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1883

REPORT  
OF  
E. LE NEVE FOSTER,  
STATE GEOLOGIST,  
COLORADO.

1884

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REPORT

OF

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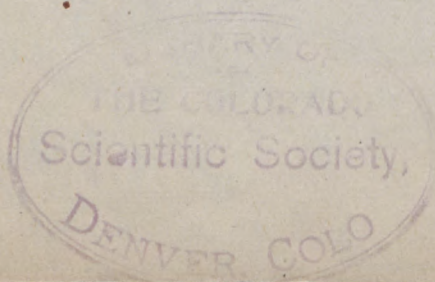
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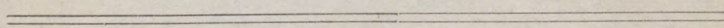
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REPORT

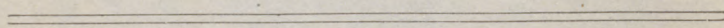
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DENVER, COLORADO;

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1885.



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GEORGETOWN, COLO, Dec. 31, 1884.

*To His Excellency,*

HON. JAMES B. GRANT,

*Governor of the State of Colorado:*

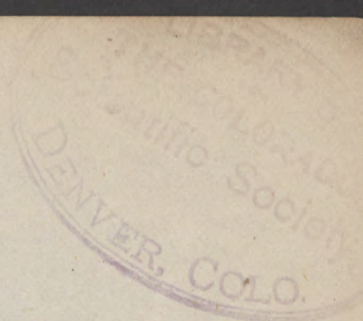
SIR:

Herewith I have the honor to hand you my biennial report as State Geologist, for the years 1883 and 1884, and, doing so, I desire to acknowledge valuable information received from the following gentlemen: Prof. Arthur Lakes, Prof. Regis Chauvenet, T. E. Schwarz, F. G. Bulkley and P. H. Van Diest.

Yours, respectfully,

ERNEST LE NEVE FOSTER.





## REPORT OF STATE GEOLOGIST.

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The resources of the State of Colorado are so multifarious and extend over so large an area, that to make a thorough geological examination of the whole region and a complete report upon its resources, would be the work of many years. In this short report, however, this will not be attempted, but such portions of the State as have come under my personal observation, or upon which I have been able to obtain reliable information, will be dealt with in a general way, with some special remarks on some sections.

Colorado now stands prominent before the world, and in the foreground, as the largest producer of the precious metals.

Her vast mineral resources of all kinds are unequaled by those of any other State. Among her products are gold, silver, lead, zinc, copper and iron, which occur in vast quantities through the whole length of the great backbone of the Continent, as it passes through from Wyoming, on the north, to New Mexico, on the south.

In addition to the metals above enumerated, vast areas are underlayed by coal, which is extensively mined. Petroleum in workable quantities is found in some parts, and future exploration is liable to lead to the discovery of large quantities in places where it is as yet unknown to exist. Fire clay and pottery clay are both products that are yielded in some parts, whilst scattered through almost every county are hot and cold sulphur, soda and mineral springs.

### GOLD

Is found largely in the alluvium of many of the gulches and streams. It exists also in lodes of the granitic and metamorphic rocks, where it is usually associated with the

sulphides of iron, copper, lead and zinc. In some portions of the State, and notably Boulder county, it is found combined with tellurium. There is scarcely a county in the mineral bearing portion of the State that does not annually yield a fair amount of the yellow metal.

#### SILVER.

The most important product of the mines of the State is found scattered through the whole length of the Rocky Mountain range. Its occurrence is chiefly in association with the sulphides of lead and zinc, those of iron and copper being also frequently present. It is found native and in combination with sulphur, antimony, arsenic, chlorine and bromine. Also in several parts of the State tellurides and bismuthides are of frequent occurrence.

#### LEAD

Is a very important product of this State. Its occurrence is principally as carbonate and sulphide. In the former chemical compound chiefly in the bedded deposits of the Leadville region, and in the latter form in the argentiferous and auriferous fissure veins of the granitic and metamorphic rocks.

#### ZINC

Is found in most of the gold and silver mines. It occurs chiefly as sphalerite or zinc blende, which varies in color from a deep black to almost white. In some of the varieties a small percentage of cadmium is present. The carbonate of zinc also occurs in some instances.

#### COPPER

Is chiefly found in the auriferous fissure veins. As copper pyrites it also occurs as green and blue carbonate, but only in small quantities. Other compounds, as well as native, are also met with.

#### IRON

In all its numerous varieties has been discovered, and some

large deposits of iron ore of excellent quality are worked and still greater areas are as yet untouched.

#### COAL,

Principally of tertiary origin, has been opened in many parts of the State, from the most northern to the most southern portion, the yield now being nearly two million tons per annum. The coal measures are from two to sixteen feet in thickness, and are mainly lignites, though of finer quality than the lignites of other countries. They are both denser and contain less ash than lignites usually do. Beside these, some areas yield a good bituminous coal and others anthracite. The principal coal fields are those of Boulder, Jefferson, Larimer, Grand, Routt, Park, Fremont, Huerfano, Gunnison and Las Animas counties. Not having had an opportunity to examine minutely any of these districts, the geology of which would require careful study, I shall, in the portion of my report which follows, say but little on the subject of coal, more especially as the report of the Inspectors of Coal Mines will, in all probability, thoroughly ventilate the subject.

#### BUILDING STONE.

Probably no State in the whole Union is richer in building material than this one, nor is there one that can supply a greater variety. Granite, in many varieties, sandstones innumerable, from fine to coarse grain, lavas, limestones and marble of different texture and color, and volcanic rocks of different kinds, are among the varieties of material the builder has to select from. The buildings and sidewalks of Denver and other cities show that this part of the resources of our State are not neglected.

The following analysis of some of the rocks, made by Professor Regis Chauvenet, of the State School of Mines, for the State Capital Commission, will no doubt be of value:

*Gray Granite.*—Brownville, Clear Creek County. Not analyzed; very fine and evenly divided particles of black mica and glossy feldspar of a grey color.



Sp. gr.....	2.71	Apparent sp. gr.....	2.70
Absorbs, per cent.....	0.17	Cubic feet weighs, lbs.....	168.48
Loss by freezing, 0.009 per cent.			

*Gray Granite*—Pine Creek, Chaffee County. Not analyzed; fine black mica and glossy feldspar in larger quantity than mica and not evenly divided:

Sp. gr.....	2.67	Apparent sp. gr.....	2.64
Absorbs, per cent.....	0.31	Cubic feet weighs, lbs.....	164.74
Loss by freezing, 0.056 per cent.			

*Red Granite*—Platte Cañon, Jefferson County. Not analyzed; a coarse-grained, flesh-colored variety:

Sp. gr.....	2.65	Apparent sp. gr.....	2.63
Absorbs, per cent.....	0.19	Cubic foot weighs, lbs.....	164.11
Loss by freezing, 0.033 per cent.			

*Gray Granite*—Hancock, Chaffee County. Not analyzed; gray feldspar in excess; mica coarser than in other gray varieties:

Sp. gr.....	2.71	Apparent sp. gr.....	2.69
Absorbs, per cent.....	0.26	Cubic foot weighs, lbs.....	167.86
Loss by freezing, 0.023 per cent.			

*Lava*—Lathrop, Chaffee County. Color, ash gray; shows many small cavities, not affecting its general appearance:

Silica.....	76.56	Sp. gr.....	2.45
Alumina and Ox. Iron.....	14.25	Apparent sp. gr.....	2.27
Lime.....	1.17	Absorbs, per cent.....	3.18
Magnesia.....	0.42	Cubic foot weighs, lbs.....	141.65
Potassa.....	3.78	Loss by freezing, per cent.....	0.034
Soda.....	3.93		
	100.11		

*Dolomite*—Calumet, Chaffee County. Banded, blue streaks on white; very compact and fine in grain:

Silica .....	0.66	Sp. gr.....	2.87
Ox. Iron.....	0.41	Apparent sp. gr.....	2.87
Lime .....	31.02	Absorbs, per cent.....	0.07
Magnesia.....	21.04	Cubic foot weighs, lbs.....	179.09
Carbonic acid.....	46.90	Loss by freezing, per cent.....	0.004
	<u>100.03</u>		

*Marble* — Calumet, Chaffee County. Color, white; slightly seamed :

Silica.....	1.57	Sp. gr.....	2.86
Alumina.....	0.57	Apparent sp. gr.....	2.85
Lime .....	33.85	Absorbs, per cent.....	0.09
Magnesia.....	17.88	Cubic foot weighs, lbs.....	177.84
Carbonic acid.....	45.96	Loss by freezing, per cent.....	0.022
	<u>99.83</u>		

*Sandstone*—Armejo, Conejos County. Gray, with yellowish tinge; fine grained:

Silica.....	81.01		
Alumina and Ox. Iron.....	13.02		
Lime .....	0.65	Sp. gr.....	2.50
Magnesia.....	0.56	Apparent sp. gr.....	2.24
Potassa.....	1.71	Absorbs, per cent.....	4.42
Soda.....	1.59	Cubic foot weighs, lbs.....	139.77
Loss by ignition.....	1.62	Loss by freezing, per cent.....	0.243
	<u>100.16</u>		

*Sandstone*—Berthoud, Larimer County. Color, light red; effervesces with acids :

Silica.....	74.86		
Ox. Iron.....	4.05	Sp. gr.....	2.49
Lime .....	10.25	Apparent sp. gr.....	2.24
Magnesia.....	1.10	Absorbs, per cent.....	4.44
Loss by ignition.....	7.90	Cubic foot weighs, lbs.....	139.77
Alkalies undetermined.....	.....	Loss by freezing, per cent.....	0.110
	<u>98.16</u>		

*Sandstone*—Goodnight, Pueblo County. Porous and very friable; yellowish white in color:

Silica.....	89.94	Sp. gr.....	2.39
Alumina and Ox. Iron.....	5.62	Apparent sp. gr.....	2.05
Lime.....	1.95	Absorbs, per cent.....	6.94
Magnesia.....	0.19	Cubic foot weighs, lbs.....	127.92
Loss by ignition.....	2.46	Loss by freezing, per cent.....	0.166
	<u>100.16</u>		

*Sandstone*—Beaver Creek, Fremont County. Color, light gray; firm texture, fine grain; shows fine specks of oxide of iron:

Silica.....	92.92	Sp. gr.....	2.45
Ox. Iron.....	4.61	Apparent sp. gr.....	2.16
Lime.....	0.90	Absorbs, per cent.....	5.28
Magnesia.....	0.23	Cubic foot weighs, lbs.....	134.78
Loss by ignition.....	1.41	Loss by freezing.....	0.062
	<u>100.07</u>		

*Sandstone*—Oak Creek, Fremont County. Yellow color, fine grain:

Silica.....	76.02	Sp. gr.....	2.41
Alumina and Ox. Iron.....	16.42	Apparent sp. gr.....	1.92
Lime.....	2.10	Absorbs, per cent.....	9.69
Magnesia.....	0.88	Cubic foot weighs, lbs.....	119.81
Potassa.....	2.24	Loss by freezing, per cent.....	0.700
Soda.....	1.04		
Loss by ignition.....	1.15		
	<u>99.85</u>		

*Sandstone*—Coal Creek, Fremont County. Yellow-gray, inclining to brown:

Silica.....	74.20	Sp. gr.....	2.44
Alumina and Ox. Iron.....	17.02	Apparent sp. gr.....	2.09
Lime.....	2.68		
Magnesia.....	1.23		

Potassa.....	1.04	Absorbs, per cent.....	6.05
Soda.....	0.65	Cubic foot weighs, lbs.....	130.42
Loss by ignition.....	2.81	Loss by freezing, per cent.....	0.649
	<u>99.63</u>		

*Sandstone*—Trinidad, Las Animas County. Pure light gray; fine grain:

Silica.....	71.00		
Alumina and Ox. Iron.....	19.39		
Lime.....	0.98	Sp. gr.....	2.64
Magnesia.....	0.19	Apparent sp. gr.....	2.42
Potassa.....	1.64	Absorbs, per cent.....	3.12
Soda.....	3.80	Cubic foot weighs, lbs.....	151.01
Loss by ignition.....	2.87	Loss by freezing, per cent.....	0.324
	<u>99.87</u>		

*Sandstone*—Brandford, Fremont County. Brown color; probably quite alkaline:

Silica.....	75.77		
Alumina and Ox. Iron.....	14.57	Sp. gr.....	2.49
Lime.....	0.97	Apparent sp. gr.....	2.02
Magnesia.....	0.49	Absorbs, per cent.....	8.99
Loss by ignition.....	1.68	Cubic foot weighs, lbs.....	126.05
Alkalies, not determined.....	.....	Loss by freezing, per cent.....	0.322
	<u>93.46</u>		

*Sandstone*—Feeney, Manitou, El Paso County. Dull white; fine in grain:

Silica.....	70.75		
Alumina and Ox. Iron.....	17.68		
Lime.....	1.15	Sp. gr.....	2.51
Magnesia.....	0.76	Apparent sp. gr.....	2.15
Potassa.....	2.25	Absorbs, per cent.....	6.46
Soda.....	3.67	Cubic foot weighs, lbs.....	134.76
Loss by ignition.....	3.34	Loss by freezing, per cent.....	0.190
	<u>99.60</u>		

*Sandstone*—Stout, Larimer County. Effervesces with acids; fine grain; color, pinkish gray :

Silica.....	84.07		
Alumina and Ox. Iron.....	2.95		
Lime.....	4.36	Sp. gr.....	2.56
Magnesia.....	0.91	Apparent sp. gr.....	2.46
Potassa.....	1.24	Absorbs, per cent.....	1.54
Soda.....	2.32	Cubic foot weighs, lbs.....	153.50
Loss by ignition.....	4.21	Loss by freezing, per cent.....	0.050
	<u>100.26</u>		

*Sandstone*—W. H. Case quarry, near Boulder. Light pink; firm; works to fine edges; very compact in structure :

Silica.....	95.37	Sp. gr.....	2.49
Ox. Iron.....	2.40	Apparent sp. gr.....	2.42
Lime.....	0.92	Absorbs, per cent.....	1.13
Magnesia.....	0.50	Cubic foot weighs, lbs....	151.01
Loss by ignition.....	0.55	Loss by freezing, per cent.....	0.007
	<u>99.74</u>		

*Sandstone*—Morrison, Jefferson County. Fine grain; rather porous; color, light yellow :

Silica.....	96.06	Sp. gr.....	2.47
Alumina and Ox. Iron.....	2.25	Apparent sp. gr.....	2.15
Lime.....	0.81	Absorbs, per cent.....	6.00
Magnesia.....	0.32	Cubic foot weighs, lbs.....	134.16
Loss by ignition.....	0.60	Loss by freezing, per cent.....	0.022
	<u>100.04</u>		

*Sandstone*—Morrison, Jefferson County. Light red color; effervesces with acids :

Silica.....	79.20	Sp. gr.....	2.48
Alumina and Ox. Iron.....	4.23	Apparent sp. gr.....	2.22
Lime.....	8.44	Absorbs, per cent.....	4.64
Magnesia.....	0.93	Cubic foot weighs, lbs.....	138.53
Loss by ignition.....	6.60	Loss by freezing, per cent.....	0.120
	<u>99.40</u>		

*Sandstone*—Morrison, Jefferson County. Dark red; very compact; alkalies are in a micaceous mineral included, visible under glass:

Silica.....	74.02		
Ox. Iron.....	16.31		
Lime.....	1.91	Sp. gr.....	2.61
Magnesia.....	0.60	Apparent sp. gr.....	2.54
Potassa.....	3.39	Absorbs, per cent.....	0.77
Soda.....	0.23	Cubic foot weighs, lbs.....	158.50
Loss by ignition.....	3.71	Loss by freezing, per cent.....	0.251
	<u>100.17</u>		

*Sandstone*—Morrison, Jefferson County. Color, red; coarse granules of quartz enclosed:

Silica.....	68.56		
Ox. Iron and Alumina.....	20.63		
Lime.....	1.36	Sp. gr.....	2.64
Magnesia.....	0.80	Apparent sp. gr.....	2.57
Potassa.....	2.21	Absorbs, per cent.....	0.85
Soda.....	2.25	Cubic foot weighs, lbs.....	160.37
Loss by ignition.....	3.85	Loss by freezing, per cent.....	0.279
	<u>99.66</u>		

*Sandstone*—Morrison, Jefferson County. Nearly white, or pinkish white; very friable:

Silica.....	95.70	Sp. gr.....	2.41
Alumina and Ox. Iron.....	2.67	Apparent sp. gr.....	2.17
Lime.....	0.96	Absorbs, per cent.....	4.64
Magnesia.....	0.14	Cubic foot weighs, lbs.....	135.41
Loss by ignition.....	0.68	Loss by freezing, per cent.....	0.083
	<u>100.15</u>		

*Sandstone*—Morrison, Jefferson County. Dull white in color:

Silica.....	78.65		
Alumina.....	13.06		
Lime.....	1.65	Sp. gr.....	2.50

Magnesia.....	0.58	Apparent sp. gr.....	2.17
Potassa.....	3.28	Absorbs, per cent.....	5.95
Soda.....	0.55	Cubic foot weighs, lbs.....	135.41
Loss by ignition.....	1.86	Loss by freezing, per cent.....	0.174
	<u>99.63</u>		

*Sandstone*—Dillon, Summit County. Firm texture; mottled with small spots of yellow (hydrated), oxide of iron and a darker (nearly black) mineral:

Silica.....	94.02	Sp. gr.....	2.50
Alumina and Ox. Iron.....	3.40	Apparent sp. gr.....	2.41
Lime.....	1.72	Absorbs, per cent.....	1.52
Magnesia.....	0.18	Cubic foot weighs, lbs.....	150.38
Loss by ignition.....	0.86	Loss by freezing, per cent.....	0.040
	<u>100.18</u>		

*Sandstone*—El Moro, Las Animas County:

Silica.....	76.29	Sp. gr.....	2.46
Alumina and Ox. Iron.....	15.91	Apparent sp. gr.....	2.12
Lime.....	0.91	Absorbs, per cent.....	5.89
Magnesia.....	0.50	Cubic foot weighs, lbs.....	132.29
Loss by ignition.....	2.07	Loss by freezing, per cent.....	0.471
Alkalies not determined.....	.....		
	<u>95.68</u>		

*Sandstone*—Eureka. Very friable; yellowish white in color:

Silica.....	90.71	Sp. gr.....	2.40
Alumina and Ox. Iron.....	5.11	Apparent sp. gr.....	2.04
Lime.....	1.52	Absorbs, per cent.....	7.03
Magnesia.....	0.23	Cubic foot weighs, lbs.....	127.30
Loss by ignition.....	2.58	Loss by freezing, per cent.....	0.209
	<u>100.15</u>		

*Lava*—Garfield quarry, Douglas County. Pink color:

Silica.....	73.20	Sp. gr.....	2.14
Alumina and Ox. Iron.....	16.50	Apparent sp. gr.....	1.75
Lime.....	3.10	Absorbs, per cent.....	9.76

Magnesia.....	1.45	Cubic foot weighs, lbs.....	109.20
Potassa .....	3.20	Loss by freezing, per cent.....	0.161
Soda.....	1.42		
Loss by ignition.....	0.75		
	<u>99.62</u>		

*Lava*—Curry quarry, Douglas County. Gray color :

Silica.....	75.26	Sp. gr.....	2.23
Alumina and Ox. Iron.....	14.15	Apparent sp. gr.....	1.91
Lime.....	2.02	Absorbs, per cent.....	7.36
Magnesia.....	trace	Cubic foot weighs, lbs.....	119.18
Potassa.....	4.62	Loss by freezing, per cent.....	0.200
Soda.....	3.05		
Loss by ignition.....	1.03		
	<u>100.13</u>		

*Sandstone*—Buckhorn quarry, U. P. R. R. Nearly white; highly siliceous :

Silica.....	96.45	Sp. gr.....	2.45
Ox. Iron.....	1.90	Apparent sp. gr.....	2.22
Lime.....	1.06	Absorbs, per cent.....	4.27
Magnesia.....	0.64	Cubic foot weighs, lbs.....	138.53
	<u>100.05</u>	Loss by freezing, per cent.....	0.018

*Sandstone*—U. P. R. R. quarry at Stout. Gray color, with flecks of rust :

Silica.....	95.50	Sp. gr.....	2.49
Ox. Iron.....	0.78	Apparent sp. gr.....	2.35
Lime.....	0.88	Absorbs, per cent.....	2.35
Magnesia.....	1.45	Cubic foot weighs, lbs.....	146.64
Loss by ignition.....	1.18	Loss by freezing, per cent.....	0.015
	<u>99.79</u>		

In making the above analyses, alumina and oxide of iron were not separated, except in a single instance. When one of these only is named, it indicates a very great preponderance of the same, but not to the entire exclusion of



the other. When both are named, the one placed first is the largest in amount.

#### SUBTERRANEAN WATERS.

The tapping by artesian wells of supplies of subterranean water in the neighborhood of Denver and other places, has given this subject much interest and importance; and for the future benefit of Colorado, and especially Denver, will be found of great value, it gives to that city an almost inexhaustible supply of pure water for all purposes. A few words, therefore, on artesian wells will surely be of interest. Certain essential conditions are necessary for the formation of an artesian well which may briefly be stated as more or less inclined strata permeable to water over and underlaid by impervious beds, the water which falls upon or flows over the upturned edges of these beds will, in part, pass down through the permeable strata and accumulate until some new opening, such for instance, as a borehole, is made by which it can find a means of escape. These boreholes are what are termed artesian wells. They were so called from the District of Artois, in France, where the first wells of this description were sunk. The leaky beds of creeks and artificial water courses are frequent sources of supply to these wells. The height to which the water will rise when tapped, always falls far short of the head from which it is derived, which is due to friction and the resistance of the air.

The region at and around Denver is of the class favorable to the formation of these wells. Denver lies near the center of a synclinal basin formed of sedimentary rocks of silurian, carboniferous, triassic, jurassic and cretaceous rocks, the upturned edges of which are found exposed abutting on the granitic and gneissic rocks of the foot hills.

The water supply of Denver comes from the Larimer beds, which there lie in the form of a long oval basin about sixty miles in length and thirty to thirty-five in width; its northern and long axis corresponds nearly with the course of the Platte valley. Its boundaries may approximately be stated, as extending from Platteville on the north, to near Sedalia on the south, and in width from the foot hills on the west to near Box Elder on the east. These

beds consist of numerous alternating layers of sandstone and clay, usually varying from one to twenty feet in thickness, though in places found much thicker. Several water-bearing strata have been encountered, though but two with water of sufficient hydrostatic pressure to ensure a constant flow have been found, and these at average depths of 375 feet and 600 feet respectively.

A typical section of these beds, and therefore, of the Denver basin in general, is the section afforded by the well of the Omaha and Grant Smelting and Refining Company, which is as follows:

Alluvial deposit of gravel and wash.....	30 feet.
Blue clay.....	90 feet.
Fine sand and small flow of water.....	4 feet.
Indurated clay.....	210 feet.
Fine sand and clay—increased flow of water.....	60 feet.
Iron pyrites.....	1.5 feet.
Rounded quartz and feldspar—large flow of water.....	5 feet.
Blue clay.....	190 feet.
Quartz and feldspar—largest flow of water.....	8 feet.
Blue clay.....	22 feet.
Total depth.....	620.5 feet.

A matter of vast importance in these wells is the quantity of water they will supply, as well as the probability or possibility of their exhaustion. As these wells derive their water entirely from the surface it is well to consider what amount of water will enter the earth from that surface, and whether or not it is sufficient to supply the constant drain there is from it by the wells now flowing or likely to be sunk. From French reports on the artesian water supply of the Paris basin it is estimated that of the total rainfall of that region, 23 per cent. is found to enter the earth, whilst the remaining 77 per cent. flows off, partly in the rivers, part is consumed by the vegetation and the remainder is carried off by evaporation. The data thus furnished by the Paris basin will be found to be fair data on which to base calculations for the Denver basin, for though there will undoubtedly be much greater loss by evaporation in the

latter, this loss will be compensated for, by a much smaller consumption by vegetation.

In the Denver basin the average rainfall during the last twelve years has been about fifteen inches. This falling over an area of 450 square miles, which is practically the area from which a source of supply to the artesian well system can be based upon, would give an annual supply falling on the surface of 117,569,812,500 gallons, of which twenty-three per cent. or 27,041,056,875 gallons would enter the earth to replenish the wells. Besides this source of supply there must be taken into consideration the water that would enter from the rivers as they pass over the edges of the beds, and such as would be brought in by ditches and artificial water courses for irrigating purposes. It is estimated that the several ditches, for three months in the year, deliver an average of 500 cubic feet of water per second, equivalent to a total supply during that period of 29,160,000,000 gallons, if only one fifth of this amount finds its way to the artesian wells, which is a smaller estimate than that of the rainfall, it would give a supply of 5,832,000,000 gallons, or there could be estimated, as entering the ground from all sources, 32,873,056,875 gallons, equivalent to a daily supply of 90,063,170 gallons. Of course it is not practicable or possible to bring the whole of this supply to the surface, but even though an exceedingly high percentage is calculated as loss, yet there still remains an ample supply for a city of very much greater size than Denver. Observations made at many of the Denver wells show that at different periods the pressure in them has varied, the reason of which is undoubtedly due to two or three causes. Probably the principal is that of other wells being sunk in the neighborhood. Imperfect tubing is also a frequent cause, either from caving of the sides or the escape through upper strata of a portion of the water supply.

The following analysis of the water of these wells, made by Prof. Regis Chauvenet, of the State School of Mines, are of interest as showing the purity of the water :

ANDERSON WELL.

<i>Solid Residue—</i>	<i>Grains to Gallon, Parts in 100,000,</i>	
	<i>10.41.</i>	<i>17.85.</i>
Calcium sulphate.....	0.87	1.49
Sodium carbonate.....	8.22	14.09
Sodium sulphate.....	0.44	0.75
Magnesium chloride.....	0.10	0.17
Ferrous carbonate.....	0.03	0.05
Silica.....	0.69	1.18
	<hr/>	<hr/>
	10.35	17.73
Lime (Ca. O).....	0.36	0.62
Magnesia (Mg. O).....	0.04	0.07
Soda (Na.2 O).....	5.00	8.57
Ferrous oxide (Fe. O).....	0.02	0.03
Sulphuric oxide (S. O <sub>3</sub> ).....	0.76	1.30
Silica (Si. O <sub>2</sub> ).....	0.69	1.18
Chlorine (Cl.).....	0.07	0.12

WINDSOR WELL—UPPER FLOW.

<i>Solid Residue—</i>	<i>Grains to Gallon, Parts in 100,000,</i>	
	<i>10.03</i>	<i>17.20</i>
Calcium sulphate.....	0.85	1.46
Sodium carbonate.....	7.93	13.60
Sodium sulphate.....	0.44	0.75
Magnesium chloride.....	0.10	0.17
Ferrous carbonate.....	0.03	0.05
Silica.....	0.61	1.05
	<hr/>	<hr/>
	9.96	17.08
Lime (Ca. O).....	0.35	0.60
Magnesia (Mg. O).....	0.04	0.07
Soda (Na.2 O).....	4.83	8.28
Ferrous oxide (Fe. O).....	0.02	0.03
Sulphuric oxide (S. O <sub>3</sub> ).....	0.76	1.30
Silica (Si. O <sub>2</sub> ).....	0.61	1.05
Chlorine (Cl.).....	0.07	0.12

## REPORT STATE GEOLOGIST.

## WINDSOR WELL—LOWER FLOW.

<i>Solid Residue—</i>	<i>Grains to Gallon, Parts in 100,000,</i>	
	<i>10.70</i>	<i>18.45</i>
Calcium sulphate.....	0.92	1.58
Sodium carbonate.....	8.48	14.54
Sodium sulphate.....	0.44	0.75
Magnesium chloride.....	0.07	0.12
Ferrous carbonate.....	0.03	0.05
Silica.....	0.76	1.30
	<u>10.70</u>	<u>18.34</u>
Lime (Ca. O).....	0.38	0.65
Magnesia (Mg. O).....	0.03	0.05
Soda (Na. 2 O).....	5.15	8.83
Ferrous oxide (Fe. O).....	0.02	0.03
Sulphuric oxide (S. O <sub>3</sub> ).....	0.79	1.35
Silica (Si. O <sub>2</sub> ).....	0.76	1.30
Chlorine (Cl.).....	0.05	0.08

## COURT HOUSE WELL.

<i>Solid Residue—</i>	<i>Grains to Gallon, Parts in 100,000,</i>	
	<i>33.01</i>	<i>50.60</i>
Calcium sulphate.....	0.36	0.62
Calcium carbonate.....	1.64	2.81
Sodium carbonate.....	15.83	27.14
Sodium chloride.....	14.04	24.07
Magnesium carbonate.....	0.32	0.55
Ferrous carbonate.....	0.06	0.10
Silica.....	0.63	1.08
Lime (Ca. O).....	1.07	1.84
Magnesia (Mg. O).....	0.15	0.26
Soda (Na. 2 O).....	16.71	28.65
Ferrous oxide (Fe. O).....	0.04	0.07
Sulphuric oxide (S. O <sub>3</sub> ).....	0.21	0.36
Silica (Si. O <sub>2</sub> ).....	0.63	1.08
Chlorine (Cl.).....	8.52	14.61

## BOULDER COUNTY,

Has sustained its yield of the precious metals, and mining through the several districts is in as healthy a condition as at any time of its history. The mining districts are situated in the metamorphic rocks, gneiss, granite, mica schist being the principal forms, these being intersected by porphyry dykes. The mines are all true fissure veins, but not all of the same character; there are really three distinct kinds, viz: True silver, true gold and the tellurium mines which carry both metals. This tellurium belt for which Boulder county is celebrated is found extending through Gold Hill, Sunshine, Magnolia and Sugar Loaf districts. It is peculiarly interesting on account of the character of its lodes, and some remarks regarding them will doubtless be of interest. As above stated, these districts have a general geological formation of metamorphic rocks running through all the forms of gneiss and metamorphic granite, through which are found masses of intrusive or eruptive granite, and it is only in vicinity of these masses that the tellurium veins are found, so that to them the veins are most decidedly related. From careful study of these districts it is not possible to obtain any given direction for the veins. They are found to strike in almost every direction, and to form a large net work of veins and stringers. These veins can seldom be traced for any great distance—a few hundred feet is usually the most, when they will be found to fork, and these forks will again split up into smaller veins and stringers, until at last they will disappear into mere seams. It is worthy of observation that the best pockets or accumulations of telluride ore is almost invariably at the point of junction of the forks in the veins. The veins, the matrix of which is silicious ore are from one to four feet wide, though in some cases as much as ten or twelve feet. These carry fine iron pyrites disseminated through them. Sometimes this is arsenical, and occasionally a little light colored (rosin) zinc blende is met with. The ore leaders which carry the valuable portion of the metalliferous contents, viz: the tellurides, are generally narrow, a few inches at the most. Through the granite formation many feldspar dykes can be traced, and it is of interest to note what, if any, influence they have on the metalliferous veins in their vicinity. In the Sunshine district it is doubtful whether

any connection between the two can be traced, although future observation may lead to the discovery of some influence these dykes have upon the veins, since it is the universal opinion of the prospectors and miners that the vein will improve after passing through spar. In the Gold Hill district there is scarcely a doubt but that a close connection exists between the occurrence of rich telluride deposits and these dykes. The dykes, however, in this district are of a different lithological character, and more nearly resemble the elvans of Cornwall than the dykes of Sunshine, or any other part of Colorado. As examples of this we find the Coldspring and Red Cloud mines, whose workings extended along such a dyke; the Oro Cash and Gray Eagle are similarly situated, as also the Prussian and Bismark lodes, all of which have been large producers of telluride ore. Among the most productive mines at the present time in this district are the Slide and Prussian, whilst further north on James Creek is the John Jay, and the Smuggler in Long's gulch. Near Sunshine the Emancipation has been the chief producer, and has attained a depth of upwards of four hundred feet. The Napoleon has also been worked to some extent, and numerous prospects have produced small quantities of ore, which go to swell the general output. The tellurium belt is from fifteen to twenty miles in length and from three to six miles in width.

The silver district of this county is situate south of the tellurium belt, and in the southwest part of the county. Caribou is the principal camp. This is in metamorphic rocks, the lodes being true fissures carrying as ore, an intimate mixture of galena and zinc blende chiefly, with considerable iron and copper pyrites; with these are associated true silver minerals such as native, glance and ruby.

The principal mine of the district is the Caribou, which works both the Caribou and No Name lodes, and has reached a depth of over 1,000 feet. The ore body at this depth is equally as large and rich as it was nearer the surface, the depth having no apparent influence upon the richness of the ore. Unfortunately this mine has been idle for the past two years and been allowed to fill with water, the reason of which is best known to the owners. The Poorman, the first silver lode discovered in the county, has

been a steady producer and is now 600 feet deep. It has a vein three to five feet in width, which carries an ore streak of three to ten inches of argentiferous galena and zinc blende.

At Crisman the Yellow Pine has been steadily worked, yielding a good product of an average value of \$250 per ton.

Before closing my remarks on this county I desire to express my thanks to Mr. P. H. Van Diest for valuable notes on Sunshine and Gold Hill districts.

#### CLEAR CREEK COUNTY,

Although one of the smallest in area of the counties of the State, is nevertheless one of the most important in the production of the precious metals; it is pre-eminently a silver producer, its gold interests being of secondary importance. Since 1859, when the first gold placers were discovered at the mouth of Chicago creek, up to the present time, mining has been continuously carried on in this county, every year bringing with it important developments. It is singular how, within the small area of this county, are sandwiched in together the true silver and the true gold lodes without apparent change in the character of the country rock, or other cause, to account for the different character of the filling of these two distinct classes of veins.

In the early days of mining in this county, a large proportion of the ore extracted was treated at Georgetown for the separation of its silver contents, and chiefly by roasting, chloridizing and amalgamation, but one by one these works, unable to compete with the more perfect methods of smelting, have succumbed, until at last there are none left in the county. Now, the ore as it comes from the mines is generally sampled, at a sampling mill, and sold through an agent to the smelters; or in some cases the ore is sent direct to the smelting works at Denver, Golden or Pueblo, and there sold. These sampling mills, merely crush the ore through a five or six hole sieve, and sample them, either automatically by catching a portion of the ore as it falls



through a perpendicular pipe, or by hand, by shoveling the whole of the ore on to a split shovel, which retains a portion; and in large lots this is reduced in quantity by similar process, until it is sufficiently reduced in quantity to pulverize fine. The low grade ores of this county, by which I mean those ores which, though rich in silver themselves, are so impregnated through the gangue of the lodes as not to be separated by hand picking, and consequently to be unmarketable, have received considerable attention of late, and methods of concentration, both wet and dry, have been attempted to separate the pure, rich mineral from the worthless gangue, and doubtless, as mines are worked extensively, these will come more and more into use, and much valuable material will be saved which, at the present time, has either to be dumped among the worthless rock or be forever lost or has to be piled away and kept till it can be cheaply dealt with.

The general topography of this county is very rugged, it consists of archean rocks of granitic and gneissic nature almost entirely. These rocks have been much contorted, and present every mineralogical and lithological variety of this class. The most prevalent variety is gneiss, but with constant transition from one structure, or mineral composition, to that of another, and this often at very short intervals. The finely laminated will rapidly change to the coarsely granular, and *vice versa*. At one point you will find a soft mica schist with an abundance of mica, changing in a short distance into a hard gneiss with but little mica and superfluity of feldspar.

Georgetown is the center of the silver district of Clear Creek county, the mines of this character extending northerly to Empire, westerly up the west branch of the south fork of Clear Creek, past the important mining camp of Silver Plume to Brownville, Bakerville, West Argentine and the snowy range, southerly up the south fork of Clear Creek, past the mining camps of Leavenworth mountain to East Argentine and the Continental Divide, and easterly over Griffith mountain to Cascade mining district.

The developments made during the past two years in this region have been of great importance in proving the permanency of the value of its true fissure veins. At no

time in its history have so many mines been productive, or has its output been so large. Among the most productive of its mines are the Terrible, Baltimore, Mendota, Colorado Central and Seven Thirty.

The silver veins of this region seldom exceed ten to fifteen feet in width, though many exceptions may be noticed. They are usually found to follow very nearly the trend of the mountain in course. There appear to be three general directions in which these lodes strike, viz.: northeast and southwest, northwest and southeast, and north and south, and of these, the two first classes are usually ore bearing, whilst the latter seldom carry much ore. As to the relative age of these three classes of lodes I have not been able to determine satisfactorily, since the cases of crossings, dislocations or heaves are not of frequent occurrence, or at least but few well authenticated cases have come under my observation.

The character of the filling of these lodes, whether of the northeasterly or northwesterly class is not materially different. They may truly be termed fissure veins, and were probably originally small fissures, through which vapors or water, or possibly both flowed, causing an alteration of the country rock, which now forms the gangue of the lodes, or as it is commonly termed by the miners "the crevice material;" ramifying through the gangue rock are more or less regular leaders of argentiferous ores, sometimes showing banded or ribbon-like structure and more or less symmetrical in depositions, and sometimes a brecciated appearance due to re-opening of the vein fissures, after having been partially filled. In almost all cases, the metalliferous portions of the lode, by which is meant that which yields the ore in an approximately marketable state, constitutes but a comparatively small proportion of the lode, and in working mines of this character large dumps of worthless rock are formed, from the necessity of extracting much of the non-metalliferous portions of the veins, in order to attack the metalliferous parts. The ores of these mines are almost without exception found in massive form. Crevices containing crystals are of rare occurrence, though large crystals of zinc blende and galena were found in the Coldstream and Terrible mines. The ore of the district is argentifer-

ous galena and zinc blende, the latter generally predominating. Associated with these are iron pyrites in almost all the veins and disseminated through it are native silver in fine wire or leaf form, argentite, pyrargyrite, stephanite and fahlerz. Of the non-metalliferous minerals that are found carbonate of iron is the most frequent; barytes also occurs especially in the Geneva mining district; it is, however, seldom present in large quantity. Fluor spar and calespar are not often met with, though occasionally they are to be noticed.

The mines of this district, although they have been worked for nearly twenty years, are still in their infancy. No mine in the district has yet reached a depth of 1,000 feet, and but very few exceed 400 feet, so that they may truly be said only to have had the surface scratched. There is apparently no change in the character or value of ores in the deeper mines, nor any diminution in the quantity, the changes that do occur being no greater or different than is met with upon the same veins when explored laterally for a long distance. The mines are all excessively free from water, there being but few pumps in use, and those only of small capacity.

The most important gold sections of the county are at Empire, Trail Creek and Dumont. The lodes of the Empire district are true fissure veins which, near the surface, like the veins of Gilpin county, carried free gold in quartz, and in the early days of '60 to '64 this quartz was worked to great profit in stamp mills. These lodes are usually large, from five to fifty feet, the metalliferous portions being principally auriferous iron pyrites, with which is also associated copper pyrites. This sometimes occurs disseminated through a feldspathic gangue, when it is termed mill ore, from being treated by the stamp mills, and it also comes in solid streaks, which is usually picked and sold to the smelter. None of the mines of this district have been worked to any depth. The deepest, the Tenth Legion, is only 260 feet, and is said to be the only mine that has gone through the cap, by which is meant a portion of the vein which is usually found to be barren, underlying the rich surface quartz. The mines of this district have for many years past been much neglected. This was doubtless due partly to the silver excitement, which drew

the prospectors and miners to other parts of the county, and partly to the change which occurs in these veins as depth is attained, from a free milling surface and decomposed quartz to auriferous pyrites, from which the ordinary stamp mill only saves a small proportion of the gold. At present several of these mines are being prospected in a systematic manner, and in the near future I expect to see the mines of this district producing largely and their product an important factor in the yield of the county. The miner will no longer have to rely on the stamp mill for the extraction of his gold, but will be able to ship it to the smelter, and there is but little doubt that in the preparation of the ore for the smelter the processes of concentration will play an important part.

At Dumont the lethargy which for a number of years seems to have hung over this camp has, to some extent, been removed, and the product of this camp has not been inconsiderable. Although but two or three mines have been worked yet, the results there achieved hold out the strongest encouragement for the future prosperity of this once very productive camp.

The mines of Trail Run district also deserve attention. The most important mine of that district is the Freeland, which has been developed 2,600 feet in length. Its outcrop is about 9,000 feet above sea level, and follows very closely the trend of the southeastern slope of the mountain. Its general strike is S. 50° W. It has a flat dip, being only 40° from the horizontal. The lode is very well defined. Both walls are usually quite distinctly marked, being on an average of about eight feet apart. The contents of the lode are auriferous copper and iron pyrites, with which is associated carbonate of iron. This pyrites has, in the deepest parts of the mine, been found excessively rich in gold, yielding as much as fifty and sixty ounces of gold per ton. Near the mine a smelter has been erected, in which the ore is treated and run into matte. Other lodes in this section have received considerable attention and have produced an important amount of ore. There is no doubt that if the same energy and capital was brought to bear on other mines of this region that has been bestowed upon the Freeland, that more productive and profitable mines would result.

The mines up Chicago creek and in the neighborhood of Idaho Springs, on Seaton mountain, Gilson gulch and other points, have all been worked with regularity, and their production has been an important factor in the bullion yield of the county.

Placer or bar mining has been in years past an important industry in this county, and added materially to the gold production, but most of the gulches and bars have been washed over, and although considerable work of this character is being carried on at the present time, its importance as a factor in the bullion returns of the county has greatly diminished. This class of mining has been carried on successfully during the past two years on the bars below Fall River, past Idaho Springs, for several miles in length on Clear creek. In Lincoln mining district, at the head of Fall river, quite an important piece of hydraulic mining has been going on, and a large area of ground has been washed over with very satisfactory result.

The bullion yield of this county in 1883 was \$1,830,000, based upon as authentic data as it is possible to obtain, and it is estimated that there were employed in the county not to exceed 2,000 miners, which would give a per capita production of \$915.00. In 1884, whilst the number of miners engaged has not increased any, the bullion yield has increased and will be about \$2,100,000, or a per capita yield of \$1,050.

Among the prominent mines of the district is the Colorado Central, situated on the southern slope of Leavenworth mountain, which is a lateral spur of the Continental Divide, terminating at Georgetown, one and one-half miles distant. The outcrop of the lode at the discovery shaft is at an elevation of 10,200 feet. This lode was discovered in the year 1872, since which time it has been almost constantly worked, and has produced upwards of \$1,000,000. The general course of the lode is north 42° east, and follows very nearly the trend of the mountain. It has been developed in depth 750 feet, and longitudinally 2,500 feet. The outcrop of the lode is covered with debris from 10 to 100 feet; and at one time a portion of it seems to have formed the bed of an ancient water course, being denuded and filled with rounded boulders and sand. Before the dis-

covery of the lode the slide or debris below was worked very extensively for float ore, it having undoubtedly broken off from the lode by the process of disintegration and slid down among the debris. The north wall of the lode, although frequently not well defined, is nearly perpendicular, but on the south side there is apparently no well defined wall, but several smaller veins or lodes, with greater dip, unite and form a portion of it.

The country rock is gneiss, mica, schist and some granite, and the north wall is formed in part by these rocks, and for a large portion of the mine there has been encountered as the wall a vein or dyke of pitchstone, which varies much both in color and character. This is called by the miners obsidian or abysinnian. It was first found a short distance north of the discovery shaft, but has since been traced down, nearly to the lowest workings, and westerly 1,000 feet. The gangue of the lode, or as it is here termed, "crevice material," is composed chiefly of granular quartz, feldspar, the latter frequently much decomposed, chlorite and talc, all of which are laminated in character. Ramifying through this in streaks, or small veins, occurs the ore, which is principally an argentiferous galena and zinc blende, impregnated with pyrargyrite, (ruby silver,) stephanite, (brittle silver,) these latter being frequently so finely disseminated as not to be visible to the naked eye, but from the large yield of silver from the ore they are undoubtedly present. With these there is also found associated some iron pyrites. As a matrix of these streaks a hard flinty quartz or hornstone frequently occurs. The ore shoots have a small dip in the lode to the west, and vary in size from a knife blade seam to several feet. They are irregular in their course, but frequently cross diagonally in the lode from wall to wall. The material composing the lode gangue is from 50 to 150 feet wide, and the lode, from its size, may be called the mother lode of the mountain.

Having described the general occurrence and characteristics of the lode, I desire to say a few words regarding the manner in which it may have been formed. Its origin in the first place is undoubtedly due to a fissure or number of small fissures through the country, which were doubtless formed by the intrusion of the granite masses through the gneiss and other rocks. Through these cracks or fissures

either solutions or vapors ascended, which attacked and decomposed the adjacent rock for a width of fifty to one hundred and fifty feet, more or less thoroughly. This decomposed rock now forms what is known as the gangue of the lode or crevice material. In many places the structure of the old gneissic or granitic rock still remains, pointing clearly to this manner of formation. The fissures and cracks formed through this mass of decomposed rock are irregular, both horizontally and vertically, as would naturally be expected where movement of the sides has taken place, which is here shown by innumerable slickensides. These also are the places which have been filled with the ores above mentioned, which at times were deposited with great regularity from either side of the fissures, giving a banded appearance, and in other parts cementing a breccia of angular hornstone together.

#### CHAFFEE COUNTY,

Lies in a highly metalliferous region, and has yearly made great strides in its production of the precious metals. The principal mining districts are in metamorphic and granitic rocks, through which dykes of porphyry and feldspathic rocks are frequently found; limestone also is found in some parts of the county. The principal mining districts are Monarch, Chalk Creek, Granite, Hope, Cottonwood and South Arkansas. In Chalk Creek district the Mary Murphy mine is the most important; it has been continuously worked, and is producing from thirty to forty tons of ore daily. The mines of North Cottonwood have received considerable attention, and the developments made give promise that this district will in the near future come to the front as a large ore producer. In Monarch district much work has been carried on, and the developments have fully sustained the good name of the district. The following short account of the Columbus mine, for which I am indebted to Mr. F. G. Bulkley, is of interest as showing the character of the mines:

The Columbus mine is situated about 12,000 feet above sea level on the southern slope of Taylor mountain. Its workings consist of shafts and tunnels, and develop a true fissure vein to a depth of 300 feet, and horizontally 1,100

feet. The outcropping of the vein may be clearly traced upon the surface for this entire distance, with almost unbroken continuity, commencing at its southern extremity in a deep depression in the side of the mountain, and following very crookedly a mean northeasterly course up an ascent of  $30^{\circ}$ , where it is finally hidden under surface debris. Neither the true streak nor dip can be ascertained from present developments. Commencing at the southerly end, the following changes of course are found at about equal distances on the surface: North  $5^{\circ}$  east, north  $10^{\circ}$  east, north  $20^{\circ}$  east, north  $45^{\circ}$  east, and north  $14^{\circ}$  east. In its downward descent into the earth at the point of greatest development, the vein is vertical for fifty feet; here it gradually inclines to the west, and at a depth of 200 feet dips at an angle of  $70^{\circ}$ ; changing again the dip passes through the vertical, and at 300 feet is found to be at an angle of  $25^{\circ}$  from the vertical inclined to the east. At other points on the vein 200 feet north or south, these changes of pitch are as remarkable, and frequently, at corresponding depths to those named, in the contrary direction; so it may be said that the pitch is constantly changing in the horizontal direction of the vein, as well as in its downward course. From this condition of affairs it follows that the course of the vein is totally different at different depths. It may be said generally that the strike of the vein is in a northeasterly direction.

In this immediate neighborhood Taylor mountain is composed as follows from east to west:

*First*—A vast mass of granite.

*Second*—A vertical sheet of white porphyry, forty to sixty feet thick.

*Third*—A vertical bed or sheet of metamorphic crystalline schist, probably granulite.

*Fourth*—A vertical porphyry dyke not less than 200 feet long.

The vein at its outcrop appears about midway in the thin porphyry sheet above mentioned, at its northerly end, but near its southern extremity it cuts into the adjoining beds of granulite. In its downward descent it is generally



found enclosed in walls of porphyry, but in the lowest developed depths it is found sometimes with one and sometimes with both walls of granulite.

The matrix of the vein is quartz from wall to wall. The clay selvage usually accompanying the walls of fissure veins is in this instance more often lacking, though occasionally present, with a thickness of one-fourth to two inches. For the first 200 feet of depth the quartz is irregularly banded, composed in a great measure of agglomerations of coarse amorphous crystals, or spongy from the decomposition of pyrite, and deep brown in color from the presence of much iron oxide. The whole width of the vein, from six to twenty feet, is productive of good value in silver, which occurs as a sulphuret and contains also varying quantities of gold. At the depth of 200 feet the vein material changes abruptly to a pure white quartz, containing large quantities of pyrite and sphælerite intimately associated in very perfectly shaped crystals of one-twentieth to one-half inch diameter. Copper is also found; native, in spongy masses and as a thin coating of blue or green carbonate, while silver is less widely distributed through the thickness of the vein, being confined to certain localities rich in iron and zinc sulphurets. These conditions remain constant in the nature of the vein material to the lowest depths of exploration. A spur or branch of the vein has its apex in the granite to the west and joins the main vein at a depth of 200 feet. Its strike is due north, and its dip about  $70^{\circ}$  to the east. The vein material here is productive of small quantities of silver, and consists of a compact brownish quartz. No influence seems to be exerted upon the productiveness of the vein by the junction of this spur, either in quality or quantity of the ore. Where the granulite forms either one or both walls, however, there seems to be a falling off, both in respect to quantity and quality of productive material. The product of this mine is between 20,000 and 30,000 tons of ore of an average value of \$5 to \$80 per ton net.

Near Salida there are many very promising mines. The Sedalia has opened up well, showing both black oxide of copper and copper pyrites which, it is said, contains from thirty-five to fifty per cent. of copper, beside five to ten ounces of silver per ton.

Placer and bar mining is carried on principally in Granite and Hope districts, and these have yielded their regular quota of gold toward the county's product. Near Buena Vista and Granite, true fissure veins carrying free gold, have been wrought to some extent, but these have not been developed largely.

The county, however, from its rich mineral resources of great variety, has a basis on which to hope for a permanent increase in its production and consequently in its prosperity.

#### CUSTER COUNTY

Lies east of the Sangre de Christo mountains, and but a small portion of its area is metalliferous. The principal mining districts are at Silver Cliff and Rosita, both of which are located in eruptive rocks which form a narrow belt from one to four miles wide; beyond them, the formation is principally metamorphic granite, although on the eastern edge of the county strata of the jura-trias and cretaceous rocks crop out.

The mineral deposits of this section, of which the Bassick and Bull-Domingo mines are the most important, are somewhat peculiar, and numerous theories have been advanced as to the methods of their formation. Although I have not been able to personally examine these ore deposits, yet from what I have been able to learn regarding them, there seems to be no great difficulty in accounting for their formation by the theories now generally accepted for the formation of fissure veins and their filling, without going into the elaborate and often complicated theories that have been suggested from time to time.

The Bassick mine occurs in trachyte, and it is probable that there has been two or more flows of this rock at different periods—the fissure of the deposit is filled with boulders of trachyte rock cemented together by mineral matter. These boulders are usually surrounded by two or more different layers; the innermost one is usually sulphide of lead (galena), though often intimately associated with it is zinc blende and some sulphide of antimony; the second coating is generally zinc blende, whilst over this is frequently found

a layer of copper pyrites. Considerable quantities of tellurium compounds have also been found in the vein. The several coatings or layers above referred to all carry gold and silver in variable quantities. The mine has been explored to a depth of over one thousand feet, and the same features and character of ore continue. Many other mines have received attention and been among the producers; but, generally speaking, the mines around Silver Cliff have been inactive.

There is no doubt that this county contains much mineral wealth, and that in the course of time, especially when a means of utilizing the low grade ores near Silver Cliff shall have been found, the output of the county will be materially increased.

#### DOLORES COUNTY.

The principal and important mining region of this county is found in the neighborhood of Rico, but the development of this section is doubtless being much retarded for want of better communications, and although the fine ranges of mountains show themselves rich in mineral wealth, their development is very slow. Notwithstanding these drawbacks, the progress made year by year is very cheering and points to a brighter future.

Most of the properties developed to any extent proves them to be rather deposits than true fissures, although in some cases these are met with. The country rock, or formation in which the mines are found, consist largely of limestone and sandstones belonging to the upper carboniferous rocks, and breaking through these are frequently found dykes and masses of porphyry and other eruptive rocks, the most frequent being hornblendic trachyte.

Most of the mines are contacts of the porphyry and lime, and generally carry as ore the carbonates of lead and copper, which are argentiferous, from the presence of sulphide, chloride and bromide of silver, and other silver minerals. Iron, both as oxide, sulphide and carbonate are also frequent associates of the more valuable ore; whilst zinc and bismuth in some combination are also often met with.

Among the more important mines of the district are the Puzzle Extension, which has shown up some large bodies of ore; it has a hanging wall of porphyry and a foot wall of lime, and is a true contact vein, from three to six feet in width. The output of ore is from fifteen to twenty tons per day, of an average value of \$100 per ton. The Leila Davis is another producer of great promise; has a vein from three to five feet wide, and is shipping much ore. The Maggie, on Mount Wilson, the Alma Mater, and numerous other properties might be mentioned which, together, help to swell up the grand total of Dolores county production. With increased facilities and means of communication, the large number of very promising prospects which are to be found in this section will undoubtedly receive attention and inaugurate an era of much greater prosperity for this portion of the State.

#### EAGLE COUNTY.

Prior to 1883 the area now forming this county was a part of Summit County, but in that year the Legislature separated it, and formed a new county. It embraces the mining districts of the Holy Cross and Eagle River. The formation on Eagle River consists of the silurian carboniferous, permian and triassic rocks which are well exposed in the cañons. They consist of limestones, sandstones of various colors, conglomeritic sandstones, shales and quartzites. The chief mining camp is Red Cliff, in the vicinity of which are found the largest producers in the county, viz.: the Belden, Clinton, Crown Point, Spirit, Eagle Bird, Silver Age and others. The following description of the Combined Discovery vein on Battle mountain, by Mr. F. G. Bulkley, is a fair description of the mines of similar character on this mountain:

“Four miles northwesterly from Red Cliff the Eagle River flows through a deep cañon whose precipitous walls rise to a height of over 500 feet on either side, while the general surface of the country at the top of the cañon rises with steep ascents to the northeast, forming Battle mountain, and to the southwest forming Girard mountain. Intersecting the country at right angles with Eagle cañon is a ravine or gorge cut deep into the formation by Rock

Creek, a tributary to the Eagle, which flows in from the northeast. At the point of junction of the two streams the naked rocks rise in bold relief, exhibiting plainly in the walls of the two water courses the geology of the country in two sections, as follows :

“*First*—A thickness of 200 feet of granite.

“*Second*—Cambrian quartzite, 320 feet.

“*Third*—White silurian limestone, 300 feet.

“*Fourth*—White porphyry, several hundred feet thick, forming main upper mass of Battle mountain.

“These lie conformable with a dip of  $10^{\circ}$  to  $12^{\circ}$  in the direction N.  $35^{\circ}$  E. The quartzite bed containing the ore deposit consists of a white or grayish metamorphosed sandstone of very fine texture, with the planes of stratification well preserved. Owing to the compactness and the purely silicious character of the rock the effects of weathering are slight. In the upper portion of this bed, which is exposed to view throughout its entire thickness, occurs a stratum of quartzite of much looser texture, nearly resembling sandstone, having a constant thickness of five feet, and having, also, clearly defined, its planes of contact with the contiguous rock above and below. This stratum appears to constitute a zone to which is confined the ore-bearing mass of a valuable mineral deposit. The nature of this deposit is that of a sheet of mineral matter of variable thickness, of indefinite depth and lateral extent; being divided at times into two or more parallel sheets, with but a thin interval of separating medium. This sheet is enclosed within the distinctly marked boundaries of the porous stratum of quartzite before mentioned; has identically the same strike and dip and occupies a space of from three inches to five feet; while its outcrop can be distinctly traced for a distance of 600 feet upon the surface. By far the greater portion of this sheet consists of gangue composed of impure sandy clays colored by from five to fifteen per cent. of oxide of iron; minute traces of copper occur as carbonate; and from one to five ounces silver probably in the form of chloride. The gangue is somewhat banded in appearance owing to the unequal disposition of the coloring matter, and in this feature of arrangement shows unmistakable evidences of the

action of a current of water. As is usual in metalliferous veins the ore mass is confined to chutes, which in this instance traverse the vein sheet in a direction a little east of north, with a varying width of from ten to sixty feet. A careful study of these productive localities reveals the following vein structure with considerable uniformity throughout:

“The cap rock or hanging wall consists of a compact quartzite, which has a singularly even and clearly defined surface. Under this comes from two to six inches of banded aragonite, followed by four to ten inches of quartzite, varying in texture from extremes of compactness and hardness to friability and softness. Next comes one to six inches of fine grained massive argentiferous galena, carrying from sixty to three hundred ounces silver per ton and occasionally more. After this is a thin sheet of hard quartzite, which in places is lacking. Then follows six inches to three feet of a soft ochreous clayey mass, of a yellow to red color, containing galena disseminated, together with its secondary products, cerussite, anglesite and minium, all yielding silver in good proportions. Immediately under this comes the foot wall, which is of the same material as the hanging. In some parts of the vein the aragonite is lacking, in which case its space is unoccupied, leaving a crevice without filling. In other parts this crevice is only partially filled, the aragonite being still in process of deposition in stalactite form. Stalagmites do not occur, however, owing to the very gradual percolation of the waters carrying the carbonate of lime in solution, and to its evaporation before sufficiently accumulated to form drops. The means by which the enclosing crevice of this vein was formed must remain a matter of speculation, so far as exact proof is concerned. It may have been the result of one or several combined causes. There are some facts shown, however, by an examination in its entirety of the geology of this section, which offer material for a satisfactory theory. An inspection of the district is sufficient to show that the portion of the vein which is open for investigation is located at a point between the foot and summit of an immense anticlinal fold, which involved all the present existing beds; and corroboration of this fact is found in the gradual increase of dip as the

strata enter further to the north. In fact, the locality for miles is one of great geological folding, and doubtless from this cause a separation of the strata may have occurred, especially midway between the foot and summit of such folds, forming the parallel crevices ready for the reception of their metalliferous contents. With reference to the formation of the filling, it may be said generally that the conditions therein found accord perfectly with the theory of lateral secretion, and that the filling came by percolating waters from above, which very probably, to a considerable extent, drew their metallic contents from the porphyry rock. This conjecture gains strength from the fact that percolating waters from above are now depositing the band of aragonite before referred to. Undoubtedly this mineral is dissolved out from the superincumbent beds of limestone. The contorting of the strata here was undoubtedly the occasion of the evolution of the intense heat. This would increase the solvency of the waters, and however weak the solution may have been, the existence of a crevice would permit the accumulation until filled by precipitation carried on through a long interval of time. What agency caused the precipitation is an unsolved problem, but that the metals were originally deposited as sulphides there is little room for doubt, because they are now found in that chemical condition, both as the nucleus or unaltered interior of masses of lead carbonate ore, and also where enclosed and protected by unchanged quartzite, from the subsequent influences which have perhaps repeatedly had their effect. No doubt many features of the vein, as they are now exposed, are the result of secondary action. Thus sulphides have been changed to oxides and carbonates, and ensuing sulphurous waters have perhaps acted upon the enclosing rocks with more or less effect."

In the Holy Cross district the formation is metamorphic granite, through which strong true fissure veins of great permanence course. These veins are auriferous, and very similar in general character to the auriferous veins of Gilpin county. The Calumet, Great Eastern, Great Western and Kansas Chief are properties that have produced considerable quantities of ore containing from one to four ounces of gold per ton. There is no doubt that this section will become more important in a few years' time.

## FREMONT COUNTY.

This county can scarcely be numbered among the producers of precious metals, although their existence is well known, and considerable development has been done upon some of the claims, and in 1883 the silver production of the county amounted to \$20,000. The mines are principally in limestone, with, in some cases, one wall of porphyry. The ores are galena, and the sulphides of iron and copper. Up Grape Creek, south of Cañon City, the Gem mine carries considerable nickel ore, a point of much interest if not of great value.

The existence of petroleum upon Oil Creek has been known for many years, and as far back as 1862 operations were carried on, not more than six miles from Cañon City, and as much as 10,000 gallons were at that time pumped, crudely refined and sold in the markets of the Territory.

The geology of the district, as given by Prof. Arthur Lakes of the State School of Mines, is: Starting from Cañon City along the wagon road across Cañon City Park, which is covered by about six feet of washed pebbles and adobe earth, under which there is at least 200 feet of eocene tertiary deposits of shale, then come evidences of the cretaceous No. 3 and No. 2 group. The Dakota beds are present, though not very thick, as evidenced by the net leaves found therein. Still pursuing a northerly course until Oil Creek is reached, the red dividing line of fine conglomerate is met with. Entering Oil Creek cañon the rocks gradually approach horizontality, having thus far exhibited a constant dip of about twenty-five degrees. When the position of the old oil wells is reached, the strata have a dip of about 1 to 100. Beyond this point, to the northward, the rocks lie conformably horizontal for several miles. Prominent among them is the deep red sandstone, of a thickness of 400 feet near the bottom. This may be said, owing to its compactness, to be the limiting stratum for filtration of waters down or for percolation of any oil upward.

The geological horizon for the occurrence of oil is by no means a fixed one. It is found in strata of almost all ages, although the evidences of its occurrence in quantity



are in favor of the earlier periods. The old oil wells of this region were in jurassic sandstones, whereas the more recent ones have penetrated into shales below the cretaceous, or at least below the sandstone which accompanies the coal. This is readily proved, as the shales which have been bored through are found at the base of Castle rock. All the wells at present in operation are pumping wells, producing a heavy oil of 29° Baumé test. The first commenced producing April, 1883, and has been a constant producer since, with the exception of about six months occupied in putting in a giant torpedo and blowing it up and cleaning it out; it produces about 75 gallons per day. No. 2 well was finished in April of this year, and in the two first days yielded 600 gallons; since then it has averaged 225 gallons daily. Two other wells, producing together 200 gallons daily, are also in operation now, so that the total production is now 500 gallons per diem. These wells are from 1,200 to 1,500 feet deep, and were drilled almost entirely through shales, though of somewhat different lithological character at different depths.

The fine coal mines of this county have been constantly worked and yielded their usual quota of fuel for the State.

#### GARFIELD COUNTY

Was cut off from Summit county in 1883.

By far the largest portion is covered by tertiary formation. The eastern part, however, has outcrops of silurian and carboniferous rocks. Near the junction of these rocks is situated the mining camp of Carbonate. Although about two years ago there was considerable excitement about this region, the results attained have not been nearly as good as anticipated. The boom, however, that was experienced has resulted in some good in prospecting the section, and the mining boom, which at that time was premature, will no doubt lead to the development of a good mining region. The mines here opened are either bedded deposits in limestone, or small pipe veins coming up through the silurian limestone and leading out into flats. The ore is an argentiferous carbonate and sulphide of lead, carrying from fifteen to fifty ounces silver per ton, and in

some cases gold amounting from a trace to three or four ounces per ton. The Night Hawk, Ella and Eagle are claims which have been developed from fifty to one hundred and twenty feet deep.

The coal beds which are being worked near Crested Butte, Gunnison county, pass a short distance south of Glenwood Springs, and have been worked a little, crossing the Grand at Elk creek. These give promise of furnishing immense quantities of very fine and pure coal, and will be of great value to the county and its mining interests.

#### GILPIN COUNTY,

The oldest and most important gold section of the State has shown increased prosperity during the past years. Its mines have, under careful and economical management, yielded larger quantities of ore, and its mills have been taxed to their full capacity, and I believe the yield of 1884 will be greater than at any former period of its history.

The geological structure of the country is principally metamorphic granite, and granite showing a vast amount of contortion and disturbances, the bedding being frequently tilted at very high angles, whilst irregular masses and dykes of feldspathic porphyry traverse both gneissic and granitic masses.

The metalliferous lodes are not all of the same age, but are undoubtedly of later formation than the porphyry dykes, since, as a rule, they keep their course through them without break. In some cases it is observable the dykes have caused the vein to swerve in its course, and follow for a short distance the contact of the two rocks, and especially is this the case when the course of vein and dyke meet at an acute angle. This has given rise in some cases to the appearance of contact veins, but development has almost invariably proved that that the contact was of only short duration and an accident of fracture.

The mineral resources of the county are chiefly gold, which is obtained from both placers and lodes, but there is also an important silver belt traversing a portion of the county.

The gold belt is about four miles in length by one in width, and is partly in granitic rocks, which passes on all sides by imperceptible graduations into gneiss, and partly in gneissic rocks. Through the granitic area, which is hardly a mile in diameter, there are two main porphyry dykes, besides several minor branches or shoots. One of these crosses Bobtail and Mammoth hills in a north and south direction, having a width where crossed by the Mammoth lode of several hundred feet, but dwindling rapidly in either direction into small seams. The other runs in a north-northwest direction across Quartz and Gunnell hills and can be followed several miles; it has a width of from ten to forty feet. The influence, if any, that these dykes have had upon the richness of lodes passing through or near them, is yet an unsettled matter, as the data is conflicting, and it is therefore doubtful if connection between the two can be traced. The mines of this region are true fissure veins, which vary in size from two to twenty feet. The filling is usually feldspathic, with granular quartz, all impregnated with auriferous iron pyrites, though this gangue occurs sometimes in regular streaks and sometimes in irregular masses, veins of auriferous copper and iron pyrites, galena and zinc blende, and associated with them are calcete, chlorite, tale, feldspar and carbonate of iron. In almost all cases the lodes near the surface are found to have undergone considerable change. Atmospheric and other influences have acted upon the metalliferous contents, resulting in the forming of secondary products. The surface quartz is consequently generally free from iron pyrites and colored brown from the oxide of iron. This surface quartz is generally rich in gold and of a much more free milling character than the pyriteferous ores obtained at greater depths. The deepest mines in Colorado are situated in this section. The California is now explored to a depth of upwards of 1,600 feet, and this increased depth shows no material change in the character of the vein, its ore or gold contents. The same is the case with several other mines, which have been opened to upwards of 1,200 feet, and it is therefore safe to conclude that depth has no special influence upon the gold veins of this district.

The silver district or belt includes that portion of the county lying to the north and northwest of Black Hawk,

across North Clear Creek from York Gulch and Wide Awake to Dory Hill. Its structure is metamorphic granite, gneiss and schists traversed by porphyry dykes; and as veins of equal richness occur in all these varieties of rock, it is difficult to trace any immediate connection between the rock, and the deposits of argentiferous ores. As a rule the strike of the veins is northeast and southwest and vary in width from one to ten feet. The filling is usually feldspathic and quartz ore, probably only an alteration of the country rock. The ore streaks are not always continuous, but found in irregular bunches through the gangue. These consist of galena, zinc blende and gray copper, with which are frequently associated some auriferous vein and copper pyrites. Although it is only since 1878 the silver mines of this district have received attention, considerable development has been made upon them, and the yield has been most satisfactory, being estimated at upwards of \$1,200,000 during that period.

In the district around Mount Pisgah the Swamp Angel lode is one with a north and south strike. It is of a large size and notable for the amount of copper pyrites it contains in connection with galena and ruby silver. Professor S. W. Tyler, of Central City, states that in pannings said to have been taken from a clay gouge occurring in this mine, he has found platinum and osmium-iridium.

The Anglo-Celt, on Clear Creek, is another vein with nearly due north and south strike across the general cleavage or stratification of the gneiss, and carrying as ore grey copper in a gangue, which is sometimes quartz (hornstone) and sometimes a sort of talcose schist, most probably an alteration of the surrounding country rock.

Before closing my remarks on this county, I have to thank Professor S. W. Tyler for much valuable information in regard to the mines of this district.

#### GRAND COUNTY

Is situated in northern central Colorado. The principal formations are metamorphic rocks, through which are intrusions of eruptive rocks. Basalt and rhyolite are both

met with, and dykes of porphyry are not infrequent. At the foot of the Continental Divide are to be found the Laramie beds, usually designated as post cretaceous; the divide itself is formed of eruptive and metamorphic rocks. Still lower down, along the valley of the Muddy, the cretaceous strata crop out. In many parts of the county the remains of glacial action are quite marked, and especially is this noticeable in the large moraines near Grand Lake, and to which the lake, in all probability, owes its existence.

The mines of Grand county are chiefly those of gold and silver. Along the Continental Divide, in that part usually known as the Rabbit Ear Range, from the peculiar rabbit ear shape of one of the principal peaks, the principal mines of silver are found. Their ores are the sulphides of lead, iron, copper and zinc, but are valuable only for the silver which they carry, probably in the form of sulphides, arsenides, antimonides and the complex mineral fahlerz. The ores are of medium grade, and of a value of \$25 to \$100 per ton. The most important mine is the Wolverine, which is the only one that has been worked much. At Teller, on the north side of the divide, a camp of considerable promise has been opened, but the country is as yet difficult of access, and the consequence is a slow development of its resources.

The gold mines are almost entirely placers, and are found on many of the streams of the county. On Grizzley, placers have been worked for many years. Near Hantz peak also valuable placers have been discovered. A few miles east of Grand Lake, the creek beds have been worked successfully for gold, and in the northern part of the county, at Independence Mountain, nearly on the divide between Colorado and Wyoming, are very rich placers. These have received attention for many years, but owing to the cost of obtaining water in sufficient quantity, have not been worked extensively. The whole of Independence Mountain, which is apparently an outlyer from the main range, is covered with a deep gravel, worth from twenty-five to fifty cents per cubic yard, and of unknown depth, through this gravel is an abundance of spinel rubies, magnetic iron and epidote. Also in this neighborhood, upon Lincoln and Douglas creeks, rich prospects have been

found. With capital and increased facilities there is no doubt that very profitable placers and silver mines will be opened up and worked in this county.

#### GUNNISON COUNTY,

Is covered largely by metamorphic rocks. There is also a considerable area covered by eruptive rocks. The cretaceous rocks of both the upper and lower series crop out in a belt from five to ten miles in width at Gunnison City, and northwesterly from it across the county east of these the rocks of the upper and lower carboniferous era come to the surface, and on the southern and eastern edges of this outcrop is a band from one-half to four miles of silurian rocks.

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

In Tomichi district the rocks are both sedimentary, eruptive and metamorphic. Through it are found many large lodes from five to twenty feet wide, carrying a quartzose gangue, with galena, gray copper, zinc blende, copper and iron pyrites, and some free gold as an ore. Among the mines of this section are the Rockford, North Star and Chicago mines.

Ruby district lies in an area which is largely composed of sedimentary rocks of the cretaceous age, through which are protruding masses of eruptive rocks. The ore deposits occur in both fissure veins and contacts. The most important mine of this section is the Forest Queen, which has been quite a large and steady producer. It has a vein from seven to twelve feet in width, with an ore streak of about three feet, of an average value of \$100 per ton. The ore is of a silicious nature, carrying native, ruby and brittle silver. Beside the Forest Queen, the Ruby Chief and Bullion King are good properties.

Tin Cup district forms a portion of the Elk mountains, and has a very varied geological character. This district,

notwithstanding many drawbacks from bad communications, has been the richest and most productive in the county. On Gold hill are found a series of porphyry dykes, traversing the limestone which at the north end dip to the east with an average inclination of  $25^\circ$  from the horizontal, whilst at the south end they are found tilted almost perpendicular. The mines are generally found entirely in limestone, although contact veins are also met with. These deposits generally carry as ore chloride and bromide of silver, the sulphide of silver, lead and iron, and also some free gold. The Gold Cup mine is considered the most important mine, and has been steadily worked. It dips into the mountain about  $20^\circ$  from the horizontal on an average, and varies in width from one to seven feet. The ore is of the kind already described, of a grade of from 150 to 175 ounces silver, and one-half to two and one-half ounces gold per ton. The Emma, Iron Cup and many others are of essentially the same character.

The Jimmy Mack is a contact vein between lime and porphyry. It has been one of the most productive mines of the district, yielding ore from 35 to 800 ounces silver per ton, consisting of argentiferous galena, some native silver, and also chloride and sulphide of silver. Its vein varies from three and one-half to six feet in width.

The M. C. R. R. is entirely in porphyry, and carries a very pure hæmatite iron ore, assaying from seven to ten ounces of silver per ton.

The Anna mountain formation is principally granite and porphyry. It possesses many promising fissure vein claims, some of which are very large, varying from four to forty feet in width. The character of the ore is galena, horn silver, native silver, gray copper and free gold. The Anna Dereia and Anna's Treasure are the best developed mines.

Poverty gulch district lies between Ruby on the south and Gothic on the north, and is one of the most important mining districts of the Elk mountains. It contains many true fissure veins, and its mineral resources are yet in their infancy. The ores are argentiferous galena, gray copper, native silver and gold, and of high grade in silver. The

veins vary from four to ten feet in width, and among the most important are the Augusta, Excelsior and Jacob Strader.

The placer mines in Tin Cup district have been actively worked, and many miles of ditches and flumes added to those already existing. The results attained have been very good and profitable.

#### HINSDALE COUNTY

Forms a very precipitous and topographically rough portion of the State. The Continental Divide crosses it diagonally, entering on the western boundary about ten miles south of the northeast corner, and thence extending in a southwesterly direction to its eastern boundary, at a point nearly due east of Silverton in San Juan County. The character of the rocks that extend over this area are mostly eruptive, a trachytic rock being the most predominant, though masses of basalt occur at many points. The principal mining camp is situate in the northwest part of the county near Lake City, which is the main point of supply for the four mining districts of Galena, Sherman, Lake and Park. The Ute and Ulay mines, in Galena district, situated on Hanson Creek, are the most important mines and are without doubt the most extensively developed properties in the region. Their output is very large, and although a large portion is of low grade in silver, by means of concentration it is made available, and the concentrates, together with the better grades of ores, are shipped to the smelters. The Capital City is a vein about four to six feet wide, carrying as ore, galena, zinc blende, iron pyrites and copper pyrites. The mines of this district usually carry as vein material heavy spar, quartz and calcite. Near Mineral Point the county is traversed by great fissure veins from ten to fifty feet in width. The principal mines are the Red Cloud, Bill Young and Maid of the Mist. The Red Cloud has been the most extensively developed; it is upward of 200 feet deep. For ore it has a streak three to five feet in width, which consists of galena, zinc blende and fahlerz. In some cases the fahlerz or gray copper is nearly solid. Altogether the ore body is remarkably compact.



In Lake district, the most important and most extensively developed mine is the Belle of the West. The lode, which is composed of quartz, impregnated with iron pyrites, galena and gray copper. These metalliferous minerals, at times forming almost the entire filling, is from two to three feet wide. There are also many other very promising claims, both in this and other districts, undergoing development, and which will no doubt be heard from before the lapse of many years.

As to the general value of the ore, it is generally considered of low grade, but this is not altogether true, for many tons have been shipped containing 200 ounces and upwards of silver per ton.

The veins of this region cannot be said to have any general or mean strike. They apparently run in every direction, and can better be described as radiating from some central point or peak than given a general degree of parallelism in any direction. The occurrence of fissure veins, as these seem to be, from their frequent ribbon-like structure, speaking clearly of their gradual deposition from the sides of the fissure by aqueous solutions, is rather a phenomenal one in a geological view, and it will probably require more extended and careful examinations to fully determine the real character of these mines. As to their value, future development alone will show their worth.

#### LAKE COUNTY.

The reputation of Leadville as the principal mining camp of Colorado has been well sustained during the past two years, and its future prospects are as favorable now as at any time in its past history. Explorations and developments in all parts are daily leading to new discoveries, and thus many mines which heretofore have been unproductive are now among the list of profitable and productive properties. The ore deposits of this region are contact veins between limestone and porphyry, varying from a few inches in thickness to sixty and even seventy feet.

The ores consist of a general matrix of the oxides iron, with carbonate and sulphide of lead; also zinc blende

and calamine are met with. There are also many secondary products of lead formed from the decomposition of galena.

The geological characteristics of the Leadville deposits have been so exhaustively treated by S. F. Emmons, Esq., of the United States Geological Survey, in his report to the Secretary of the Interior, that there is nothing left for me to say regarding them, since I entirely coincide with the theories advanced by him in regard to their formation.

The average value of the ores of the Leadville district is not as high as it has been, owing to the fact that the ore at present raised is of a more uniform value, the wonderfully rich chlorides and bromides being less frequently met with. The average now will not exceed twenty ounces silver per ton and twenty-five per cent. of lead. Owing, however, to the large ore bodies and the ease with which they can be extracted, together with the good smelting qualities they possess, rendering their reduction both easy and cheap, they can be worked profitably.

The output of the Leadville mines in tonnage will exceed that of previous years and the number of mines yielding from 1 to 400 tons daily, is greater.

The Placer mines of California gulch have received much attention and been worked on a moderate scale. The yield in gold has been as good as usual and the results attained will show up well.

The output of Lake County for the year 1883 was \$400,000 in gold and \$11,700,000 in silver, a total of \$12,100,000; for the year 1884 it is probable the yield will not fall very far short of this amount.

#### LA PLATA COUNTY

Is located in the southwest corner of the State. It is principally covered by rocks of the middle cretaceous age. Though near Parrott City, there is an area of several miles where the hornblendic trachyte comes through to the surface. Also in the northeast corner of the county meta-

morphic granite is the rock of the country, and on the edge of this are found beds belonging to both the upper and lower carboniferous period. This county has, during the past two years, made considerable progress, and is slowly but surely advancing, and preparing for a future important place in the metalliferous counties of the State.

The mining districts are Needle Mountain, Cascade, Florida and California.

Near Parrott City the lodes are auriferous, gold being carried through the gangue associated with iron pyrites, though there are also a number of veins which carry tellurides, mostly sylvanite. These extend westward from Junction Creek across the intervening mountains to the several branches of the La Plata River. So little development, however, has been made that it is premature yet to say much about them. Some of the more important prospects are the Kennebec, Gold Wedge and Iridos. In this latter mine it is stated that both gold amalgam and native mercury are found, but not having come under my own observation I give this statement as the observation of others. The Century mine, in the Clear Creek basin, nearly at timber line, is three to five feet wide. The ore streak, from six to eighteen inches in width, is chiefly auriferous pyrites. The Wabash is another strong lode, with a mean course of about northeast. It has been but little developed, but promises well. The ore is pyrites, disseminated through a quartzose gangue.

There are many other prospects in the several districts which are opening up well, and which, as times go on will help to swell the annual production of the county.

#### OURAY COUNTY.

The progress made in the development of the mining region of this part of the State has been very great, and probably no portion of the State has received greater attention. The mineral area is composed almost entirely of eruptive rocks; porphyry, trachyte, basalt, diorite and granite are the most frequently met with. The ores are usually a matrix of quartz, in which is found galena, fahlerz, argentite, zinc blende, iron and copper pyrites.

The mines of Red Mountain contain some of the richest veins of the county; though the average grade of the ore is only medium. It occurs in immense bodies, which renders its extraction cheap and profitable. The Yankee Girl is undoubtedly the most important mine, and has shipped a very large quantity of ore. The National Belle is also a good mine and yields well. In Ouray County there are three mining districts, viz.: Red Mountain, Uncompahgre and Sneffles. In the Sneffles mining district the veins are apparently true fissures, showing not only the selvage or gouge on one wall, so common with veins of this character, but also a ribbon or banded structure. In the Yellow Rose lode the gangue is frequently composed of both silicate and carbonate of manganese, which is associated with native silver and sulphide of silver (argentite). The most important properties are the Yellow Rose, Hidden Treasure, Wheel of Fortune, El Dorado and others.

The Uncompahgre district comprises the mines in the neighborhood of Ouray. Among its most important mines are the Grand View and the Union—a vein coursing through the trachyte with a northwest and southeast course. It is usually from four to six feet wide, and has for metalliferous contents iron pyrites associated with silver ores. The Silver Link and Belle of Ouray—this latter is ten to fifteen feet wide, and has a metalliferous vein of quartz, impregnated with argentiferous galena, in places as much as four to five feet wide, of a grade of about twenty ounces silver per ton.

In Red Mountain district, beside the prominent mines that I have mentioned, there are many others which have been and still are producing, and many most encouraging prospects are also to be found.

The stimulus that the mining industry in this county has received is based upon something tangible, and the results of the past two years will largely aid in giving it prominence.

#### PARK COUNTY.

The riches of this area are comprised in the five mining districts of Montgomery, Buckskin, Horseshoe, Hall's Valley and Mosquito, which together form a mineral belt

about thirty-five miles long and twelve wide. The geological features of this area are very interesting. Mount Lincoln is composed of alternate layers of limestone and quartzite. These limestone contain fossil shells which prove them to be of old silurian age. The silver producing properties of this district are invariably found between the two classes of rock above mentioned, and are no doubt contact deposits, and for ore carry either a quartz or heavy spar gangue, frequently both, through which is disseminated galena, zinc blende and gray copper; also, iron and copper pyrites are met with. In Buckskin district, beside the contact vein, some true fissures are met with. The Dolly Varden and Moose mines, both contacts, lie in this district, and have yielded very largely in former years, though at present nearly idle. The ore has been sulphides of lead, zinc and iron. The principal mine in the Mosquito district is the London., the vein of which is said to be traceable for upwards of fifteen miles. It is from four to six feet wide, and varies much in its mineral contents, carrying both gold and silver ores.

The Hall Valley district is situated in metamorphic and granitic rocks, through which course large true fissure veins carrying silver ores, such as argentiferous galena, zinc blende, iron and copper pyrites, and associated with this as a frequent gangue is heavy spar. This district is destined to far greater importance than it now has, and some day will be worked more vigorously. The Whale, Leftwick, Missouri, Ypsilanti, are among the most important mines.

The placer mines of the county have yielded well, and are far from being exhausted. There are yet large tracts of auriferous gravel which will be worked and made to yield their treasure. In Tarryall Gulch, Beaver Creek and the Platte, with its tributaries, these gravel beds are found, which are from ten to fifty feet thick.

There is no doubt that both the placers, contact and true fissure mines of Park County when extensively worked will be found far more valuable than the mines of many parts of the State which have heretofore been looked upon with a greater degree of confidence.

## PITKIN COUNTY

Covers an area about sixty miles from east to west and thirty-five from north to south. The geological characteristics of the country vary much. At the eastern extremity the country is metamorphic granite, through which are dykes of the eruptive rocks. In these at Independence are found large true fissure veins, with an auriferous ore of iron and copper pyrites, zinc blende and galena, through a matrix of quartz. Further west, at Aspen, the upper cretaceous, jurassic and silurian rocks crop out. These consist of limestone, quartzite and dykes of porphyry, in which are found contact veins carrying argentiferous galena, zinc blende and some sulphide of silver, and in some instances carbonate of zinc has been met with, which is notably the case in the Smuggler mine.

Near Ashcroft are true fissure veins in metamorphic granite, through which are many bodies of eruptive rocks. These veins have an ore consisting of medium high grade galena, with fahlerz, and the true silver ores. Among the most promising properties are the Montezuma, Tam O'Shanter, Cummings, St. Elmo, Hidden Treasure and others. The veins are usually very well defined, varying in size from three to twelve feet. The facilities for operating mines in this county have been poor, but these are being gradually overcome. A fine wagon road has been built over Pearl Pass between Ashcroft and Crested Butte, a distance of twenty-four miles, which will materially assist in giving an impetus to the mines of that region. The great richness of the mineral resources of the region is the reason that it has been able to struggle so long against adverse circumstances, and therefore when equally as favored as other parts of the State with means of communication, it may be looked upon with the greatest of favor.

## RIO GRANDE COUNTY

In the southern central portion of the State, covers an area of about 1,200 square miles. Its mineral resources are confined to but one district, that of Summit, in the south part of the county, where the whole district is covered with eruptive rocks, principally of the trachyte class.

The geology of the country requires much study to fully understand it or write much about it. The mines are entirely auriferous; the ore is almost entirely free gold, through a matrix of porphyritic material; the ore is free milling, and consequently readily extracted by stamp mills. The Golconda, one of the prominent mines, is a large vein, being from twelve to twenty-five feet wide, and a large proportion of it good pay material under the stamps. It is said to yield on an average \$18.00 per ton by raw amalgamation. The Aztec, another good property, carries ore of similar character to the Golconda, and generally resembles it. The Annie is, perhaps, the most important property in the district at the present time. It resembles the mines already mentioned, and is yielding a large quantity of gold. Like other mining camps, there are many improvements needed before its resources can be fully and extensively developed, but from the results already attained, under many adverse circumstances and difficulties, it is fair to assume that before many years roll by the results that will be achieved will be both important and very profitable.

#### ROUTT COUNTY

Lies in the extreme northwestern portion of the State. It is more particularly an agricultural part, though near Hahn's Peak gold placers have been worked on Elk River and its tributary streams. Owing to a scarcity of water these placers can only be operated one or two months in the year. The formation around Hahn's Peak is eruptive rock. South of it some miles, near Hayden, are found cretaceous and post-cretaceous strata, whilst to the east the beds of tertiary age crop out; and still further east are found beds belonging to the silurian and carboniferous eras. In the year 1883 the estimated yield of gold from placers was \$38,000, and this year (1884) it will probably amount to about the same figures.

#### SAGUACHE COUNTY

Has not materially increased in prosperity during the past two years, but the outlook for the future is rather better. Its mines are principally found in the eruptive and meta-

morphic rocks of the range forming the Continental Divide, in the northern part of the county. On Kerber Creek the principal mines are located, which are broad lodes carrying pay streaks from two to ten feet wide. The Rawley mine, in Rawley Gulch, is one of the most productive mines in the county. It is a strong, permanent vein from eight to twelve feet in width, in which are found two ore veins, one a quartz impregnated with gray copper, and much stained by the carbonates of copper and averaging about twenty ounces silver per ton, is quite wide; the other streak is an argenteriferous galena with about twenty-five ounces of silver per ton, and forty per cent. lead.

The Albert mine, in Enterprise Gulch, is a lode from three to four feet in width, with a pay streak of about twelve inches, and shipped considerable ore of an average yield of about \$90 per ton. In the southwest part of the county, near Carnero, some valuable mines are said to have been opened. These are stated to be contact deposits of a black manganese ore, carrying considerable gold and silver. Among the mines of this section are the Buckhorn, Montezuma, Newport and Kesler, besides which there are many other very promising prospects. This county, in 1883, produced about \$105,000, of which \$5,000 was in gold, the remainder being silver.

The mountains and mineral region of this county are in a rich mineral belt, and when more extensively developed, and with increased facilities, will yield much more extensively than at present.

#### SAN JUAN COUNTY,

Lying south of Ouray County, and crossed by the San Juan Mountains, presents topographical features and geological characteristics of great interest. Its resources are wonderful, and its richness is best understood when one learns that out of an area of 405 square miles, 70 square miles, or more than one-sixth part, has been located as lode claims. The general character of the rock met with is eruptive, viz., trachyte and granites; schists, gneiss and metamorphic rocks also occur, tilted at a high angle. Mr. T. E. Schwarz says: "The mineral-bearing portion, which ex-



tends from Sultan Mountain, near Silverton, on the south, by the headwaters of the San Miguel to Mount Sneffles, and then east to the headwaters of the Rio Grande, is a division of the trachytes classed by Dr. F. M. Endlich as No. 4, and at the top of the series. The larger part of this area is prolific in strong, well-defined fissure veins, which have been proven to extend in depth into the lower trachyte series, and into the metamorphic schists. Many of these veins, notably in the vicinity of Animas Forks and Eureka, are of great width, from fifteen to seventy-five feet, and show large bodies of low grade (twenty to forty ounces silver) galena ores. Poughkeepsie Gulch has become prominent during the past two years for the high grade ores contained in its fissure veins. In this district the Old Lout has been a large producer of an ore rich in silver, and carrying as high as 38 per cent. of the sulphide of bismuth, besides the sulphides of lead, copper and zinc."

The veins of this region do not appear to have any general degree of parallelism, but are found to trend rather in converging directions toward some general focal point or points. All the lodes of this section are not of the same geological age, which is evidenced by the dislocation of older by younger veins; but these dislocations are either not of frequent occurrence, or have not been observed. However, when more extensive development of the mines of the district have been made, careful study and observation of the general vein structure will certainly produce data from which definite conclusions may be arrived at.

On the San Juan County side of Red Mountain are many good mines, but as the geological characteristics of this district have been treated under the head of Ouray County, it would be useless repetition to go into statements of it here.

The ores found in the veins in the different sections of this county consist of the sulphides of lead, zinc, iron and copper, together with fahlerz or gray copper. Both dark and light ruby silver ore are met with, as well as the compounds of tellurium, antimony and bismuth.

Immense strides have been made in this county during the past year, and probably no section in the State has

improved more rapidly, or can any district show better mines or results.

## SAN MIGUEL COUNTY

Was, previous to 1883, a portion of Ouray County. Its location is west of San Juan and Ouray Counties, extending to the western boundary of the State. Like Ouray and San Juan Counties, its mineral resources are found in the great San Juan range, and in general what has been said regarding the geology of those counties will apply to this.

The mines in general are strong, permanent fissure veins of both gold and silver, and can be traced for long distances; the ore bodies are proving themselves to be both continuous and rich. The ores are free gold, native, brittle, and ruby silver, associated with galena, zinc blende, iron and copper pyrites; the gangues are usually quartzose, and in many instances rhodonite or manganese silicate, called by the miners rose quartz, forms an important part. Close to the Divide which separates San Miguel and Ouray Counties, and on the western slope of Virginius Pass, is Marshall, where are located several very important mines, which have brought this district into great prominence during the past two years, and foremost among them are the Sheridan, Mendota, Smuggler, Cimarron and Nellie mines, which have steadily produced high grade silver and gold ores. The Smuggler vein, upon which the Sheridan and Mendota mines are also located, is easily traceable for nearly three miles, with a strong, bold outcrop; its general strike is N. 18° W., whilst its dip is to the west; in width it is found to be from six to fifteen feet, carrying a mineral streak from six inches to three feet in size, which carries in quantity an ore consisting of brittle and ruby silver and free gold, associated with iron and copper pyrites and some galena. The Nellie mine has produced largely, for its small development, a high grade free milling gold quartz. The Cimarron has been one of the largest and most profitable producers in the San Juan region; its pay streak is from fifteen to twenty-four inches in width, the vein itself being six to eight feet between walls; it carries very rich

argentiferous galena and gray copper, also free gold in leaf and wire form.

Along the beds of most of the principal streams and their branches, gold is found, but this has so far generally been very fine and difficult to save. The time, however, will most assuredly come when improved methods and machinery will render this source of wealth available.

In the district around Ophir, considerable advance has been made, and it is surely, though slowly, pushing its way to the front, with a most encouraging outlook for the future. From this camp of true fissure veins considerable high-grade argentiferous ores have been shipped across the range to the railroad at Silverton, showing permanency and satisfactory results. Among its important mines are the Summit, Tip Top, Nevada, Caribou, Silver Bell and Santa Cruz.

The production of the precious metals from this county shows a large increase over former years, although it is a difficult matter to arrive at an exact comparison, as formerly the product was estimated with that of Ouray County, of which it formed a part, and the exact proportion belonging to each county cannot be accurately ascertained.

#### SUMMIT COUNTY

Was formerly much larger than at present, but the legislature of 1883 took from it the area now forming the counties of Eagle and Garfield. A large portion of the county is covered with granitic and eruptive rocks, whilst in the southwestern portion of the county, in the Ten Mile region, the rocks are limestone, dolomite and sandstone. The ore deposits in the granitic rocks are true fissure veins, yielding as ore the sulphides of lead and zinc, usually low in silver contents, with which are associated the sulphides of iron and copper in smaller quantity. The average grade of ore is from 20 to 100 ounces silver per ton. Many of the lodes carry gray copper, but it is poor in silver. The veins in the neighborhood of Montezuma, St. Johns, Decatur and Chihuahua are usually strong, permanent fissure veins, from three to fifteen feet in width, with a general mean strike of northeast and southwest. They usually carry a tolerably uniform mineral streak. On the Conti-

mental Divide, between Montezuma and Geneva Gulch, are a series of lodes, with a general direction a few degrees west of north, which are of older origin than the silver lead lodes. These are usually strong, with large outcrops of honeycomb quartz of a brownish color, caused from the decomposition of iron pyrites. They carry as ore a bismuth silver ore called shermerite, which is very rich in silver, and associated with it is iron pyrites, and occasionally a little galena. Prominent among the mines of this class are the Glendale, Treasure Vault and Israel Williams lodes. Although some of the mines around Montezuma have made considerable advance since the advent of the railroad at Keystone, yet generally speaking this camp, and those of Decatur and Chihuahua, have been very quiet the last year, and little more than assessment work has been done.

In the Ten Mile district the ore occurs in contact deposits. The ores are usually of low grade in silver, from fifteen to eighty ounces per ton, but carry a good percentage of lead, viz.: from twenty to fifty per cent., but they are desirable smelting ores, consisting largely of carbonate of lead associated with oxide and carbonate of iron. This district, which in 1881-1882 was full of life and excitement, owing principally to the wonderful yield of the Robinson mine, has been steadily losing ground and is apparently falling into a dormant state. Among the most prominent mines worked, all of which produced considerable ore, are the Robinson, Wheel of Fortune, Crown Point, Aftermath and others.

In the vicinity of Breckenridge, on Gibson and Farncome hills, the past year has shown much progress and some good gold properties have been developed, notably the Jumbo and Buffalo mines, and the stability of the camp has been materially increased.

Work has been steadily carried on in the placer mines along the Blue River and its tributary gulches, which in the early days of Colorado were among the richest and most productive in the State, and the yield from these has been very satisfactory.

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