or *red plum* (prunus Americana), *chickasa plum*, *sugar berry* (celtis occidentalis), and two or three other varieties of large plums, grow luxuriantly in many places along the streams near the base of the mountains, both in the low cañons, and on the plains, fully equal in size and flavor to the same varieties grown under cultivation in the Middle and Eastern

States. In the mountains, wild red, black and choke *cherries*, fox and Oregon *grapes*, red *raspberries*, *strawberries*, *mulberries*, *huckleberries*, red, yellow and black *currants*, smooth and prickly *gooseberries*, *service berries*, etc., grow in profusion, of good size and extra fine flavor. The raspberries, strawberries and huckleberries are especially noted for their high, delicious flavor, and the yellow and black currants (ribes floridum), for their remarkable size, being from one-third to half an inch in diameter. They are highly prized and extensively used for jellies and preserves. Experience has proven that many of these native plums and berries, though growing in such perfection in the wild state, can be greatly improved by cultivation, if intelligently managed. I hope to see more attention paid to this matter in the future.

AGRICULTURAL.

In the matter of profitable gains from agricultural pursuits, Colorado has few equals among the States and Territories. The official reports published annually furnish conclusive testimony on these points. The following extract from that of the Colorado Agricultural and Industrial Association for 1873, is put in evidence:

"In 1869 one of our farmers on the South Platte, a few miles above Denver, raised 90 bushels of wheat on one acre of land, 65½ bushels on another acre, and 550 bushels of wheat on ten acres of another farm. Another farmer raised on a single acre of land, 90 bushels of oats; and still another raised on eight acres, 640 bushels of oats. In one instance 250 bushels of onions were raised on a half acre of land. One thousand bushels of potatoes were the product of three acres. From one pound of seed barley 110 pounds were produced. Garden vegetables of all kinds attain an enormous size. Potatoes, cabbages, onions, squashes, melons, tomatoes, etc., yield astonishing crops. Experiments in the culture of the grape have demonstrated that vine-growing can be most successfully and most profitably undertaken," and that they can be grown as cheaply

and in nearly the same abundance as in California and Ohio, and of superior quality, for wine especially.

The following have been determined as about the average crops throughout the territory:

Wheat	28	bushels	per acre.
Oats	45	"	"
Barley	40	"	"
Corn	35	"	"
Potatoes	200	"	"
Onions	250	"	"

But these figures are far below what may be produced with extra care and labor. For three successive years the premium crops of wheat, exhibited at the Territorial fair, ranged from 67 bushels to 73 bushels per acre. In one year two fields of corn were sworn to as having yielded over 200 bushels per acre.

Potatoes have given from 400 bushels to 600 bushels per acre. Onions have reached 1,000 bushels per acre. A cabbage of 82 pounds weight has been sold in the Denver market. Those of 40 to 60 pounds each are plentiful at every annual fair. Car loads have been shipped away in which the closely trimmed heads averaged throughout 23 pounds apiece."

These were the results of ten years ago. The intervening period has developed a large increase of cultivable area, but less attention has been given to securing extraordinary returns from small tracts than formerly. Much comparatively poor land has been occupied and improved. In some cases the yields have declined, because of too frequently repeated cropping of the older and better farms, which exhausted the fertility of the soil; in others the want of adequate water for irrigating has effected a material decrease of yields. It is hoped that this difficulty will be partially, if not wholly, removed by the discovery of abundant artesian waters. An experimental well is now being sunk by the general government at Akron, near our eastern boundary, and the results are anxiously awaited, because upon

the issue will measurably depend the future of agriculture in this State. If successful, like wells will be rapidly multiplied, and vast tracts of land now practically valueless except for grazing, will be brought under tillage. The average yield of various crops for the past year is given below. It is proper to state, however, that 1882 was particularly unfavorable to farmers for various reasons, among them the cold storms of last spring, severe hail storms, and later the excessive drouth. In these estimates the several valleys are grouped together and the aggregate given:

Wheat.—Acreage, 18,835; yield, 376,700 bushels; average per acre, 20 bushels; value, $301,360.

Oats.—Acreage, 3,100; yield, 93,100 bushels; average per acre, 33 bushels; value, $65,170.

Barley.—Acreage, 4,000; yield, 81,620 bushels; average per acre, 21 bushels; value, $100,000.

Corn.—Acreage, 2,600; yield, 46,800 bushels; average per acre, 18 bushels; value, $42,120.

Hay.—Acreage, 6,000; yield, 5,925 tons; average red acre about one ton; value, $55,000.

Alfalfa.—Acreage, 1,250; yield—250 acres cutting three tons and 1,000 newly seeded cutting half a ton—1,250 tons; value, $15,000

Garden stuff, fruit, dairy products, poultry, eggs, etc., etc., $120,000; total nearly $800,000.

Wheat at the present writing is as low as 70 cents per bushel and a slow market.

WILD HOPS

abound, and attain high perfection in many of the cañons near the base of the mountains. I have the authority of one of the most intelligent brewers in the country for saying that in the manufacture of ale and beer, after repeated trials, he has found them to be worth fully 10 per cent. more than the best "New York extras." No attempt at cultivating them has yet been made, within my knowledge, but there can be no doubt of the success of the enterprise, when undertaken by persons of intelligence, having a good

practical knowledge of the business. There is now a very promising opening for enterprising, practical men to start business in this line, and one that promises as good returns for the capital and labor as any branch of industry established here.

WILD FLAX

of two varieties (*Linum Bootii and L. perenne*), also grows abundantly and with great luxuriance in many places, especially in the Parks, and its cultivation and manufacture will, at some time in the future, become an important branch of industry.

BEE CULTURE.

In this direction very gratifying advances have been made. I have no data showing the product of honey in past years, but I am convinced that if collated and published, its magnitude would be surprising to those unfamiliar with the progress of this industry, more especially because only a few years have elapsed since the first swarms were introduced. At the present time there are, probably, not less than 2,000 stands in this State, and it is believed they make as much honey on the average, as those of most Eastern States, and the quality is equally fine. The most successful apiarists of my acquaintance are Dr. D. W. King, of Boulder; Mrs. L. Groves, Arvada; Jesse Eastlake, Littleton; R. A. Southworth, W. C. Lothrop, Robert James, J. L. Peabody, E. Millison, John McBrown, James M. Clark, O. M. Chilcott and D. S. Grimes, of Denver.

FISH CULTURE.

This departure was inaugurated by the State Government two years since as an experiment, and Hon. Wilson E. Sisty appointed Commissioner. Under his management the progress made and results attained are very gratifying. A large number of German carp have been procured and distributed in the numerous lakes, where they have grown and multiplied. A hatchery has been established eight and a half miles below Denver, near the Platte River. In

December, 1881, 310,000 brook trout eggs from Massachusetts and California were placed in the troughs, 99⅛ per cent. of which were hatched. During the past year 283,000 of these fish were distributed in the streams adapted to them in different quarters, and reports therefrom say they are doing well. Two thousand remain on hand for the use of the State. Lots of mirror carp, black bass and croppy have been placed in the ponds at the hatchery, and it is believed they will flourish here as well as in their native waters.

FRUIT GROWING.

Developments in this direction have assumed more than ordinary importance in the past few years. While grave doubts are entertained by many of our more experienced farmers as to our ability to grow apples, pears, peaches and other varieties of large fruits, and market them at prices that will enable us to compete with importations from neighboring States, there is no doubt whatever as to the matter of raising all the better grades of small fruits, and their profitable sale in all our home markets. We have all the evidence required on this point. In most settled localities near the base of the mountains, strawberries, raspberries, blackberries, currants, gooseberries, cherries, grapes, plums, etc., etc., yield, under systematic culture, averages fully equal to those of the favored districts in California. The "Boulder strawberries" are widely recognized and eagerly sought, commanding much higher prices than those brought from California and Kansas because of their superior flavor. Hon. Joseph Wolff, Wm. Newland, Geo. W. Webster, C. S. Faurot, John Brierly and several others are among the principal cultivators of small fruits in the Boulder and St. Vrain sections, from whom I have been favored with much valuable data on this interesting subject. Some idea of the extent and importance of the advancement made, may be obtained from the following account of the shipments of a few gardeners in the town of Boulder, during the season of 1882:

Joseph Wolff raised 10,000 quarts of strawberries, 3,000 quarts of raspberries, 2,800 quarts of blackberries and 5,000 pounds of grapes.

Wm. Newland raised 1,000 quarts blackberries, 11,000 quarts of strawberries, 566 baskets of grapes, 600 quarts of currants, and 500 quarts of raspberries.

C. S. Faurot reports 2,500 boxes of strawberries, 500 boxes of blackberries and raspberries, and 1,200 baskets of grapes from one acre of land, which netted him a profit of $1,100, being the first season his vines have borne.

Perry White raised 2,000 pounds of grapes.

Byron Bliss raised 700 quarts of strawberries.

Other comparatively small shippers and private gardens raised half as many more, making the total products as follows:

Strawberries	36,300 qts.
Raspberries	5,250 "
Blackberries	6,450 "
Currants	1,000 "
Gooseberries	1,000 "
Grapes	24,000 lbs.

The prices of the berries varied from 20 cts. to 35 cts. per quart at the railroad station, averaging about 28 cts., and the grapes 25 cts. per pound, which gives a net income of $20,000 from these crops alone.

It is proper to add that the past season was extremely unfavorable, owing to the effects of late frosts. The principal growers estimate a loss of one-fourth of the usual crop from this cause. The chief varieties of strawberries grown are the Wilsons and Jocundas, as they are more prolific bearers, besides being in greater demand by consumers.

In addition to eleven acres of strawberries, Mr. Wolff has seven acres of blackberries, embracing the Hoosac, Thornless, Snyder, Wilson, Kitatiny and Dorchester; seven acres of raspberries, of the Philadelphia, Turner and Hersteine, of the red and black-cap varieties, with the Gregg and Miami of the black; 4,000 grape vines, comprising the Lady Walter, Clinton, Croton, Catawba, Isabella, Moore's Early,

Duchesse, Hartford Prolific, Concord and Delaware. Of these the last four varieties have been thoroughly acclimated, andproven highly satisfactory in all respects. Mr. Wolff is confident that there will be no difficulty in making these grow luxuriantly in our soil, and that they will bear each year, with proper attention to their natural requirements under new conditions. It will be necessary, however, to remove the vines from their trellises before cold weather occurs, to thoroughly prune, and cover them with sufficient earth to prevent the winds from breaking them when rendered brittle by frost.

The sales of small fruits have been supplemented by a new branch of this industry, which promises to become quite extensive and profitable, namely, the manufacture of wines. During the past two years, Mr. Wolff has utilized his surplus of strawberries, currants, gooseberries, grapes, etc., in this manner, producing delicious and very superior wines at insignificant cost.

Many experimental attempts to raise apples, pears and peaches have been made, but generally with no very encouraging results. The greatest obstruction seems to be in the usual occurrence of warm weather in March and April, which causes the buds to swell, when they are killed by succeeding hard frosts. This difficulty has been measurably overcome in some localities by planting the trees on northerly slopes and mulching them heavily. But the mulching is not always advantageous, because it affords shelter for field mice, who gnaw the bark from the trees near the ground. At Longmont, Greeley, Fort Collins, Evans and other points, considerable quantities of small fruits are grown, but I have no statistics showing the extent.

In the Valley of Clear Creek, between Golden and Denver, there are several flourishing and quite extensive apple, peach, cherry and plum orchards, grape vineyards, strawberry, raspberry, blackberry, currant and gooseberry plants, which furnish Denver with a certain part of its demand.

From insignificant beginnings, this industry has been gradually enlarged from year to year, but it may be said to be still in the infant stage, with great encouragement for the future.

Fremont County, in the neighborhood of Cañon City, has some of the largest and most productive apple orchards in the State. Mr. Jesse Frazer was the first to undertake fruit raising in that section. He planted twenty trees in 1860, began root grafting in 1869, and continued it through 1871-72-73, and now has 40 acres of land in fruit—eight miles below the town mentioned above. About 20 acres are producing apples, pears, peaches, grapes, cherries, plums, raspberries, blackberries, currants, gooseberries, strawberries, etc. He permits the apple, pear and peach trees to branch very near the ground, so low indeed, it is said, that standing by the trees he can gather fruit from the topmost limbs. Mr. McCandless and Edwin Lobach also have productive orchards. This is undoubtedly one of the best fruit growing sections of Colorado. I am informed that over 200 acres, near Cañon City, are devoted to orchard settings, and the acreage is constantly increasing. The trees begin to bear at six years of age, and are believed to be in full power at ten to twelve years. Further down the Arkansas, in Bent County, there are a few fine orchards in bearing, many others approaching it, and still others being started. Wild grapes and plums grow in that region in wonderful luxuriance and profusion, and there is no doubt that all varieties of small fruits grown in the Middle and Eastern States may be brought to high perfection there. Some fruit has been raised in the Animas Valley above and below Durango, and it is generally supposed that this region will, in the course of time, take a conspicuous part in its culture.

In closing this report, I desire to thank the Union Pacific, Denver & Rio Grande, Atchison, Topeka & Santa Fe and the Atlantic & Pacific Railroad Managers for many courtesies extended; also the members of the press, for their uniform interest in and encouragement of my labors.

I append a catalogue of all the minerals of Colorado thus far noticed, together with remarks on the local peculiarities of several species. Quite an extensive collection of minerals and fossils has been made, and a large portion placed in the cabinets of the State University, at Boulder, and the School of Mines, at Golden. A large number of duplicates remain on hand for other State institutions, subject to their call.

CATALOGUE

OF THE

PRINCIPAL MINERALS OF COLORADO,

WITH ANNOTATIONS

ON THE

LOCAL PECULIARITIES OF SEVERAL SPECIES.

By J. ALDEN SMITH.

The following is believed to be a full (or nearly complete) list of all the minerals noticed in the State of Colorado, up to this time. The author first published a catalogue of the minerals which had up to that time come under his observation, in the Black Hawk *Journal*, in 1865, and in 1870 and 1880 he published revised and amended catalogues, in pamphlet form. In making up the following he has availed himself of the observations of Dr. Frederick M. Endlich, Whitman Cross and W. F. Hillebrand, of the United States Geological Survey; of Mr. Persifor Frazer, Mr. Arch. Marvin, R. C. Hills, E. E. Burlingame, Drs. Genth, Loew, Peale and others. The single initial after the notice of the mineral indicates the name of the gentleman who first observed it.

Agates of the different varieties are common in many localities. Beautiful *moss agates* are found in the Middle Park, and many fine gems have been and are to be found there. The dendritic delineations (" moss ") are usually of a brownish black color, but green, red, yellow and white are not uncommon colors. They are found in many local-

ities in Colorado, but so far as my knowledge extends, no fine gems have been found outside of the Middle Park.

Fortification and Ribbon Agates are abundant near the mouth of Willow Creek, Middle Park, and at different points on the Arkansas River, but are of inferior quality as compared with the Oberstein and Lake Superior agates.

Fine geodic specimens, lined with amethyst, have been found on the summit of the Range, east of the Animas. S.

Actinolite.—Abundant in many localities. Radiated form, in fine specimens near Bergen's ranche. Asbestiform variety in metalliferous veins, associated with lead, zinc, copper and iron, near the head of North Boulder Creek. In radiated form, of light green and bluish green colors, on Mount Ouray. S.

Alabandite.—At Quartzville, Park County. P.

Alabaster.—Near Mount Vernon and Cañon City in considerable quantity and fair quality. S.

Albite.—Common in several localities. Fine xls. near Central City; Gold Hill, Boulder County; and Breckenridge, Summit County. S.

Allophane.—Has been noticed in the Franklin mine, Gilson Gulch, and in the Cincinnati mine, Central City, associated with native silver. S.

Altaite.—Slide, Cold Spring, Prussian and Red Cloud mines, Gold Hill. Some fine xld. specimens have been found in the Slide mine.

Alum.—Is to be found, native, near Mount Vernon—also *aluminite*, or alum stone, at the same place. S.

Amalgam.—Has been found in connection with Coloradoite, in the American, and several other mines, at Sunshine, Boulder County; Keystone, Magnolia; and Smuggler, Balarat. S.

Amber.—One specimen, said to have been found near the head of Cherry Creek. Doubtful. E.

Amazon Stone.—Fine, large crystallized specimens on Elk Creek, five miles above the crossing of the Tarryall road, associated with orthoclase, smoky quartz, aventurine,

micaceous iron and anhydrite, the latter rare. Also at Crystal Peaks, Park County. One xl. in the author's collection, from the latter locality, is fourteen inches long, four inches square, of a very fine, even, dark green color, and has one good termination. S.

Amethyst.—Has been found in many different localities in Colorado, and in some places quite abundant. Small crystals of rare brilliance and good color have been found at Nevada. The author obtained some exceedingly fine ones there in 1864, one of which was cut, making a jewel which measures 7x10 lines, and is pronounced by lapidaries and jewelers to be the finest amethyst ever found in America. S.

Amianthus.—Head of North Boulder Creek, in galena veins. S.

Amphibole.—Common in dikes traversing granite, in many localities. P.

Analcite.—In minute xls. in basalt, near Uncompahgre Peak. E.

Andesite.—Minute xls. in trachytes, near Black Mountain. E.

Anglesite.—Freeland mine, Trail Creek, and in many of the carbonate mines about Leadville. S.

Anhydrite.—A single specimen in the author's collection, of a wine-red color and quite transparent, from near the head of Elk Creek. S.

Anthophyllite.—Near Post's ranch, and head of North Boulder Creek. S.

Anthracite.—In the Elk Mountains, Anthracite Creek, Uncompahgre Cañon, etc. Dr. Endlich says: "This anthracite coal is of lower and upper cretaceous age. Partly its greater age, and partly other causes, have given to it the anthracitic character. Nearly all of it was originally simply bituminous coal." Dr. Peale says: "The eruption of the trachyte found near the coal first mentioned probably so heated it as to deprive it of the bituminous matter."

Antimony.—Occurs as a sulphuret, and probably in other forms, associated with silver, copper, lead, etc., in many of our gold and silver mines. S.

Antrimolite.—Occurs sparingly in amygdaloid at Table Mountain, near Golden City. S.

Apatite.—In beautiful nodular clusters of crystals, occurring in clay, near Fort Collins. S.

Apophyllite.—Hunt's Peak. Also from the basalts near Golden, and San Luis Valley. E.

Arfvedsonite.—In quartz, El Paso County. E.

Aragonite.—Near Golden City, and at Georgetown, in fine specimens. S.

Arsenic.—Occurs occasionally in our mines, the same as antimony, but neither of them has ever been found in the native state, within my knowledge. Fine specimens of arsenical iron, yielding as high as 400 ounces silver per ton, have been taken from the Whale mine, Spanish Bar. S.

Asbestos.—Is occasionally found with actinolite, on the head of North Boulder Creek. S.

Argentite.—Occurs sparingly, rarely xld., in many of the silver mines at Georgetown, Caribou, Mount Lincoln, Tomichi, etc. S.

Arsenopyrite.—Crystallized and massive in Burroughs, Kansas, Illinois, California, Kent County, and many other mines in Gilpin County. It is associated with iron and copper pyrites, usually carries a small per cent. of gold, and a much higher per cent. of silver. S.

Asphalt.—Occurs in veins, and in springs in the White River region, and near Cañon City. E.

Astrophyllite.—Occurs in quartz on Cheyenne Mountain. E.

Atacamite.—In some of the silver mines on Kendall Mountain, near Howardsville. E.

Augite.—Table Mountains, near Golden City. S.

Aventurine Quartz (?).—From Elk Creek. The specimens in the author's collection show *white* scales or blisters, instead of yellow, the usual color. S.

Aventurine Feldspar.—With Amazon stone, from Elk Creek. S.

Aurichalcite.—In Jones mine, Nevada, coating zinc blende. G.

Azurite.—In the surface ores of many of the silver mines of Boulder, Gilpin, Clear Creek and Park Counties. No large xls. have been found, but some very brilliant small ones have been observed. S.

Baryta.—Occurs as a sulphate (heavy spar), in many of our mines and in extensive beds on Vasquez River. Some splendid *transparent* xls. are found with calc spar, on Apishapa Creek. S.

Basanite.—South Park, east of salt works, with flint, in trachyte. P.

Beryl.—From Bear Creek, below Harrington's saw mill, and on Tiffany's ranch. A few very good specimens of aqua marine have been obtained in the latter locality, and on Mt. Antero, Chaffee County. S.

Biotite.—Small xls. are found in porphyritic trachytes, Buffalo Peak, South Park. P.

Bismuth.—Occurs native, as a sulphide and carbonate in the Las Animas Mine, Sugar Loaf District, Boulder County, and in some of the Snake River silver mines. A copper-bismuth mineral, containing much silver, has been noticed by R. C. Hills, as occurring in the Comstock mine, near Parrott City, La Plata County. It has not been satisfactorily investigated as yet. May be a new mineral, or possibly argentiferous wittichenite or emplectite. S.

Bornite.—Occurs on the Rio Dolores, San Juan and near Cañon City. Beautiful specimens in Hukill Mine, Spanish Bar. E.

Bournonite.—Terrible Mine, near Georgetown, xld. E.

Bloodstone, or Heliotrope.—Found sparingly in Middle Park. S.

Brucite.—A single specimen, from Jamestown, noticed by the author in 1866. S.

Cairngorm Stone.—Head of Elk Creek. Some fine gems, equal if not superior to the best Scottish stones, have been obtained in this locality. Also some very large and fine transparent xls. have been found at Crystal Peaks, west of Pike's Peak. One xl. in the writer's collection is twenty-six inches in length, four inches in diameter, and clear. S.

Calamine.—Gilpin and Clear Creek Counties.

Calaverite.—Associated with other tellurides in the Slide, Cold Spring, American, Keystone and other mines in Boulder County. S.

Calcareous Spar.—Near Mount Vernon, and at Bergen's ranch, in brownish white xls. Also in octahedral xls. on Apishapa Creek; scalenohedra in Elk Mountains; fibrous in Trout Creek Park; beautiful rose color, in San Juan. S.

Caledonite.—Freeland Mine, Trail Creek. S.

Carnallite.—Salt Works, South Park. P.

Carnelian.—White, from the South Park, and flesh-red, rare, from the Middle Park. S.

Cerargyrite.—In masses sometimes an inch or more in thickness, in some of the mines about Leadville; at Rosita, Silver Cliff, etc. S.

Cerussite.—Pleasant View and Gunnell Mines, Central City; Rosita and Leadville Mines, etc. S.

Chabazite.—Table Mountains, Golden City, and in basaltic geodes, Uncompahgre Peak. E.

Celestite.—Apishapa Creek, and near Manitou, in beautiful azure blue xls. S.

Chalcanthite.—On Clear Creek, below Black Hawk, in a deposit. Also on many old mine dumps near Central. E.

Chalcedony.—Beautiful specimens of the hydrous varieties are obtained from a large vein of siliceous sinter, below the Salt Works, South Park, in botryoidol, mammillary and stalactitic forms. It is frequently met with lining cavities in the mines. One specimen in the author's collection, of the mammillary form, shows green, brown, red, yellow and white colors. Nodules and geodes occur in abundance in the Middle Park, from the size of a pea to four inches in diameter. S.

Chalk.—On the Smoky Hill route, eastern part of the State, in huge bluffs, 100 to 300 feet high. S.

Chalcocite.—Bergen District; Liberty lode, Bear Creek and Sugar Loaf, Boulder County. S.

Chalcopyrite.—Common in many of the gold and silver mines throughout the State. In the gold mines of Gilpin County it is always both auriferous and argentiferous, but in different mines it varies very much in the per cent. of precious metals. In the Bobtail, Gregory, Bates, Fisk and others, it is the richest portion of the ore, yielding from four to fifteen ozs. gold per ton, and twenty to forty ozs. silver, while the iron pyrites is comparatively barren. In the Burroughs mine the chalcopyrite does not yield one ounce gold per ton, while the iron pyrites yields from four to ten ozs. The same is true to a greater or less extent in several others of the mines in that region. At times, beautiful xld. specimens of this mineral can be found in nearly all the paying gold mines of Gilpin County. S.

Chlorite.—Trail Creek and Mount Princeton. S.

Chlorophane.—In many copper and lead lodes, in Bergen District. S.

Chromite.—Mount Silver Heels, near Fairplay. P.

Chrysocolla.—Trail Creek and head of San Luis Valley. S.

Chrysolite.—Occurs in the drift in the extreme southern portion of the State, and in the trachytes in several places. E.

Chrysoprase.—Occurs very rarely; but some very fine gems of this mineral have been found in the San Juan region. S.

Coal.—Brown coal or ligneous coal, in banks twelve to sixteen feet thick, near Denver, Boulder, Golden, Cañon City, Trinidad, El Moro, etc. S.

Albertine coal, in veins three feet wide, in the Middle Park, noticed by Professor Denton, in 1865. S.

Coloradoite (*sp nov.*), *Telluride of Mercury.*—Occurs in several of the Telluride mines in Sunshine, Magnolia and Balarat Districts, Boulder County. S.

Columbite.—Occurs in prismatic needles, penetrating the zircons of Pike's Peak. E.

Copper.—Native copper is occasionally found in the form of dendritic coatings, filling seams in the gangue rock of several of our mines, but it is rare. A few very fine cabinet specimens of dendritic, or moss copper, in masses of several pounds weight have been taken from the Narragansett Mine, Gregory lode. Beautiful microscopic xls. are found in seams of the gangue rock, in the Ni Wot Mine, Ward District. S.

Covellite.—Gunnell and Sap Mines, near Central City.

Copper Pyrites.—Sulphuret of copper and iron. This mineral is quite common in most of our mines, below the permanent water level, and usually contains a good per cent. of gold, selected specimens sometimes yielding as much as fifty ounces per ton. Good cabinet specimens may be obtained from any of our deep mines. S.

Cryolite.—Crystal beds, near Pike's Peak. C.

Cuprite.—Fine specimens from the Malachite lode, Bear Creek. In crystals, from Sacramento Gulch, and from Sweet Home Mine, Buckskin. S.

Dolomite.—Occurs as a rock at Leadville, and other places in the State. S.

Dechenite (*?*).—Carbonate mines, Leadville.

Descloizite (*?*).— " " "

Derbyshire Spar.—Argentine and Wisconsin lodes, Bear Creek. S.

Dyscrasite.—Reported from Poughkeepsie Gulch, head of the Uncompahgre. E. and Hills.

Embolite.—Peru District, Snake River, and Leadville. S.

Enargite.—Beautifully crystallized and massive specimens have been found in the Powers Mine, Russell District, and massive, in San Juan. S.

Egeran.—Fine specimens south of Genesee ranch, on Bear Creek. S.

Epidote.—Fine crystalline specimens on Trail Creek, Virginia Cañon, Russell District, and other localities. S.

Fahlerz.—Common in many of the silver mines at Georgetown, Caribou, San Juan, etc. Some beautiful xls. have been obtained from the Freeland Mine, Trail Creek.

Feldspar.—Fine, large xls., detached and in clusters, abundant on Elk Creek, and at Crystal Peaks, west of Pike's Peak. Also xls. of the sanidin variety in great abundance on Gregory Hill, Black Hawk. Some rare pseudomorphs after micaceous specular iron occur at the Elk Creek locality. Also a few very perfect *hopper shaped* xls. were found by the author, near Idaho, in 1867. In crystalline form they are square prisms one-fourth to three-fourths of an inch in diameter, and one inch in length, with the tops indented in the same form as salt xls. S.

Fire Clay.—In great abundance near the coal banks of Golden City, Ralston, Boulder, and in the Middle and South Parks. S.

Float-stone.—Very large, fine specimens, snow-white, and in some cases showing thin scales of gold, have been taken from the Mammoth lode, Central City. S.

Flos Ferri.—Specimens of rare beauty have been found in a vein near Golden Gate. S.

Fluor Spar.—Massive, in wide metalliferous veins, near Bear Creek. The white, green, pink and purple colors are common, and often all these colors occur in irregular bands in a single specimen. It also occurs quite frequently in the silver mines at Argentine and Georgetown; also in extensive beds at James Creek, sometimes containing visible *free gold.* Large crystals, sometimes ten inches across, are found at Crystal Peaks. S.

Franklinite.—In mispickel, on Rio Dolores. E.

Freislebenite.—At head of Cement Creek, near Baker Park. E.

Galenite.—Occurs in many of our gold and silver mines. Beautifully crystallized specimens have been found in the Glennan and Running lodes, Black Hawk, the Delaware and Calhoun lodes, Russell District, Mount Desert, Forks and others, Nevada. Some fine crystals, two inches across, from the Glennan lode.

The galena of this State is frequently remarkably rich in silver, sometimes yielding 200 to 300 ozs. per ton; and one specimen in the collection of Prof. C. A. Martine, of Georgetown, from the McClellan lode, is 11 per cent. silver. S.

Garnets.—Precious garnets are found in quantities in the bar diggings of the South Park, and also across the Range, about Breckenridge and other places. They are usually quite small, however, and of no value as gems. Ferruginous garnets occur in great abundance at Central City, Trail Creek, Bergen's ranch and other localities, in large veins, associated with epidote, quartz, calc spar, and sometimes copper pyrites. Dodecahedrons, six inches in diameter, have been found at Bergen's ranch.

Manganesian garnets occur in gneiss, at Spanish Bar, Sugar Loaf and other localities, in great abundance. Beautiful specimens of *topazolite* are found near the Malachite lode, on Bear Creek. S.

Glockerite.—Central City, on many old dumps. E.

Gothite.—With hematite, on Topaz Buttes. E.

Gold.—Crystallized gold is quite rare in this State, though a few very good specimens have been found. Beautiful microscopic crystals have been found in considerable abundance, in the Gunnell, Gregory, Bates and other mines near Central City. Some beautiful and rare specimens were taken from the Leavitt lode, Mountain City, in 1866. The gold was in coarse wires, attached to the gangue by the ends only, and bowing out from it half an inch to an inch, forming a net-work of angles and circles. Many of the wires of gold were covered with a drusy siliceous coating, and some were covered with minute crystals of GALENA. "Wire gold," strings of minute octahedral crystals, united and forming serrated, fluted, or chain like wires, an inch or more in length, are sometimes found in many of our mines. One specimen from the Briggs Mine, consisting of small striated wires of gold, interwoven among quartz xls. and cubes of iron pyrites, is the most beautiful and interesting

specimen of the kind that I have ever seen. Some beautiful octahedral xls. about the size of pin heads attached to xls. of iron pyrites, zinc blende and galena, were taken from the Pleasant View Mine in 1869. A large quantity of crystalline gold of peculiar forms was taken from a vein in California Gulch, in 1869. There was about 100 ozs. in the lot shown me, in xls., arborescent masses and thin plates, from less than a troy grain up to fourteen ozs. in weight. The whole was in crystalline forms, more or less perfect—some in small but distinct cubes and octahedrons, some in chain-like wires, flattened and striated wires, arborescent masses resembling bunches of moss, and some in smooth plates, showing the crystalline form around the edges only, which were finely serrated. Some of the plates were half an inch broad, by an inch long, and of the thickness of heavy letter paper. Much wire gold has been taken from the American and Slide mines, in Boulder County, associated with telluride ores. Some of the wires from the American are four inches in length, and not larger in diameter than a fine cambric needle; and many of them have microscopic xls. of petzite attached to them. Most of the wires from these mines, however, are short and thick, being one-fourth to half an inch in length, by one-eighth to three-sixteenths of an inch in diameter, and beautifully striated. Many of these wires are petzite, simply coated with a thin plate of gold. Much material has been taken from the American and Slide mines that is of great interest for microscopic investigation, as well as for careful analysis. S.

Gold in fluor spar, Jamestown, and in sul. baryta xls., and in enargite, Summit District. S. Hills.

Electrum.—Has been found in the Champion mine, Trail Creek and in some of the Gunnison County mines.

Gearksutite.—Crystal beds, near Pike's Peak. C.

Goslarite.—On the dump of the Wood mine, Leavenworth Gulch, Gilpin County. E.

Graphic Granite.—Near Colver's Mill, Bear Creek, and on Gold Hill, Boulder County. Very fine specimens in the latter locality. S.

Graphite.—Trinidad mines, Las Animas County, in large xls. S.

Greenockite.—On sphalerite, in the Dallas mine, Black Hawk and Jones mine, near Central. S.

Gypsum.—In beds ten feet thick, in the South Park; also in fine arrow-head xls. and fibrous masses near Mount Vernon, Cache-la-Poudre and other places. S.

Halite.—Occurs at Salt Works, South Park and at salt-licks in various parts of the State. P.

Hæmatite, Red and Brown.—Bellemonte Furnace, Golden City and other localities. S.

Halloysite.—Leadville.

Henryite (*sp. nov.*).—First found in the Red Cloud and Cold Spring mines at Gold Hill by Dr. Endlich.

The analysis corresponds very nearly with that of Altaite, with the exception of the quantity of iron, which might be accounted for by the presence of a little pyrite in the altaite, with which it is always intimately associated in those mines. S.

Hessite.—Occurs abundantly in the Slide and Prussian mines, and sparingly in the Cold Spring, American and other mines at Gold Hill and Sunshine, and in the Hotchkiss mine, near Lake City.

Heulandite.—Near Uncompahgre Peak, in basalt. E.

Hyalite.—Near the Hot Sulphur Springs, Middle Park—rare. S.

Hypersthene.—In some of the dikes of the Front Range. E.

Idocrase.—Near Malachite lode, Bear Creek, and on North Saint Vrain Creek—fine specimens. S.

Iodyrite.—A small fragment found in some surface ore from the Red Cloud mine, Gold Hill; also at Leadville. E.

Iron,—Bi-Sulphuret, or Iron Pyrites.—This very common mineral is found in abundance in all our gold and silver mines, crystallized and massive, and always carries more or less gold and silver in chemical or mechanical combination, and is sometimes very rich in those metals. Beautiful cab-

inet specimens, in cubes from one to three inches across, have been taken from the Kingston, Hill House, S. P. Chase and other lodes, Russell District. Fine octahedral xls. are found in the San Juan region. Also some fine clusters of *rhombic* xls. are found in the Elk Mountains, p ntagonal dodecahedra in several mines in Gilpin County. *Radiated* and *Botryoidal* masses are found in Gilpin and Boulder Counties. S.

Jamesonite.—Sweet Home mine, San Juan and Summit District, near Del Norte. P.

Jarosite.—On the dump of the Wood mine, Leavenworth Gulch, Gilpin County. E.

Jasper.—Is found abundantly in the South and Middle Parks, of various colors, red, brown, yellow, green and black. S.

Jet.—Found near Golden City, and in the Cañon coal-fields. S.

Kaolinite.—The white, chalk-like bluffs on Chalk Creek. Product of decomposed oligoclase. E.

Kobellite.—Has been found sparingly in Moscow mine, Sugar Loaf District, Boulder County. S.

Labradorite.—In the dolerites of the State, generally, and in large xls. on Parmelee's ranch, Deer Creek, Park County. S.

Lanarkite.—Carbonate mines, at Leadville, and in Tin Cup mines, and Sacramento mines, Park County. E.

Lead.—Native lead. A single specimen only has been noticed here, which was found in a lot of ore sent to the author to be assayed, from a lode near Breckenridge, the name of which is unknown. The metal occurs in small grains and wires, attached to partially decomposed galena. S.

Leadhillite.—Leadville.

Lepidolite.—Rito Alto Peak, in a form resembling the Saxon Zinnwaldite. E.

Leucite.—Table Mountain, near Golden City. S.

Leucopyrites.—Fine specimens of this mineral, rich in silver, from the Whale mine, Spanish Bar. S.

Lignite.—Greenland, on Denver & Rio Grande Railway, where it retains its woody structure in an eminent degree. S.

Limonite.—Common in several localities. Pseudomorph after Siderite, crystal beds, near Pike's Peak. S.

Lievrite.—North Clear Creek, below Black Hawk.

Lime.—Mount Vernon, Golden City, Boulder, South and Middle Parks, etc. A deposit of limestone of the variety known as Gibraltar Marble, was discovered by the author near Idaho, in 1867, where fine specimens can be obtained in abundance. Also fine brecciated marble, in Boulder County. White and clouded marbles in Park and Chaffee Counties. S.

Lithographic Stone.—Specimens of this stone of very good quality, occur near Boulder City, but it is doubtful if large specimens could be obtained. S.

Lionite (*sp. nov.*).—From Mountain Lion mine, Magnolia District, Boulder County.

Magnesite.—Occurs in the Bobtail, Running and Pewabic mines, Gilpin County. S.

Magnetite.—In octahedrons, is found on Gunnell Hill, Central City; Vasquez River, below Idaho, and other localities. Also massive in a large vein, at Caribou. S.

Magnetic Pyrites.—Near Running lode, Bobtail Hill and in Sharkskin lode, Sugar Loaf District. S.

Magnolite (*sp. nov.*).—From American, Keystone and other telluride mines, in Boulder County. It is the result of decomposition of Coloradoite, according to Dr. Genth, and occurs in capilloid and acicular crystals. It has the formula Hg_2TeO_4.

Malachite—Green Carbonate of Copper.—The earthy variety has been found quite abundantly near the surface, in Malachite lode, Bear Creek; also some small crystalline specimens, of fine color and high lustre, from the Champion and Coyote lodes, Trail Creek. S.

Manganese.—The per-oxide and bin oxide occurs in many places throughout the State. It occurs in arborescent delineations between layers of sandstone, and in seams

in other rocks (by the miners called "forest rock,"), frequently forming dendritic specimens of rare beauty. S.

Marcasite.—In several gold mines in Boulder and Gilpin Counties. S.

Melaconite.—Occurs in the Gunnell, Sap, Briggs and other gold mines in Gilpin County. P.

Melanterite.—On the old dumps of many of the gold mines in Gilpin County. E.

Melonite.—Occurs rarely in some of the telluride mines in Sunshine District, Boulder County. S.

Mercury.—Occurs native, as the result of decomposition of Coloradoite, in the surface ores of many of the telluride mines of Boulder County. S.

Mesitine Spar.—Fine specimens of this mineral are found in the Black Prince lode, Lump Gulch. S.

Mesolite.—North Table Mountain, near Golden. E.

Minium—Oxide of Lead.—Occurs sparingly in the Freeland mine, Trail Creek. S.

Mineral Resin.—Marshall's coal mine, Boulder; also in the Golden City and Ralston Creek coal mines. S.

Mica.—Abundantly distributed throughout the mountains, but rarely in fine xls., or in plates of sufficient size or purity to be commercially valuable. S.

Microclin.—Crystal beds, near Pike's Peak. C.

Molybdenite.—Leavitt lode, Central City, Boulder and Gunnison Counties. S.

Molybdite.—Alice Carey mine, San Juan District. E.

Nagyagite.—In American and Phil. Sheridan mines, Sunshine, and probably in other telluride mines, in Boulder County. S.

Natrolite.—Table Mountains, near Golden City. E.

Nicolite.—Gem mine, Grape Creek Cañon, Fremont County.

Obsidian.—Silver Cliff, Buffalo Peaks, etc. A heavy vein of porphyritic obsidian occurs near the Rio Grande Pyramid, and nodules occur in the lower trachytic series. P.

Oligoclase.—Occurs in many of the granites, and in the volcanic rocks of the State. Good xls. are quite rare. E.

Olivene.—Transparent, green, in the basalts of the San Luis Valley. E.

Onyx.—Middle Park, west side of Grand River, near Willow Creek, associated with chalcedony, jasper and fortification agate. S.

Opal.—A variety of opal of a milky bluish-white color, and very transparent, is found near Idaho, Clear Creek County, in a vein of auriferous quartz. Some pieces show a decided opalescence when cut, but do not reflect much play of colors. A yellowish, slightly translucent variety of semi-opal is abundant in a vein of siliceous sinter, in the South Park. In this latter locality the specimens are frequently penetrated with oxide of manganese, in massive, botryoidal and arborescent forms, often presenting specimens of rare beauty. It is also found in the San Juan region, and at Buffalo Peaks. S.

Wood Opal.—On Kiowa and Bijou Creeks, in great quantity and fine specimens. S.

Ozocerite.—Near Animas City, La Plata County.

Pargasite.—In small particles in quartz, in a dike north of Centreville. E.

Petroleum.—Oil wells in Oil Creek Cañon, east of Cañon City, and Smoky Creek, ten miles south of Golden. E.

Petzite.—In American, Slide, Prussian, Cold Spring and other telluride mines in Boulder County.

Phenacite.—Crystal beds, near Pike's Peak. C.

Pickeringite.—Near Monument Park, crystalized in thin needles.

Porphyry.—Gold Hill District, and on Gregory Hill, Black Hawk, containing highly perfect xls. of feldspar, from one half inch to one inch across. S.

Prase.—Found sparingly in the Middle Park, associated with chalcedony and jasper. S.

Pitchblende.—Wood mine, Russell District. S.

Plumbogummite.—On lead and copper minerals, in Dallas mine, Black Hawk. E.

Polybasite.—In tabular xls. at the Terrible mine, near Georgetown. E.

Prehnite.—Said to occur near Fairplay. P.

Proustite.—With galenite, in Brown mine, Georgetown. E.

Pseudomalachite.—Little Platte River, south of Fairplay. P.

Psilomelane. — Seaton mine, near Idaho, and other places. E.

Pyrargyrite.—In many of the silver mines near Georgetown and in San Juan; Boulder County, etc. E.

Pyrolusite.—On Silver Heels, near Fairplay, and in San Juan. P.

Pyromorphite.—In the Freeland, and in several lodes about Georgetown.

Pyroxene.—In the younger volcanic and metamorphic rocks, near Fairplay, and in San Luis Valley. P.

Pyrrhotite.—In Gilpin and Jefferson Counties. S.

Quartz.—This very common mineral is found in all our mines, some of them producing very beautiful groups of crystals, intermixed with xls. of iron and copper pyrites, zinc blende and sometimes small wires and xls. of gold. Very large xls., from two to four inches in diameter, sometimes partially covered with micaceous iron, have been found on the Platte, near Hepburn's ranch. Fine smoky xls. have also been found on Elk Creek and at Crystal Peaks, Park County. Very fine specimens of Rock Crystal have also been found on the divide between the Platte and Arkansas Rivers, near "Dirty Woman's Ranch." Very brilliant double-terminated xls. attached to the gangue by a *stem* in the base of each, are quite common on Quartz and Nevada Hills, and in several mines on Trail Creek. They seem to have been formed by replacements on smaller xls. of a dull brownish color, the smaller xls. being the stems of the perfect ones, and are usually about one-fourth as large. Some remarkable tabular xls. also occur detached and lying loose in cavities lined with feldspar xls., at Elk Creek. The author obtained some in that locality some years since, five inches in length, three inches wide, and only half an inch thick—double terminated and perfect

in every particular except the flattened form. Jet black, double terminated xls., four inches long and half an inch in diameter, of regular six-sided form, were also found at the same time and place. S.

Rose Quartz.—Found at Central City and on Bear Creek. S.

Rhodocrisite.—In Sweet Home and Tanner Boy mines, Park County, in beautiful specimens. S.

Rhodonite.—Near Howardsville, San Juan. E.

Ripidolite.—Trail Creek, Clear Creek County, and in Little Giant lode, San Juan. E.

Roscolite (*sp. nov.*).—A greenish mineral found in many of the Telluride mines of Boulder County.

Rutile.—Occurs in quartz, on Ute Pass. P.

Sapphire.—A few pale blue and white specimens of this gem have been found in the drift, near Denver. S.

Schapbachite.—Reported near Georgetown, in silver mines. E.

Scheelite.—Reported in some of the mines near Baker Park, in crystals. E.

Schirmerite (*sp. nov.*).—In silver mines, near Montezuma.

Salt.—South Park, twenty miles southeast from Fairplay, where there are large saline springs, and works erected capable of manufacturing 10,000 pounds per day. S.

Sard.—Sardonyx. Middle Park. Fine specimens rare. S.

Satin Spar.—Abundant near Mount Vernon, associated with alabaster and arrow-head xls. of gypsum. S.

Schreibersite.—Specimens in the writer's collection from the Colorado ærolite. S.

Siliceous Sinter.—A large vein in the South Park, five miles from the Salt Works. S.

Selenium.—Occurs with sphalerite in Ætna tunnel, near Black Hawk, but in just what form has not yet been determined. S.

Serpentine.—Small specimens occur in the metamorphic rocks of Mosca Pass. E.

Siderite.—In many of the mines of Gilpin County, xld. Also at Gold Hill, Rosita, etc. S.

Silicified Wood.—Middle and South Parks, Cherry Creek, Kiowa and the Platte Valley generally, from the base of the mountains to Julesburg. A number of stumps of trees, completely silicified, and standing ten to twenty feet high, and six to twelve feet in diameter, were standing, a few years since, in Florrisant Valley, and the author has seen on Kiowa Creek, a log completely silicified, twenty inches in diameter, and of unknown length, as it was buried in the bank of the stream, with one end protruding a few feet. Specimens of the agatized variety are often met with, very transparent, and, when sawed across the grain and polished, retain all the original texture and grain of the wood. They are frequently so cut and set as gems. Fragments of roots and branches, having knots in them, are sometimes remarkably beautiful. S.

Silver.—Native Silver.—Containing a small per cent. of gold has been found in the Crystal lode, Virginia Cañon. Also in the Coaley lode, Black Hawk, in the Terrible, Brown, Equator and other mines about Georgetown, in some of the Snake River mines, the Caribou and other lodes, Grand Island, and the Hoosier, Gold Hill. Also in small nuggets, in the Gulch mines, near Fairplay, with gold; San Juan, Gunnison, Tomichi, etc. S.

Smaltite.—Gothic, Gunnison County. Iles.

Smithsonite.—On sphalerite in Jones Mine, Gilpin County. S.

Sulphate of Soda.—Occurs abundantly in a lake owned by Burdsal & Sons, twelve miles south of Denver. S.

Soda Carbonate.—At the Hot Springs, Idaho, and other places. S.

Sphalerite.—Sulphuret of zinc is a very common mineral in many of our gold and silver mines, and is frequently rich in the precious metals. Samples from the Georgetown silver mines, which to the eye appear to be nothing but pure zinc blende, of a deep black color, not unfrequently yield 400 to 600 ozs. silver per ton. One specimen tested by Prof. Martine, gave the very remarkable yield of 31 per

cent. silver. Beautiful cabinet specimens have been taken from the Coaley lode, Black Hawk, and the Delaware and Calhoun lodes, Russell. In the latter lode it occurs in chalcedony, producing specimens that might be mistaken for moss agates. The blendes of Gilpin County contain both *Cadmium* and *Indium*, in considerable quantity, in a few of the mines. S.

Spinel—Zinciferous.—Crystal lode, Virginia Cañon, in clear, brownish-white xls. S.

Staurolite.—Simple and twin xls. in micaceous schists, near Mount Oso, Quartzite Mountains. E.

Sternbergite.—Silver mines near Georgetown. E.

Stephanite. — Colorado Central, Georgetown; Moose mine, Mount Lincoln. E.

Stibnite.—Terrible mine, near Georgetown, and in Boulder County. E.

Stilbite.—Fine xls. in cavities of basalt, near Uncompahgre Peak, and near Golden. E.

Sulphur.—Native in crystalline masses, in the Hot Sulphur Springs, Middle Park, and in minute xls. with galena, in the Jones lode, Nevada. S.

Sylvanite.—In xls. and crystalline masses, in the American and Grand View mines, Sunshine; Prussian, Cold Spring and others, Gold Hill.

Talc.—Occurs in greater or less abundance in nearly all our mines. S.

Tellurite and *Ferro-tellurite.* (*sp. nov.*).—It is the result of decomposition of tellurium and tellurides. Its formula is Te O2. Found in the Keystone and Smuggler mines, in small xls.

Tellur-Pyrites (*sp. nov.*).—Discovered by the author, in the American mine, Sunshine, in 1875, and first described by Prof. C. U. Shepard. It is mammillary arsenical iron pyrites, containing a high per cent. of tellurium, and usually quite rich in gold. S.

Tellurium Native.—In Red Cloud mine, Gold Hill, and in large quantities in the Keystone mine, Magnolia District, Boulder County.

Tennantite.—Has been found sparingly, finely crystalized, in the Freeland lode, Trail Creek, in Buckskin Gulch, Park County, and Geneva District, Summit County.

Tetrahedrite.—Fine cabinet specimens, in large, beautifully formed xls, are occasionally found in the Freeland lode, Trail Creek, and in several mines in Gilpin, Boulder, and San Juan. S.

Topaz.—Fine xls. in trachyte, near Nathrop, Chaffee County.

Thomsenolite.—Crystal beds, near Pike's Peak. C.

Torbenite.—(Uranite.) Found by Captain Berthoud, on Lyden Creek. Also found on Griffith Mountain, near Georgetown. E.

Tourmaline.—In feldspathic granite, Guy Hill, and at Nevada and other places, in fine black xls. None of the red, green or blue varieties have been noticed here. Fair xls. of the brown variety have been found in Nevada (Colorado). S.

Tremolite.—Smith's Fork of the Gunnison. S.

Tufa.—Calcareous. On Currant Creek, Roaring Fork, Frying Pan. Also at many mineral springs. E.

Turquoise.—Specimens in the author's collection obtained from a Ute Indian chief, are supposed to have been found in southern Colorado, but the precise locality could not be ascertained. The specimens are rudely cut in keystone form, with a hole drilled in each, and were worn in a bracelet. The stones are highly prized by the Indians, and it is with much difficulty that they can be induced to part with them. S.

Uraconite.—Wood mine, Leavenworth Gulch, near Central. E.

Uraninite.—Occurs in large masses in the Wood mine, near Central.

Uranochalcite.—Wood mine, near Central.

Vesuvianite.—In large xls. of simple combinations, on Mount Italia, north of Arkansas River, in granite. E.

Wavellite.—South Table Mountain, near Golden. E.

Wheelerite.—Described by Dr. Oscar Loew. It is a resin related to amber, and occurs in the lignitic coals.

Willemite.—Jones mine, near Nevada, and La Plata County. S.

Wolframite.—Reported from San Juan. E.

Wollastonite.—Occurs in small quantities in some of the limestones near Fairplay. P.

Wulfenite.—Found on Gunnell Hill, near Central, and in Park County. S.

Xenotimite.—Reported from Cheyenne Mountain. E.

Zincite.—Jones mine, near Nevada. S.

Zinkenite.—Sweet Home Mine, Buckskin Gulch, in small xls. P.

Zippeite.—Wood mine, Leavenworth Gulch. E.

Zircon.—A few small but very brilliant and fine colored have been found at the Bear River diggings, west of the Middle Park. Also fine xls. are found near Pike's Peak, El Paso County. S.

ALTITUDES IN COLORADO.

The following altitudes are compiled from the lists of Henry Gannett, of the Hayden Survey, and may be relied on as very nearly accurate:

TOWNS.

Alma	10,254	Idaho	7,512
Black Hawk	7,975	Kenosha Summit	10,150
Boulder	5,536	Lake City	8,500
Breckenridge	9,674	Las Animas	3,952
Canon City		Longmont	4,957
Caribou	9,905	Manitou	6,296
Central City	8,300	Old Oro (near Leadville)	10,247
Colorado Springs	6,032	Pueblo (north)	4,713
Denver	5,244	Rollinsville	8,323
Empire	8,583	Rosita	8,500
Fairplay	9,964	Saguache	7,745
Georgetown	8,514	Salt Works (South Park)	8,917
Gold Hill	8,463	Silverton	9,400
Golden City	5,687	Trinidad	6,032
Greeley	4,779	White River Agency	6,491

MOUNTAIN PEAKS.

Arapahoe Peak	13,520	Mount Harvard	14,375
Blaine's Peak	13,905	Holy Cross Mountain	14,176
Blanca Peak	14,464	James Peak	13,283
Buckskin Mountain	14,296	Mount Lincoln	14,307
Castle Peak	14,115	Long's Peak	14,271
Chief	11,833	Massive Mountain	14,298
Mount Elbert	14,351	Pike's Peak	14,147
Mount Evans	14,330	Quandary Peak	14,269
Gray's Peak	14,341	Torrey's Peak	14,375

PASSES.

Argentine	13,100	Marshall's	10,852
Berthoud	11,349	Mosca	9,577
Boulder	11,900	Poncho	8,945
Cimmaron	6,330	Raton	5,896
Cochetopa	10,032	Sangre de Christo	9,186
Cunningham	12,090	Sultan Mountain	10,460
Georgia	11,811	Tennessee	10,418
Hamilton	12,370	Trinchera	7,079
Hoosier	11,500	Trout Creek	9,346
Lake Creek	12,239	Vasquez	11,500

PARKS.

Middle Park (mean)	7,500	South Park (mean)	9,000
North Park "	8,500	San Luis Valley	7,500

TIMBER LINE.

Sierra Blanca	10,410	Gray's Peak	11,100
Pike's Peak	11,720	Mount Byers	11,400
Buffalo Peak	12,041	Mount Lincoln	12,051
Cunningham Pass	11,500	White Rock Mountain	11,919