
APPENDIX I.

THE MINING INDUSTRIES OF UTAH.

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[NOTE.—While it would be extremely desirable to present, from the material collected by the special agents of this branch of the census, a complete and detailed account of the mining and metallurgical operations in all the states and territories, in order that the relations of the various factors involved in the industry might be clearly exhibited, still the limited space allotted to this volume of the census reports renders such a full presentation impracticable, and necessitates the substitution of a report more general in its character. It is felt, however, that, though from the above reasons it would be impracticable to give a detailed review of the industry in every section, the selection of some one for more minute discussion would, to some extent, supply the place of the fuller description.

It has been extremely difficult to determine which one of the states and territories would the best serve as a type or illustration. Each has its peculiar features, which distinguish it from the others, and each has many general features in which it resembles the others. It was necessary in the selection, on the one hand, not to choose one which so far excelled the others in its mining and metallurgical advancement as to give a false and too highly-colored idea of the progress of the industry over the whole country, and, on the other, not to take as a type one whose industry was in the early stages of its development, and thus give a depreciative impression equally erroneous.

The precious-metal mining industry of Utah appears to present features of peculiar interest from a technical point of view. Mining in this territory seems to have reached a stage which may be taken as fairly representative of the progress which has been made elsewhere in the country. The mineral resources are more varied in their character than is the case in any other region, with the possible exception of California and Colorado. The territory occupies an intermediate geographical position, its product is midway in importance, and the costs of labor, supplies, etc., are neither low, as in older mining communities, nor exceedingly high, as in newer and less developed localities. Its mining mechanical appliances, it is true, have not been brought to the degree of perfection which has been reached in Nevada, nor are they of the crude order prevalent in new places; still, the metallurgical plant and processes of its principal works illustrate by their many past experiments and failures the various stages of development in metallurgy in this country. In short, though gold mining is not an interest of fully proportionate importance, the territory is fairly typical in a sense which does not exist in the case of any of the other mining states and territories.

In view of these considerations, and of the fact that much information of importance regarding Utah has hitherto escaped publication, the territory has been selected for a somewhat detailed description.

Mr. D. B. Huntley, the special expert detailed to Utah, has prepared such a technically complete summary of the results of his investigations that it has had no little weight in the selection of the section covered by his report for more minute discussion. His report is here presented in a somewhat abridged form.]

The territory of Utah is a rich mineral country, but in general, owing to causes which will hereafter be discussed, its mining prosperity at the period under review was not commensurate with its mineral wealth. Although the Ontario continued to declare its monthly dividends, and work was being steadily prosecuted at the new districts of Frisco and Silver Reef, yet the former great ore-producing districts of West Mountain and Big and Little Cottonwoods were comparatively idle. In some instances mines which formerly employed a hundred men were not even being prospected, but were abandoned to three or four men, who were engaged in picking over the dumps and searching the workings for ore which had escaped extraction. Practical and energetic labor is confined to a few large mines, the output of which presents a strikingly noticeable falling off in the total bullion product, so that one attempting to judge of the condition of the industry, using this as a criterion, is apt to be misled. Extraordinary exertion in the development of a few rich properties do far less toward the real and substantial advancement of mining as a general profitable industry than does the continued systematic and practical working of many mines, even though smaller. Though there was a lack of energy and activity in very many quarters, still a large amount of prospecting was being carried on, particularly in the region of Parley's park and the Cottonwoods, and, on the whole, it is probable that the next computation will show an increase in the total bullion product, even though an increase far short of possibilities. In the low prices of food and moderate rates of transportation the territory possesses marked advantages.

The reports and the recollections of sundry outrageous swindles perpetrated in the past on too confiding investors have operated not a little in frightening away capitalists, more especially foreign ones, who have in a majority of the instances been the victims, having been selected as more likely to prove easy prey on account of their unfamiliarity with mining matters. This has been no small drawback to advancement.

In the early days of the industry in this territory reduction presented few difficulties, as the large surface bodies were of oxidized ore and easily worked. As these were exhausted and lower levels were reached mining became more difficult and the ores more rebellious. The old simple methods and machinery were found to be of

little use. New methods and new machinery had to be invented and purchased. These expenses in many cases soon consumed the early profits, and left the mine owners without means to prospect extensively, or even to erect pumping machinery to follow known bodies. Then, again, the rich discoveries in Colorado, Arizona, and Idaho, during the three years preceding the period under review, turned the attention of investors in those directions, and, in consequence, capital was diverted from the old mining districts. In this way the industry in Utah suffered greatly. In all probability, however, the prime factors in the existing dullness have been the exhaustion of the surface bodies and the reaching of the water level, with the consequent change in the character of the deposits. Ore which, at the surface, consisted of carbonates and sulphates of lead in a soft ocher, changed, below, to pyrite, galena, and sometimes to zincblende, in a hard siliceous or calcareous rock. The increase in the quantity of pyrite lessened the value of the ore and made smelting more expensive. Again, this hard ore cannot be so cheaply extracted or concentrated. In working the surface bodies the miner had learned to follow the ocher stain with faith that it would lead to ore. Below the water line this guide was wanting, and the ocher stain was usually replaced by a much narrower band of rock containing pyrites. The latter is not more difficult to follow than the former to one trained to it, but, by reason of a lack of experience, so few have been followed in depth with success that when the pyrite was reached mines were deemed almost valueless. The surface bodies did not alone contain all the ore worth working, but at the then existing prices, and with the methods of treatment employed, they contained all that could be worked with any profit. The great need of Utah at present is concentration works. As far as depth is concerned, mining in this territory is in its infancy. A careful study and the application of the processes of concentration to the great quantities of low-grade ore will be requisite to the profitable prosecution of mining in many of the districts. Concentrating on a small scale is now practiced, though, for the most part, in but a rude way, and it is principally confined to the separation of nodules and crystals of anglesite, cerussite, and galena from a fine ocher. Machinery is needed for the separation of galena, pyrite, and sphalerite from one another.

In several of the older districts the days are nearly at an end when mines can be worked profitably by single individuals or partnerships having but a small capital, unless rich surface bodies are chanced upon. Their mines will have to be worked by wealthy companies with the means to construct extensive apparatus for the concentration of the low-grade material found between the bodies of rich ore.

Wonderful progress has been made in metallurgy in the United States during the last thirty years. The mineral resources of the country form so large a part of its natural wealth that the inventive genius of the people has been stimulated to the extreme in the production of methods and machinery for their development. But when the necessity has arisen for a new method, or a new machine, the inventors have relied too much on themselves and their own ability, and have studied too little what has been done in the same direction in other countries. Thus, in some instances, time and money have been wasted in reinventing and testing machines which in other places and in other times have proved failures. The first requisite of an inventor is a knowledge of what has been done by others in the line to which his efforts are to be devoted. In Germany, Austria, and France great attention has been given to concentrating apparatus. The ores which it has been necessary to handle in those countries are very like the pyritous ores of Utah and some of the heretofore neglected and despised low-grade veins. A thorough study of the continental methods would be of great advantage.

It may not perhaps be out of place to give here a chronological summary of the history of the territory as far as it is connected with mining:

July 24, 1847.—Arrival of Brigham Young and a few Mormons on the site of Salt Lake City.

1858.—Arrival of General Johnston's army.

1861 to 1863.—A few tons of lead claimed to have been obtained by the Mormons from the Rawlings mine, in Beaver county.

October, 1862.—Arrival of California volunteers under General P. E. Connor for the protection of the settlers. General Connor early saw that the Mormon question could best be solved by the encouragement of outside immigration. The opening of mines, he thought, would do this, and so he gave furloughs to squads of his soldiers, old California miners, to prospect the country.

September 17, 1863.—Jordan mine located by the soldiers in the West Mountain district. First location in Utah.

Summer of 1864.—Discovery of the Emma and other mines in the Little Cottonwood district. First smelter (a reverberatory one) erected at Stockton by General Connor and officers. It proved a failure.

1869.—Completion of the Central Pacific and Union Pacific railroads.

June, 1870.—First efficient smelter (a cupola one) erected by Woodhull Brothers, 7 miles south of Salt Lake City.

1870.—Utah Central railroad completed.

1870 to 1872.—Mining excitement in Utah. Many stacks erected, but not all successful.

Spring of 1871.—Sale of the Emma mine.

1871.—Utah Southern railroad commenced.

July, 1872.—Discovery of the Ontario mine, in Summit county.

May, 1873.—Wasatch and Jordan Valley railroad (Little Cottonwood) completed.

December, 1873.—Bingham Cañon and Camp Floyd railroad completed.

1874.—First concentration works in Utah erected at Bingham Cañon.

1875.—Discovery of the Horn Silver mine, in Beaver county.

Fall of 1876.—Ontario mill erected.

1876.—Mining excitement at Silver Reef.

1877-'78.—Leaching works erected at Bingham Cañon.

1878.—Utah and Pleasant Valley railroad completed.

During the census year Utah produced gold and silver as follows:

	GOLD.		SILVER.		Total value.
	Ounces.	Value.	Ounces.	Value.	
DEEP MINES.					
From ore raised and treated during census year.....	13,063.4	\$270,045	3,555,538.0	\$4,596,954	\$4,866,999
From ore raised prior to, but treated during census year.....	74.6	1,542	112,895.0	145,902	147,504
Total from deep mines.....	13,138.0	271,587	3,668,433.0	4,742,856	5,014,503
From placer mines.....	967.5	*20,000	*132.5	*171	20,171
From all mines.....	14,105.5	291,587	3,668,565.5	4,743,027	5,034,674

* Estimated.

The base bullion production of the Utah smelting works for the census year was as follows:

Refined lead.....	Pounds. 2,586,370
Crude bullion, including weight of silver and gold contents.....	28,213,501

The weight and value of the precious metals contained in base bullion were as follows:

Gold.....	Ounces. 4,511.4	\$93,259
Silver.....	1,813,906.0	2,345,199
Total.....		<u>2,438,458</u>

Deducting from the crude bullion product 322,170 pounds produced from Idaho, Montana, and Nevada ores smelted in Utah, the remainder, 27,891,331 pounds, is the yield of Utah ores smelted in the territory. To this should be added 865,500 pounds of crude lead bullion, the estimated yield of Utah ores smelted in Chicago and in Omaha. The total crude bullion product of Utah for the census year is, therefore, 28,756,831 pounds.

The purpose of the following pages is to represent substantially the condition of the mining industries of the territory during the census year. They will embrace detailed information concerning individual properties only in cases which appear representative or illustrative. Such information of an historical character as has been obtained will be noted when it is of sufficient interest or importance. In the collection of the material for this report the writer has been obliged, in many instances, to rely wholly on the statements of individuals whose interests and prejudices may have influenced their statements consciously or unconsciously. Such data have been carefully weighed, and a liberal allowance has been made for exaggerations. Wherever values of former products have been given, it must be borne in mind that they refer to the price received for the ore or bullion sold in currency, and not in gold, unless specifically so stated. It is due to the mining men of Utah to state that they were not only courteous to the expert charged with the duty of collecting the statistics, but nearly always ready to furnish the desired information at the cost of considerable time and trouble to themselves.

SALT LAKE COUNTY.

The principal mining districts of the county are the West Mountain, Big Cottonwood, and Little Cottonwood. In the neighborhood of South Cottonwood and Sandy there is a group of smelters and sampling mills. In discussing the condition of the mining industry each district will be taken up separately, and the various groups and localities treated of by themselves.

WEST MOUNTAIN MINING DISTRICT.

[December, 1880.]

The West Mountain mining district is situated on the eastern slope of the Oquirrh range. Its breadth from east to west is about 20 miles, and its length is 35 miles from north to south. The mines, however, are included in an area some 5 miles square. It was the first mining district organized in the territory, and its first mine, the Jordan, was located September 17, 1863. The records show that about 6,500 locations have been made, but at the time of the visit probably not over 600 or 700 claims were held, and but 63 of these were patented.

There are no published maps of this district, so that a brief outline of the topography of the section in which claims have been located may, perhaps, be of some assistance in making more clear the position of the groups and individual mines and works described. The trend of the Oquirrh range is north and south. The plain of the Jordan valley rises gradually to the base of the range, at which point its altitude is about 5,400 feet. The crest of the range, about 8 miles from the foot-hills, is between 9,000 and 10,000 feet high. The mines are located within 3 miles of the summit, and are scattered through four cañons opening into the Jordan valley. In order, beginning at the north, they are: Barney's cañon, Bingham cañon, Copper gulch, and Butterfield cañon.

Bingham cañon, the principal one, and containing most of the mines, runs east and west for a few miles, then turns south and follows the trend of the range, with forks and side cañons extending nearly to its summit. On the north the cañon has the following branches: Freeman's gulch, Markham's gulch, and Carr fork, and on the south Bear and Porcupine gulches. Carr fork has as branches Cottonwood fork and Sap gulch on the north, and Ross, Muddy, and Log forks on the south. Joining Butterfield cañon on the north are Yosemite and Blackjack gulches.

The country rock of this district consists mostly of beds of Carboniferous limestone and quartzite. (a) Near the head of the cañon there are great faults, and dikes and masses of augitic granite-porphry protrude. There are bedded and contact veins in and between the quartzite and limestone, with fissure veins in the syenitic porphyry.

The great lead-producing mines of the district are found in a large bedded vein or belt about 2 miles in length, and dipping N. W. 35° to 60°. Beginning at the southwestern end they are situated in order as follows: Neptune and Kempton, Jordan, Utah, Spanish, Old Telegraph, Revere, first extension west of Telegraph, and perhaps The Lead mine, Miner's Dream, and Wasatch. At the southwestern extremity of this belt, on its hanging-wall side, and branching from it in two forks, is the gold belt of the Stewarts and Jordan. On the same side, and only a few thousand feet from the lead belt at the southwestern end, there are said to be two gold belts which extend into Barney's cañon. These are not well defined, as but comparatively little work has been done. The other mines of the district, with the exception of the Yosemite, Last Chance, and Winnamuck, are as yet relatively unimportant. They are fissure veins in the syenite, or bedded veins in quartzite, having no connection, but having a general northeast and southwest strike.

The district is connected with the outside world by the Bingham Cañon and Camp Floyd Narrow Gauge railroad, which begins at Wasatch Junction on the Utah Southern line, and in 16 miles rises 1,603 feet. Beyond the station in the cañon the road is continued as a tramway for 3 miles and has branches to the principal mines. The freight charge over both tramway and railroad is from \$1 25 to \$3 per ton, depending on the quantity shipped. In the district there are about 20 hand- and water-power Cornish jigs, which are worked irregularly during the summer months by the owners of the smaller mines.

The following is a brief chronological table showing the development of the district:

- 1863.—Discovered and organized.
- 1864.—Gold placers discovered.
- 1868 to 1873.—Gold placers extensively worked.
- 1871.—Utah smelter built. Ran from 1871 to 1873.
- 1871, *autumn*.—Winnamuck smelter built.
- 1873, *December*.—Completion of Bingham Cañon railroad.
- 1873-'74.—Jigs at Spanish mine built.
- 1874.—Concentration works erected by John Longmaid on the Utah mine. Demolished in 1876.
- 1875.—Old Revere concentration works built.
- 1875 to 1878.—Discovery of gold belt.
- 1876-'77.—Leaching commenced; continued two and one-half years.
- 1877-'78.—Old Telegraph leaching and concentration works on the Jordan river built.
- 1878.—Stewart mill built.
- 1878-'79.—New Revere concentrating works built.
- 1879.—Sale of Old Telegraph property to French company.
- 1879.—Experimental Jordan 10-stamp mill built.

MINES OF UPPER MAIN BINGHAM CAÑON.

Of the mines of this cañon the Jordan is deserving of special notice. It is the oldest mine in the territory, and was discovered September 17, 1863, by a party of General Connor's volunteers. It is situated 2½ miles southwest of Bingham, on the eastern slope of a ridge of medium size and steepness. The mine was purchased by J. W. Kerr & Co., who, in 1872, erected the Galena smelter (one stack). Afterward the property was bought by Carson & Buzzo, who constructed a wooden flume (5 by 9 feet) 12 miles long, at a cost of \$120,000, to furnish water-power. They failed in 1875, and the Galena Silver Mining Company became the owner. In the same year the Galena smelters (five stacks) were built on the Jordan river. In 1877 the property was sold to the Jordan Mining and Smelting Company, which Company was reorganized in 1879, with but slight change of ownership, under the name of the Jordan Mining and Milling Company.

The total product could not be ascertained, but the following approximate figures were given:

Prior to 1873, 18 ounces silver and 42 per cent. lead.....	Tons.
1873 to April, 1875 (higher grade)	7,000
April, 1875, to 1877 (estimated).....	17,000
1877 to June, 1880.....	50,000
.....	13,000
Total.....	87,000

In addition to the above, several hundred tons of gold ore were run through the 10-stamp mill in the census year in experimenting. Its average assay value was \$19 90 gold and \$8 40 silver per ton.

The property of this company consists of the following claims: Jordan mine, 5,200 by 200 feet patented; the Galena mine, 2,000 by 140 feet patented; the American Flag, Little Mattie, Excelsior, Excelsior No. 2, Steamboat, and some others. These overlap somewhat. The company also owns a 10-stamp gold mill, built in 1879-'80, for the purpose of experimenting on the gold ores; 106 acres of land, one-half of a canal 12 miles long; and a 60-stamp gold mill on the Jordan river, which was begun in 1880, but was not completed when visited.

The Jordan vein is a bedded vein, perhaps 200 feet wide, dipping 30° to 35° NW. in siliceous limestone. The foot-wall may be quartzite. Fragments of limestone from the hillside and hanging wall above have fallen into the vein, forming one or more large horses. On the foot-wall of this vein immense bodies of cerussite with some anglesite and galena were found. They formed almost a continuous body 300 feet in length, and were from 50 to 130 feet (average 70 feet) deep, and from 10 to 100 feet (average 30 feet) wide. Next to the hanging wall is a belt of very friable, porous, ocher-stained gold quartz ore, from 20 to 185 feet in width, from 400 to 500 feet in length, and at least 100 or 200 feet deep. The first-class lead ore taken from the mine in late years assayed about 40 to 45 per cent. lead, 15 ounces silver, and \$5 gold. There was some second-class lead ore in the mine and some dump ore averaging 15 per cent. lead, 10 ounces silver, and \$3 50 gold. The gold ore assayed from \$1 50 to \$1,500, and it was claimed it would average \$10 or more per ton. At a short distance above the water level, which occurs at about 250 feet on the dip, the oxidized ore changed to pyrites containing a small percentage of copper and lead. One great fault having a north-and-south strike cut the vein, which was not found beyond this line. The mine is developed by 12 tunnels and three incline shafts to a vertical depth in places of 200 feet, and horizontally for 500 feet. The total length of openings is estimated at 15,000 feet.

The Galena and American Flag are small diagonal cross-veins containing lead ore. The Excelsior is on the same vein as the Jordan, and has about 1,000 feet of openings, showing large bodies of gold ore. There is no machinery upon this group of mines, work being prosecuted by tunnels. During the preceding year or two, many hundred feet of drifts and cross-cuts had been run to open the previously-described gold ore body.

The 10-stamp mill at the mine is a steam gold mill with 500-pound stamps, amalgamated copper-plate rifles, two pans, one settler, one Ball amalgamator, and some tie-boxes for concentration of lead ores. During the census year, while experimenting on the gold ore, but 1,500 tons were worked. The ore is not free, and though it worked well in pans, that was found to be too expensive a process for ore of such low grade.

The 60-stamp gold mill on the Jordan river, 2 miles northwest of Sandy, is a fine, substantial structure, which had cost \$60,000 and was not completed. It was thought at the time it was planned that the ore was free milling. Work had been suspended awaiting the result of experiments at the other mill. Its fittings consist of one large engine, two boilers, 4½ by 16 feet, two Blake rock-breakers, 9 by 15 inches, one pair of Cornish rolls, 30 inches in diameter with 16-inch face, with chilled steel shells, Tulloch's self-feeders, 60 850-pound stamps, single discharge mortars, and two electric lights. The ore will be dumped into large ore bins from cars loaded at the mine.

The Steamboat is an east-and-west vein, from 1 to 3 feet wide, in a porphyry dike crossing the northwest end of the Jordan patent. It was originally worked as a lead mine, but in 1877 a pocket of very rich gold ore (oxidized pyrites) was found near the surface 125 feet long and from 75 to 100 feet deep. This yielded, it is estimated, \$55,000; and, although some gold had been found in 1876, this was the real commencement of the gold excitement in Bingham. The mine has a 400-foot tunnel and 550 feet of other openings.

The Sheridan Hill Mining and Smelting Company, which failed in 1876, had their stacks on the Jordan river, and worked the Neptune and Kempton, Wall Street (now Northern Chief), and the Damn Fool (now Bonanza). These mines were discovered about 1872, and were vigorously worked in 1874, 1875, and 1876. Their total product for these years is estimated at over \$800,000. Since that time but little profitable work has been done.

The Utah mine is an old soldier location. The first smelter in Bingham cañon was erected here in 1871 by Buel & Bateman. In the same year it was sold to an English company at a price said to have been \$450,000. This company ran the smelter until 1873, when pyrites were struck. In 1874 concentrating works, costing \$40,000, consisting of buddles, tables, jigs, and tie-boxes, were erected by John Longmaid. These did the work comparatively well, but as there was not a ready sale for the mixture of galena and pyrite they were sold to Holden, and the apparatus was moved in 1876 to the Old Telegraph. Since that time the mine has been worked upon lease. About six men were employed during the census year. In 1879, T. R. Jones, a banker of Salt Lake City, bought the property, including several adjacent and overlapping patented locations of 1,500 by 200 feet. The total product has been several hundred thousand dollars, but on the whole it has not paid expenses. The vein is a continuation of the Jordan, and has the same peculiarities of gold ore on the hanging wall and lead ore on the foot wall. One incline was sunk 300 feet, but the general workings of the mine extend 1,000 feet horizontally and 140 feet deep, showing 6,000 to 7,000 feet of openings. The bodies of carbonate ore only extended 50 feet below the surface, where they were replaced by pyrites containing occasional masses of galena. The carbonate ore averaged 45 per cent. lead, 12 to 20 ounces silver, and \$4 gold. The gold ore on the hanging wall is 45, 60, 80, and 120 feet wide, where it has been developed by tunnels. The average of 100 assays was \$17, of which \$6 was free. Chloridizing-roasting would have saved the gold, but it was too expensive.

The Spanish mine is adjacent to the Utah and is on the same belt; but, being on the other side of the cañon, the hanging-wall body of gold ore has been eroded. It was worked vigorously from 1871 to 1878, but since then has been leased. In 1874 four jigs were erected, and in 1876 a water-wheel and steam-engine were placed to run them. It is estimated that the total product of the mine has been 65,000 tons, of which 24,000 tons were extracted in 1876, 1877, and 1878. The approximate assay value was 14 ounces silver, 35 to 40 per cent. lead, and \$3 50 to \$6 gold. There are about 5,000 feet of cuttings. There is no machinery on the mine. Pyrites and galena are plentiful in the lowest workings.

The names, total length of openings, total product, and condition at the close of the census year of the mines of the Upper Main Bingham cañon, not already referred to, are given in the following table:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Bully Boy	2,000	\$40,000	Idle	
Bonnie Blue Flag	2,000	1,200 tons	Being worked on lease	Grade of ore, 15 ounces silver, 40 per cent. lead, and \$4 gold.
Ashland	2,400	\$20,000	do	
Aladdin	1,100	40,000	do	Grade of ore, 90 ounces silver, 20 to 40 per cent. lead, and \$10 gold.
Live Yankee	840	20,000	do	Grade of ore, 100 ounces silver, 30 per cent. lead, and \$3 to \$10 gold.
Red River group	1,500	.....	Only prospect work done	Average of ninety assays said to be \$12 86 gold.
Maple Tree group	2,600	.....	do	Some lead ore has been extracted from the Story.
Alameda and Henrietta	1,300	73,000	Being worked on lease	Product census year, \$7,000. Grade of ore, 70 per cent. lead, and 90 ounces silver.
Highland	600	12,000	Worked by owners	
Galena Extension	750	25,000 .....	.....	Grade of ore, 35 ounces silver, 55 per cent. lead, and \$4 gold.
Orphan Boy	600	.....	Leased	
Eagle Bird	500	.....	Idle	
Emily	400	.....	.....
Comfort	400	.....	.....
Fanny Bemis	850	400 tons	Idle	
Sundown	550	1,000 tons	Active	
Northern Light Company	1,400	.....	Being worked on lease	
Albino	1,000	.....	Idle	
Silver Plume	400	.....	do	
Sanders	550	Few thousand dollars	Being worked on lease	During census year 35 tons of \$50 ore were produced.
Miller	600	Few hundred tons	Idle	

MINES OF LOWER MAIN BINGHAM CAÑON.

The most important mines in this cañon are the Winnamuck and the Tiewankee, with the adjacent groups belonging to them. The Winnamuck was discovered in 1867 by Mormon farmers, who ran a tunnel into a body of soft, oxidized, ochery ore. This ore, though rich, was thrown over the dumps, only the nodules of galena being saved. In the year of its discovery the mine was bought by Bristol & Dagget for \$15,000. In August, 1871, smelting was begun. The mine was sold in 1872 to an English company for \$300,000 and 50,000 shares of the stock. Smelting proved so unprofitable that in 1875 it was abandoned and the ore sold. In 1876 the property was bought by an Amsterdam company. Smelting has never been resumed, though fairly successful attempts were made in 1877 to concentrate the ore by stamps, jigs, and shaking-tables. Leaching, both raw and after a chloridizing-roasting, was tried in 1878 with no success. Considerable prospecting was done in 1876, but since that time the mine has been worked most of the time on lease. The following table, showing the financial account of the mine, has been furnished by the superintendent. Some ore has doubtless escaped record. A small amount has been produced since 1878, but the figures could not be obtained:

Year.	Number of tons produced.	Per cent. lead.	Ounces of silver.	Cost of mining.	Cost of smelting.	Total cost, including salaries and expenses.	Value of product.	Profit.	Loss.	Total net profit.
Total	20,104.824	.....	.....	.....	.....	\$957,042 08	\$1,523,758 73	\$577,107 02	\$390 87	\$570,716 05
1871	986.000	28.0	76.00	.....	.....	43,045 77	60,416 55	17,370 78	.....	.....
1872	3,954.913	35.0	51.40	\$23,430 17	\$174,422 03	217,548 16	353,551 26	130,003 10	.....	.....
1873	4,729.765	28.7	65.10	70,248 87	103,512 16	267,894 90	437,677 64	169,782 74	.....	.....
1874	3,144.383	25.5	48.90	81,602 23	213,844 97	273,662 48	290,706 60	17,044 18	.....	.....
1875	181.000	13.6	67.51	19,314 86	14,387 29	15,010 70	22,039 14	7,028 44	.....	.....
1875	2,245.880	.....	.....	.....	.....	42,818 54	119,250 59	76,432 05	.....	.....
1876	2,023.891	28.0	52.50	25,745 52	.....	47,066 41	157,946 02	109,979 01	.....	.....
1877	1,972.253	15.0	82.60	16,580 23	.....	35,043 02	78,509 14	43,466 12	.....	.....
1878	916.759	21.7	51.30	3,942 50	.....	14,052 10	13,661 73	.....	390 87	.....

a Ore sold and not smelted.

This company owns adjacent properties, extensions, parallel veins, and stringers, as follows: Dixon, Dixon No. 3, Veto, Winnamuck, Winnamuck No. 2, Brilliant, Savage, Mountain Maid, Mineral Point, Torpedo, and Amazon. These are mostly 1,500 by 200 feet each, and patented or patents applied for. They also own the Winnamuck placer claim in the bed of Bingham cañon and the Wasatch mine in Copper gulch. The Winnamuck vein is a contact vein between a black clay-shale hanging wall and a quartzite foot wall. The dip is 45° N.NE. The mine consists of one body or chimney extending from near the surface on the hillside to the pyrites near the level of the cañon, a distance of 460 feet. This body is from 100 to 300 feet long and from 1 to 18 feet (average $4\frac{1}{2}$ feet) wide, and extends northwest in the vein diagonally between the dip and the strike. This ore is for the most part a soft, brown-yellow or gray siliceous ocher, containing horn-silver and cerussite. Some parts of the body assayed as high as \$2,000 per ton. At about 150 feet above the water-line the ore changes from a "free" to a "base" ore, which has been worked to a depth of 85 feet, 100 feet long, and 4 feet wide. It still continues, but its grade is quite low. This lower part of the mine and the dump show large bodies of pyritous low-grade ore, containing galena, sphalerite, tetrahedrite, cubanite, and pyrargyrite, and assays about 15 ounces silver per ton. The gangue of the vein is clay and quartz, with some calcite and gypsum. In some unventilated parts of the mine, where the air was moist, an efflorescence of fibrous crystals of sulphate of zinc, sometimes 6 inches long, was formed on the hanging wall. At the southwest end of the ore body the vein was dislocated by a vertical fault and was thrown 28 feet NE. In some places the ore continues in the line of fault, but in the vein beyond it nothing has ever been found. The water level in this part of the mine was 130 feet above that at the ore body. A tunnel several hundred feet long has been run on the vein beyond the fault and a 60-foot body or dike of porphyry has been found. The water which enters near this from the hanging wall deposited thick coatings of sesquioxide of iron in the tunnel. This indicates a body of pyrites on the hanging-wall side. It was proposed to cross-cut at this point.

The developments consisted of a main tunnel 1,300 feet long on the vein about 40 feet above the bed of the cañon; three smaller tunnels and a vertical two-compartment shaft 240 feet deep through the hanging wall on the ravine side from about the level of the tunnel. The total length of drifts, shafts, and winzes on this and the smaller adjacent properties owned by the company was estimated at over 9,500 feet. The hoisting works, which had been idle for several years, consisted of a Cope and Bacon vertical 30 horse-power engine, one horizontal boiler, 2-inch hemp rope, and a Blake steam-pump. During the census year a few men were employed in prospecting and on lease. The product was only two or three hundred tons. The old slag dump had also been leased at about one-quarter royalty, and produced 3 tons of scrap bullion, worth \$200 per ton; 60 tons of matte, worth \$62 per ton; and 40 tons of jigged material, worth \$48 per ton. The results from this, as from most other old slag dumps, were not flattering to the early smelters.

The Dixon mine is on the opposite side of the ravine, and, as before stated, is owned by the same company. It has about 800 feet of openings, and is worked upon lease by a few men.

The Tiewaukee group consists of the Tiewaukee, 200 by 1,500 feet; Tilden, 200 by 960 feet; George, 100 by 2,400 feet; Ely, 100 by 2,400 feet; and the Surprise and the Lorenzo, which overlap the others; and is situated near the railroad station on the side of the steep ridge which forms the eastern side of the Main Bingham cañon. Ore was discovered in 1871, and work was prosecuted only at intervals until 1878, when the present body of ore was discovered. In August, 1879, the mine was bought by Mr. Goldberg. Troubles with adjacent claim owners gave rise to the consolidation in November, 1880, of all interests under the Tiewaukee Gold and Silver Mining Company. The property was worked steadily during the census year (Sundays excepted) by a force of fifteen men, who received from \$2 50 to \$3 per day. The total product prior to the census year was estimated at 1,200 tons, which were sold at about \$100 per ton. In the year, 360 tons were extracted, which assayed about 95 ounces silver, 40 per cent. lead, and \$12 gold. Ore of this grade was sold by sample (see description of sampling works) to the smelters for \$80 per ton. The vein is a bedded vein in black quartzite, on the hanging-wall side of a belt supposed to be 250 feet wide. The strike is $N. 28^{\circ} E.$, and dip NW. about 38° . Its width is from 4 inches to 15 feet, with an average of 2 feet. The dip and strike are parallel to the hillside, and 75 feet from it. Near the summit there are large, prominent ocher-stained quartz croppings, in which some good ore was found. Little was known, however, of the vein beyond the workings, which extended 600 feet below the croppings. At this point, which is near the level of the ravine, a tunnel has been driven through the hanging wall cutting the vein. Drifts have been run on it 380 feet (showing ore, however, for but 200 feet), also short winzes and raises, in all 1,400 feet of cuttings. Although the ore was very moist, water had not been encountered. The largest body found to up date of the visit was lenticular in shape and 60 by 40 feet by 15 feet in size. The gangue of the vein is a very soft blue clay, with bands of quartz, in which binnite, pyrargyrite, zincblende, pyrite, galena, and sometimes native silver occur quite irregularly. On either side of the vein there is a 10-inch band of low-grade pyritous ore. For 60 feet from the croppings only ochery carbonates were found. At about 550 feet ruby silver and large quantities of zincblende appeared. The different minerals are in bands; ruby silver occurring on the foot wall, zincblende and pyrites in the center, and galena on the hanging wall. No faults have been found, but it was said that surface indications pointed to an extensive fault at a depth of from 200 to 300 feet. As to this the writer can express no opinion, as snow covered the hillside at the time of his visit.

The works of the New York and Utah Milling Company are located at Revere Switch, at the mouth of Bingham cañon, 5½ miles below Bingham. They were built in the summer of 1878 as leaching works for raw ore. About 400 tons of ore, principally from the Lucky Boy mine, assaying from 20 to 25 ounces, were leached, and yielded from 8 to 10 ounces per ton. The present company was organized in March, 1880. The works are intended to treat the "rebellious" silver and gold ores of Bingham, or sulphurets of iron, zinc, etc. (lead excepted); and at the time of the writer's visit were almost completed. They have cost to date about \$30,000. The intended process is to roast and leach both the gold and silver. The company owns 5 acres of land and water rights, and have erected buildings containing a 40 horse-power engine, rotary drier, Howland crusher, one pulverizer, one Libsey single-stamp battery, one Brewster roasting furnace, and leaching vats. The Libsey stamp is an eastern invention (patented June 3, 1880). It consists of one 900-pound stamp, speed 120 drops per minute, and drop 5 inches; a pulley also gives it seventy-five revolutions per minute. The shoe and die are 15 inches in diameter, the feed being through an opening in the boss.

The Brewster furnace is a circular reverberatory roasting furnace, with rotary hearth. It had been tested for a year or more at Jersey City, New Jersey, on North Carolina gold sulphurets, and two others are in course of construction in that state. The furnace is 15 feet in diameter, the height 40 inches, and the walls are 30 inches thick. The hearth is covered with fire-brick. There are four stationary arms, from which prongs 2 inches apart extend to within a quarter of an inch of the hearth for the purpose of turning the ore. The arms and prongs are made of iron pipe and covered with fire-clay. There is a small fan blower to force air currents through these arms and prongs, which, impinging on the ore, will assist desulphurization and oxidation. The ore, salt, etc., are fed through holes in the roof of the furnace. The prongs are oblong, and, being set at an oblique angle to the radii, the furnace is self-discharging at the circumference. The time required to roast is said to be twenty minutes. One of these furnaces cost \$6,000. No criticisms can rightfully be made at present upon the working of this new machinery upon the ores of the district. It was expected the works would be ready for operation by April 1, 1881.

The names, total length of openings, total product, and condition at the close of the census year of the mines of Lower Main Bingham cañon, other than those already described, are as follows:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Caledonia.....	2,100	\$15,000.....	Being worked on lease.....	Ore sold at \$75 per ton.
Occident.....	1,300	25,000.....	Active.....	Value of ore, \$50 per ton.
Thrush.....	600	Small.....	.....	Ore contains gold, silver, and but little lead.
Extension.....	500	.....	.....	Ore of low grade.
North Star.....	300	.....	.....	.....
Dial.....	400	.....	.....	.....
Elvina.....	350	.....	.....	Ore, \$12 to \$15 gold.

MINES OF PORCUPINE GULCH.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Live Pine Consolidated.....	2,650	\$85,000.....	Active.....	The ore is galena, averaging 75 ounces silver and 30 per cent. lead.
Saint James.....	600	Nothing.....	Assessment work done.....	.....
Prince of Wales.....	300	do.....	do.....	.....
Irish-American Tunnel.....	800	do.....	do.....	Ore low-grade pyritous.
Silver Shield.....	840	\$15,000.....	.....	Assays: 25 per cent. lead; 50 ounces silver; \$10 gold; 10 per cent. lead; 15 ounces silver; \$4 gold.

MINES OF BEAR GULCH.

Litigation and the enormous amount of its purchase price have made the Old Telegraph group of mines the most noted in the West Mountain district. This property is situated 2 miles south of the town of Bingham, near the head of Bear Gulch, and on each side of it, and embraces the third west extension of the Telegraph, No You Don't, Nez Percés Chief, Grecian Bend, Roman Empire, Montana, Montreal, and other claims. They overlap one another to some considerable extent and, with the exception of the Montreal, are all patented. They became gradually consolidated by litigation and purchase until in 1877 or 1878 the name of Old Telegraph was given to the group. There was very little work done on any of these claims until 1873 and 1874, when Windsor & Randall bought the Nez Percés Chief and No You Don't, and organized a company in the East. An expert came out and took charge as superintendent, but as the mines did not prove profitable he returned. In the meantime (1873 to 1875) the Montreal company was running on a good body of ore. In 1874 a large body of ore was encountered in the No You Don't, and the former

superintendent returned and began tracing out the Montreal. The rival claims of these mines were litigated in 1877, and the No You Don't was successful. During 1877, and the preceding and the following year, there was the greatest output of ore. Suit was brought in the spring of 1878 by the old eastern company against its superintendent for alleged misrepresentation of facts in sending letters east stating that the mine was doing little, when it was in reality shipping large quantities of ore, and thus depreciating the market value of the stock then held, and purchasing it at a price very far below its real value. There were two trials. The first resulted in a verdict for the superintendent, and in the second the company was successful. Pending an appeal, the mine was sold to a French company, and a compromise of the suit was made, whereby the superintendent paid the company two hundred thousand dollars.

Current reports furnish the details of the placing of this property on the French market. The Old Telegraph group of mines, with the smelting and leaching works, were bonded to an individual for \$1,000,000, who sold it to the French company for 17,000,000 francs. Previous to the sale, three reports were made upon the property, one by an American, and two by Continental engineers. One of the latter reported 1,500,000 tons above the 460-foot level, and as the vein grew wider, at least an equal amount below, in all, 3,000,000 tons; also, that the ore assayed 20 per cent. lead, and 40 ounces silver, and the pyrites 16 ounces silver and \$10 gold. He estimated that 200 tons per day for 300 days, or 60,000 tons per year, could be worked; that the expenses per ton for mining and transporting would be \$8 50; for leaching, \$1; and for smelting, \$4; and that the annual profits would be \$1,600,000. He also suggested many ways in which the expenses might be decreased, such as roasting the pyrites from the mine, thus saving the purchase of iron flux, and selling the sulphuric acid produced.

The report of the other Continental engineer did not speak so definitely of the number of tons in sight, but estimated the profit on a daily yield of 100 tons at \$805,000 per year.

The American engineer reported 30,000 tons in sight assaying from 15 to 20 ounces of silver, and that the mine was not worth over \$1,000,000. In making his report he took forty-eight average samples from the mine, three of which assayed 21 ounces silver, and the others from 30 to 230 ounces per ton. He called attention to the fact that, notwithstanding these assays, the ore formerly sold had not yielded at that rate, nor had that which was worked daily, and that, in his opinion, the ore worked in the future would not yield at that rate.

The French capitalists preferred the French engineers' reports, and purchased the mines for the price above stated. The "Société des Mines d'Argent et Fonderies de Bingham" came into possession of the property on May 10, 1879, and ran both mines and furnaces until September 1, 1880, employing about 200 men. A few months previous to the writer's visit the mine was leased for two years. From five to fifteen men were employed.

The Old Telegraph group is located on a bedded vein or a mineral belt, in quartzite, from 20 to 250 feet wide, and dipping NW. 30°. This dip is quite irregular. The gangue of this belt is mostly a hard, tough, jointed quartzite, which is thoroughly impregnated with oxide of iron; but some strata of a soft, siliceous, granular material, evidently the result of the decomposition of siliceous limestone by acid formed from iron pyrites, and some clay and talcose clay are found. The vein had prominent ocher-stained quartz croppings on the summit of the ridge; but only came to the surface in a space a few feet square. The ore was of two kinds. On the foot-wall was cerussite and galena having a general width of from 6 to 26 feet. Occasionally it was much wider, one place showing 54 feet in width of square sets. An analysis of samples from 1,000 tons of this ore, made in 1876 by Otho Wuth, at Pittsburgh, is as follows:

	Per cent.
Carbonate of lead.....	50.43
Galena.....	15.02
Oxide of iron.....	3.78
Sulphide of copper.....	0.67
Sulphide of iron.....	7.37
Silica.....	12.47
Alumina.....	3.01
Carbonate of lime.....	3.64
Carbonate of magnesia.....	0.26
Sulphate of lime.....	3.04
Water.....	0.19
Silver (21.14 ounces—varies from 15 to 25).....	0.0647
	99.94

Traces of antimony, arsenic, and cobalt.

On the hanging-wall side of this body of lead ore and adjacent to it was a belt of leaching ore from 6 to 16 feet in width. This was an extremely porous quartz of all shades of blue, white, and yellow, containing a small percentage of lead and from 10 to 80 ounces (average, 15 ounces) of silver. At times these ores shaded insensibly the one into the other. There were two enlargements of the vein, which formed great ore chambers several hundred feet below the croppings on the ridge. One of these was irregularly lenticular, with the following maximum dimensions: 250 feet long, 600 feet on the dip, and 60 feet wide. A portion of this body 100 feet long, 50 feet wide, and 50 feet deep, was solid galena.

The timbers of the square sets used were 10 inches square; posts, 6 feet 6 inches; caps, 4 feet 8 inches. These were cut in a saw-mill belonging to the company. One of the lessees stated that white pine mining timbers will last in this district five or six years, and quaking aspen ten years. In the spring the ground in this mine slips somewhat, and many of the timbers are crushed. In a few years the spaces from which the large bodies of ore were extracted will probably be filled by caves and slides. The mines were formerly developed by one incline 1,200 feet long through the ore body, and 1,000 feet on the strike, and by six tunnels and their drifts. The total openings were estimated at $3\frac{1}{2}$ miles. The large bodies of ore were about 180 feet from the hillside surface, and consequently were easily worked. A tunnel from the bed of the ravine on its eastern side, called the 460-foot level, was the lowest opening. This cut a body of pyritous ore (sulphides of iron, copper, and lead) 60 feet wide, which extended 30 feet above it. It also furnished drainage for a small amount of water.

On the opposite side of the ravine, in the Roman Empire and Grecian Bend claims, a body of carbonate ore was found. It was also lenticular in shape, being 100 feet long, 100 feet deep, and 20 feet thick. In the lowest tunnel in these claims there is a body of pyritous ore 131 feet across. The best portions of it will assay \$10 silver, 10 to 15 per cent. lead, and \$3 to \$5 gold. At each end of this group of claims there was said to be a heavy porphyry dike, faulting and separating it from adjacent portions of the belt.

At the mine, and belonging to it, there are a large number of buildings, boarding-houses, offices, stables, saw-mill, leaching works, etc. The leaching works were built in 1877, and cost about \$5,000. They consisted of a rock-breaker, a pulverizer, a revolving screen with a quarter-inch mesh, six ore vats 3 feet deep and 10 feet square, twelve precipitating vats, a large tank to hold the solution, a boiler, engine, and a rubber or wooden pump. These works were partially dismantled, but over 1,000 tons were treated in the few months during which they ran.

A narrow-gauge railroad or tramway $2\frac{1}{2}$ miles long, with steep descending grade, runs between the mine and the depot of the Bingham Cañon railroad, thence $13\frac{1}{2}$ miles to the extensive works on the Jordan river. The cost of transportation was \$1 25 per ton.

During the census year about 12,000 tons (*a*) were extracted assaying 35 per cent. lead, 15 ounces silver, and \$0 50 gold. Eighty men were employed at from \$2 50 to \$3 per day. The cost of extraction, including general expenses and superintendence, was about \$10 25 per ton. The total product of this mine can never be known. The superintendent estimated it at 120,000 tons of all grades, but others thought this too high. Figures in the reports of the French experts, taken from the Old Telegraph books, show that from February, 1876, to November, 1878, 48,125 tons were extracted, valued at \$1,129,660 58 (market price at the time). This was at the flood tide of the production.

The smelter was very complete, though from disuse it was somewhat out of repair at the time of examination. It was built in 1876 and 1877. Ore, coke, coal, and flux were dumped directly from freight cars into large bins, and taken thence in wheelbarrows to the feed floor. The plant consisted of a Blake rock-breaker, a sampling coffee mill, several platform and railroad scales, five water-jacket furnaces, a fan-blower, a No. 5 Baker blower, a No. 5 Root blower, flue-dust chambers, a large 65 horse-power engine, a turbine water-wheel supplied by a flume 12 miles long, a pair of Cornish rolls for matte, a small vertical matte-roasting furnace (not a success), a reverberatory matte-roasting furnace, and an old cupel furnace. The stack was of brick, square in section, and rested upon iron pillars from 5 to 10 feet in length. The crucible was of brick in an iron box 8 feet square. The jacket, composed of 8 cast-iron sections, rested on 6 inches of fire-brick. For 10 inches the jacket was vertical, and each side of the remaining 2 feet 8 inches had a batter of 11 inches. Each section was open at the top, and therefore had a free overflow. Sections were bolted together through lugs. Between the jacket and the stack there was an inch of fire-brick. The chimney was 40 inches square and 20 feet high, with cover. Each furnace was provided with a hood and siphon tap, or lead well. The flue-dust chamber for three stacks were of brick, 10 inches high and 20 inches square, resting upon a frame work about 15 inches above the ground. This chamber terminated on the lower side in four sheet-iron hoppers. The flue-dust which collected could thus be easily drawn off into cars.

The concentration works had been idle since the autumn of 1879, and were also somewhat out of repair. They consisted of Cornish rolls, four revolving screens, four jigs, one 5-stamp and two 10-stamp batteries, four revolving washing tables, 22 inches in diameter, on an incline of 10°, and a large number of tie-boxes.

The leaching works were built in the spring of 1878, and ran most of the time until the French company bought the property. They cost \$16,000, and the plant consisted of a revolving screen, with quarter-inch mesh; a pair of Cornish rolls (*b*) of 20-inch face and 26-inch diameter; 10 ore vats, 12 by 14 by 3 feet; 20 precipitating tanks, 4 by 7 by 4 feet; and a pump. Power for this and the concentration works was furnished by a turbine wheel.

The ore was dumped from the railroad cars into smaller ones, which carried it to the revolving cylindrical screen. Whatever did not pass through the mesh passed on to the Cornish rolls. All the fine ore fell into a bin, from which it was taken in cars along a track over the ore vats, into which it was dumped. The ore vats were in two rows, between which ran a car into which the leached ore was shoveled. The vats had a false slat bottom, on which cocoa matting was laid. The precipitating tanks were on the outside of the rectangle, and were provided with several

a The actual amount of ore extracted was about 19,500 tons, but it was reduced by concentration to the 12,000 tons mentioned.

b One pair of shells of these rolls was said to have crushed 10,000 tons of this soft ore.

wooden faucets with which to draw off the liquor from above the precipitate. The sulphides were roasted on an open sheet-iron hearth and smelted in crucibles, or roasted and smelted in a cupel furnace. These works handled from 80 to 120 tons per day.

The ore of this mine was of three kinds—smelting, concentrating, and leaching. The concentrating ore was found to carry much of its silver as chloride, which floated off and was lost while jiggling and tying the lead ore. It was estimated that 12,000 ounces were thus lost each month. During the latter part of the time the ore was first leached and afterward concentrated, a loss of from 40 to 50 per cent. being thus avoided. At times a very elaborate set of assays were made. Unfortunately, the books containing them were not accessible, but the following are approximate data regarding the mode of working: At first the size of the coarsest fragments of the leached ore was one-quarter of an inch in diameter, but this was decreased to the size of wheat. From 2 to 6 ounces per ton were obtained by leaching. The concentrated ore assayed about from 15 to 20 ounces silver and 50 per cent. lead, and the tailings from the concentration works assayed about 4 per cent. lead and from 4 to 6 ounces silver. Ores from different parts of the mine required different times to leach, but the average time was 20 hours. Ore from an old dump of 1,000 tons, which had weathered for about a year, leached in twelve hours, 75 per cent. of the silver obtained leaching out in the first hour.

The method of using the solution was to pump the vats full, the liquid entering from the bottom and rising through the ore; then, after allowing the solution to stand 20 minutes, to open the discharge taps and allow them to run from twelve to twenty hours, until only a slight coloration was produced by the sulphide of soda, all the time keeping the vats full of the solution by pumping a fresh supply upon the surface; finally, to quietly flood with water (the water and hyposulphite not mixing) and drain off. This washed out the solution from the ore so that it was not wasted. The strength of the hyposulphite solution was kept at about half a pound to the gallon. The solution became weaker with use, and it was necessary to strengthen it by adding each week, in the case of free ore, about 25 pounds to the 8,000 gallons used, and in the case of base ore about 150 pounds. The leaching of the mass of the ore was about as close as the leaching of the assay samples. Sometimes 101 per cent. of the chloride assay value of the ore would be obtained in bullion. The bullion was from 0.900 to 0.990 (average 0.940) fine in silver, and from 0.001 to 0.004 (average 0.002) fine in gold, when free ores were treated. Toward the latter part of the time, when quite base ore was treated, the bullion was only about 0.500 fine in silver; the remainder lead, and some antimony; gold unknown. The sulphides from the leaching were usually mixed with lime and other slimes, and the adobes thus made were smelted in a blast furnace with ordinary charges. This was done because it was claimed that there was little loss of silver in smelting, and as much was received for it in the lead bars, and thus the express charges for the shipment of fine bullion were saved. The total amount of silver leached out was estimated at between 50,000 to 80,000 ounces. The cost of leaching at the mines was \$1 10, but at the new works it was stated at only 20 cents per ton. The cost of concentrating was about 70 cents per ton.

The French company ran the concentrating works several months, trying the leaching apparatus occasionally, but their results were very unsatisfactory. Report says that they lost money from the commencement, and the products and expenses warrant such a conclusion. Their office force numbered 12 men, who received \$2,600 per month. During the census year about 11,150 tons of ore were smelted (about 1,500 tons of which were purchased), which produced about 3,200 tons of base bullion, assaying 63 ounces silver per ton. An average of many partial analyses of Old Telegraph ore treated during the census year was:

	Per cent.
Lead.....	(about) 35.0
Silica.....	(about) 38.0
Lime.....	2.0
Oxide of iron.....	6.0
Sulphur.....	2.5
Copper.....	0.75
Zinc.....	0.1
Antimony.....	0.05
Arsenic.....	0.04

The cost of smelting was from \$16 to \$17 per ton, including everything. The amount of fuel to the smelting charge was about 14 per cent. Varying proportions of coke and charcoal were used. The iron flux was from 50 to 116 per cent. of the ore, and the limestone flux from 20 to 50 per cent. The minimum was 80 and the maximum 135 per cent. of both lime and iron flux. For several months the smelting charge averaged 11 per cent. of lead and 6 ounces of silver. The loss of lead was from 12 to 13 per cent., while that of silver and gold was claimed to be little or nothing. The matte contained from 6 to 7 ounces of silver, 9 per cent. lead, and some copper. It was usually a waste product. The slag assayed half an ounce of silver and 1 per cent. lead.

The other mines of Bear gulch are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Rough and Ready and Grand Cross.		\$10,000	Idle	Ore is low-grade carbonate and galena. Mine has several thousand feet of openings.
Victor	975	A few hundred tons	Active	Assays 10 ounces silver, 20 per cent. lead, \$3 gold; 25 ounces silver, 50 per cent. lead, \$4 gold.
Giant Chief	800			Considerable ore shipped some years ago.
Quaking Asp	850			
Eagle Bird	350			
Gray Eagle	950			Contains bodies of gold ore. Much lead shipped formerly.
Bazonk	400		Idle	Some ore formerly shipped.
Abel Protector Tunnel	700		Assessment work done	No ore of value.
Hamlin Mining Company	1,150	\$20,000	Idle	Ore argentiferous cerussite and galena.

MINES OF MARKHAM'S GULCH.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Williams	700		Active	Ore assays 25 ounces silver, 23 per cent. lead, \$3 gold.
Old Stand By	400	\$15,000	Idle	Vein is in quartzite, and is from 2 to 10 feet wide.
Colonel Sellers	300		do	Vein 2 to 4 feet, assaying \$20 gold per ton and upward.
Vespasian	900		do	Some 35- to 50-ounce ore has been shipped.
Sacramento	500	5,000		Ore of medium grade containing pyrites.
Columbia and Silver Hill	1,000	A few thousand dollars		Vein 20 inches. Ore assays 10 to 20 ounces silver, 50 per cent. lead.

MINES OF MAIN CARR FORK.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
York	500		Worked on lease	Several hundred feet of cuttings. Ore, medium grade of silver and lead.
Harriet Mining Company	740		Active	Average assay of gold ore, \$32 gold and \$15 silver.
Omaha	400		Assessment work done	Vein, 20 to 50 feet, containing gold ore.
Henry M	350			Vein, 25 to 30 feet; gold ore assaying \$15 to \$20 per ton.
Highland Boy	950		Assessment work done	Assays: gold ore, \$18 per ton; galena ore, 12 ounces silver, 50 per cent. lead.
Levant	a200	None	Idle	Vein, 8 to 12 feet of gold ore assaying \$20 per ton.
Sunset	300			
Washington	400		Idle	
Dora	350			
Erisco	b400	A few hundred tons of \$35- to \$40-ore.	Idle	Vein, 5 to 10 feet; ore, galena, and carbonate near the surface; pyrites at water line.

a Length of tunnel; other openings.

b Total length of tunnels; also considerable drifting and stoping.

The Durant mill was erected in Main Carr Fork in the autumn of 1877 to concentrate low-grade lead ores, but was afterward changed to a gold mill. Every run has been a financial failure, partly because of the very low-grade ore worked. Attempts to concentrate the ore by passing battery sands through tie-boxes were a failure because too much pyrite was caught. It was a light 10-stamp mill with a small 12 horse-power horizontal engine and boiler, two jigs, a revolving screen, and some tie-boxes, and cost \$8,000. It had been idle, with the exception of a few weeks' run, for two years.

MINES OF COTTONWOOD FORK OF CARR FORK.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Arrowpeen	1,050	\$20,000	Worked on lease	Vein 4 feet, mainly soft ochery low-grade jigging ore; also lenticular bodies of ore assaying 20 ounces silver, 50 per cent. lead, and \$4 gold.
I. X. L.	750			Vein, 2 to 10 feet. Ore assays 20 ounces silver, 40 per cent. lead, and \$5 gold, or \$27 per ton.
Venice	315			Vein, 1 inch to 1 foot.
Knickerbocker	800		Idle	
Blue Jay and Green Grove	400			
Jersey Blue	350	16,000	Active	Ore assays 28 ounces silver and 58 per cent. lead.
				Vein, 20 inches to 5 feet. Ore assays 90 ounces silver, 40 per cent. lead.

MINES OF SAP GULCH.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Yampa No. 1	525	.....	Active.....	Tunnel has not cut the vein.
Yampa No. 2	440	.....	Idle.....	Vein 50 feet, containing large bodies of soft, red ocher, assaying \$10 gold per ton.
Overland	300	.....	.....	A large body of gold ore, said to average \$15 to \$25 per ton.
Agnes	610	\$25,000.....	.....	Vein 6 feet. Ore high-grade lead and silver 3 inches to 1 foot on foot wall.
Mormon Heel.....	600	.....	.....	Gold ore on hanging wall. In one place vein said to be 38 feet, averaging \$10 per ton.

MINES OF LOG FORK OF CARR FORK.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Elephant	350	.....	Active.....	Vein 2½ feet. Ore is galena and cerussite.
Bonham	900	\$300.....	Idle.....	Vein 75 feet. Ore low-grade gold.
Sacred	750	.....	.....do.....	Vein 5 feet. Ore high-grade lead and silver, \$50 per ton.

MINES OF MUDDY FORK OF CARR FORK.

The Stewart Mining Company was incorporated in 1878, with a capital stock of \$600,000 in 60,000 shares. The company owns the following claims: Stewart, Washington, Saratoga, and Bulldozer, which are patented; Constitution, Bobtail, Apex, Mill City, Golden Crown, Phoenix, Casco, and others, not patented; most of them are situated on a high, steep ridge which separates Main Bingham cañon from Muddy fork.

The Saratoga, Bulldozer, and Constitution had each 500 feet or more of drifts, shafts, and tunnels. They had been comparatively idle for two years, and had shipped little or no gold ore.

The Stewart is the principal mine of the group. It was discovered in early times, and was worked as a lead mine. About 100 tons of low-grade gold, silver, and lead ores were extracted from bodies found near the surface. In July, 1878, the mass of porous ocher-stained ore was first found to contain gold in paying quantities. In general little was known of this mine, the size of its veins, or the dimensions of its ore bodies, excepting that it had near the surface an immense body of low-grade gold ore, rich in places. This body appeared to lie between quartzite walls (strongly stained with iron oxide near the ore) with a dip NW. 30°. Its size was unknown. Developments showed its greatest dimensions to be from 50 to 200 feet wide, 300 feet deep, and 400 feet long. The ore is a very porous quartzite with bodies of fine quartz crystals. The whole mass is permeated by clay and is strongly stained with oxide of iron, which gives it a brownish-red color. About three-quarters of the ore is soft and fine, being only held in place near the drifts by the clay contained in it. Occasionally there are seams of a silky talcose clay, from a half-inch to 3 inches wide. This generally assayed from \$50 to over \$100 in gold. Except in the spring of the year, when the snow is melting, the mine is dry. In one spot water is found, with some galena, pyrites, and blende ore; but the dry workings extend below this. The mine was developed by several tunnels, from which many drifts, cross-cuts, and winzes had been driven in exploring the body. The office map showed 3,840 feet of cuttings, but only one-half the work was said to have been plotted. Very little powder or timber was used in the mine. In one place some square sets were put in, but the ground caved to the surface, leaving a small crater-like opening. The cost of timbering alone in working these large bodies of low-grade gold ore greatly diminishes the percentage of profits. The ore was taken in the mine cars and dumped through a chute into ore bins in the company's mill in the ravine below.

During the census year, an average of sixty-four miners were employed. The shifts were ten hours and the wages from \$2 50 to \$3 per day. After the mill shut down there were only a few men engaged in prospecting. The total yield of the mine to the date of the writer's visit was estimated at about 17,000 tons of ore, and the assay value of the bullion was \$172,825 21. The remaining claims are gold prospects upon which little work had been done.

In the autumn of 1878 Eagan & Bates' 10-stamp mill was removed from Main Bingham cañon and erected on the Stewart mine. Ten additional stamps were added in January, 1879, making the total cost of the mill \$25,000. It ran steadily until May 1, 1880, and has, for some unknown reason, been idle since. The officers said it would start again early in the spring of 1881. The mill machinery consisted of a 60 horse-power engine; a boiler, 16 feet by 60 inches; a Blake plaster-crusher, 12 by 16 inches; 20 650-pound and 750-pound stamps, speed 90, drop from 7 to 9 inches, single discharge; Russia iron No. 6 slot-screen; 2 Tulloch and 2 Hendy self-feeders; and aprons with amalgamated copper plates. The capacity of the mill was about 50 tons per day. The labor employed in 24 hours was: Two amalgamators, four feeders, two engineers, one carpenter, and one rock-breaker man. Wages were

from \$3 to \$3 50 per day. In the first eleven months of the census year 10,000 tons of ore were milled at a cost of between \$2 and \$3 per ton. The product was \$99,267 37 cash received for bullion. The ore averaged about \$11 in gold. There was also some silver. Tailings averaged about \$1 50 in gold. The fineness of bullion was 0.900 gold, 0.060 silver, and 0.040 copper. The mortars were 13 inches in width at the bottom, and the new die surface was 4 inches below the discharge edge of the screen. The quantity of water fed to the batteries was such that the stamps in their highest position never rose above it and splashed, but swashed it from end to end of the mortars in regular waves. The order of the stamp drop was 1—5—2—4—3. Two of the mortars had copper plates on the back side, but amalgamation in battery was also practiced in the other two. Quicksilver was added every thirty to sixty minutes, according to the usual rule. One-half or two-thirds of the total amalgam was caught in the mortars, the copper plates not seeming to greatly affect the quantity so caught. The screens lasted twenty days. Shoes and dies were of iron and lasted from thirty to forty days. The shoes and dies wore very irregularly concave and convex. The loss of iron per ton of ore crushed was about 1½ pounds. The copper plates upon the aprons below the mortars were 4 feet long and had a fall of 2 inches in 1 foot. Two of the mortars had four plates 30 inches wide, and at the lower edge a riffle one-half inch deep and three-fourths of an inch wide to catch any mercury or amalgam that might be carried down. The other two aprons had one plate 30 inches wide, and six plates 15 inches wide, but no riffles, thus giving, as before, 10 feet of amalgamated plate surface. The aprons were a single frame so arranged that its grade might be easily changed in case ochery or pyritous ore was being milled. There were some silver-plated copper plates which did not work satisfactorily. They began to act more quickly than new copper plates, but were too hard. It was thought that gold-plated copper plates would serve the purpose better. The copper plates in use would assay \$1 per pound in gold. Below the aprons were troughs containing riffles, which emptied into a small box. But 5 pounds of mercury was caught here in two or three months. The loss of mercury, from actual weighings, was said to be something less than one-twentieth of a pound per ton of ore.

The method of assaying for gold was as follows: Shovel samples were taken every half hour from the self-feeders, which, when broken, quartered, and pulverized, made a 24-hour sample. Tailings samples were taken every hour from the end of the sluice. These also made a 24-hour sample. Four assays, of 1 ounce each, were made in the crucible, a small piece of pure silver being added.

The Last Chance mine was discovered in 1869 or 1870. It was sold to an English company for £100,000, part in stock. Work commenced in 1872 and continued until 1877, in which year it was leased. In May, 1878, the putting in of machinery was begun. After pumping water for some time, the mine was shut down in the autumn of 1879 on account of the money being exhausted and the inadequate power of the machinery, and has been idle since. Pyrites were encountered at the water level. During the first few years of operations the company ran the smelter at Sandy, now known as the Flagstaff, on their ore. Afterward the ore was sold in the Salt Lake market. The total product of the mine was between \$400,000 and \$500,000 currency received. It was said that \$75,000 was paid in dividends. The claim has been developed 955 feet on the dip and 950 feet horizontally. It was opened by an incline through the ore body and two tunnels through the foot wall of the vein. In the lower tunnel, which is 820 feet long, and on the 700-foot level, an engine was set, and the incline was sunk 255 feet. The total length of shafts, levels, and winzes was about 6,100 feet.

The other mines of Muddy Fork of Carr Fork are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
Mineral Point Company	<i>Fect.</i>			
Edison	1,420		Idle	Comprises seven claims; little work has been done.
Hooper	400			No ore ever shipped.
Last Chance No. 2	1,260	Many thousand dollars.	Worked on lease	Vein, wide; ore, low grade.
Pea body	500			Ore, high-grade silver and lead, with some gold; 100 tons yielded \$3 50 per ton.
Saginaw Mining Company	3,500	\$30,000	Idle	
Cressus	1,260	Many hundred tons.	Worked on lease.	Vein, 2 to 4 feet; ore assays, 30 to 60 ounces silver, 20 to 40 per cent lead, and \$12 gold.
Nast	1,000		do	Annual product, 50 tons, \$17 ore; vein, 12 inches (under water).
Saturn	800		do	Has yielded considerable lead ore.
British Flag	400		Idle	Has produced some 40-ounce ore.
Glasgow Company	2,500	\$25,000	Worked on lease.	
Benton	900	8,500		
Centennial	500			Vein, 5 feet; ore, lead, silver, and gold; value, \$40 per ton. A small amount of ore shipped.

MINES OF ROSS FORK.

The Bevan Mining company owns a 10-stamp gold mill and a group of gold mines adjacent to and northeast of those of the Stewart company. The claims are: Stewart No. 2, Stewart Fractional No. 2, Ingersoll, Osage, and Wedge, none of which are patented. The mines were discovered in 1879, and the company was organized in July of the same year. A large amount of prospecting was done in the mine, and it was bonded to New York men until October, 1880. They failed, however, to take it, and the property had been idle for six months previous to the writer's visit. Only one mine, the Stewart No. 2, was developed to any extent. It was opened by two tunnels through the hanging wall, 250 and 450 feet long. About 3,500 feet of drifts, cross-cuts, and winzes have been driven. These show a body of ore from 4 to 15 feet in width, 160 feet in length, and extending, from 60 feet below the surface, 140 feet on the dip. These dimensions are those of the workings, the limits of the ore body being unknown. The dip is NW. 35°. No water or pyrites have been found in the mine. The ore is similar to that in the Stewart, but much more friable, and consists of a mass of small imperfect crystals or grains of quartz, very slightly cemented together by clay, and the whole strongly stained with oxide of iron. Seams of a white, silky, talcose clay are frequently found, and are uniformly rich. The ore is very much spotted, and assays from \$2 to \$60 in gold. There is no possible way of distinguishing between the rich and the poor ore as it occurs in the mine. Some carries quite coarse gold, and all considerable silver. The gold is said to be free and to amalgamate quite well. To the east of this body, and separated from it by 30 feet of quartzite country rock, or a horse, a second large vein has been found, but has not been drifted upon. The ore is similar, but of somewhat lower grade.

The company's 10-stamp mill, located on Carr Fork, three-quarters of a mile from the mine, was erected in July, 1879, and ran at intervals during the autumn, winter, and following spring. About 1,500 tons were crushed, from which \$20,000 were obtained. It is said that the gold was free and easily caught, but that several dollars per ton in silver were lost. Accurate information regarding the milling results was not obtainable.

The Essex Mining Company owns four gold prospects—the Essex, Chicago, Argonaut, and Parker. It is reported that there is a 10-foot vein of \$12 gold ore. There are about 400 feet of tunnels. Six men were employed during a greater part of the year.

COPPER MINES OF BINGHAM.

Above the town, about half-way up the cañon, is a copper belt, the veins of which run nearly at right angles to the silver veins of the district. The principal claims are the What Cheer, Hickman, Murphy, Kingston, and Washington. They are all small veins in quartzite, from 3 inches to 4 feet wide, containing azurite and malachite at the surface, and sulphides of copper and iron at the water line. Traces of silver and gold are also found.

The What Cheer was located in 1873, and was worked for two years; only assessment work has been done since. The vein, from 3 to 4 feet wide, assayed in places from 10 to 12 per cent. copper. A four-stamp mill was erected in 1874, but the ore could only be concentrated to 20 per cent. A 300-foot shaft and 200 feet of other cuttings constituted the developments. Considerable ore and concentrations were shipped.

The Hickman Lode has 300 feet of tunnels. From the surface deposits \$6,000 worth of copper ore was reported to have been collected.

On the Murphy mine is a 170-foot tunnel, showing a 3- to 10-inch vein, and a few feet outside of it impregnations of black sulphide and carbonate. Some jigs, erected for the purpose, failed to concentrate the ore.

Below the place where the copper belt crosses the cañon, the water which runs or percolates along the bed-rock contains a small percentage of blue and green vitriol in solution, resulting from the oxidation of copper and iron pyrites. In placer mining fragments and nuggets of copper are found, especially in alluvial soil and among partially decayed twigs and roots, where organic matter has precipitated it. So strongly is the water impregnated with this metal that picks and shovels immersed in it instantly become reddened from the deposit. No attempt has been made to save the very considerable quantity of copper daily running down the cañon.

GOLD PLACERS OF BINGHAM.

The placers of Bingham are the only profitable ones in the territory. They were discovered in 1864, though little was done until the winter of 1867-'68. From that time until 1872 and 1873 they were worked vigorously, but since then only in a small way. There are two placer-mining districts in the cañon, the upper and the lower. Each has a recorder, and contains a limited number of claims in the bed of the ravines. About twenty men are employed during about half the year, and collect about \$20,000. The gold is coarse, from half an ounce downward. One nugget, however, was found in 1878 valued at \$118. The fineness averages about 0.852 gold and 0.140 silver. The total gold-dust product of the district is unknown. In 1872 Mr. J. R. Murphy estimated it at \$1,000,000. Mr. B. A. M. Froisett placed it, June 30, 1874, at \$1,673,265. Old residents and storekeepers estimate it from a million to a million and a half. The greater portion of the gold has been extracted in the neighborhood of the town of Bingham by drifting in benches on the side of the ravine, remnants of the old channel, from 25 to 150 feet above the present one. About 1871 or 1872 some hydraulic mining on a small scale was tried, but without success. In 1878 the Argonaut Gold Mining Company, incorporated in New York, made another attempt. They bought 160

acres having a 40- to 70-foot bank, and used 300 or 400 inches of water. They had worked about an acre and a half up to October, 1880, when they failed, having obtained but little dust. The gold is within 3 or 4 feet of the bed-rock. Part of the ground was drifted on in early times, and produced over \$100,000.

The bed of Main Bingham cañon is supposed to be very rich. Near the town, where the ravine is narrow and steep, two long tunnels have been run through the gravel to drain and work the bed-rock. One worked from 1870 to 1874 was 1,000 feet long. It ran up both Carr fork and Bingham, and paid well. The present one is 1,500 feet long. Every 250 feet a shaft is sunk through the 60 feet of overlying *débris*. The gravel drifted out is washed in sluices on the surface. The pay is found within 5 feet of the bed-rock, covered by a stratum of cement an inch or two thick. The channel here is about 60 feet wide, and though rather spotted, owing to its steep grade, has paid good wages. The cañon bed below this is covered by the placer claims of the Winnamuck company; Clay & Walker, 200 by 4,700 feet; Watson & Ireland, 400 by 4,200 feet, and others. Many attempts have been made in the lower part of the cañon to reach the bed-rock, which is supposed to be 100 feet below the surface, but the small pumps used could not control the water. A tunnel from 2,000 to 3,000 feet long will probably be necessary.

MINES OF BARNEY'S CAÑON.

Gold was first discovered in Barney's cañon in 1878. There are perhaps 30 claims. The veins are between limestone hanging and quartzite foot walls, and are supposed to be continuations of the gold belt in Carr fork. They are 20 feet wide and upward, and carry from 6 to 8 feet of \$15 to \$30 ore. The principal prospects are the Salt Lake and the Cave. The former has 250 feet of openings.

MINES OF COPPER GULCH.

The Lead mine was discovered in 1871, and was relocated in 1875 by the Yosemite company. It has been worked by its owners almost continuously since its relocation. It was purchased by the Lead Mine Company in the spring of 1880. Two parallel adjacent claims, the Carbonate and the Chloride, are included in the property. The developments extend 400 feet on the dip, 300 feet in length, 200 feet in width, and indicate a large bedded vein or mineral belt, dipping N.N.W. 50° between quartzite walls. The ore, in a wedge-shaped mass, came within 4 feet of the surface. All between the walls (the only partial cross-cut shows 150 feet of ledge matter) was ore of the same grade, which consisted of a light-brown, granular, and crystallized cerussite (locally called "crystallized lead") mixed with small angular fragments of quartz. In about the center of the mass, dipping irregularly 45° SW., was a body or chimney of clear cerussite 10 inches square. Branching from this, and in all parts of the mine, occur bodies and stringers of the clean ore, from a few inches to a few feet in width. The clean or first-class ore is shipped, and averages from 48 to 58 (average 50) per cent. lead and 7 ounces silver. The second-class ore was piled upon the dump to await the erection of concentration works the next season. The waste dump was very small, but 75 feet of drift having been run in country rock. No water was encountered. The mine was opened by a vertical 200-foot shaft and two inclines. The total amount of drifts, shafts, and winzes is 1,120 feet, not including old upper works partially filled. A Copeland & Bacon 40 horse-power engine had just been placed in position, and was supposed to be able to sink to a depth of 1,000 feet. About twenty men were employed. During the census year 1,500 tons of first-class ore were sold at the rate of about \$18 per ton. In addition to this 2,500 tons of second-class ore were produced. Transportation, 12 miles to Sandy, cost \$2 50 per ton. The total product of the mine to June 1, 1880, was estimated at 4,500 tons of first-class ore, which sold for about \$81,000 in coin, and 10,000 tons of second-class ore, which it was intended to concentrate by stamps, riddles, and tie-boxes.

The other mines of Copper gulch are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
Wasatch and Olympia	1,910	Estimated at 4,000 to 10,000 tons.	Worked on lease	Vein, 60 feet; ore, carbonate of lead; assays 6 to 50 ounces (average, 10 ounces) silver, 35 to 60 (average, 45) per cent. lead.
Miner's Dream and Vanderbilt.	2,000	\$80,000	do	Vein, 5 to 15 feet. The first-class ore is carbonate of lead, and assays 30 to 55 per cent. lead, 12 to 17 ounces silver, and \$3 to \$10 gold. Also much low-grade ore.
Mayflower	2,500	52,000	Idle	Vein, 15 feet. First ore assayed \$15 to \$300, one-third of which was gold. Pyrites encountered at water level.
Evergreen	400	15,000	do	Vein, 1 inch to 2 feet. Assays 90 ounces silver, \$12 to \$20 gold, 35 per cent. iron.
Union Flag	800	.....	.....	Similar to Evergreen and Union Flag; supposed to be the same vein. Some ore extracted, but none shipped.
Yosemite No. 2	1,350	.....	.....	Greatest width of vein 10 feet; ore assays 10 ounces silver and 50 per cent. lead. Several hundred tons have been shipped.

MINES OF BUTTERFIELD CAÑON.

The Yosemite mine was discovered in 1866. Little work was done until 1870. The mine was worked vigorously during 1874, 1875, 1876, and 1878, at times as many as one hundred and fifty men being employed. During the census year but eighteen were at work, and at the date of the writer's visit a less number, owing to the state of the mine and the low price of lead. The vein is near the summit of the high steep ridge which separates Butterfield cañon from both Copper gulch and Bingham cañon. It is 16 miles west of Sandy, on the Utah Southern railroad. The cost of transportation is \$4 per ton. The ore-bearing formation is a bedded vein from 6 inches to 30 feet (average, 4 feet) wide, in quartzite, dipping NW. 45° to 55°. The ore outcrops at the surface in places for several hundred feet, and usually occurs on the foot wall. One chute was found from 20 to 60 feet long, and from 5 to 25 feet (average, 7 feet) wide, extending from the surface to a depth of 500 feet. Another body of very clean carbonate ore began 160 feet from the surface and extended 100 feet, being 6 feet wide and 50 feet long. Various other small bodies have been found. The gangue of the vein is composed of quartz, clay, and talcose clay, stained with oxide of iron above the water line, or 450-foot level. The country rock is very seamy and quite soft in the vicinity of the vein. The ore is principally cerussite with some galena, associated with ocher, quartz, and clay. It assays from 45 to 70 per cent. lead, from 11 to 24 ounces silver, and a trace of gold. Below the water line, and in bunches far above it, the ore is composed of pyrite, chalcopyrite, galenite, and sphalerite. These pyrites sometimes assay \$12 silver. The mine is opened to a depth of 600 feet by an incline 6 by 6 feet, and elsewhere by a 600-foot tunnel, 4½ by 7 feet. The extreme horizontal extent of the workings is about 1,500 feet, and the total length of levels, shafts, and winzes in the neighborhood of 6,000 feet, 1,200 feet, and 2,000 feet, respectively. The machinery consists of a 35 horse-power horizontal engine and boiler, a half-inch steel wire rope, and a No. 7 Blake pump. When the pump was used, the flow of water was estimated at 2,000 gallons per hour. The hoisting plant cost \$6,000, and is thought to be capable of sinking to a depth of 1,000 feet. During the census year the output was about 1,800 tons, assaying from 12 to 16 ounces silver, and from 55 to 60 per cent. lead. The ore sold for about \$21 per ton. The total product to September 1, 1880, was estimated at 25,000 tons, which sold for \$750,000. There was also a large dump, containing several thousand tons of second-class ore, assaying from 7 to 22 per cent. lead, and from 6 to 8 ounces silver.

The old Revere concentrating works were erected in 1875 or 1876, and consisted of a 20-stamp mill, tie-boxes, and tossing tubs. They were bought, torn down, and rebuilt by the Union Ore Concentrating Company, of New York city. The new works were completed in June, 1880. They ran until August, and have been idle since. The cause of this idleness was said to be the increased price charged by the mine owners for the low-grade ore of their waste dumps. The works are situated in Butterfield cañon, 1 mile from its mouth, and 2 or 3 miles from the low-grade ore on the ridge above. They are in an imposing three-story building, and are said to have cost about \$60,000. Their capacity is 2½ tons per hour, but it is probable that were the crushing apparatus increased this could be doubled. Eight men per shift are required. The machinery consists of a Leffel turbine wheel, an Ames 40 horse-power engine, a Blake rock-breaker, a rotary drier, 3 feet by 30 feet; three sets of Cornish rolls, several reels and screens for sizing the ore, two double water jigs, two single water jigs, six Paddock's pneumatic jigs (used after sizing through screens Nos. 60, 80, 100, and 120), a belt machine or vanner for the very fine dust, and a tossing-tub. Good results were obtained from the waste dumps of some of the neighboring mines, especially where the ore was an ocher and a carbonate of lead. This class of ores assayed from 6 to 8 per cent. lead, and from 7 to 8 ounces silver, and they were concentrated to 50 per cent. lead, and from 15 to 25 ounces silver. Ten tons of ore from the Carbonate mine, in Beaver county, assaying 18 per cent. lead and 40 ounces silver, were concentrated to 63 per cent. lead and 200 ounces silver. Attempts, however, to separate galena, pyrite, and blende were not so successful. Careful weighings, samplings, and assays were made during the short run, but the results were not accessible.

The Holt concentrating works were erected in the spring of 1880 at the mouth of Butterfield cañon. They had a 6 horse-power engine, a revolving screen, four jigs, and four tie-boxes. They worked two months, during the year preceding the writer's visit, on waste-dump material from the Wasatch and Yosemite mines, assaying from 12 to 20 per cent. lead and from 5 to 9 ounces silver. Concentrations (about 1 to 3½) assayed 55 per cent. lead, 14 ounces silver, and \$4 gold.

The other mines of Butterfield cañon and its adjacent gulches are:

Mines.	Total length of openings	Total product.	Condition at the close of the census year.	Remarks.
	<i>Fect.</i>			
Revere	5,000	\$300,000.....	Idle	Ore assays: first-class, 15 ounces silver, 45 per cent. lead; low-grade, 10 ounces silver, 15 per cent. lead.
Telegraph	550		Active.....	Vein, 5 feet to 6 feet between limestone foot and quartzite hanging walls.
First W. Extension Tele- graph.	1,030	2,000.....	do	Ore assays 44 to 50 per cent. lead, \$5 to \$13 silver, \$1 to \$3 gold.
Summit (a)	215		do	Vein, 8 to 12 inches; ore averages 60 ounces silver.
Liberty (a)	145		do	
Red Cloud (a)			do	
Chubb (a)			do	
Experiment (a)	900	125 tons.....	Active.....	Vein, 3 feet; ore, one-half inch to 7 inches, assays 12 ounces silver, 88 per cent. lead, \$3 gold.
Queen and Bemis (a).....	515	100 tons.....	do	Average assays, 65 ounces silver, 4½ per cent. lead, and \$5 gold.
Lucky Boy	1,200		do	Vein, 6 feet, containing 6 to 30 inches sulphuretted ore.
Hlatt	1,000	150 tons.....	Idle	Ore assays 23 ounces silver, 9 per cent. lead, and \$5 gold.
S. and S	900		Assessment work done ..	A few thousand dollars' worth of ore shipped formerly.
Burstow	400			A small amount of ore shipped formerly.
Happy Go Lucky.....	220			Ore, silver and lead.
Badger	220			Do.

a Owned by Northern Chief Mining Company.

MINES OF SPRING GULCH.

There are a number of prospects in this gulch, the principal one of which is the Black Metallic. This mine was sold for \$20,000. The vein, from 4 to 9 feet, is in quartzite, and carries 3 feet of ore. Assays of a few tons assayed averaged \$30 silver, \$11 50 gold, and 17 per cent. copper. It has been idle for some time.

LITTLE COTTONWOOD MINING DISTRICT.

[October, 1880.]

The Little Cottonwood mining district is at the head of Little Cottonwood cañon, near the summit of the Wasatch range. Mineral was first discovered by soldiers in 1864 and the Wasatch district was organized, but soon abandoned owing to the great expense of working. In 1867 most of the claims were jumped and a new district organized called the Mountain Lake, which included a large area of country in the Wasatch range. It was divided in 1869 and 1870 into Big and Little Cottonwood, American Fork, and Uintah districts.

The Little Cottonwood district records show about 3,500 locations, of which probably not more than 400 are still held. These claims are situated in an area 2½ miles square. They are on precipitous hillsides and ridges, which rise from the bed of the cañon to summits from 10,000 to 12,000 feet above sea level. The formation is Carboniferous limestone (*a*) underlaid by quartzite, schist, and granite. The mines, with few exceptions, are in the limestone. The district is connected with the Utah Southern railroad at Sandy by the Wasatch and Jordan Valley railroad and tramway, 18 miles in length. The rise between Sandy and Alta, the terminal points, is 4,536½ feet. The freight rates at the time of the writer's visit were as follows:

Ore assaying over 30 ounces	Per ton.
Ore assaying between 30 and 15 ounces	\$4 00
Ore assaying less than 15 ounces	3 50
Granite	2 75
	1 00

During the census year 6,343⁰⁰⁰/₂₀₀₀ tons of ore were shipped by this road; also 5,385 tons of granite for the Mormon temple at Salt Lake City. Owing to the great depth of the snow in winter (from 6 to 15 feet) several miles of the Alta end of the tramway is protected by sheds. These are frequently swept away by snow-slides and the road is temporarily blocked. The railroad was completed in May, 1873, and the tramway in 1875 or 1876. The district was very dull at the time of the writer's visit. But two mines, the Vallejo and the City Rock, were working regularly, and but few companies were driving long tunnels to cut their veins at any considerable depth; the others were idle or leased. This state of things was due to legal troubles, the exhaustion of the working capital of several large prospecting companies, the giving out of surface bodies, the finding of pyrite and water in the lower levels, and the low price of lead. Very little metallurgical work had been done in the district, as most of the ore was sold in the Salt Lake market. In 1866 the owner of the North Star mine built a Scotch hearth furnace, and ran out about 3 tons of lead. In the following year he erected a reverberatory and a cupel furnace. The former was a success, but the latter failed. The Jones smelter was built at the mouth of the cañon in 1871 or 1872, and ran on custom ores for two years. In 1872 or 1873 the Davenport smelter was started at the same place. In addition to that from the

mine, it worked some custom ore, but was shut down in 1875. The Flagstaff company also erected three stacks in this vicinity; several unsuccessful attempts were made to leach ores on a small scale. Concentration works were built for the Emma mine, which were financially successful, though the percentage obtained was low.

The Emma mine is situated half-way up the southern slope of a high steep ridge called Emma hill. It was located in 1868 by Woodman, Chrisholm, Woodhull & Reich. Little work was done until the autumn of 1869, when the ore body was struck. Some ore was shipped and sold prior to the sale of the mine to the Emma Mining Company, of New York, in 1870. This company worked the mine quite vigorously, and shipped a large amount of ore. The following year the property was sold to the Emma Silver Mining Company of Utah (limited) for \$5,000,000 cash; another authority placed the price at \$3,500,000. The mine was then worked by English managers, paid \$300,000 in dividends (one authority says \$1,300,000) until September, 1874, when it was attached by T. W. Park and others for an indebtedness of \$300,000. It was then idle until October, 1877, when the American Emma Mining Company was incorporated and work resumed. (a) The second ore body failed in the autumn of 1873, up to which time most of the ore had been shipped to Swansea, Wales. During the years 1873, 1874, 1878, and 1879 much low-grade ore was concentrated by jigs.

When the American Emma company began work it first prospected the old ore bodies, and then leased the Bay City tunnel, which was 1,700 feet long, and 90 feet below the lowest old workings of the Emma. This tunnel had been run by a Saint Louis company at a cost of \$75,000, and had been abandoned in 1876. Since making the connection, a small ocher-stained seam, in an incline or winze 130 feet below the tunnel level, has been followed. At the mouth of the tunnel are two horizontal boilers, 14 feet by 40 inches, and two Clayton No. 2½ air-compressors. These force the compressed air through a 4-inch galvanized iron pipe, warranted to stand a pressure of 150 pounds, 1,800 feet, to an 8 horse-power engine over the winze, and a Knowles No. 7 pump. The pressure of air is kept at 60 pounds. About 3,500 gallons of water per hour is raised. During the census year about fourteen men were employed. The property of this company consists of the Emma, 2,400 by 100 feet, and the Cincinnati, 1,200 by 100 feet. One hundred thousand dollars was paid for the latter, but the claim having been jumped, the title is in dispute. The ore-bearing formation is a belt of siliceous limestone, between a limestone hanging and a dolomite foot wall, the belt being about 200 feet wide, dipping 45° NE. parallel to the stratification of the country rock. The ore did not come to the surface, but was found by following a small seam of ocher 50 feet in a tunnel. Two large bodies were found somewhat nearer to the hanging than to the foot wall, following the general dip and strike of the belt. One began near the surface, and was 100 feet deep, 300 feet long, and from 1 to 30 feet wide; and the other, a few feet below the first, was 200 feet long, 150 feet deep, and from 1 to 20 feet wide. The ore was a soft brownish-red ocher, containing cerussite, anglesite, galena, and some manganese oxide. During the census year 778 tons were obtained by chloriders and from jigs, which sold for \$55,071 54. From Mr. Charles Smith, of Salt Lake City, whose accounts included all but the first few hundred tons sold, the writer learned that the sales of ore to June 1, 1880, amounted to 27,451 tons, for which \$2,637,727 44 was received. The mine had been developed below the discovery only about 500 feet vertically and 350 feet horizontally. The openings of the old workings were estimated at something less than 4,000 feet, and those of the new workings at about 700 feet.

The Flagstaff mine is situated a quarter of a mile north of Alta, half way up the southern slope of a high ridge which separates Big from Little Cottonwood cañon, from 700 to 800 feet above the valley. It was located in 1879 by Grosbeck, Schneider, and others, who worked it under the name of the Salt Lake Mining Company until February, 1872, when it was bonded to one Davis for \$300,000, who sold it to English capitalists for \$1,500,000. They organized the Flagstaff Silver Mining Company of Utah (limited), and worked the mine in a very expensive manner until December, 1873, when the ore bodies in sight gave out. The company was then found to be in debt to Davis, for money advanced, some three hundred thousand dollars. Davis took the mine and worked it under agreement with the company until December 24, 1876, when he was dispossessed by the United States marshal under orders from the English directors. Heavy lawsuits with small results followed. Since 1876 the mine has been leased and subleased many times, but has been idle since the summer of 1880. At the time of examination it was owned by Seligman Brothers, of New York, who took it for debt. They had lately bought the Nabob, an adjacent property, and the new owners expected to begin work soon. The English company erected the Flagstaff smelter (three stacks) at the mouth of Little Cottonwood cañon, and ran it until November, 1873, when they leased the Last Chance smelter, near Sandy. Smelting was not as profitable as selling the ore, which, after April, 1876, was disposed of in the Salt Lake market. The dividends paid to the English company amounted to about \$350,000. The property consists of the Flagstaff, South Star and Titus, Virginia, and Nabob. The Flagstaff is 2,200 by 100 feet, but it extends across and not along the belt. In early times, before the suits, the right to "swing their patent" was insisted on, and the workings extended 1,000 feet or more on the belt. The formation is the same mineral belt as the Emma. Ore came to the surface in one spot, and, following this indication a short distance, the discoverers came to the first and largest body. It was 400 feet long and 500 feet deep, extreme dimensions, and 3 feet wide. Some twenty or thirty other large-sized bodies were found, in all shapes and

a There has been a great amount of litigation between the English stockholders and T. W. Park and others, but these differences have recently been amicably adjusted.

positions, usually near the hanging wall, and invariably connected with one another by a small seam of ore or ocher. One body upon the foot wall was joined to another near the hanging wall by a pipe of galena the size of a lead pencil.

The total product was estimated by the superintendent to be as follows:

	Tons.
Prior to 1872	6,000
1872	8,000
1873	17,000
1874 to 1876	35,000
1877 and 1878	30,000
1879	4,000
Total	100,000

Of this, 30,000 tons probably assayed \$10 gold, 60 ounces silver, and 40 per cent. lead, and sold for, or was worth, \$50 per ton. The remainder probably assayed \$4 gold, 30 ounces silver, and 20 per cent. lead, and was worth \$30 per ton.

The mine is developed by a 530-foot tunnel, from which there is an incline 515 feet in length, at an angle of 49°. From this incline there are six levels, from 700 to 1,400 feet in length. The lower level is about 700 feet vertically below the discovery croppings. The total cuttings, exclusive of stopes, are variously estimated at from 9,000 to 14,000 feet. From the mouth of the tunnel the ore is sent to the foot of the hill on a tramway 2,800 feet in length. A 40 horse-power Babcock & Wilcox engine, situated in the tunnel, supplied with compressed air through 2,270 feet of 4-inch pipe, from two Burleigh No. 2 air-compressors, is sufficient to do the hoisting. No water has been encountered except surface water in the spring, which was controlled by a No. 4 Knowles steam-pump. The cost of the plant was about \$60,000.

The South Star and Titus, an older location than the Flagstaff, has been constantly harassed by law suits. Several hundred thousand dollars' worth of ore have been extracted. It is developed by tunnel and shaft to the extent of several thousand feet. Active work ceased in 1878.

The Nabob was located in 1876. A large body of ore, lying partly in the Virginia ground, was struck in the winter of 1876-77, which yielded about \$100,000. Little has been done since. The mine is a part of the mineral belt of Emma hill. An ore body, 30 by 25 by 4 feet, was found not 50 feet from the surface. The average assay of this ore was \$74 76, of which \$26 was gold. The developments consist of a 115-foot incline and 300 feet of other cuttings.

The Joab Lawrence Company, the principal actively working company on Emma hill at the time of the writer's visit, was organized in the spring of 1879. Its property consists of the Vallejo and the North Star, adjacent claims, situated between the Emma and the Flagstaff. The North Star was one of the earliest claims of the district, having been located in 1865, and has yielded largely. There are said to be large bodies of low-grade oxide of iron ore in the lower levels, but little had been done for some time excepting a small amount of "tribute" work. The Vallejo was worked in 1872, 1873, 1874, 1875, and 1877 by several companies, and much ore was extracted. It was being worked on an extensive scale at the time of the writer's visit. The ore is found in irregular chutes or pipes near the hanging wall. Three bodies began near the grass roots, and others were found as depth was attained. At the period under review there were ten chutes having a triangular or lenticular cross-section, and a uniform dip SE. 80°. These were from 20 to 100 feet apart, and lay almost at right angles to the strike of the belt. The largest was 150 feet long, extreme dimensions from 6 inches to 10 feet wide, and had been followed 300 feet deep. In this mine the foot wall of the belt had not been prospected, and the horizontal development did not exceed 200 feet. It was worked by tunnels, from which were raises and short inclines. It had no machinery. The total cuttings were estimated at several thousand feet. The mine was dry. The ore was an oxide of iron, carrying galena, cerussite, anglesite, and a little oxide of manganese and malachite. It was fine, and contained from 20 to 45 per cent. lead, from 15 to 90 ounces silver, from 20 to 35 per cent. iron, and from 9 to 14 per cent. of moisture. It was in great demand among the smelters, owing to the lack of silica and the presence of so much iron. A low grade of ore containing from 40 to 50 per cent. of iron, no lead, and a few ounces of silver was also shipped. The following table shows the price received per ton for some lots of ore in February and March, 1880:

Weight.	ASSAY VALUE.		Price received.
	Lead.	Silver.	
Pounds.	Per cent.	Ounces.	Per ton.
111,855	5	5	\$10 00
76,225	41	48	66 50
56,877	42	65	85 10
54,376	35	39	52 25
74,011	12	15	17 50
130,364	43	54	73 75
140,525	6	9	12 40

The ore was transported from the mine to the tramway of the Wasatch and Jordan Valley railway by a wire-rope tramway.

The Toledo-Utah Silver Mining and Smelting Company bought the Toledo mine shortly after its discovery in 1872, and worked it quite extensively until April, 1880. The property consists of the Toledo and the Fuller claims. On the latter most of the ore has been found and most of the work done. The ore occurs in a fissure vein, from 1 to 3 feet wide, cutting diagonally across a quartzite formation, dipping N.NW. 80°, and is found in several chimneys 50 feet long on the strike, and about 50 feet apart. They dip with the strike toward the east. The ore is a hard, porous, brown siliceous oxide of iron of very high grade. It was said to have averaged from 80 to 100 ounces to the ton. Water was found 200 feet from the surface, but the character of the ore did not change. Where the vein passed from the quartzite into a belt of schist there was much pyrite. The mine is operated through a shaft 455 feet deep, vertical for part of its length. The horizontal development of the vein is 350 feet, and the total cuttings are estimated at 2,000 feet. The engine and two Knowles steam pumps are run by compressed air from a Bowers air compressor placed in the bed of Little Cottonwood ravine half a mile or more below the mine. The total product of the mine and its output during the census year were large. The exact figures cannot be given, owing to the confidential character of the information furnished.

The Emily mine is situated in a small ravine between the Toledo and Emma hill. It was discovered in 1870. It is owned by the Emily Mining Company, of Pittsburgh, Pennsylvania. They ceased regular work in 1874, and the mine has been leased since at one-fifth royalty. It is a bedded vein of clay slate in quartzite, dipping about 60° E. The ore is from 1 to 6 inches wide, and consists of quartz containing pyrite, sphalerite, galena, and tetrahedrite. When sorted it assays from \$80 to \$100. Mine is opened by three tunnels on the vein. The total length of cuttings is 800 feet. The mine is very wet and has no machinery. The total yield has been \$15,000 or \$20,000.

The City Rock and Utah group is situated at the head of Little Cottonwood cañon, and comprises the Utah, 100 by 1,000 feet; City Rock, 100 by 1,000 feet; West Wind, 100 by 495 feet; King of the West, Utah No. 2, Utah No. 3, and Freeland. The first three are on the Utah vein, and the others are on the parallel King of the West vein, 200 feet distant, and have but little development. Most of these claims were located in 1870. In 1872 much work was done. Between 1872 and 1876 the mines were involved in litigation. Twelve men were employed during the census year.

The Utah is a fissure vein, from 1 foot to 20 feet wide, dipping 70° or more NW. through strata of blue and white siliceous limestone or dolomite, which dip about 30° NE. It had outcrops in places, and is known to extend 4,000 feet in length and 700 feet in depth. The gangue of the vein is oxide of iron, and a sand, apparently the result of the decomposition of the siliceous country rock. The ore is from 1 foot to 10 feet (averaging from 2 to 3 feet) wide, immediately in contact with the walls, but not confined to either. Three chimneys have been found, 200 feet long, and about 300 feet apart. One came to the surface, and the others to within 100 feet of it. They dip with the strike about 65° NE. The positions of these chimneys appear to be determined by the strata of white limestone. The ore makes where the vein crosses the white limestone, but pinches where the harder blue limestone is encountered. It is a soft red, sometimes rather sandy oxide of iron containing carbonate of lead and galena, and in places stains of malachite. The first class assays 30 per cent. lead, 30 ounces and upward of silver, and a trace of gold. There is also much low-grade jigging ore in the mine. On the south side a dike of porphyry appears, running nearly parallel with the vein. Near the porphyry the ore has not been so rich.

The mine was being thoroughly opened at intervals of 100 feet by levels and winzes through the ore bodies. Very little stoping has been done. The developments consisted of two inclines and three tunnels on the vein. The lower one, which was to be the main working tunnel, is 5 by 7 feet, well timbered, has an iron rail track, and is 600 feet long. The middle tunnel, 490 feet vertically above the lower one, is 1,300 feet long. One hundred feet below this is the water level. The upper tunnel is 600 feet long, and 201 feet above the middle one. These tunnels have a grade of half an inch in 12 feet. The total cuttings amount to 4,800 feet. The cost of drifting in the vein is from \$3 to \$6 per foot. The cost of transportation to the tramway is \$2 per ton. During the census year 385 tons of ore were sold for \$25,480 67. The previous product was estimated at \$50,000.

The other mines of the Little Cottonwood district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Cincinnati Group	1,500	\$10,000	Worked irregularly.....	Ore, a sulphuret containing considerable zinc.
Enterprise	500	.....	Idle.....	One ore body yielded \$10,000 or more.
Dexter Consolidated.....	300	Small .....	.....do	
Brian Lode .....	.....	A few thousand dollars	.....do	
Marion Group	1,800	.....	Worked irregularly.....	
Manitoba	630	.....	Idle.....	Vein not well defined.
Emily	800	\$18,000.....	Worked on lease.....	Ore assays \$80 to \$100 per ton.
Calcedonia.....	700	.....	.....do	Several thousand dollars have been extracted.

PRECIOUS METALS.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
Highland Chief	<i>Fect.</i> 1,100	.....	Idle.....	Ore assays 20 ounces silver and 25 per cent lead. Many hundred tons have been shipped.
Ohio River Group.....	500	\$60,000.....	Little work done.....	
Savage and Montezuma Group.....	3,000	200,000.....	Idle.....	Ore 35 per cent lead and 35 to 150 ounces silver.
Stoker.....	450	Small.....	do.....	Ore medium grade.
McKay and Revolution.....	1,000	.....	Tunnel being run.....	A few hundred tons have been extracted.
Grizzly and Lavinia.....	3,000	Large.....	Idle.....	Contains large bodies of low-grade ore.
Darlington.....	500	Small.....	do.....	
Davenport.....	4,800	\$600,000.....	do.....	
Island.....	1,000	.....	do.....	Contains large bodies of low-grade ore.
Slakiyou.....	500	Small.....	do.....	
Alpha.....	500	\$37,000.....	.....	Average assays: 200 ounces silver, 10 per cent lead, \$10 gold.
Evergreen.....	.....	.....	Worked irregularly.....	
North Pole.....	380	.....	.....	Ore, galena in small seams in limestone.
Albion and Rising Sun.....	1,800	\$100,000.....	Idle.....	
Oxford and Geneva.....	1,910	20,000.....	Worked on lease.....	Ore assays 30 to 60 ounces silver, 40 to 60 per cent lead, \$3 gold.
Louisa.....	600	8,000.....	Idle.....	Ore, 10 to 12 ounces ochery carbonate and 40 to 50 ounces galena.
Sedan.....	300	Small.....	.....	Ore, cerussite, galena, and pyrites, containing 10 to 60 ounces silver.
Fritz.....	460	do.....	.....	Vein, 20 feet; soft, low-grade ochre.
Peruvian.....	700	do.....	.....	A few tons shipped, assaying 40 to 60 ounces silver, 40 to 70 per cent lead, and \$6 gold.
Kenosha.....	500	do.....	.....
Highland Boy.....	500	None.....	.....	Small stringers of carbonate ore in limestone.

Five miles west of Alta, in Little Cottonwood cañon, there are said to be a few small veins of quartz in the granite country rock, from 1 to 3 feet wide, carrying considerable molybdenite. They assay, however, but a few ounces in silver, and have never been worked.

TUNNEL SITES.

The topography of this district is very favorable for the location of tunnel sites. Accordingly, in early times, work was begun upon a great many. They have cost fortunes, but have rarely been successful in finding ore; and though all are still claimed, few are worked more than is sufficient for assessment work. These tunnel sites, in a legal way, are a great drawback to the district. They were located before many of the present claims; they ran in all directions, and, in case large and rich bodies should be found, some of them might be used to make serious legal difficulties. The following are the principal tunnel sites in the order of their situation, beginning at the west, on the north side of Little Cottonwood, and continuing in a semi-circle around the head of the cañon:

The Frederick tunnel.—This was driven to develop the Frederick and Crown Point claims. These are parallel veins, 70 feet apart, 3 and 4½ feet wide, dipping 54° N. in limestone, and between limestone and quartzite. The ore is a carbonate, 18 inches wide, and averages 60 ounces silver and 35 per cent lead. The claims were located in 1870, and were worked until 1873, when water and galena were encountered at a depth of 337 feet. The value of the ore sold was estimated at \$35,000. The mines were leased until May, 1876, when the tunnel was begun. It is 1,300 feet long, and has to be driven several hundred feet further before cutting the veins, which are expected to be reached at 980 feet below the croppings. Its size is 6 feet 6 inches by 4 feet 4 inches. Timbering is unnecessary. The track is laid with a T-rail, 13 pounds to the yard, and has a 20-inch gauge. The tunnel is ventilated for 800 feet by a small stove and a 5½-inch pipe. A small engine is used to run a Sturtevant No. 3 fan-blower two hours twice a day. The cost of the tunnel is estimated at \$17 50 per foot, which was the contract price. During the census year four or five men were regularly employed; they used single-handed drills, No. 2 giant powder, and drove the tunnel about 300 feet.

The Howland tunnel.—Work was begun on this several years ago. It has been relocated several times and was, at the period under review, known as the Solitary. Its length is 600 feet. Only assessment work is being done.

The Geneva tunnel.—Abandoned. Length unknown.

The Lady Emma tunnel.—Length, 370 feet. Relocated and called Prince-of-the-Hills. Only assessment work is being done.

The Chicago tunnel.—Length, 600 feet. Relocated and called the Fitzgerald tunnel.

The Vallejo tunnel.—Used in the early development of the Vallejo mine.

The Utah tunnel.—Relocated as the Burgess, and used to work the Vallejo mine.

The Gladiator tunnel.—Length, about 1,000 feet. Used to work the North Star mine.

The Great Salt Lake Tunnel and Mining Company.—This is better known as the Buffalo tunnel. It was located in 1871, is 600 feet in length, and is regularly worked, 275 feet having been run the preceding year.

This company had located two claims, the Buffalo and another, having 9-inch veins, containing galena and pyrites. Three small bodies were found. The ore sold for about \$80 per ton, and yielded a few thousand dollars. The Allegan mine, operated through this tunnel, has about 550 feet of cuttings, and yielded a few thousand dollars some years ago.

The Bay City tunnel.—Length, 1,700 feet. (See description of Emma mine.)

The Illinois tunnel.—Length, 800 feet. (See Cincinnati group.)

The Equitable Tunnel and Mining Company.—This company's tunnel is about 1,500 feet in length, with side drifts and winzes amounting to 900 feet, and is situated above the Bay City. Three small claims, Bolles & Collins, Equitable, and Equitable No. 2, as well as the Phoenix and the Lady Esten tunnel site, in other parts of the district, are owned by this company. Ventilation is obtained by a stove and a 6-inch pipe. This apparatus is similar to many others used in Utah. The stove is of sheet-iron, conical in shape, 3 feet high, and 3 feet in diameter at the base. It has no bottom, resting upon the earth or a bed of ashes, and is plastered around to make it air-tight. An ordinary 6-inch stove-pipe, from 20 to 25 feet high from the conical top of the stove, furnishes the draft. The door is a hole on one side, 8 inches square, covered by a closely-fitting piece of sheet-iron. A 6-inch galvanized iron pipe from the tunnel enters the stove near the base. The pipes in the tunnel are in 12-foot lengths, and are made air-tight by using tarred rags at the joints. They run near the top of the tunnel, and are supported by wooden plugs driven into drill-holes. The pipe branches off into the various drifts, and at the end the draft is nearly strong enough to draw out a candle. During the census year about 15 cords of wood were used, and seven men were regularly employed.

The Little Cottonwood tunnel.—Relocated and called the Buckland. It is 600 feet long, and was run to tap the Savage and Montezuma group.

The Reliance tunnel.—Abandoned. Little work done.

The Manhattan tunnel.—Abandoned and relocated as the McKay and Revolution. Length, 500 feet.

The Ely tunnel.—Abandoned.

The Phoenix tunnel.—Owned by the Equitable Tunnel and Mining Company. Length, 700 feet.

The Herman tunnel, known as the Tilden.—Length, 500 feet.

The Emma Hill tunnel.—Length, 900 feet.

The Victoria tunnel.—Length, 900 feet. Used to work the Victoria, Imperial, Emma May, and Alice mines. These have a large amount of cuttings, have shipped considerable ore, and are being worked upon lease.

The Christiana tunnel, known as the Oneida.—Length, 250 feet.

The Brewer & Lapham tunnel.—Length, 150 feet. Located to develop the Darlington mine.

The Lady Esten tunnel.—Length, 300 feet. Owned by the Equitable Tunnel and Mining Company.

The Iris Tunnel Company.—This was a San Francisco company which began work in the spring of 1872, and failed in the autumn of 1877, having spent about \$100,000. The tunnel was taken by one of the creditors for debt. The property consists of eight locations and two tunnel sites on Emerald hill. The upper tunnel is 1,165 feet in length and has 600 feet of drifts. Two veins, from 6 inches to 2 feet and from 2 to 4 feet wide, were cut. Some galena and pyrite ore was extracted. Water is very plentiful, and the lower tunnel, 300 feet below, was run to drain the ledges. The lower tunnel is 635 feet long, and has to be run 300 feet further before cutting the first vein. The tunnels are large and straight, and are ventilated by means of a water blast driven by the waste water.

The Etna, St. Joseph, Wasatch, Silver Belt, and Rothschild tunnel sites are of varying lengths, and have all been abandoned.

Besides the tunnels above mentioned, there are many others having more or less development.

BIG COTTONWOOD DISTRICT.

[October, 1880.]

The Big Cottonwood mining district, situated in the cañon of the same name, lies north of Little Cottonwood district, and was organized July 11, 1870. It extends 16 miles east and west and 6 miles north and south, its boundaries being the summits of the ridges each side of Big Cottonwood cañon. The mines are situated, with but few exceptions, upon the southern or Little Cottonwood ridge. At the period under review records showed 1,354 locations, of which, probably, between 300 and 400 were still held. The principal camp of the district is Argenta, which has communication with Salt Lake by a tri-weekly stage. Ore is taken down the cañon to Sandy by teams. The geological formation is the same as in Little Cottonwood, Carboniferous limestone underlaid by quartzite, schist, and granite. There have been great faults, and erosion has worn precipitous ravines in the Cottonwood ridge, so that in general the surface of the country is much rougher than in the Little Cottonwood district. The mines are at about the same or, perhaps, a little higher altitude, and the deep snow and snowslides give as much or more trouble. Supplies of food and fuel are laid in during October to last until the following June.

The mines upon the north side of the cañon are the Hayes and the Maxfield. The Hayes mine, $2\frac{1}{2}$ miles north of Argenta, has 400 feet of cuttings. No ore was ever shipped.

The Maxfield is situated a quarter of a mile northwest of Argenta and 14 miles east of Sandy, in a side ravine, and near the bed of the main cañon. It is owned by the Maxfield Mining Company of Salt Lake City,

incorporated in March, 1879. This company also owns the extensions or parallel claims Vinnie, Amanda, Red Pine, Tyler, and Fairview. These are mostly patented, but only slightly developed. The Maxfield is a bedded vein, from 1 to 8 feet wide, dipping 45° NE., between strata of a compact bluish-white limestone. The ore occurs usually upon the foot wall, in one chimney 200 feet long and 2 feet wide. It is a soft, brown, ochery carbonate and galena, assaying from 30 to 100 ounces. On the hanging wall there was a band of quartz, from 3 to 8 inches wide, containing galena and pyrites. When carefully sorted this yields good ore. The mine is dry and has been developed 75 feet vertically and 212 feet horizontally by a tunnel on the vein from the bed of the ravine. The total openings aggregate 800 feet. There is no machinery. During the census year about 90 tons of ore were produced, which sold for \$4,518. The cost of transportation is from \$4 to \$4 50 per ton. The former product is roughly estimated at \$20,000.

The several side ravines or forks on the south side of the main Big Cottonwood cañon, beginning at the upper end, are named as follows: Mill, South, Honeycomb, Silver, Day's, South, and Mineral.

On Scott hill, at the head of Big Cottonwood cañon, there were many prospects idle at the time, some having a large amount of workings, and showing considerable low-grade silver ore in quartzite.

MINES OF HONEYCOMB FORK.

The Butte mine, at the head of Honeycomb fork, 2½ miles northeast of Alta, was discovered in 1869, and has been worked irregularly since. It is said to be a fissure vein in limestone, from 6 inches to 4 feet wide, dipping 55° N., and is supposed to be an extension of the Utah and City Rock of Little Cottonwood district. It outcropped for several hundred feet on the hillside in the form of a soft ocher-stained limestone. Ore occurs on the foot wall in eight or ten lenticular bodies, from 1 inch to 3 feet wide, at considerable distance below the surface. It is a high-grade ocher and carbonate. Sometimes much black oxide of manganese is found. The mine is dry (excepting surface water), and is worked through a 200-foot tunnel. The total cuttings, including two old inclines, are 2,300 feet. Nine men were employed during the census year. The total product to June 1, 1880, was estimated at \$27,000.

The Oregon is an extension of the Butte. The property is held by a Canadian corporation, and also includes four patented prospects on which very little work has been done; the Columbus, the Taylor, the Abbey, and the Black Bess. It is a fissure vein, from 1 to 15 feet (average, 3 feet) wide, dipping 60° N.NE. in limestone. Only one body of ore has been found. This came to the surface, and was 120 feet long, from 3 inches to 3 feet wide, and extended to a depth of 300 feet. It assayed about 50 ounces silver and 30 per cent. lead. The mine contains 1,600 feet of cuttings, and has been opened 350 feet on the dip and 480 feet horizontally by means of an 8 horse-power vertical engine. Water was found at 100 feet, but no change occurred in the oxidized character of the ore. During the census year eight men were employed, and a small amount of ore was extracted. It was idle at the time of the writer's visit, owing to the loss of the lawsuit between it and the Butte. The total product was estimated at \$10,000.

The Madelon Consolidated Silver Mining and Mill Company, a New York stock company, organized in October, 1879, having 400,000 shares and a capital stock of \$10,000,000, owns 5 patented and 11 unpatented overlapping claims of 1,500 by 600 feet, in all about 207 acres, at the head of Honeycomb fork and South fork. They are all prospects, few having 100 feet of development, and some showing bodies of ore of a grade sufficient to ship. It was proposed to cut these veins at a great depth by the Colbath tunnel, and perhaps to extend it several thousand feet into Little Cottonwood district, and cut the City Rock vein at a depth of about 2,000 feet. Work was begun on January 4, 1880, and from that time had been steadily prosecuted by about twelve men. The tunnel is 5 by 6 feet, and 512 feet long, exclusive of 250 feet of cross-cuts and drifts, and has a grade of half an inch in 20 feet. Good ventilation is obtained by a stove and a 6-inch pipe.

MINES OF SILVER FORK.

The Antelope and Prince of Wales group, situated on the high, steep ridge between Honeycomb and Silver Forks, 2½ miles northeast of Alta, consists of the Antelope, Prince of Wales, Wandering Boy, Highland Chief, Wellington, and Warrior claims. All were discovered about 1870. Very important lawsuits were pending between 1871 and 1875, in which the Highland Chief was defeated and a compromise was effected with the Wellington. The mines have been worked extensively since the latter date. During the census year about thirty men were employed. At the period under review there were nearly the same number, but they were, for the most part, working on contracts or leases. The ore-bearing formation is said to be a bedded vein, dipping about 45° NW. in blue and white limestone. Four distinct chimneys or chutes of ore, 130 feet, 200 feet, and 260 feet apart, have been found. They occur where the limestone is white, metamorphic, and soft; while the barren spaces between these chutes contain the vein only as a narrow seam in hard blue limestone. These chutes outcropped at the surface, or were covered by a few feet of drift, as low-grade ocher-stained seams of limestone and clay. Good ore was found by sinking a few feet. The Antelope and Prince of Wales chute is from 2 inches to 4 feet (average, 12 inches) wide, 120 feet long, and has been followed on the dip 1,200 feet. The Highland Chief chute is from 2 inches to 3 feet (average, 8 inches) wide, 75 feet long, and 800 feet deep. The Wellington chutes are each about from 2½ to 7 feet (average, 3 feet) wide, from 10 to 30 feet long, and 700 feet deep. The ore from the first assays

about 140 ounces silver and 45 per cent. lead; that from the second, 100 ounces silver and 40 per cent. lead; and that from the third and fourth, 60 ounces silver and 50 per cent. lead. The ore is a soft, brownish-yellow ocher, containing argentiferous cerussite and galena and occasional stains of oxides of manganese and copper. The mine is opened by several tunnels, the main one being 2,200 feet long, and running on the vein entirely through the ridge, and a 1,100-foot incline, on which there are hoisting works, on the crest of the ridge. The cuttings are said to be 1,300 feet in extent. The hoisting works are large and apparently (the writer could not gain access to them) substantial, and are connected with the road in Little Cottonwood district by a covered tramway to allow the shipment of ore in winter, however deep the snow. With the exception of two or three men employed by the company, all work was done by contracts, which were let every thirty to ninety days. The miners received from \$4 to \$7 per foot for sinking winzes, and from \$3 50 to \$7 for running drifts.

The other mines of Silver fork are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.
Richmond and Theresa	<i>Feet.</i> 1,400	\$150,000	Idle.
Congress .....	.....	.....	do.
Cooper .....	.....	20,000	do.

MINES OF DAY'S FORK.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Eclipse	a 158	None	Active	A two-compartment shaft was begun July 26, 1880.
Grosbeck or Emperor	1,400	do	Idle	

a Depth of the shaft.

MINES OF SOUTH FORK.

The Reed & Benson mine is situated on a spur of the Cottonwood divide, between Day's and South forks, 11,000 feet above sea-level and 2½ miles northwest of Alta. It was located in 1870, and was worked vigorously from September, 1871, until April, 1878. Since then it has been idle or leased to a very limited extent. This mine is supposed to be upon the same mineral belt as the Flagstaff and the Emma. The belt at this point is about 200 feet wide. The ore occurs in a vein or chimney on the hanging-wall side, and in about twenty irregular lenticular bodies, which branch at all angles from the chimney, on its foot-wall side. These do not, as a rule, extend more than 75 feet from the main chimney, and vary from 6 inches to several feet in width. One outcropped as a low-grade ocher. The largest is about 170 feet from the surface. The ore is of the kind usually found in this limestone formation, namely, a yellow and red oxide of iron carrying argentiferous cerussite and galena. It is claimed that the total shipments have averaged 120 ounces silver and 35 per cent. lead per ton. The mine is developed by a 380-foot tunnel, in which there is a whim on a 400-foot incline, dipping 35° N.N.E. Below this there are four windlasses, which carry the incline down 400 or 500 feet deeper. In general, the mine may be said to have been opened from the surface 1,100 feet on the dip (35°) by an irregular incline following the chimney. Near the surface the ore extended 100 feet, and the workings 200 feet, horizontally; but in the bottom of the incline not over 40 feet of drifting have been done. The openings have a total length of 1,950 feet. The mine will probably be idle until the chimney is cut by the Reed & Goodspeed tunnel. Ore is transported from the mouth of the tunnel to the foot of the hill by a 3-rail iron track tramway 1,740 feet long, having an average angle of descent of 31°. The track is 25½ inches wide. The car is 9 by 2 feet 3 inches by 10 inches. A three-quarter-inch steel-wire rope passes over a 9-foot drum controlled by a brake. This tramway was built in 1873, and cost about \$20,000. Ore was then transported in wagons to the South Cottonwood smelters, 23 miles distant, at a cost of from \$7 50 to \$8 50 per ton. The total product is estimated at \$600,000.

The Ophir is a few hundred feet southeast of the Reed & Benson, and has the same owners and officers. It was discovered in 1870, purchased by Reed & Goodspeed in 1871, leased until May, 1878, and worked steadily since by about ten men. Ore is found in three bodies in a 30-foot stratum of compact, dark-blue limestone. A stratum of white limestone above carries no ore. The outcrop was a pipe 2½ feet in diameter of low-grade ocher. The shape of the bodies is that of a flattened or an elongated ball, the largest being 50 by 20 by 15 feet. They are 4 and 10 feet apart, and not over 50 feet from the surface. At the period under review drifting was being carried on upon a seam of ocher in the expectation of finding another body. The total cuttings did not exceed 700 feet. During the census year 173 tons of ore similar to that of the Reed & Benson, excepting that it was of lower grade, assaying only about 45 per cent. lead, 42 ounces silver, with 3 per cent. moisture, were sold for \$8,581. The previous product was estimated at \$22,000.

PRECIOUS METALS.

The Reed & Goodspeed was located as a tunnel site to cut the Reed & Benson chimney and all blind ledges. Work was begun on it October 14, 1875, and with the exception of a few months' intermission in 1876, had been prosecuted continuously since. It is 5 by 8 feet, and 1,617 feet long, and is timbered for the first 225 feet only. It is dry, excepting surface water in the spring, and has a grade of three-quarters of an inch to the rod. The track is 25½ inches wide, and is of scantling and strap-iron. Ventilation is secured by a 4-inch pipe, a 4-foot fan-blower, and a 3½ horse-power Bookwalter engine. Work is done by day's labor, five men being employed. Blasts are made three times a day, after which the blower is run for two hours. The cost was about \$20 per linear foot. It is expected to cut the chimney 400 feet farther on at a depth of from 1,500 feet to 1,800 feet from the croppings. During the preceding year the face had been advanced 330 feet. In March, 1879, the owners formed a corporation under the name of the Reed & Goodspeed Mining Company, having a capital stock of \$1,000,000 in shares of \$10 each.

The Saint Louis tunnel was begun in 1875 to develop the Sampson mine, situated on the Reed & Benson ridge. Work ceased in the spring of 1880. The tunnel is 700 feet long. The Sampson mine had about 500 feet of cuttings, showing one chimney of low-grade ore. No ore had been shipped.

The Jupiter Mining Company owns several claims on the Reed & Benson ridge, 1½ miles north of the Reed & Benson mine. The developments are less than 310 feet in extent. The ore is a gold ore in narrow seams, and consists of an oxide of iron assaying from \$20 to \$100. No ore has been shipped.

MINES OF SILVER MOUNTAIN BETWEEN SOUTH FORK AND MINERAL FORK.

The mine of the Kessler Mining Company covers part of the ground of the old Provo claim. It was worked by a New York company in 1872, 1873, and 1874. Little ore was obtained, and it was abandoned. About 1875 a prospector discovered the carbonate ore body while overhauling the old dump, so says tradition. The mine was bought by the Carbonate Company of Salt Lake City, which extracted large quantities of ore. In January, 1879, after the large discovery ore body had been nearly all extracted, the mine was sold to the Kessler Mining Company of New York city. This company took out considerable ore and did much prospecting, but ceased work some months previous to the writer's visit, at which time the mine was worked by a few lessees. The property consists of the following overlapping, unpatented claims: Carbonate, 1,500 by 200 feet, Little Giant, Sailor Jack, Alturas, Baker, and Defiance. These are situated on the summit of the ridge of Silver mountain, about 11,000 feet above sea-level, 3 miles south of Argenta, and about 6 miles northwest of Alta. The formation is supposed by some to be a part of the Flagstaff and Emma belt. Though it is 3 miles from the Reed & Benson, its position and dip favor such a belief. The ore is found in several bodies near the surface on the hanging-wall side of a stratum or belt of limestone. The largest body was just below the surface, and was lenticular in shape, its dimensions being 200 by 100 by 50 feet. It was timbered by 365 square sets, but had caved in. The gangue, if such it may be called, which surrounds the bodies and also serves as a connecting link between them, consists of a valueless ocher or limonite. It is very abundant, sometimes fine and soft; at other points hard and siliceous. Occasionally heavy spar, oxide of manganese, and stains of malachite are found. The ore is an ocher, containing cerussite and galena, and assays from 30 to 50 per cent. lead and from 30 to 100 ounces silver. A fissure vein, called the Sailor Jack, connects with this body, and has been the cause of much litigation. There is also a vertical fault of 500 feet. The mine is opened 950 feet horizontally and 300 feet vertically, below the croppings, by six tunnels and one incline shaft. Four of the tunnels and the shaft are upon the fissure vein. The cuttings are 5,500 feet in length. The mine is dry, excepting from surface water from melting snows in the spring. There is no machinery. The ore is sent down an extremely steep and rough trail, 1 mile in length, in "stone boats" or sleds, to the bed of the South Fork ravine, whence it is conveyed in wagons 18 miles to Sandy, at a total cost of \$8 50 per ton. During the census year, 692 tons were produced, which sold for \$16,554 74. The total product of the mine prior to October, 1877, is estimated at \$120,000. Between the above date and the beginning of the census year, 4,549 gross tons, averaging about 8 per cent. moisture, were sold for \$261,044 41.

The other mines of Silver mountain, between South and Mineral forks, are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Silver Mountain Mining Company.	500	\$10,000.....	Active.....	Ore assays 50 ounces silver, 35 per cent lead, and \$3 gold.
Thor and Bright Point.....	500	2,000.....	do.....	Ore assays 60 to 100 ounces silver and 40 to 60 per cent. lead.
Elgin Mining Company.....	700	Small.....	Prospected irregularly....	Veins small.
Paterbaugh.....	300	a \$840.....		
Imperial Mining, Milling and Smelting Company.		Small.....		A few hundred feet of cuttings. Worked irregularly for two other years.
Dolly Varden.....	1,400	\$25,000.....		Property in litigation.

a During the census year.

HOT SPRINGS DISTRICT.

This district is situated in the Wasatch range, adjacent to and east of Salt Lake City, extending 10 miles east and west and 5 miles north and south. It was organized in December, 1870, and now includes the old Adams and Mill Creek districts. About two hundred and thirty locations have been made, but not over forty are still held and worked. The country rock is limestone. The ore, which occurs in small veins, is a low-grade ocher containing cerussite and galena, and sometimes assays from 15 to 25 ounces silver per ton. Only a few tons have been shipped. The principal mines are the Henry, cuttings 350 feet; Lawrence, cuttings 250 feet; General Scott, cuttings 150 feet; and the Magnet iron mine, having 300 feet of openings, from which several hundred tons of flux have been shipped.

DRAPERSVILLE AND NEW EL DORADO DISTRICTS.

These districts have been abandoned for several years.

SMELTERS AND SAMPLING MILLS IN THE VICINITY OF SALT LAKE CITY.

GERMANIA SMELTING AND REFINING COMPANY.—This is the only refining works in the territory. It was completed in the autumn of 1872 as refining works only. Smelting furnaces were added in the spring of 1874, since which time the works have been running continuously in some department. It is situated on the Utah Southern railroad, 7 miles south of Salt Lake City, and consists of one reverberatory furnace for roasting ore and matte or slagging flue-dust, three shaft smelting furnaces, three softening and refining furnaces, seven pots for desilverization by zinc and refining of lead, six Faber du Faur zinc distillation furnaces, and three English cupel furnaces. This is among the most important metallurgical works of the west. It cost a large sum of money, is complete, well managed, and probably profitable. In the last few years it has divided with the Morgan and the Mingo smelters the greater part of the trade in Utah ores. For a description of the works, necessarily imperfect owing to later changes and improvements, reference may be had to the United States Mining Commissioner's report for 1873, page 261; and for 1875, page 416.

MINGO FURNACE COMPANY.—Two stacks were built in 1872, and were known as the Mountain Chief furnaces. They ran a few months, and then were idle until November, 1876, when the property came into the possession of the Mingo Company, a branch of the Pittsburgh Lead Company. The old stacks were repaired, and two others were erected in October, 1877. One or more furnaces have been run quite steadily upon ore purchased in the Salt Lake market. The works are situated a half a mile south of Sandy, on the Utah Southern railroad, are complete, clean, airy, and well managed. The apparatus consists of a Blake rock-breaker, one pair of Cornish rolls, two reverberatory furnaces for ore, matte, or flue-dust, three shaft furnaces, one No. 5 Baker blower, two Root blowers Nos. 5 and 6, two boilers, and one 35 horse-power horizontal engine.

The shaft furnaces are constructed as follows: First, 5 feet of concrete, three courses of common brick, and two courses of fire-brick arched and convex below were laid. Then the iron frame of the crucible, 7 by 8 feet, rising 28 inches above the ground line, was placed in position and the interior was filled with fire-brick, excepting a cubical 4-foot space. This was tamped with a moist mixture of two-thirds fire-clay and one-third ground fire-brick, and the crucible 36 inches deep was cut out. An opening was also made to communicate with the lead well. The shaft of the furnace rests upon a cast-iron plate supported by four hollow iron pillars 8 inches in diameter and 7 feet long, which stand at the corners and outside of the iron box. Between the crucible and the iron plate 44-inch walls of fire-brick 13 inches thick, having a batter of 12 inches, were built. The shaft of the furnace is of brick, rectangular, 5 by 5 feet 4 inches in cross-section, and 34 feet high. Size of the furnace at the tuyeres 3 by 3 feet 6 inches. Tuyeres to lead well, 10 inches. Tuyeres to charging door, 13 feet 6 inches. Each furnace has four tuyeres, two at the back and one at each side. The tuyeres are water-cooled, of wrought iron, with $2\frac{1}{2}$ -inch openings. They usually last two runs or about eight months. Experiments were made with two bronze and two phosphor bronze tuyeres. These were three times as expensive, and lasted about the same time, becoming porous and leaky. It was supposed that the fire-brick walls would burn out in ten days if not protected. Small jets of water were thrown on the brick, in the smelting zone, on the back and sides of the furnace. This water ran in a channel at the bottom to waste pipes at the back and sides. Very little steam was made. Sometimes the brick crumbled under the direct action of the water. In such cases a thin sheet-iron plate was braced against the brick, and the jets of water turned upon it. In this way runs of three and four months were made. The top of each stack can be closed by a pair of doors operated by a lever. The draught is then through an inclined sheet-iron flue, which passes by each shaft furnace and into a downcast about 5 feet square, thence through an underground flue 150 feet to a brick smoke stack 93 feet high and 4 feet in cross-section. The sheet-iron flue has a cross-section of 3 by $4\frac{1}{2}$ feet. After passing each stack the bottom is removed for about 8 feet, and replaced by a funnel terminating in a sheet-iron pipe 1 foot in diameter, which passes to the mixing floor. About three-quarters of the flue-dust caught is obtained here, very little being lost.

Ore is bought in the Salt Lake market (see rates under head of "sampling works"), and is then resampled at the furnace, as a check, and to give accurate data from which to calculate the percentage of loss. These lots of ore are spread in layers of uniform thickness over a rectangular area of varying size, and thus form heaps from 3 to 4 feet in height. These heaps, which are called "batches", containing from five to twenty different kinds of ore in varying quantities, are shoveled into wheelbarrows and taken to the furnace. Every lot of ore is not only assayed for gold, silver, and lead, but is also analyzed, in a well-appointed laboratory, for iron, silica, and sometimes for lime. The analyses are made rapidly, the apparatus being arranged so that one sample can be furnished in two hours or even less. Though not absolutely accurate, the results are close enough for practical purposes. For iron, 500 milligrams are boiled with hydrochloric acid, and the solution is titrated with permanganate of potash; for silica, 200 milligrams are digested in hydrochloric acid, washed with water, and from one to three times with acetate of ammonia to dissolve any sulphate of lead, dried on filter, ignited, and weighed. Slag is fused with carbonates of soda and potash and niter, and then treated as before mentioned. Ore assays are made in crucibles, one-sixth to one-third assay ton being taken. For lead assays 100 grains, and for moisture a half-pound, are taken. Two hundred lead bars, weighing about 108 pounds each, constitute a "lot". Each bar is sampled with a gouge, alternate ones upon the top and bottom, at one-fourth of the distance from the end of the bar. These samples are melted, and four assays, one from each end and side, made from the resulting bar. An average of these is taken.

The capacity of one furnace of the above dimensions is from 35 to 40 tons of smelting mixture per twenty-four hours. From eleven-twentieths to twelve-twentieths of this is ore, and the remainder flux. The iron flux comes from the Tintic district, and is hematite, containing about 50 per cent. iron, from 8 to 10 per cent. silica, and traces of gold and silver; it costs \$7 50 per ton. The limestone comes from Salt Lake City, contains about 4 per cent. of silica, and costs \$2 25 per ton. The fuel used is from 13 to 14 per cent. of the smelting charge of Connellsville, Pennsylvania, coke, costing from \$22 to \$26 per ton. The pressure of the blast is from 10 to 18 inches of water, averaging 14 inches. It requires nine hours for a charge to reach the tuyeres. Accretions of basic sulphides form on the side of the furnace about 3 inches below the feed-door. The smelting charge is so made that the slag should contain from 40 to 45 per cent. ferrous oxide, from 28 to 33 per cent. silica, and from 15 to 20 per cent. lime. The length of a run is about four months. The smelting charge contains from 13 to 22 per cent. of lead. The furnace is run with a closed hearth. The lead from the lead-well tap runs into an old slag-pot, and, when cooled somewhat, is skimmed. These skimmings, or lumps, consisting probably of subsulphide of lead, and being about one-sixth of the total product, are returned to the furnace through the feed-hole.

The various metallurgical products assay as follows:

Products.	Gold.	Silver.	Lead.
	Ounces.	Ounces.	Per cent.
Lead bullion.....	$\frac{1}{2}$	a 70 to 250	98
Matte.....	Trace.	15	7
Speiss.....	0.2	7 $\frac{1}{2}$	7
Slag.....		$\frac{1}{2}$	$\frac{1}{2}$ to $\frac{3}{4}$
Flue-dust.....	Trace.	20	20

a Average, 100 ounces.

The flue-dust, matte, and speiss are treated in a reverberatory furnace constructed as follows: There are two hearths, one of which is level, 30 by 12 feet; the other, or slagging hearth, at one end of the first, is 10 by 10 feet, slightly concave in length and convex in width. This is to keep the material upon the slag hearth and also to make it run toward the doors. The fire-box extends entirely across the end of the slagging hearth. The walls are of fire-brick and are 13 inches thick. The height of the furnace is 10 inches on the side and 15 inches at the center. There are twelve openings, 7 by 10 inches, on a side, and closed by iron doors. Charges are fed to the furnace through two hoppers at the back end. An underground flue, 3 by 4 $\frac{1}{2}$ feet, is connected with the main stack. The only repairs necessary are made about once a year to the fire-arch or bridge-wall. Flue-dust is wet down and put in with shovels at the back of the slag-hearth, and a very quick fire is made. It melts with very little loss and is raked out through holes at the side. Ore is rarely roasted, as sulphide ores are seldom bought. Matte and speiss are first roasted in heaps of from 50 to 200 tons. Wood to the depth of 15 inches is laid upon the ground and 4 or 5 feet of the matte piled upon it. It is roasted from four to six weeks. This imperfectly roasted material is carted to the rock-breaker and crushed to the size of a hazel nut, and is dumped through the hoppers into the reverberatories. A charge is 2,400 pounds, and remains in the furnace sixteen hours. One, however, is drawn and another added every four hours. It is stirred with a rake every thirty minutes while on the main hearth, and it is not slagged. At the best it contains several per cent. of sulphur. Six men, on twelve-hour shifts, at from \$2 to \$2 50, are employed on each furnace per twenty-four hours. The fuel used is bituminous coal, from 20 to 25 per cent. of the quantity of matte roasted. When one stack is running, the force of men employed is as follows:

Class.	Number employed.	Length of shift.	Wages per shift.
		<i>Hours.</i>	
Superintendent	1	.....	.....
Chemist	1	.....	.....
Assayer	1	.....	.....
Foreman	2	12	\$5 00
Smelters	2	12	3 00
Helpers	2	12	2 25
Chargers	2	12	3 00
Suppliers	2	12	2 25
Roustabouts	5	12	1 75
Engineers	2	12	3 00
Blacksmith	1	10	2 75
Roasting-furnace men	0	12	2 25

The lead bullion is shipped directly to the refining works of the company, located at Mansfield, seven miles from Pittsburgh, Pennsylvania.

The statistics for the census year are as follows:

Ore smelted (net)	tons..	6,959
Matte smelted	do...	1,422
Lead bullion produced	do...	2,359
Silver contained therein	ounces..	242,563.2
Gold contained therein	do...	802.72
Coal consumed (roasting)	tons..	592½
Coal consumed (steam)	do...	306½
Coke consumed	do...	2,384

Some of these amounts are approximations.

MORGAN MINING AND SMELTING COMPANY.—The works of this company are situated on the line of the Utah Southern railroad, 6 miles south of Salt Lake City. They were built in 1874, and have been running almost continually from that time. The company owns the Pittsburgh mine, in the American Fork district, but their principal ore supply is purchased in the Salt Lake market. The plant consists of a Blake rock-breaker, 9 by 15 inches; two reverberatory furnaces, 12 by 20 feet; a shaft furnace; a No. 4½ Baker blower; a hydraulic elevator to raise slag, etc., to the feed floor; a brick flue-dust chamber; and a turbine water-wheel of 40 horse-power. The furnace is a brick stack, resting upon a cast-iron plate and pillars, below which are several courses of brick and a wrought-iron water-jacket. The crucible is of fire-brick, surrounded by an iron frame. In the bottom is a firmly tamped bed of fire-clay and sand, 6 inches thick, and below all an iron plate to keep out the moisture. The furnace is rectangular and 37 by 60 inches inside measurement. The distance from the tuyeres to the lead well is 10 inches, and to the feed door 9 feet 6 inches, which was acknowledged to be too low. The sides of the furnace and jackets are vertical. The water-jacket is 7 inches thick, and is made in four sections. The side sections are stationary. The end sections are hinged at the upper corners, thus allowing them to be swung up overhead by a pulley attached to the feed floor, and giving easy access to the furnace. There are two tap holes, one at each end, and the usual lead well at one corner. The furnace is run with closed front. There are eight 2-inch tuyeres, four on each side. The tuyeres are simply holes in the jacket, fitted with small movable castings, into which the galvanized-iron air-pipes are fitted, but they are not liked. The usual tuyere-holes and tuyeres would be better, as they would now and then allow a bar in the furnace. The air-pipes are all underground, except a single T opposite the tuyeres on each side of the furnace.

The ore is bought in the Salt Lake market, and is rarely sampled again. Sometimes "batches" are made, as in the Mingo works, but not regularly; the same limestone and hematite fluxes are used. At the works the limestone costs \$1 65 per ton, and the Tintic hematite from \$7 25 to \$8 25 per ton, depending on whether it is Dragon ore (1 ounce silver and 65 per cent. iron) or Black Stallion ore (12 ounces silver and 50 per cent. iron). Sometimes ocher from the Vallejo mine, Little Cottonwood district, containing 45 per cent. iron, 12 ounces silver, and 5 per cent. lead, is used. About 50 per cent. of flux (20 per cent. of lime and 30 per cent. of iron) is employed, so that the slag contains about 40 per cent. ferrous oxide, 30 per cent. silica, and 20 per cent. lime. The fuel is about 15 per cent. of the smelting charge, and consists of Connellsville coke, costing from \$22 to \$25 per ton, and charcoal at 12½ cents per bushel of 12 pounds. The proportion in which these are used varies greatly; perhaps a fair average would be 1 pound of charcoal to 5 pounds of coke. The percentage of lead in the charge varies from 17 to 20. The pressure of the blast is 1 inch of mercury. Accretions form about 4 feet above the tuyeres. The capacity of this furnace is about 20 tons of ore per twenty-four hours. The ordinary length of a run is thirty days. It requires seven hours for a charge to reach the tuyeres.

PRECIOUS METALS.

The furnace products assayed as follows:

Products.	Gold.	Silver.	Lead.
	<i>Ounces.</i>	<i>Ounces.</i>	
Lead	0.24	90 to 250	95 per cent.
Matte	Trace.	10 to 20	3 to 10 per cent.
Speiss	\$1.50	6	3 per cent.
Slag		0.3	Trace to 1 per cent.
Flue-dust	Trace.	10 to 25	Varied with ore.

Speiss is a waste product. The flue-dust caught is estimated to be about $1\frac{3}{8}$ per cent. of the charge. It is collected in the various compartments of a brick dust chamber, 70 by 12 by 12 feet, having an inclined floor, from which it is scraped with hoes into vats on one side, where it is wet down and fed to the furnace daily. The smoke-stack is at one end of this chamber and 60 feet in height. The matte, mixed with refuse coke dust, is piled upon layers of wood and roasted in heaps (1 foot wood, $2\frac{1}{2}$ feet matte). It is then imperfectly roasted for twelve hours in 1,200-pound charges in the reverberatories. Each furnace requires four men per twenty-four hours. The quantity of matte produced varies with the ore, but is about from one-fifth to one-eighth of the ore smelted. The slag-pots of this furnace and those of the Germania and the Mingo have about the same dimensions, and give satisfaction. The essentials of a good slag-pot are: It should be light, well-balanced, and easily moved; it should hang on the truck far enough above the ground to dump easily; it should have a large cooling surface, that the slag may chill quickly; the bottom of the pot should be of such shape that the matte will accumulate in one mass; the area of joining surfaces (matte and slag) should be small that they may be easily separated. The pots in use conform to these conditions. The dimensions are as follows: Wheels, 22 inches in diameter; bottom of pot 4 or 5 inches above the ground. A pot of slag weighs about 260 pounds, and is handled by one man.

The turbine water-wheel is 20 inches in diameter, has 22 feet pressure, and uses 1,200 inches of water, as measured by the cross-section of the flume.

The furnace force is as follows:

Class.	Number employed.	Length of shift.	Wages per shift.
		<i>Hours.</i>	
Foremen	2	12	\$3 00
Furnace men	2	12	3 25
Helpers	2	12	2 25
Feeders	2	12	3 25
Wheelers	2	12	2 00
Weighers	2	12	2 00
Laborers	3	10	1 02
Blacksmith	1	12	2 75

The bullion produced is shipped to the Omaha Smelting and Refining Company or sold to the Germania works, 1 mile distant. The following are the statistics for the census year:

Ore smelted (gross)	Tons. 4,797 $\frac{371}{1000}$
Ore smelted (net)	4,484 $\frac{1711}{1000}$
Bullion produced	1,135 $\frac{584}{1000}$

Containing 172,257 ounces silver and 671.3 ounces gold.

The losses of various runs during the year are reported as follows:

One run	Loss, 8.46 per cent. lead	Loss, 4.76 per cent. silver	Gain of gold.
Do	Loss, 6.65 per cent. lead	Gain, silver	Do.
Do	Loss, 5.24 per cent. lead	Gain, silver	Do.
Do	Loss, 9 per cent. lead	Loss, 10 per cent. silver	Do.
Do	Loss, 10 per cent. lead	Loss, 5 per cent. silver	Do.

Almost invariably there was a gain of one-half per cent., or less, in gold, showing traces of gold in the ore or flux, or both, which were not accounted for. The gains in silver were due to some barrings which were added to the furnace without counting their silver value. In general, in estimating loss account is taken of the difference in the assay of the lead-well at the beginning and the assay at the end of the given time, the amount of ore in the body of the furnace, its grade, etc.

The following is a report of the working of the Morgan furnace during December, 1880:

Ore smelted (gross)	tons..	595 $\frac{11}{16}$
Ore smelted (net)	do...	547 $\frac{1}{2}$
Assay value in lead	do...	205 $\frac{1}{2}$
Assay value in silver	ounces..	2,617

	Lead.	Silver.
	Tons.	Ounces.
Bullion produced	192 $\frac{1}{16}$	
Silver contents		23,439.0
Contents of 82 tons of matte produced in December	7 $\frac{1}{16}$	1,770.0
Total	201 $\frac{1}{16}$	25,209.0

The loss, therefore, was as follows (including loss on working matte): Silver, 4.22 per cent.; lead, 2.06 per cent. The following table shows the material used, including waste of 3 per cent. for coke and 15 per cent. for charcoal:

	Amount used.	Cost per unit.	Total cost.	Average cost per ton.
Coke	185,000	\$0 01 $\frac{1}{2}$	\$2,320 00	} \$6 33
Charcoal	4,752	11 $\frac{1}{2}$	540 48	
Iron ore	03.0	7 50	477 00	
Limestone	71	1 75	124 25	
Labor (including superintendent)			1,701 33	
Sundries (oil, tools, rent, etc.)				40
Total				9 00

SATURN SMELTER.—Situated half a mile south of Sandy, near the Mingo works. It consists of three very dilapidated stacks, and has been idle for several years.

FLAGSTAFF SMELTER.—This smelter is located at Sandy, and was built about 1873 by the Last Chance Company, of West Mountain district. It was leased to the Flagstaff Company a few years later, and has been subleased occasionally by them. It has been idle since September, 1878, and is consequently somewhat dilapidated. Some of the machinery has been moved to Colorado. There are four stacks, resting on brick pillars 2 feet square. The water-jacket is in four sections, one for each side and end. The sections are from 3 to 5 inches thick and 4 feet 9 inches high. The cross-section of the furnace at the tuyeres is 4 feet by 3 feet 3 inches, and at the feed-floor 4 by 4 feet. The height of the furnace above the tuyeres is 9 $\frac{1}{2}$ feet. The flue-dust chambers are 24 by 15 by 10 feet, and the 4-foot stack is 80 feet high. A Brückner cylinder was used to roast the matte.

STEVENS SMELTER.—This smelter is situated at Sandy, and is a new style of furnace, in which it was proposed to roast the ore with the waste heat and smelt it with gas fuel, using raw fuel, and a blast of superheated steam and hot air. This furnace is the invention of Mr. Levi Stevens. A small one was tried here several years ago, and was a complete failure. Another small one was built at Omaha in the spring of 1880, and gave such satisfaction that this large one was erected here in June, 1880. It made short experimental runs during the summer, turning out eight car-loads of bullion. The summer's work showed some defects, which were to be modified in succeeding furnaces, but in general it was satisfactory to the inventor. It is said that several have been ordered for Arizona and Colorado. The plant consists of a 24 horse-power horizontal engine and boiler, a rock-breaker, a pair of Cornish rolls, a small Startevant blower, and the furnace. The latter is a cast-iron box, 6 feet long, 7 $\frac{1}{2}$ feet wide, and about 3 $\frac{1}{2}$ feet high, having part of the bottom inclined; it is 3 feet above the ground, and rests on iron pillars. The lower part of the sides, the inclined portion of the bottom, and part of one end are protected by a water-jacket. The flat part of the bottom and the upper portion of the sides are lined with fire-brick, and the top is covered with an arch of the same material. The space left in the box (6 feet wide, 6 feet long, and from 18 inches to 2 feet high) is the crucible and the furnace proper. Joined to the inclined side is another iron box, 12 feet long, inclined at an angle of about 35°, and also resting on iron pillars. The sides are lined with fire-brick, the top is covered with an arch of the same material (the continuation of the arch previously mentioned), and the bottom is formed by a series of cast-iron shelves, 21 inches wide, 5 inches apart, overlapping 6 inches, extending entirely across the furnace (6 feet), and also partly covered with fire-brick. This is the roasting part of the furnace. At the upper end is an ordinary brick chimney, in which is a superheater—an iron box containing a coil of steam-pipe. The fire-box is at the other end of the furnace proper, and is inclosed with iron and lined and arched with fire-brick. There are two sets of grate-bars—one set inclined and stationary, and the other horizontal and attached to a rod which can be rotated from the outside of the fire-box, thus removing the clinkers. All drafts of air are excluded from the grates, except those which pass through five 3-inch holes on each side, in each of which there is a jet of superheated steam. The arched brick roof is double, having an

air-tight space of 4 inches, through which air is forced by a fan-blower into a small air-chamber over the fire-box, thence through twenty or thirty small pipes into the furnace, where it mixes with the coal gases. Of course, this arrangement gives an intense heat and melts almost anything. The fire-bridge and the arch are said to have been burned out once or twice. The iron boxing is merely the frame in which to hold the various parts of the furnace.

Ore is fed into the upper end of the roasting furnace by a conveyer. It accumulates on the shelves, and every few minutes is pushed with a small hoe from one shelf and falls to the next below, thus being roasted by the waste heat of the furnace. Two men per shift are required for this work. When the ore reaches the lower shelf it melts and runs into the crucible. The slag is tapped and the lead is dipped from an improvised lead-well as in the ordinary furnace. The roasting is imperfect, as some matte and speiss are occasionally made. Common Utah lignite coal is shoveled into a sort of hopper, from which it falls into the fire-box as fast as there is space for it and it is therefore needed. This requires about as many men as an ordinary furnace, but the cost of construction was claimed to be less. In some of the most successful runs 1 ton of coal smelted 4 tons of the smelting charge, and the loss of lead was only 8 per cent. The average loss of lead was 16 per cent. It was claimed that there was little or no loss of silver. (a) At times the capacity of the furnace was 25 tons per twenty-four hours. The inventor's great idea was to get heat enough, and in that he was more than successful. His trouble was in controlling the heat. Ore was sometimes melted on the upper shelf, and a white cloud of oxide and carbonate of lead was passing off in the flame that poured from the chimney. Local smelters were inclined to ridicule the new furnace. Considering, however, the inventor's lack of experience and knowledge of fluxing ores, and that this was the first real working furnace built, the results were good. It is to be hoped that additional experiments will be made with the modifications and improvements which use always suggests for new inventions.

In the proposed new furnace, the writer was told, the crucible will be 7 feet long, and a matting hearth 7 feet long will connect it with the shelves. These are to be eighteen in number, instead of six or seven as formerly, and a flue-dust chamber is to be added.

THE HORN-SILVER SMELTER.—This smelter was in process of construction at the time of the writer's visit, at South Cottonwood, on the Utah Southern Railroad, 7 miles south of Salt Lake City, and intended to smelt ore from the Horn-Silver mine at Frisco. When finished it is to contain five stacks, though at first but one is to be completed. If experiments with that are successful the others are to be built. It is to be constructed as follows: An iron plate is placed 2 feet below the surface of the ground. On this the crucible of fire-brick, having a bottom tamped with a mixture of clay, sand, and coke, is built. The water-jackets will be 5 feet high, of cast-iron, and in ten sections; four on each side and one at each end. The end sections will be hinged at the two upper corners, that they may be easily lifted up by a pulley. The cross-section of the furnace at the tuyeres (inside) is 9 feet by 40 inches, with the corners rounded on a radius of 14 inches. Cross-section at the feed-floor, 9 feet by 68 inches. Distance between tuyeres and feed floor, 10 feet 7½ inches. The ends of the furnace are vertical. Tuyeres to lead-well, 10 inches. There will be sixteen tuyeres, eight on each side, opposite each other; two tap-holes, one at each end; but only one lead-well. The capacity is estimated at 80 tons per day. Each furnace will have a No. 6 Baker blower and a separate flue-dust chamber.

THE WARM SPRINGS SMELTING WORKS.—These are situated about 2 miles north of the center of Salt Lake City. They were among the first works in the territory. Two reverberatory furnaces were erected in 1870, which were replaced by shaft furnaces. They ran quite steadily until 1877, since which time little has been done. The plant, although rather old, is in fair condition, and works small lots of ore bought in the Salt Lake market; but the establishment is not backed by much capital and is comparatively unimportant. It consists of one Gates rock-breaker; one reverberatory roasting furnace, 8 by 20 feet; one shaft furnace of 30 tons' capacity; one No. 5½ Baker blower; one flue-dust chamber, 8 by 10 by 15 feet, and one 25 horse-power engine with boiler. During the census year but two short runs were made, and less than 1,000 tons of ore were smelted. A peculiarity, which may be of value in small furnaces, is found in the construction of the upper portion of the stack. The brick terminates at the level of the feed floor. Above that point the stack is a sheet-iron pipe, 3 feet in diameter, resting on an iron tripod. The circular ring, 1 foot wide, between the brick and the iron stack, is covered with movable iron plates, thus enabling a bar to be used and a sledge to be swung to detach incrustations from the sides of the furnace.

THE NICHOLS CONCENTRATING WORKS.—These are situated on the Utah Central Railroad, in the suburbs of Salt Lake City. They were begun in 1873, when a fine three and a half story brick building, 60 by 80 feet, costing in the neighborhood of \$75,000, was erected. Losses by the Chicago fire had so crippled some of those interested in the enterprise that the necessary machinery has never been added. It was intended to use Krom's dry-ore concentrating process. (b) While believing that the great need of Utah is concentrating works, and recognizing the value of the process upon certain ores, the writer fears that the expense of transportation of the low-grade ores from the mines to these works will prevent profitable operation.

a Of course this is a mistake, showing incorrect assaying or sampling.

b For a description of the machinery and process, see the United States Mining Commissioner's Report for 1876, page 419.

SAMPLING WORKS.

At the close of the census year there were four sampling works in Utah: the Utah Sampling Works, at Salt Lake City; the Pioneer and the Sandy Sampling Mills, at Sandy; and McCorkindale's Sampling Works, at Milford, Beaver county. As the apparatus and processes are similar at all the sampling mills, a description of two of them will, it is thought, suffice.

THE PIONEER SAMPLING MILL.—This was established at Salt Lake City in 1871, and was moved to Sandy in 1872, where, since that time, it has been in operation continuously. The force employed consists of an engineer, bookkeeper, night watchman, and, on an average, twelve laborers. Sometimes the cars are unloaded by contract, the men receiving 10 cents per ton to handle the ore, or 12½ cents if it has to be weighed. The plant consists of a horizontal boiler 4 by 12 feet, a 15 horse-power horizontal engine, a rock-breaker 6 by 4 inches, a peculiar sampling machine, two coffee-mill crushers, a dry kiln 10 by 30 feet, several railroad and platform scales, a sampling floor in the main building 30 by 100 feet, and sheds for ore 12 feet wide by 400 feet long, 12 by 140 feet and 14 by 175 feet. The cost of the real estate and plant was about \$25,000. The total amount sampled during the census year was stated to be 15,550.³⁵⁰/₁₀₀₀ tons.

The peculiar sampling machine above mentioned was invented at this place, and cost about \$4,000. It occupies a space of 8 feet square and 40 feet high. An elevator belt with buckets carries the ore to the top and drops it into a hopper, which is self-dumping when filled to a certain depth. The ore falls upon the center of two vertical partitions placed at right angles to each other, and is thus quartered. Two alternate quarters are dumped into a hopper below. This process is repeated three times. The machine was very successful with Flagstaff ore, which contained 8 per cent. moisture, but when tried on dry ores it gave too much dust, and wet ores stuck to the elevator cups. It was a great time-saver, but it gave considerable trouble to clean up. It had been idle for two years.

This mill also owned the buildings and fixtures of the old Wasatch sampling mill. They were, however, only used in case of a rush of ore.

SANDY SAMPLING MILL.—This mill was established in Salt Lake City in 1870, was moved to Sandy in January, 1876, and has been running steadily since that time. The works consist of a Brodie rock-breaker; a Coleman coffee-mill crusher; a 10 horse-power engine and boiler; sampling floor, 30 by 80 feet; dry kiln; steam room, which is used in case the ore is frozen in the sacks; and ore-sheds. The cost of the plant was about \$8,000. Eight men are usually employed.

In sampling ore in Utah it is the custom to sample the entire lot if it assays 100 ounces or over, one-fifth of the lot if from 50 to 100 ounces, and one-tenth if below 50 ounces. Nothing less than one-tenth is ever taken for a sample. The uniform charges are \$5 per ton for every ton sampled, the correctness of the sample being guaranteed, 50 cents per ton on the whole lot for commission, and three-fourths of a cent per sack for unsacking and reshipping sacks.

The following is the method of sampling: The ore is shoveled upon a screen with longitudinal ½-inch spaces. The coarse ore is put through a rock-breaker or coffee-mill-crusher. This is spread upon the fine ore and mixed by shoveling into a heap. This heap is then wheeled away, every tenth shovelful being reserved as the sample. The one-tenth reserved is shoveled into a conical heap, every shovelful falling upon the apex of the cone. Beginning at the top of the cone, the ore is worked outward with a shovel until it covers a circle upon the floor, and is from 6 to 12 inches deep. This is quartered. Diagonally opposite quarters are rejected, and the remainder is treated in the same manner until the amount is reduced to from 30 to 50 pounds. A moisture sample of from ½ a pound to 1 pound is then taken. It is next placed on the "plate", a disk of chilled iron 3 feet 9 inches in diameter, where it is ground with a hammer like a blacksmith's flatter. The quartering process is continued until only 2 pounds remain. This is ground so that it will all pass through a No. 40 sieve, and is thoroughly dried over an oil lamp or a water-bath, and five 5-ounce bottles are filled and sealed. The label upon the bottle gives the mark of the ore, the date, the weight of the ore actually sampled, the proportion sampled, and the percentage of moisture. One bottle is kept by the sampling works, one goes to the buyer and one to the seller, and two are sent to any two of the four recognized assayers in Salt Lake City whom the seller designates. The seller then calls, gets his certificates of assay, visits the ore buyers of the Morgan, Mingo, and Germania Works, and, showing his assay certificates, asks for bids. Upon receiving them, he goes to the highest bidder, gives up his sampling mill receipt, and takes his check. All this requires but a few hours.

Ore-buyers have had no sliding scale of prices for several years, but make an arbitrary one. There was some complaint among the small sellers, who claimed that outsiders did not get within a few ounces as high assays as they deserved. From what the writer could see during a brief visit, business seemed to be conducted honestly.

All the buyers bid for ore according to the following rules: From the average of the assay certificates the total amount of gold, silver, and lead contained in the given lot is estimated. Ten per cent. of the lead and 5 per cent. of the silver are deducted for loss in smelting. The remaining ounces of silver are multiplied by the Salt Lake market price (uniformly 3 cents lower than the New York quotations). The weight of the lead is multiplied by its local market price (variable, depending on the refiners' needs). The weight of gold (if over \$3 per ton) is multiplied

by \$16 per ounce. These products are added, and from them from \$12 to \$75 per ton is deducted, depending on the character of the ore and the need of the individual furnaces of such ores. Usually only from \$8 to \$10 is deducted from low-grade silver ores rich in lead.

FIRE-BRICK.

Morris & Evans were the only firm in Utah which, at the period under review, was manufacturing fire-brick. The clay used was obtained from a clay vein or stratum, from 10 to 25 feet wide, on the north side of main Bingham cañon, 2½ miles below the town. They owned the clay bank, which outcropped for half a mile, and had worked it to a depth of 50 feet and about 400 feet in length. The siliceous rock used came from two quarries, one 4 miles north and the other 4 miles east of Salt Lake City. The stone from the latter quarry was an excellent fire-rock, and was used to line furnaces before the introduction of water-jackets. The works were established in 1871 or 1872, and were located about a mile and a half southwest from the center of Salt Lake City. From 10 to 15 men were regularly employed. Two kinds of pressed brick were made. The kind most used contained one-third ground fire-rock and two-thirds clay. The other kind was made of equal parts of each. These bricks were of a brownish-red color, weighed a trifle over 6 pounds, cost \$65 per thousand, and were 9 by 4½ by 2¾ inches in size. They have been employed in the construction or lining of all reverberatory furnaces and fire-boxes of metallurgical works in Utah, and have given satisfaction. About 205,000 were manufactured during the census year.

Several years ago a company began the manufacture of a similar fire-brick. They were bought out by Morris & Evans in the spring of 1880.

LEADING.

Leading, which is the principal cause of sickness among the miners, is caused not so much by breathing the fumes from the furnaces as from the inhalation of particles of dust in the close stopes in the dry lead-producing mines. When the symptoms appear, a rest of a week or two in the hospital generally effects a cure. In such cases large doses of chloride of magnesium are administered, also some tincture of iron. The lead is eliminated in the form of a soluble chloride. Over five hundred cases per year are treated in the two hospitals.

SUMMIT COUNTY.

UINTAH DISTRICT.

[October, 1880.]

The Uintah district is situated on the eastern slope of the Wasatch range, and covers an area 8 miles north and south by 5 miles east and west of its well rounded outlying ridges. Park City, a thriving town of about 1,000 inhabitants, about 32 miles east-southeast of Salt Lake City, and 30 miles south-southwest of Echo, on the Union Pacific railroad, is the only settlement. The district was organized July 8, 1871. The records show 1,270 locations, though not over 500 are in force. The country rock is principally quartzite, but limestone and porphyry are found. The general altitude of the mines is from 7,500 to 9,500 feet. A branch of the Union Pacific railroad, broad gauge, from Echo to Park City, was within a few months of completion at the time of visit. The Utah Eastern narrow-gauge railroad, between Park City and the Coalville coal mines, was to be completed about the same time.

The Ontario mine, the principal one in the district, as well as in the territory, is situated 1½ miles south of Park City, in a ravine having an easy grade and smooth, but steep sides. The altitude of the mine above sea-level is 7,800 feet. It was discovered June 19, 1872, at which time it had an outcrop of ore about 2 feet square. It was sold in the following August for \$30,000, since which time work had been prosecuted vigorously and continuously. The earlier workings were by tunnels on the vein from the bed of the ravine. In November, 1873, hoisting works were erected. During the years 1873 and 1874 the ore was shipped to Salt Lake City and sold. During parts of the years 1875 and 1876 the McHenry and the Marsac mills were leased and run on Ontario ore.

The Ontario Silver Mining Company was incorporated December 16, 1876, with a capital stock of \$10,000,000 in 100,000 shares. A new shaft was begun in April, 1878. In the following October the old hoisting works were destroyed by a fire which started in the store-room and disabled the fire-pump and hose before it was discovered. The loss of property and supplies was estimated at \$156,574. In the autumn of 1880, to avoid threatened litigation which the property had previously escaped, a compromise was made with the Last Chance and some adjacent claims, whereby 50,000 additional shares of capital stock were to be issued, of which the Last Chance was to receive a large proportion. The property of this company includes the Ontario, Switzerland, Last Chance, Banner, Great Eastern, and Monitor claims, each being 1,500 by 200 feet. The company also owns two hoisting works, one saw-mill, boarding, lodging, and store houses, two 3-acre mill-sites, and one 40-stamp mill. With the exception of a 350-foot vertical whim-shaft and about 1,000 feet of cuttings, the work of exploration had been confined to the ground of the Ontario claim.

The ore-bearing formation is a fissure vein from 4 to 28 feet (averaging 8 feet) wide, dipping about 66° N* in a seamy white quartzite. In sinking the new shaft on the hanging-wall side of the vein, the quartzite was replaced by porphyry at the depth of about 400 feet, but in cross-cutting for the vein a body of quartzite had still to be passed through. Porphyry also occurs in bunches beside the vein in the lower levels, and the indications are that as depth is attained this will replace the quartzite as the country rock. In the hill east of the shafts the ore came within 15 feet of the surface for 150 feet in length. In other other places ore which could be profitably extracted did not come within 100 feet of the surface, from which depth the ore body extended from 900 to 1,500 feet in length on the vein. Between the 100- and 400-foot levels there was a contraction of the vein for from 100 to 200 feet in length. In the lower levels there were enlargements of the vein, three chimneys, as a rule, being found upon a level. These were from 100 to 300 feet apart, from 6 to 8 feet wide, and 50 feet long. The ore is from 3 inches to 6 feet (averaging 2 feet) wide on the hanging-wall side of the vein, the richest occurring in a narrow band immediately upon the hanging wall. The ore consists of a soft bluish clay and quartz, containing zincblende, tetrahedrite, galena, pyrite, and probably other sulphides of copper, antimony, and arsenic. (a) It assays from \$40 to \$700, the battery samples averaging about \$130 at the time of the writer's visit. That above the 400-foot level was mostly oxidized or free-milling ore, and contained horn-silver and the carbonates of copper. The gangue of the vein is quartz, mostly fragmentary, mixed with a bluish porphyritic clay containing a small percentage of pyrite. No faults have ever been found. Water was encountered 39 feet below the surface at the point of discovery. It came entirely from the foot-wall side of the vein, and had steadily increased until, at the period under review, 1,600 gallons per minute were raised.

The early working of the mine was by tunnels upon the vein, extending 400 feet either way from the bed of the ravine. A 500-foot vertical three-compartment shaft was then sunk 105 feet north of the croppings. The inside dimensions of these compartments were 4 by 4 feet, 4 by 4 feet, and 4 by 6 feet. The shaft cut the vein at about 430 feet, and is still used as a main working shaft. The new shaft, begun in April, 1878, is in the ravine, 250 feet north of the old one. It is thought that it will cut the vein at a depth of 1,500 feet. It is 700 feet in depth. Cross-cuts from the fifth, sixth, and seventh levels have been run, intersecting the vein. It has three compartments, $4\frac{1}{2}$ by 5 feet, $4\frac{1}{2}$ by 5 feet, and 5 by 7 feet. The timbers are 10 by 12 inches, the sets 5 feet from center to center, and lagged with 3-inch plank. The grade of the levels is three-quarters of an inch in 12 feet. The track is $18\frac{1}{2}$ inches wide, and is made of scantling and strap iron. Above ground all the track is of iron T-rail. The cars are of iron, 2 feet 4 inches by 1 foot 10 inches by 3 feet 4 inches in size, and hold about 1,400 pounds. The length of the various levels is as follows: First level, 1,000 feet; second, 1,315 feet; third, 1,250 feet; fourth, 1,500 feet; fifth, 1,510 feet; and sixth, 1,535 feet. The total cuttings, aside from winzes which were obliterated as the stopes advanced, are about 12,000 feet. Most of the ore was stoped out above the 300-foot level, but in the remaining levels it was claimed that there was ore enough in sight to last two or three years at the current rate of production.

The method of working is to stope overhand, whether ore is found or not, the entire length of the chimney. The stopes are timbered with posts and caps, as the ground swells slightly. It is the general intention to keep the mine opened one level below the point where stoping was carried on. Both giant and black powder are used. Stopes are worked single-handed, and drifts and cross-cuts double-handed. Drifting costs about \$7 50 per foot. Ventilation is secured through the two shafts and the numerous winzes by air currents caused by warm steam pipes; sometimes a water-blast is employed, consisting of a 4-inch pipe full of water, under 1 foot head, which falls into an 8-inch square box column 100 feet long. The air collected can be carried in 4-inch galvanized iron pipes 1,000 feet. The temperature of the various levels, several hundred feet from the steam pumps, but necessarily affected somewhat by them, is as follows: One hundred-foot level, $40\frac{1}{2}^{\circ}$; 200-foot level, 52° ; 300-foot level, $55\frac{1}{2}^{\circ}$; 400-foot level, $49\frac{1}{2}^{\circ}$; 500-foot level, 45° ; 600-foot level, 44° ; 600-foot level, near the steam pump, 57° .

The hoisting works at the old shaft have been rebuilt, and occupy a building 46 by 140 feet. It contains six 54-inch by 16-foot horizontal boilers and one 65 horse-power engine. The rope is of hemp, 2 inches in diameter, and lasts about eight months. The sheaves are 32 feet in height.

The hoisting works at the new shaft are about 40 by 160 feet, and compare favorably with those on the Comstock. The machinery consists of two direct-acting, coupled, hoisting engines, with 18-inch cylinders and 60-inch stroke, of 250 horse-power, four horizontal 54-inch by 16-foot boilers, and two large Babcock & Wilcox boilers. This great steam-generating capacity is necessary to supply the large number of steam pumps employed. The pressure of steam is from 90 to 95 pounds. The sheaves are 44 feet high. A flat steel cable, 5 inches by $\frac{1}{2}$ inch, cages weighing 1,100 pounds, safeties, and indicators are used. The flat cable has lasted twenty-one months, and was to be used about a year longer. At the hoisting works about 35 cords of wood and 27 tons of coal are burned daily. The pumping is done entirely by Knowles's steam pumps. A large Cornish pump has been ordered, and is to be placed in position in a few months. At the time of the writer's visit the pumps were working at their utmost capacity. A 700-gallon tank was used part of the time to control the flood. The water was pumped to the Union tunnel, 107 feet below the collar of the old shaft, through which it ran 1,051 feet to the surface.

a From experiments made by himself Mr. Stetefeldt estimated that rich Ontario ore contained 15 per cent. zincblende, 6 per cent. galena, 3.3 per cent. fahlore, and 2 per cent. pyrite.

PRECIOUS METALS.

The following description of the pumps was furnished by the chief engineer:

Pumps.	Diameter of steam cylinder.	Diameter of expansion cylinder.	Number and size of plungers.	Estimated capacity in gallons per minute.	Strokes per minute.	Length of stroke.	Height of throw.	Location.	Remarks.	
	Inches.	Inches.				Ft. In.	Feet.			
Knowles's compound steam.....	19½	38	Two 14-inch.....	850	85	3 00	200	700-foot level (a) ..	Spare pump.	
Do.....	20	(f)	Two 7-inch.....	250	85	2 00	550	600-foot level.....		
Silver, Salt Lake City.....	16	(f)	Two 8-inch.....	800	160	2 00	100	.....do.....		
Knowles's piston.....	14	(f)	7-inch (b).....	550	300	12	100	.....do.....		
Blake No. 5.....	7	(f)	4½-inch.....	190	(f)	10	100	(f)		
Knowles's compound double plunger.....	24	42	Two 15-inch.....	780	30	3 00	400	500-foot level (c) ..		To feed boilers.
Do.....	20	38	Two 12-inch.....	500	45	2 00	400	.....do.....		Spare pump.
Knowles's No. 13 fire.....	12	6	(f)	90	60	12	350	300-foot level.....		Do.
Knowles's double plunger.....	24		Two 10-inch.....	600		2 00	400	400-foot level.....		Do.
Knowles's water piston, No. C.....	14	27		400		12	100	300-foot level.....		
Knowles's water piston, No. 7.....	8	25		200		12	100	.....do.....		
Knowles's vertical bucket-plunger sinking.....	12		7-inch.....	200		12	200	720-foot level.....		

a North works.

b Water piston.

c Old works.

d Piston.

In addition to these there are six Knowles pumps of smaller sizes upon the surface, for fire purposes, feed of boilers, etc.

The regular force employed at the mine is as follows:

Class.	Number employed.	Length of shift.	Wages per shift.
		Hours.	
Underground foreman.....	1		
Outside boss.....	1		
Chief engineer.....	1		
Clerk.....	1		
Carmen.....	11	10	\$3 00
Shift bosses.....	2	10	5 00
Blacksmiths.....	8	10	3 50 to 5 00
Blacksmith's helpers.....	2	10	3 00
Timbermen.....	4	10	4 00 to 4 50
Machinist.....	1	10	4 50
Pipe fitter.....	1	10	5 00
Pumpmen.....	6	12	3 25 to 4 00
Engineers.....	3	8	4 50
Do.....	2	12	4 00
Chinese cooks.....	5		1 50
Firemen.....	6	8	3 25 to 4 00
Carpenters.....	4	10	3 00 to 5 00
Roustabouts.....	8	10	2 50 to 3 00
Miners.....	70	8 and 10	3 00 to 3 50
Total.....	132		

The cost of mining per ton is about \$11 75.

The ore is dumped into ore-houses holding several hundred tons, which are kept constantly full. It is taken thence to the mill, about a mile down the ravine, on contract, by four-horse teams. The cost of hauling is 50 cents per ton, except in the three winter months, when it is 60 cents. At the beginning of the census year there were 42 tons in the mine ore-houses. They contained 1,858 tons at the end of that year, 14,037 tons having been shipped to the mill. Thus the year's product was 15,853 tons.

The disbursements during the census year were as follows: Labor, \$145,034 92; mining supplies, \$110,561 72; dividends, \$600,000.

The total product since the date of incorporation, and prior to the census year, was 44,776 tons, from which \$2,150,000 dividends have been paid. The bullion product has been as follows:

Production prior to date of incorporation, 13,604 tons.....	\$1,014,596 96
Production from date of incorporation (December 16, 1876) to June 1, 1879.....	5,039,665 97
Production during the census year.....	1,344,723 73
Total.....	7,398,986 66

[A description of the Ontario mill is given on page 276.]

The Empire Mining Company of Utah was incorporated in May, 1878. Its property comprises a group of fourteen overlapping locations $1\frac{1}{2}$ miles southwest of Park City and about half a mile west of the Ontario. The average size of these is 1,500 by 200 feet. The Clara Davis alone is developed to a considerable extent. This claim was discovered in 1871; but little was done, however, until the organization of the company. Since that time it has been worked by a large force until October, 1880, when operations ceased until the Utah Eastern railroad should be completed, which would lower the price of coal and lessen the expenses \$60 per day. The company also owns a 20-acre mill site, $1\frac{1}{2}$ miles north of Park City, on which much grading had been done for the erection of a 30-stamp silver mill. Much of the machinery is on the ground, but financial troubles seem likely to prevent its completion. The capital stock of the company is \$10,000,000 in 100,000 shares.

The Clara Davis is a fissure vein in hard quartzite, dipping about 45° S.; on the hanging wall bodies of porphyry are also found. It is in the direction of the western extension of the Ontario. The width varies from 2 to 30 feet, averaging about 6 feet. The ore, as far as known, occurs in three or four bodies, from 2 to 4 feet wide, upon the foot wall. None has been stoped, but it is supposed to average \$60 to \$100. The ore and gangue of this vein are very similar to the Ontario. The hoisting works consist of a substantial building, 130 by 40 feet, containing a horizontal coupled engine of 60 horse-power and four Babcock & Wilcox boilers. The sheaves are 29 feet high and the steel rope $\frac{7}{8}$ inch in diameter and 700 feet long. The mine is very wet, 500 gallons per minute being raised during the last workings. For this purpose two Blake steam pumps, No. 3 and No. 6 $\frac{1}{2}$, one Worthington pump, and one Crane pump are used. The shaft, which was sunk vertically from the croppings through the foot wall, is 412 feet deep and has three compartments, 4 by 4 feet, 4 by 4 feet, and 4 by 5 feet. From this cross-cuts are run to the vein at intervals of 100 feet, and drifts are then started upon it. The greatest horizontal extent of these drifts from east to west is 560 feet. The 400-foot level had not at the period under review cut the vein, owing to the inability of the pumps to control the water. The total cuttings are 2,200 feet. Ventilation is produced by a water-blast. An inch pipe throws a jet of water into a 4-inch square box, which extends 300 feet down the shaft. The imprisoned air is collected in a barrel and conveyed in 4-inch galvanized-iron pipes to the various drifts. About fifty men are regularly employed during the census year. The cost of running drifts per foot is \$5; cross-cuts, \$12; sinking shaft, 4 by 14 feet, \$15 for labor and \$4 25 for timber per foot. The cost of the improvements was \$46,000.

The White Pine mine is situated on the summit and northern slope of a ridge 3 miles southwest of Park City, and has an altitude of about 9,500 feet. It was discovered in 1870. Little was done, however, until 1878. Hoisting works were erected in the autumn of 1879, and work had been prosecuted, for development only, up to time of the writer's visit. Parts of the General Washington, War Eagle, Tinney, and Addie, overlapping adjacent claims, are included in the property. The mine is known as the White Pine, although the veins carrying ore are the General Washington and War Eagle. These have a parallel strike, but different dip, being 225 feet apart at the surface, and estimated to be 400 feet apart where cut by the 400-foot level.

The General Washington vein is not worked because of legal troubles. It is a 4-foot vein in quartzite and porphyry, dipping 70° N.NE. The developments consist of a 208-foot incline and 30 feet of drifting. Water was found 80 feet below the surface.

The War Eagle vein is claimed to be a large fissure or bedded vein, about 60 feet wide, dipping 40° NW. in a quartzite and porphyry formation. The ore is principally in a band from 1 inch to 3 feet wide, and assays about \$50 silver and 35 per cent. lead. Outside of this, sometimes extending for 30 feet, there is low-grade ore assaying from \$5 to \$30. The ore and the gangue of the vein are very similar to those of the Ontario, from which it is supposed that this was a part of the latter's vein. It may be so, but the more natural conclusion is that this is due to a similarity of the country rock. Water was encountered 60 feet below the surface, where the ore changed to a sulphuret; the quantity raised is about 900 gallons per hour. The mine is developed by a 400-foot vertical two-compartment shaft, from which cross-cuts run to the vein at intervals of 100 feet. Three levels of about 400 feet each have been driven. The total cuttings are 2,650 feet. The work has been directed to developing the property and no ore is being stoped. About thirty men were employed during two-thirds of the census year. The hoisting works consist of an 18 horse-power horizontal engine, three vertical boilers, two Knowles No. 6 $\frac{1}{2}$ steam pumps, and $\frac{3}{4}$ -inch wire rope. They are capable of sinking the shaft 500 feet, and are reported to have cost \$40,000.

The Marsac Silver Mining and Milling Company built a mill at Park City in the summer of 1874. The company also owns the Flagstaff and six adjacent claims. A two-compartment vertical shaft was sunk 400 feet with a whim. About 500 feet of other cuttings were made prior to 1878, when work ceased. A limited amount of ore was shipped. The mill is a 20-stamp pan mill, and was leased about a year in 1875-76 to the Ontario. It was repaired in 1878, and ran during the whole of 1879 on Ontario tailings. At the time of the writer's visit it was being completely remodeled. Dry kilns and a White & Howell roaster were being added. It was to be a custom mill.

In a building near the Marsac mill and owned by the company are four McKim concentrating machines, which were used successfully to concentrate both the tailings of the Ontario and the second tailings of the same mine after they had passed through the Marsac mill. The McKim concentrator, patented February 15, 1876, was invented at this place. After considerable experimenting, the machines were built in 1878 and ran nearly two

years, or until the old reservoirs of tailings were exhausted. The machine consists of a frame of 3- by 4-inch timber, 15 feet long, 5 feet wide, and 3 feet high. In this frame is an endless canvas belt 3 feet 9 inches wide, and 14 feet long (from center to center of the rollers), which passes over rollers at each end 10 inches in diameter. The canvas is nailed to laths which are on the underside or inside of the belt, half an inch apart, at right angles to its length. This gives stiffness and also a certain flexibility to the belt. Sagging is prevented by two supports on which the laths slide. The belt is level longitudinally, but has an inclination of an inch to a foot latitudinally. This can be varied to suit the ore by means of two screws to which the ends of the rollers are attached. Motion is imparted by a belt from a cone-pulley to one of the rollers. A pipe or box, pierced with small holes, runs the entire length of the upper side, furnishing a supply of water. There are also distributing boxes at one end of the upper side, troughs for the water and waste along the lower side, and boxes for the ore, which is washed from the belt at the end by jets of water. The process is as follows: The tailings to be treated are fed into a common agitator, from which they run in a stream upon the belt from the upper side at one end. The belt usually moves at the rate of 50 feet per minute. Small streams of clear water flow over it from the distributing box or pipe above. The heavier particles settle near the top, and the light ones are washed off into the waste trough. Jets of water play upon the belt as it passes over one of the rollers and wash off the adhering sands. The sands of the upper 8 inches are caught in one box as "final concentrations". Those of the next 14 inches are caught in another box as "middlings", while the lower 23 inches is waste. Two machines are placed side by side and the "middlings" are run into a third placed below. A fourth machine is used below all for refuse, etc. The "final concentrations" from all three machines are run into a settling tank and saved. Another method is to pass the "middlings" and "final concentrations" from the first two machines over the third, and the "middlings" of the third over the fourth. Two men per shift are employed, one on the agitator, and one on the machines. Sometimes a boss is also needed. The average of the tailings treated was \$13. The waste sands assayed from \$5 to \$6. Concentrations assayed from \$85 to \$140. It required 17 tons of tailings to make one of concentrations. This was about the average of a shift's work. Power is furnished by a Leffel turbine wheel, 15½ inches in diameter. The penstock is of wrought-iron pipe, 1 foot in diameter and 40 feet high. The power actually required to run one machine is estimated at one-half horse-power.

The Park City Smelting Company has a small water-jacket shaft furnace in Park City. It was built in the spring of 1880, and made a short run in June. It started again in the following October, but there was not sufficient ore to keep it running longer than a few weeks. The water-jacket is of wrought iron, made in one section. It is 3 feet 2 inches high, 4 inches thick, and has a batter of 4 inches upon each side. There are five 3-inch openings, which serve as tuyeres. Ore is bought at the market prices ruling in Salt Lake City. The cost of the grading, the roomy ore-bins, and furnace building, and the particularly neat little furnace, was about \$25,000.

The other mines of the Uintah district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Boss	1, 200	None	20 men employed	Mining began November, 1879.
Woodside	2, 728	Small	Active	Ore assays \$30 per ton silver.
Walker & Buckeye	1, 800	.....do	Idle	Ore assays 18 to 25 ounces silver and 35 per cent. lead.
Sampson Mining Company	335	None .....	.....do	
Park City Mining Company				Developments of limited extent.
Fairview Mining Company	300		Idle	
Little Mac	300		.....do	
Jeannette group	1, 300	None	Active	Group includes twelve mines.

WASATCH COUNTY.

SNAKE CREEK DISTRICT.

[October, 1880.]

The Snake Creek district is about 4 miles wide and 6 miles long. It is south of the Uintah district and is adjacent to it. It also follows the boundary line between Wasatch, Salt Lake, and Summit counties, and includes most of the old White Pine and Howland districts. It was organized in 1870 and 1871. At the period under review there were 350 locations on the records, on 100 of which assessment work was done. The topographical and geological features of this district are similar to those of the Uintah.

MINES OF SNAKE CREEK DISTRICT.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Utah	700	None	Active	Hoisting works being built.
Jones Bonanza	1,125	Small	do	Ore assays about 75 ounces silver.
Pioneer	1,570	None	Assessment work	Ore on dump assayed 35 to 40 ounces silver.
New Bedford Mining Company.	430	do	Active	Six feet of milling ore assaying \$20.

MARBLE DISTRICT.

In this district, 7 miles south of Park City, and 12 miles east of Alta, near the divide between Snake Creek and Little Cottonwood districts, the claim of the Wasatch Marble Company is located. So far as opened, the quarry is only 30 feet wide and 40 feet long; but there is said to be a vast supply of a good bluish-white marble, which it was hoped would be sufficient for the Utah trade. The company has appropriated a small water-power, and erected a mill costing about \$4,000 to saw out marble slabs. Blocks from 5 to 7 feet thick and 40 feet long can be obtained. This company also owns some copper claims upon the divide. The development is nominal, but the croppings show a vein, from 4 to 6 feet wide, in limestone assaying from 10 to 12 per cent. copper, \$8 silver, and \$4 gold. Wood and water are very abundant. Near this copper group are many lead and silver prospects in limestone. In one, the Shenandoah, a stratum of peculiar rock, locally called "hell-fire rock", is found. It is a soft, somewhat granular, limestone which possesses the property of showing a streak of fire and emitting sparks when rubbed in the dark by any hard substance.

BLUE LEDGE DISTRICT.

[October, 1880.]

The Blue Ledge district is situated east of the Uintah and Snake Creek districts. It is very irregular in shape, but may be called 4 by 6 miles in size. It was organized April 13, 1870. There were, at the time of the writer's visit, 694 locations on record, of which probably not over 300 are still held. In this district little ore was being extracted; but works were in course of erection to thoroughly prospect some of the more promising veins.

The McHenry mine was one of the first claims located in the district. The old McHenry Mining Company was organized in 1873, and built a 20-stamp mill at Park City. The mill ran on company's ore for two months, but the ore was not free milling. The mill was then leased to the Ontario company for about a year. In 1876 the entire property was sold to the Winnamuck company, which expended considerable money in prospecting. The mine was bonded to Chambers, Hanauer & McIntosh for \$140,000, who, in 1878-'79, spent \$20,000 in prospecting it. About December 1, 1880, the Winnamuck company again took possession. The vein is supposed to be the same as the Ontario, less than half a mile distant, owing to its location and similar characteristics. It is in quartzite, is from 4 to 10 feet wide, dips N., and has from 1 inch to 4 feet of \$60 ore on the hanging wall. The mine is developed by several tunnels, which, with the various drifts and cross-cuts, aggregate 3,900 feet. The lower tunnel runs on or near the vein, is 1,300 feet long, and opens the vein 320 feet below the croppings. Much water is found.

The other mines of Blue Ledge district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Lady of the Lake	585	None	Shaft being sunk	Hoisting works contain 60 horse-power engine and 2 large steam pumps
Free Silver Mining Company.	700	.....	.....	Vein, 3½ feet. Development has shown little ore.
Hawkeye Mining Company.	455	.....	Active	Hoisting works begun in July, 1880, to cost \$20,000.
Williamson & Lowell .....	.....	.....	Hoisting works being erected.	Has several hundred feet of drifts and tunnels.
Homestake Mining Company.	.....	.....	.....	Claims developed to a limited extent.
Little Giant Mining Company.	.....	.....	.....	Do.
East Park Mining Company.	.....	.....	.....	Do.
Wasatch	450	Small	Active	Ore assays from \$25 to \$75 per ton.
Glencoe	460	.....	.....	Ore assays 55 per cent. lead, 80 ounces silver, and \$4 gold.
Pocatello	300	None .....	.....	.....

PRECIOUS METALS.

ELK HORN DISTRICT.

[October, 1880.]

The Elk Horn district is east of the Blue Ledge district. It was organized in the spring of 1879, and had when visited 40 locations in force, with limited developments.

UTAH COUNTY.

AMERICAN FORK DISTRICT.

[September, 1880.]

The American Fork district is at the head of American Fork cañon, and is separated from Little Cottonwood district by a sharp divide. Its area is 6 square miles. The records show that 780 locations have been made from the date of its organization, July 21, 1870, to September, 1880, at which time not over 200 were actually held. Forest City, 18 miles from American Fork city, on the Utah Southern railroad, is the mining town of the district. The surface of the country is very precipitous, consisting of sharp ridges, with almost perpendicular bluffs and deep mountain gorges, the results of great faults and subsequent erosion. The formation is limestone and quartzite. The mines are mostly at an altitude of from 9,000 to 11,000 feet above sea-level. In late years, since the decline of the Miller mine, the district has been comparatively idle. During the census year about fifty men were employed either for wages or in prospecting, but at the period under review there were not over fifteen.

The Miller mine, formerly the principal mine of the district, was discovered in September, 1870, and was sold the following year for \$120,000 or over. The Sultana smelter (3 stacks) was erected in 1871-'72, and ran irregularly until the spring of 1875. In 1871-'72 a narrow-gauge railroad was built up the cañon to within 4 miles of the smelter, costing \$240,000, if report is correct. At the same time 25 stone charcoal kilns, 15 at the smelter and 10 at the end of the railroad, were constructed. Everything was done on a grand scale. At times 200 men were employed. The ore bodies gave out, and the company shut down the mine in December, 1876, since which time it has only been worked on lease. The coal kilns, which were of the bee-hive pattern, and held about 25 cords each, ran almost continuously from 1872 to 1877, making coal for the Salt Lake smelters. The track was taken up in 1878, and the iron sold. The bottoms of the old furnaces were torn up to get the large amount of lead contained in them, and the old slag dumps were profitably picked over four times to find scraps of lead, unreduced ore, and matte. In the winter of 1871-'72 a siphon tap, or, more properly speaking, lead-well, was invented at this smelter by Mr. J. S. Gorham, almost contemporaneously with those constructed at Eureka, Nevada, by Mr. Agents. The mining property consists of nine patented and overlapping locations adjacent to the Miller, on the summit and western slope of a very high and precipitous ridge $2\frac{1}{2}$ miles north of Forest City. The fact that a large part of the old workings are filled up renders it difficult to give a full description of this mine. There are 10 tunnels, 4 shafts, and 10,000 feet of openings, exclusive of the stopes. The deepest workings are 600 feet below the hill-top, and extend horizontally 900 feet. Ore was found in six or eight large bodies, which began within 70 feet of the surface, in a belt of dolomite. About 4,800 tons were extracted from the largest body. The ore was a soft and very ferruginous ocher, containing carbonate of lead and some galena. Wulfenite and carbonates of copper were also occasionally found, together with a little zincblende and pyrite below the water-level (500 feet). Various estimates are given of the total product and the average grade of the ore. The range of these is between 13,000 and 15,000 tons, assaying from 40 to 54 per cent. lead, from 30 to 47 ounces silver, and from \$2 to \$10 gold. A nearly vertical porphyry dike cuts through this hill near the ore bodies, and, according to some accounts, faults the vein. The vein proper, as known at the period under review, was from 2 to 4 inches wide, containing 60-ounce ore. It was not this, however, that was being worked by the lessees. In the old ore bodies, among the crushed timbers, there were supposed to be several thousand tons of a mixture of waste and ore. Although rather dangerous work, this was being extracted and the spaces retimbered. In the early days \$20 ore would hardly pay; now \$5 ore will give a handsome profit. This material, together with selected portions of the old dumps, is taken a quarter of a mile, straight down a hill having a slope of 40° , in stone boats 8 feet long and $2\frac{1}{2}$ feet wide, each holding about a ton and drawn by one mule, to a water-course in a ravine. In the ravine it is treated by two slightly modified Cornish hand-jigs which together require about a miner's inch of water. These jigs have one man each to operate them, and make about 3 tons of concentrations per day from 15 tons of the ore. This method of treatment was possible by reason of the silver being contained in the fine crystals of cerussite, which abound in the low-grade ores. The concentrations assay about from 40 to 60 ounces silver and 60 per cent. lead. They are shipped to Sandy at a cost of \$7 per ton.

The Wild Dutchman mine is a quarter of a mile east of Forest City. It was discovered in 1872, and sold to the Omaha Smelting and Refining Company of Nebraska, who worked it until September, 1876, when it was leased. It had been idle since 1880. The ore-bearing formation is a bedded vein, from 3 to 40 feet (average, 20 feet) wide, in dolomite, dipping 40° SE. This has been worked 300 feet in length and 450 feet in depth. The gangue in general consists of from 2 to 3 feet of shale upon the foot wall and a soft clay containing fragments of silica, and strongly

stained by oxide of iron, locally known as "lime porphyry." The ore occurs in scattered egg-shaped bunches of from a few pounds to 600 tons. Five large bodies have been found, one 20 feet from the surface, one 300 feet from the surface, and the others between these. The ore is the usual ochery carbonate of lead found in a lime formation, and contains small amounts of heavy spar. At the water-line, in the 450-foot tunnel level, a large body of base ore was found. This consisted of iron and copper pyrites, galena, and a very large percentage of zincblende. A porphyry dike is said to cut through the foot wall into the vein near the large bodies of ore. The mine is opened by seven working tunnels from the hillsides at various levels. The total cuttings are 3,500 feet. The lessees obtained 2,880 tons by work similar to that which was being carried on at the Miller. The total product of the mine is estimated at 7,900 tons, averaging 45 ounces silver and 40 per cent. lead.

The other mines of American Fork district are :

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Pittsburgh	1,185	2,000 tons.....	Active.....	Ore assays 18 ounces silver, 44 per cent lead, and \$2 gold.
Sunday	800	\$17,000.....	Five men tunneling.....	
Silver Bell	α 120	130 tons of 100-ounce ore.	Active.....	
Excelsior Silver Mining Company.....			do.....	Developments limited; ore argentiferous galena, assaying 60 ounces silver and 50 per cent. lead and a trace of gold.
Utah Consolidated Mining Company.....				Seven claims. Several hundred feet of developments.
Queen of the West	1,000		Idle.....	In 1874 \$28,000 taken from one pocket.
Orphan		250 tons.....	Active.....	Ore assays 60 ounces silver and 40 per cent. lead.
Live Yankee and Mary Ellen.....		600 tons.....	Idle.....	Ore formerly assayed 18 ounces silver, 7 per cent. lead, and \$4 gold.
Treasurer	475	A few tons.....		Ore assayed 85 ounces silver and some lead.
Silver Dipper.....	600			Ore assays 10 to 20 ounces silver and 40 per cent. lead.
Whirlwind	1,000	\$3,000.....		
Non-compromise.....	400	15,000.....		Ore assayed 40 ounces silver.
Hudson		None.....	Some prospecting done.....	An extension of the Pittsburgh.

α Incline; also some tunneling work.

There are many other claims in the American Fork district, perhaps more valuable than some of those mentioned, but whose development is very limited.

SILVER LAKE DISTRICT.

[September, 1880.]

The Silver Lake district is southeast of the American Fork district, and covers an area about 6 miles square. The country is very rough and precipitous, the formation being quartzite and limestone, with some granite. It was organized in January, 1871, and the records showed 260 locations at the time of the writer's visit, of which not over 10 were held.

The mines of Silver Lake district are :

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Milkmaid	535	\$13,000.....	Active.....	Ore assays 36 per cent. lead, 58 ounces silver, and a trace of gold; sells for \$55.
Wasatch King.....	370	500.....	Worked on lease.....	Ore assays 11 ounces silver and 27 per cent. lead.
Austin	700	None.....	Idle.....	From 200 to 300 tons ore and waste on the dump.
Nebraska.....	250	10 tons.....		Ore assays 20 ounces silver and 35 per cent. lead.

PROVO MINING DISTRICT.

[September, 1880.]

The Provo mining district lies upon the western face of the Wasatch range, northeast of the town of Provo. It was organized in the spring of 1871, but for years no regular organization has been kept up. The country rock is limestone and quartzite. The ore is an ochery carbonate of high grade in silver, but occurs in very small quantities. There were, at the period under review, about thirty claims, few of which had over 100 feet of development.

PRECIOUS METALS.

COOK AND SPANISH FORK DISTRICTS.

[September, 1880.]

These are on the western flank of the Wasatch range, south of Provo district. They were organized during the great mining excitement of 1871 and 1872. The country rock is limestone. The ore is galena, carrying from 5 to 15 ounces silver. All the mines have been abandoned.

SANTAQUIN DISTRICT.

[September, 1880.]

The Santaquin mining district was organized in 1871. It is situated east of the town of Santaquin, and occupies an area about 6 miles square.

PAYSON MINING DISTRICT.

[September, 1880.]

The Payson district was organized in 1871-72. It is situated on the western foot-hills of the Wasatch, and is 12 miles square, having the town of Payson as a center. Seventy locations had been made up to September, 1880, at which time but five were in force. These had from 120 to 300 feet of cuttings. The country rock is limestone. The ore is low grade, from 12 to 15 ounces silver. None was ever shipped.

WHITE RIVER DISTRICT.

[September, 1880.]

The White River mining district, a mineral wax region, was organized in September, 1879. It is situated northeast of Clear Creek station, on the Utah and Pleasant Valley railroad. Its size is about 20 by 30 miles. It occupies the summit and part of the eastern slope of the Wasatch range, and lies in both Utah and Wasatch counties. There are about forty locations, the average dimensions of which are 1,500 by 600 feet. The developments in no place exceed 50 feet of shaft. A shale, which is said to extend many miles, lies in nearly horizontal beds of varying thickness. The reports conflict, but there are evidently two or three beds from 60 to 600 feet thick. This shale has yielded from 13 to 45 per cent. of paraffine oil and some wax. The wax proper (ozocerite) is found in sandstone at the base of the ridges and under the shale. It occurs in small isolated bodies and in seams. The seams are generally from $\frac{1}{2}$ inch to 3 inches wide, and rarely 8 inches. The total product has been about 1,500 pounds. This crude material was said to average 25 per cent. paraffine wax. Cleaner pieces, having less admixture of sandstone, yielded from 90 to 95 per cent. by analysis.

The Tintic Mining and Milling Company's mill is situated at Homansville, Utah county, just over the line from Tintic district, Juab county, from which it obtains its ore. It is $2\frac{1}{2}$ miles east of the Eureka Mill mines and 18 miles west of Santaquin. The mill was built by an Ohio company, called the Wyoming Mining and Milling Company, and started in January, 1873, on ore from the old Wyoming mine. This mine failed, and the company bought others and milled much ore during the year. In the spring of 1874 Colonel Locke took charge, and purchased it in February, 1877. The mill was bought by the Tintic company, and began operations July 14, 1880. The mill is very neat, fully equipped, substantial, and convenient. It was built at a cost of \$65,000. It contains a Blake rock-breaker 8 by 10 inches, a dry-floor 10 by 30 feet, ten 750-pound stamps, four Horn pans 2 feet 2 inches by 4 feet 8 inches, two settlers, 3 by 8 feet, a clean-up pan, a retort, a Stetefeldt furnace, and a very fine 45 horse-power engine made in Marysville, California. The batteries are double-discharge, and have a No. 40 brass wire screen, 8-inch drop, speed 90, and a capacity of from 7 to 20 tons per day, depending on the ore. The pans hold 1,800 pounds, and are run eight hours. No chemicals, except a little potassium cyanide, are added. The loss of mercury is 1 pound per ton. Settlers containing two-pan charges are run eight hours. The bullion is from 0.300 to 0.650 fine. There are about 4,000 tons of tailings in the reservoir. These assay \$9 per ton. The Stetefeldt furnace has a 40-foot shaft with pit 5 feet square, flue-dust chambers 42 by 15 feet by 12 feet, and 100 feet of underground flue to a 70-foot stack. It requires the labor of four men and $1\frac{1}{2}$ cords of wood per twenty-four hours. From 5 to 6 per cent. of salt is used. The company's charges are \$25 per ton for working, guaranteeing 80 per cent. in bullion of the assay value of the silver, and also of the gold if it exceeded \$10 per ton. The product of this mill while under Colonel Locke's management, from the spring of 1874 to the spring of 1878, was \$39,058 73 gold and \$241,112 23 silver, from 3,261.7 tons of ore.

The Pleasant Grove clay bank was discovered in early days. From six to ten car-loads per year have been shipped to the Salt Lake smelters. The price obtained was \$3 50 per ton. This bed of fire-clay is situated 1 mile northeast of Pleasant Grove at the base of the Wasatch mountains. It is exposed only for about 100 feet in length and 50 feet in depth, but surface signs seem to indicate a bed at least 200 feet in thickness. It is overlaid by a lime shale, dipping slightly to the east. Several inches of water flow from the mountains at the line of junction between the clay and the shale.

TOOELE COUNTY.

RUSH VALLEY DISTRICT.

[November, 1880.]

The Rush Valley mining district is situated among the foot-hills, on the western slope of the Oquirrh range, and covers an area about 7 miles square. Its altitude is between 6,000 and 7,000 feet. Stockton, the town of the district, is 38 miles southwest of Salt Lake City, and a mile from the terminus of the Utah Western railroad. The district was organized by soldiers in June, 1865. In May, 1870, there were 850 locations on the books, but most of the titles had lapsed. At that time a party of miners came from White Pine, reorganized the district, and jumped everything. Very little was done in the district until 1875, when there was quite an excitement. It gradually died out, however, until 1879, when the large ore body in the Great Basin mine was discovered. Except at the above mine little is being done. The records since 1870 show 840 claims, not more than 125 of which were ever worked. The country rock is a siliceous limestone and quartzite, the strata having a general east and west strike, and belonging to the Carboniferous age. (a) The veins are for the most part large, but contain a large amount of valueless or low-grade ocher. It is a peculiarity of the region that the silver is not found as a chloride, but is associated with cerussite and galena, thus making it a good "jigging" ore. There are two classes of veins in the district, E. and W. bedded veins between a black and gray siliceous limestone, of which kind there are three belts, and fissure veins having a N. and S. strike. These last, with the exception of the Catherine, have never yielded much. There are also several granitic porphyry dikes having a general NE. and SW. strike.

The Great Basin mine is the principal mine of the district, and is situated $1\frac{1}{2}$ miles northeast of Stockton. It was discovered in 1865, and, except a small interest, was owned by General Connor. It was worked at intervals on lease until 1879, when a large body of ore was found at a depth of 250 feet. General Connor then went east, and, securing Boston capital, the Great Basin Mining and Smelting Company was incorporated in May, 1879, under the laws of Connecticut. This company has erected concentration works and is working vigorously. The property of the company consists of the Great Basin, the General Garfield, and the Arthur, parallel side claims, and the Silver Queen, a vein at right angles; the concentration works; a smelter, formerly the Jacobs smelter; and some large springs connected with the town and works by 6 miles of 4-inch pipe. The capital stock of the company is \$2,500,000 in 100,000 shares. The ore is found in irregular masses in a bedded vein, from 9 to 16 feet wide, dipping from 60° to 70° N.NE., between a black limestone hanging wall and a hard, gray siliceous limestone foot wall. The outcrop is a broad band of ocher. Ore in small quantities was found from 10 to 30 feet below the surface, but no large bodies were encountered until a depth of 250 feet was reached. The vein is supposed to extend for several thousand feet, and has been explored 460 feet horizontally and 840 feet on the dip. The ore is a soft, fine ferruginous and siliceous material containing crystals and nodules of carbonate of lead, bowlders of galena, some oxide of manganese, and rarely a stain of carbonate of copper. It is of all shades of brown, red, and yellow. The best ore is as a rule found nearest the foot wall. On the hanging wall is a band of ocher, worthless or of extremely low grade. On each side of the ore proper there is a 3- to 5-foot belt of soft decomposed country rock strongly stained with oxide of iron, with frequent seams of talcose clay. The ore averages from 3 to 5 feet in width. The size of the bodies in sight could not be determined, as comparatively little drifting had been done. The main body or its branches are continuous between 250 and 840 feet on the incline. From the above the banded structure of the vein is manifest. There is a small fault where the Silver Queen fissure cuts across this vein. At the bottom of the incline a dike of porphyry has just been encountered. Ore is in contact with it. No water has been found, but as the ore is very moist it is expected daily. The mine is opened by an 840 feet incline on the vein. This is at an angle of about 50° , making an angle of 15° with the true dip. From this 2,585 feet of levels, cross-cuts, and winzes have been driven. The hoisting works, though rather rude, serve the purpose. They consist of a 16 horse-power horizontal engine, with $1\frac{1}{2}$ -inch hemp rope, and a single horizontal boiler. Ore is hoisted on a giraffe holding about 1 ton and having a sheet-iron cover to prevent ore from falling out on steep places in the incline. The machinery for new hoisting works has been ordered. The ore is extracted by overhand stoping, the ground being timbered only by stulls. The ground is soft, so that black powder is in most cases used. During the census year 45 men were employed. Shifts are 10 hours day and 9 hours night. Miners receive \$3 per shift. Wood costs \$8 per cord and drifting \$6 per foot. First-class ore, averaging 40 per cent. lead, from 18 to 21 ounces silver, and \$2 gold, is shipped to Salt Lake City at a cost of \$3 25 per ton; but it is intended for the future to smelt it at the company's works. During the census year \$48,275 33 was received for 3,382 $\frac{1}{2}$ tons of ore sold. The former product was estimated at \$20,000.

The concentration works are located at Stockton, $1\frac{1}{2}$ miles from the mine, on an easy descending grade. The buildings are those of the old Jacobs smelter erected in 1872. They were bought by the company in 1879, and enlarged for the concentration plant. Owing to the fact that they were not originally designed for concentration works they are not models of elegance or convenience, but they do good work. The concentrating apparatus was completed in June, 1880, and with some slight stoppages has been running since that time. As they are the only

works of the kind in Utah, those at the Old Telegraph being out of repair, and as the subject of concentration is a very important one, they are deserving of special description. The apparatus consists of a Dodge crusher, a pair of Cornish rolls, a chain bucket-elevator, 5 revolving screens, 8 Fraser & Chalmers automatic jigs, and 4 tie-boxes. The whole is run by a horizontal engine of 50 horse-power. The building is lighted by two Brush electric lights of 2,000 candle-power. This apparatus require about 3 horse-power from the engine, and cost \$950. Four Jablokoff carbon candles are burned per night at a cost of 20 cents. These gave such satisfaction that a third light was to be placed upon the dump. The Cornish rolls are each 2 feet in diameter, and are fitted with steel shells. Although they had crushed several thousand tons of ore, they showed but little wear. The chain elevator carries cups, holding about a quart, 15 inches apart. It raises ore to the top of the building, 25 feet, and makes a little more than one revolution per minute. The five revolving screens are so arranged that whatever passes through the mesh of the screen is caught by a fixed semicircular sheet-iron trough below, having sufficient grade to pass it into the end of the succeeding revolving screen. Whatever does not pass through the first screen is discharged into a box tube and falls back to the Cornish rolls 15 feet below. That which does not pass through the mesh of screen No. 2 falls through a box tube to jigs No. 1. In the same manner screen No. 3 sends material to jigs No. 2, screen No. 4 to jigs No. 3, and screen No. 5 to jigs No. 4. Whatever passes through the mesh of revolving screen No. 5 (about one-half of the total ore) goes through troughs to a small reservoir, and thence to the tie-boxes. Screen No. 1 is 10 feet long, 2 feet in diameter, and has a grade of $\frac{3}{4}$ inch to the foot. The first 3 feet is of sheet iron, and the remainder is covered with a No. 4 mesh iron-wire screen. This screen receives the ordinary dry ore. Screens Nos. 2, 3, 4, and 5 are each 5 feet long, 2 feet 9 inches in diameter, and has a grade of $\frac{1}{2}$ to $\frac{3}{4}$ inch to the foot. Above each of these is a small level water trough. This is made to overflow, thus washing the screens clean and aiding in the sifting. Screen No. 2 had No. 3 and No. 4 mesh, half and half each; No. 3 has a No. 6 mesh; No. 4 has a No. 9 mesh, and No. 5 has a No. 14 mesh. Each screen makes about 100 revolutions per minute. The jigs are 9 feet long, 3 feet wide, and 3 feet high, the lower half of the box being V-shaped. They are made of 2-inch plank, arranged upon the floor in two rows 6 feet apart, and are held in position by a frame-work of 6- by 6-inch timber. To a shaft running the entire length of each row are attached the eccentrics and plungers. Each jig is divided into three compartments by two crosswise partitions. Each of these compartments is subdivided, at the top only, into three others—the screen proper, the plunger, and the water-supply portions. These are, respectively, 15, 16, and 3 inches wide. The plungers fit the compartment quite closely, but are not water-tight. The screens of the successive compartments are level, and each is 2 inches lower than the preceding one. They are covered with particles of galena, just large enough not to admit of their passing through. This is called "ragging". There are two jigs of each number. The screens of jig No. 1 are the same as those of revolving screen No. 2; of No. 2 as revolving screen No. 3; of No. 3 as revolving screen No. 4; and of No. 4 as revolving screen No. 5. There is a faucet or hole, fitted with a plug, in the bottom of each compartment of the jigs, through which the material which passes through the screens (called the "hutch-work") is drawn off into shallow vats. The tie-boxes are 13 feet long, 19 inches wide, and 8 inches high, with a grade of from 6 to 7 inches.

The process is as follows: The ore on the ore-floor, where it has been dumped by teams from the mines, is shoveled into wheelbarrows and taken into the mill. If it is already fine, it is dumped through a chute having a false bottom of $\frac{1}{2}$ -inch mesh wire screen to the Cornish rolls. The fine stuff which is thus screened out goes to the elevator pit. If the ore is coarse it is put through the Dodge crusher, whence it passes through a similarly constructed chute to the Cornish rolls. Whatever passes through the Cornish rolls also falls into the elevator pit. The elevator carries the ore from the pit to a chute, whence it is dropped into the revolving screens and is sized, as previously mentioned. It will be noticed that the material which falls to each jig is small enough to pass through the mesh of the jig screen, if not prevented by the "ragging". By the action of the plunger, which has a stroke of three-quarter inch in jigs No. 1, and one-eighth inch in jigs No. 4, making two hundred strokes per minute, the water is forced up through the meshes of the jig screens, somewhat displacing the ragging. This upward current of water also lifts the particles of ore. The lighter are carried to the left by the force of the flowing water, while the heavier settle back near their original positions, and finally sink through the screen into the box beneath, and become hutch-work. The very light portions are removed further and further away, until finally carried by the water over the discharge spout. It is evident that the hutch-work in the first compartment will be the richest. The jig sands over the jig screens are kept about 2 inches deep. Each jig uses about an inch pipe full of water with very little head. The hutch-work is drawn off through the faucets every hour or so, shoveled into wheelbarrows, and wheeled to the sacking-floor or furnace-room. It is not "tied". The quantity of hutch-work produced by each set of jigs was about the same. In the tie-boxes, the first 4 feet is saved and the next 5 feet, called "middlings", "retied". The lower 4 feet is rejected as waste.

Unfortunately, accurate average assays of the various products cannot be given, as they are not regularly made. The following are estimated values:

Concentrating ore from the mine.....	8 ounces silver, 13 per cent. lead.
"Hutch-work" or jig ore.....	40 ounces silver, 55 per cent. lead.
"Tie-box" ore.....	20 ounces silver, 40 per cent. lead.
Waste.....	3 ounces silver, 5 per cent. lead.

It usually requires from 5 to 6 tons of ore to make 1 of concentrations. It is estimated that about 75 per cent. of the value of the ore is saved, though this is somewhat inconsistent with the other data. The capacity of the works is about 80 tons per day. The cost of plant was \$25,000. The cost of concentration per ton of ore is 75 cents.

The force employed is:

Class.	Number employed.	Length of shift.	Wages per shift.
		<i>Hours.</i>	
Foreman.....	1	12	\$5 00
Tie-box men.....	4	12	3 00
Engineers.....	2	12	3 50
Ore feeders and laborers.....	12	12	2 00
Jig tenders.....	3	12	3 00
Total.....	22		

This large force of laborers is owing to the unfortunate topographical situation of the works. The ore does not fall by gravity to its place at the crusher or rollers, but has to be lifted by laborers and wheeled there.

The furnace department of these works was not in running order at the time of the writer's visit, but was expected to be shortly. There is but one stack, which had been remodeled somewhat since its use in the old Jacobs smelter.

The First National mine is $1\frac{3}{4}$ miles northeast of Stockton. It was discovered in 1872, and considerable ore was extracted from near the surface. The mine has been worked irregularly since 1875, a small force being employed. It is a bedded vein, from 1 to 15 feet wide, dipping from 50° to 70° N.N.W. The vein is filled with ocher, especially upon the hanging-wall side, and a partially decomposed siliceous limestone. The ore is cerussite and galena, with oxides of iron and manganese occurring in irregular masses in the vein, and assaying: first class, 40 ounces silver and 70 per cent. lead; second class, 30 ounces silver and 45 per cent. lead; third class, 18 ounces silver and 25 per cent. lead. There are also five or six pockets of galena, containing from 1 to 40 tons near the surface, in the foot wall, from 30 to 50 feet from the vein. Bodies are also found at a depth of from 250 to 370 feet. The mine is dry, and is developed by a 450-foot incline and 1,100 feet of other cuttings. It has small steam-hoisting works containing an Ames 8 horse-power engine, costing about \$2,000. The total production to the end of the census year was estimated at \$18,000.

The other mines of the Rush Valley district are:

Mines.	Total length of openings.	Total product.	Condition at close of census year.	Remarks.
	<i>Feet.</i>			
Rush Valley M. Co.....	420	None.....	Active.....	Steam hoisting works erected, cost \$5,000.
Southport.....	225	Small.....	Assessment work.....	
Merwin and Maybell.....	410			
Granger and Jasper.....	330			
Leonora.....	1,300	\$25,000.....	Idle.....	Ore assays 40 ounces silver, 55 per cent. lead, \$5 gold.
Legal Tender.....	α 300	1,800 tons.....		Ore assays: first class, 18 ounces silver, 50 per cent. lead; second class, 10 ounces silver, 20 per cent. lead.
Katharina.....	1,100	\$15,000.....	Small force at work.....	
Chaco and Vulcan.....	α 350			Product a few thousand dollars.
Silver King.....	000	3,000 tons.....	Idle.....	Selected ore assays 20 ounces silver, 40 per cent. lead.
Silver King W. Extn.....	850			Much low-grade ore shipped to Chicago furnace.
No-You-Don't.....			Idle.....	Several hundred feet of workings.
Wade Hampton.....	α 300		Worked on lease.....	Several thousand dollars have been received for ore.
Argent.....	000		Idle.....	Do.
Muscatine.....	α 625		Assessment work.....	Many hundred tons of low-grade ore produced.
Calumet.....	300	\$6,800.....		Ore assays: first class, 70 ounces silver, 70 per cent. lead; second class, 45 ounces silver, 50 per cent. lead; third class, 12 ounces silver, 15 per cent. lead.
Hannah.....			Idle.....	Has yielded a few thousand dollars.
Gen. Connor Tunnel.....	400	None.....	Six men tunneling.....	
Lion.....	575	\$20,000.....	Idle.....	Ore assays 60 ounces silver, 65 per cent. lead.

α Incline; also other cuttings.

The Waterman smelter is situated half a mile southwest of Stockton, near the northern shore of Rush lake. The first furnace in the territory, an unsuccessful reverberatory, was erected here in 1864 by General Connor and his officers. It was bought in 1871 or 1872 by Mr. I. S. Waterman. Two stone stacks were erected, and water-jackets were finally added. The buildings were burned in 1876, but were immediately rebuilt. This smelter ran quite steadily for several years on Hidden Treasure ore and some custom rock, but not profitably. It has been idle for nearly two years. The works are neat, roomy, and in good condition. All parts of the building are made of sheet iron, or lined, or covered with it. There is also a fine brick boarding-house and office. The machinery consists of a Blake rock-breaker, two No. 5 Baker blowers, two steam pumps, two horizontal boilers, $4\frac{1}{2}$ by 16 feet, a 40 horse-power engine, and two shaft furnaces. These latter are water-jacket furnaces of about the same size. There is a flue-dust condenser, invented by a former superintendent. It is so constructed that the dust should pass through water, the draft being increased by a fan blower. Owing to idleness of the works it cannot be described. A report made by George W. Maynard gives the following details: During the four years ending April 1, 1878, 26,270 tons of ore were smelted, and yielded 8,312 tons of base bullion, which sold for \$109 64 per ton, or \$911,350. During this time 3,300 tons of flue-dust were caught, which assayed from 36 to 57 per cent. lead and from 13 to 35 ounces silver.

The Chicago smelter is at Slagtown, on the eastern shore of Rush lake, about 2 miles south of Stockton. It was built in 1873 by the Chicago Silver Mining Company, an English company, which once owned the Chicago and the Queen of the Hills mines in Dry cañon. It ran quite steadily until 1877. It was then idle until leased in 1879 to Mr. Brooks, who ran it until the autumn of 1880, when it was shut down. The plant consists of one 50 horse-power engine, two boilers, two Blake rock-breakers, one No. 6 Baker blower, and three stacks with small dust chambers. (For dimensions of these see table of Utah furnaces.) These stacks are similar to the others, excepting that the water-jackets might more properly be called spray-jackets. One stack has a rectangular cross-section 4 by 3 feet. The jacket is in four sections, one on each side and end. These sections are 3 feet high, and are made of cast iron. They have no open space between the walls to contain water, but instead have three flanges upon the outside which form three V-troughs 2 inches deep. These are set level, and a stream of water is poured into the upper one. It overflows into the middle and lower troughs, from which it runs off in a pipe, thus wetting the entire side of the jacket. The cast iron is about an inch thick. The jackets appeared to have stood well without warping or bulging. One stack has a hexagonal jacket, 1 foot 9 inches on a side, having the same V-troughs. Another has a circular 5-foot jacket of cast iron, single thickness, without the V-troughs cast on the side. This is used with a spray of water.

OPHIR MINING DISTRICT.

[November, 1880.]

The Ophir district is situated south of and adjoining Rush Valley district, from which it was separated in the summer of 1870. It includes several cañons and ridges on the western slope of the Oquirrh range, the principal of which are Ophir or East cañon and Dry cañon, containing the mining camps of Ophir City and Jacob City, respectively. There was much excitement in 1872, 1873, and 1874, since which time the camp has gradually declined. At the period under review there were not 50 persons where formerly there were 1,000. The records showed about 2,500 locations, on not over 150 of which was assessment work kept up. The surface of the country is very rough, consisting of steep hillsides and precipitous walls of mountain gorges. The altitude of the claims varies from 6,500 to 9,000 feet. In general, the country rock consists of a distinctly stratified limestone, having a small northerly dip. Near Ophir City, there are strata of quartzite and siliceous limestone. In many places, particularly in Dry cañon, the limestone is interstratified with calcareous shale. In this place, also, there is one large dike of granitic porphyry and several great faults.

Much of the ore of the district has been very rich, the assays sometimes averaging among the hundreds, and even thousands. In East cañon the ore was usually a very siliceous or milling ore; but that from Dry cañon contained much lead, and was smelted. This district has produced many million dollars; how many, can never be known, as the mine owners of the early days are scattered over the Pacific coast. Many local attempts to treat the ores were made in East cañon, but were for the most part failures. The works remaining at the period under review were the buildings of the Pioneer and the Baltic mills and the Cleveland and the New Jersey arrastras.

The Pioneer mill was built in 1871 by Walker Brothers, of Salt Lake City, to work ore from the Zella group and other mines on Lion hill. It was a 20-stamp dry-crushing silver mill with an Aiken furnace, and cost about \$75,000. Many hundred thousand dollars in bullion were extracted. The machinery was moved to Butte, Montana, several years ago. The Baltic mill was a small 5-stamp mill, with two pans and a settler, and was run by a turbine water-wheel. It was not worked regularly. The arrastras were in bad order, not having been in operation for several years. They were usually run by water-wheels. A small boiler furnished steam. They were fairly successful, owing to the high grade and free nature of the ore. Latterly, ore has been shipped to Salt Lake City or to the Stockton smelters. The distances and costs of transportation are as follows:

Jacob City to Stockton, 10 miles, from \$2 50 to \$3 per ton.

Ophir City to Stockton, 16 miles, \$4 per ton.

The following works were built in early times, but had been moved away or were in ruins:

Pioneer smelter, built in 1871. Probably produced 125 tons of bullion.

Ophir smelter, built in 1872. Produced but little.

Faucett smelter, built in 1872. Small product.

Brevoort mill, built in 1872. Two stamps.

Enterprise mill, built in 1873. Five stamps.

One mill (name unknown), built in 1874. Five stamps.

Also several small arrastras run by water-wheels.

Owing to the extreme dullness of the camp when visited, it was impossible to get full information of many of the mines. Hence probably some will be omitted and others will be described very imperfectly.

MINES OF EAST CAÑON AND VICINITY.

The Zella group comprises the Zella, Mountain Tiger, Silver Chief, and Rockwell, patented, and several others unpatented. It is situated on the western side and near the summit of Lion hill. The mines were discovered in the autumn of 1870, and sold to Walker Brothers in 1871, who worked them until 1876, since which time they have been leased. The ore outcropped in two places, the croppings assaying \$200 per ton. Three large bodies and several smaller ones were found about 20 feet below the surface. The ore is a soft, yellow, siliceous chloride assaying several hundred dollars per ton. The country rock is blue limestone. No water has been encountered. The mines are opened by several shafts and tunnels, in all over 6,500 feet. The actual working development on the stratum containing ore does not, however, extend over 125 feet vertically and 800 feet horizontally. During the census year the property was leased to six men at a royalty of from one-third to one-sixth of the net receipts. Eighty-four tons, assaying about 120 ounces silver and \$9 gold, selling for \$100 per ton, were obtained. It was impossible to ascertain, except approximately, the total product of this group, but it was estimated at \$750,000.

The Monarch group includes the Monarch, Monarch No. 2, Monarch No. 3, and Empire. The mines were discovered in 1870. The principal work was done in 1875 and 1876. Since then the property has been leased. The ore is found in a stratum of quartzite, dipping slightly NE. There is limestone below, and porphyry, in some places at least, above this stratum. The explorations were in a space from 5 to 25 feet in height, and 500 by 400 feet in length and breadth. There are two or three large bodies, one 75 feet long, from 3 to 30 feet wide, and from 2 inches to 12 feet (average, 2½ feet) thick, and several smaller ones. The ore is a porous quartz containing cavities filled with the "chloride" of the miners and some carbonate of lead. In the center of the body it is quite soft and fine, but upon the edges very hard and coarse. It is said that the ore averages 130 ounces silver per ton with from nothing to \$8 in gold, and from nothing to 12 per cent. of lead. Much of it, however, would assay upwards of \$500. The mass of the quartzite stratum near the ore is much broken, and the seams are filled with crystals of quartz and calcite, all being somewhat stained with oxide of iron. The chlorider's rule in seeking new ore bodies is to follow soft ground and the stronger ocher stain. The richest ore occurs next the lime and the porphyry. The mine is worked through tunnels, and has about 2,000 feet of cuttings. In no place are these over 125 feet below the surface. Six men were working on lease seven months during the census year, paying from one-third to one-fifth royalty. They took out ore which sold for \$12,556. The total product to the close of the census year was \$117,500.

The Douglas mine was located in 1871, and was worked principally in 1875, 1876, and 1877. It has been idle or leased since. It is situated near the western summit of Lion hill, about a mile southeast of Ophir City. It is near the Monarch group, which it greatly resembles in gangue and ore. The country rock is stratified limestone. Whether the quartzite gouge of the two former claims is an interstratified quartzite bed or a local mass of quartzite cannot be determined from the developments. This stratum is 30 feet thick, and is known to extend 250 by 350 feet. Two bodies have been found of about the same size 50 feet apart. One is 150 feet long, from 2 to 12 feet thick, and from 4 to 15 feet wide. The mine is dry and is opened by tunnels and shafts. It is worked over 150 feet from the surface, and has about 600 feet of cuttings. The total product is said to be at least 1,000 tons of 100-ounce ore. This is worked at the Pioneer mill.

The Trace group was located in August, 1878, and worked in a small way since by the owners. It embraces four claims on the northern slope of Lion hill. The principal claim is located on a fissure vein, from 6 inches to 6 feet wide, traceable for 900 feet through blue limestone, dipping 75° W. The ore is found mostly on the foot wall from 2 inches to 2 feet wide, but there is also a band of it upon the hanging wall, which contains much more gold (\$20) than the other ore. Between these bands of ore is an open fissure, from 5 inches to 2 feet, sometimes filled with a lime sand from the surface. The ore is a soft yellow sandy ocher, which assays: first class, 130 ounces silver and \$9 gold; second class, 71 ounces silver and \$12 gold. The mines of this group are developed to a limited extent, mostly by tunnels, and contain over 1,000 feet of cuttings. The total product to the end of the census year was \$11,565.

The other mines of East cañon and vicinity are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Exchange and Sunnyside ..	1,000	\$80,000.....	Assessment work done ...	
Lion	1,000	120,000.....	do	
Chloride Point and others on Silveropolis hill.			do	Several hundred feet of cuttings. Produced many thousands in early times.
Miner's Delight group.....	a 300		Worked on lease.....	Ore assays 19 ounces silver and 11 to 14 per cent. lead; sells for \$7 per ton. Total product, many thousand tons; 1,200 tons extracted in census year.
Bonanza			do	Has produced considerable ore.
Cleveland Mining Company.	1,430	100,000.....		Ore assays \$150 to \$1,000 per ton.
San Joaquin	750	35,000.....	Worked irregularly.....	Ore assays \$100 to \$400 per ton.
Poorman.....	b 500	Small.....	Idle.....	Little ore ever shipped.
Buckhorn.....	a 300		Leased.....	Ore assays 20 ounces silver, 35 per cent. lead. Much ore formerly produced.
Mountain Gem and Antelope.	1,000			Surface ore assays 20 ounces silver, 30 per cent. lead. Several thousand tons shipped in 1877 and 1878.
California			Active.....	Ore assays 25 ounces silver, 55 per cent. lead.

a Incline; also other cuttings.

b Drifts; also shaft of several hundred feet.

MINES OF DRY CAÑON.

The Hidden Treasure mine is situated on a steep hillside above and three-quarters of a mile northeast of Jacob City. It was located in 1865 as the Saint Louis lode by General Connor's soldiers, who had been told by Indians of the outcropping boulders of galena. Little work was done until April, 1870, when it was relocated as the Hidden Treasure. The mine has been extensively but irregularly worked since 1872. It was idle during a few months preceding the writer's visit. The property consists of the Hidden Treasure, Saint Louis, Cedar, Summit, Red Line, Sacramento, Hidden Treasure East Extension, Columbia, and Western, all adjacent claims. The ore is found in one or two chimneys in a bedded vein in a compact bluish limestone, which dips about 30° N. 32° W. About 3 feet above the ore there is a contact vein an inch or so in width between an overlying stratum of siliceous slate (locally called "block slate") and the limestone beneath. Very rarely, however, does the ore body make to the contact (in some of the upper works the ore was on the contact). One chimney began at the surface, or at least within 60 feet of it, and continued for 600 feet. It then split into two chimneys, which continued 800 feet or more. The upper chimney was from 20 to 100 feet wide and from 3 to 20 feet thick. The branches were from 10 to 25 feet wide and from 1 inch to 20 feet thick. The ore found in the Chicago mine was in two bedded pipes, which were in a limestone stratum about 100 feet beneath these ore bodies. The pipes turned upward and finally connected with the Hidden Treasure vein. The ore of the Hidden Treasure is a soft reddish-brown ocher, containing cerussite, galena, and traces of copper carbonates. It assays from 15 to 40 ounces silver and 20 to 50 per cent. lead. A few hundred feet to the north of this mine, in the direction in which the ore-bodies dip, a great dike of granitic porphyry cuts through the country. The mine was formerly opened by five inclines, three of which were in ore, and several tunnels. It was worked at the period under review through a 500-foot tunnel, from which an 800-foot incline was sunk between the two chutes of ore. The extent of the workings on this stratum was 1,600 feet on the dip and 450 feet horizontally. Within this area there were probably 9,000 feet of inclines, drifts, and winzes. The ore chutes continue at the bottom, though small in places. Some seepage water was encountered and zincblende occasionally appeared. The steam hoisting works consist of a 40 horse-power horizontal engine with $\frac{7}{8}$ -inch steel-wire rope in the tunnel at the top of the incline, and one horizontal boiler at the surface. Water for use in the boilers has to be purchased at 1 cent per gallon, except in the winter months, when snow is used. During the census year about twenty men were employed, at \$3 per day, 10-hour day and 9-hour night shifts. There were 1,408 tons of ore produced, which assayed about 33 per cent. lead, 18 ounces silver, a trace of gold, with 7 per cent. moisture, selling for about \$20 per ton at the Chicago smelter. During the four years ending April 1, 1878, 28,400 tons were mined. Most of this was smelted at the Waterman smelter at Stockton. The cash received for this amount of ore, whether sold as ore or as bullion, was \$988,700. It was conceded that the mine made money, but that the smelter lost it. Several thousand tons of ore were produced prior to 1874.

The Chicago mine was located in 1871, and sold to an English company soon afterward. The mine was worked vigorously for several years, but has been idle since 1876. Ore was found in two pipes 60 feet apart in the "reef" of limestone under the Hidden Treasure. These pipes came to within a few feet of the surface, covered only by the iron cap, and diverged somewhat as they went down. They were in general about 2½ feet in diameter, but varied in shape considerably, especially beyond 400 feet. One pipe was followed 1,300 feet, and decreased in size until it was only 6 inches in diameter, when work was abandoned. This had five smaller pipes branching from it. The second pipe went down quite regularly for 800 feet, then suddenly rose 60 feet and continued on its course. A second rise brought it to the Hidden Treasure vein. The ore is ocherous, assaying from 25 to 35 ounces silver and

from 40 to 45 per cent. lead. On the sides of the pipe there is usually from 6 inches to a foot of a valueless oxide of iron, frequently stained by copper carbonates. The total cuttings amount to about 5,000 feet. The mine is furnished with a Hallidie wire-rope tramway $2\frac{1}{4}$ miles long to the wagon road in the ravine below. This gave great satisfaction, and was at the time of the writer's visit still standing. The mine produced considerably over 12,000 tons of ore. This company owns the Chicago smelter, and when the mine failed bought the Queen of the Hill, Flavilla, and Mahogany locations. These claims are on three chimneys in a bedded vein, from 1 to 6 feet wide, dipping 17° to 25° W. between a siliceous limestone above and a blue limestone stratum below. They were located in 1870-'71, and were worked extensively between 1873 and 1877, but very little since. Shortly after the purchase the Chicago company came to the fault and failed. The Flavilla Mining Company was then organized, and had just begun prospecting to find the vein beyond the fault. This group of claims was the most developed of any in the district, and is situated about half way up a large steep hill, 1 mile south of Jacob City. The dip of the chimneys is N. 30° W., being oblique to the dip of the strata. The distance between them is about 80 feet and 150 feet. Two faults were found, one along the line of the Mahogany chimney northeast and southwest, and the other nearly at right angles to it, faulting all the ore chutes and dipping a little northeast. This fault showed a fissure 20 feet wide, of which 4 feet on one side was calcite (locally called "water spar"), the remainder being filled with clay and fragments of country rock. The first chimney was 350 feet long (before being cut by the fault) and was from 25 to 40 feet wide, having a thickness of from 18 inches to 2 feet of ocherous ore containing but little copper, and said to assay from 20 to 25 ounces silver and 50 per cent. lead. The second chimney was 1,000 feet long, from 60 to 70 feet wide, and also had from 18 inches to 2 feet of ore, generally upon the hanging wall, assaying about 40 ounces silver and 30 per cent. lead. The third chimney was about the same size as the second, but the ore contained some tetrahedrite, much malachite, and little lead, and assayed about 60 ounces silver. The claims are opened by two main inclines 1,000 feet and 1,400 feet long and 6 feet square, which branch near the surface like the letter Y. The horizontal development is 1,200 feet. It is claimed that there are 8 miles of openings, but if the stopes were not counted there would probably be not over 12,000 feet. The hoisting works have a Copeland & Bacon vertical engine of 35 horse-power. A double-track tramway with $\frac{3}{8}$ -inch steel-wire rope extends several hundred feet from the mine to the bed of the ravine below. The product of these mines could not be ascertained. It was probably over \$1,000,000, as 26,000 tons, assaying from 30 to 40 ounces silver, were shipped while Mr. Davis was the superintendent.

The Mono mine is situated half a mile south of Jacob City. It was discovered in the autumn of 1871, and was owned in its early days by Gisborn, Embury, Heaton & Miller. It was worked vigorously by them until 1875, when Gisborn bought the remaining two-thirds interest for \$400,000, mortgaging the whole to eastern capitalists for the money. About three months after the sale a fault was found, or the ore chute "pinched", and only a small prospecting force was employed until June, 1879, since which time it has been idle. Ore began at the surface and was found in a chute from 10 to 50 feet long, from 3 to 5 feet wide, and 300 feet deep. Below that depth it was in a series of small deposits. It was an oxidized ore, from silver, lead, copper, and iron sulphides. Slabs of horn-silver were frequently found so soft that they would retain the impression of a coin like wax. Its value, by the ton, was from \$150 to \$5,000 in silver. This ore occurs in a stratum of clay shale. The ore chute seems to cross this stratum and enter a black shale at a depth of 400 feet. In the lower workings the ore was limited in quantity, and only assayed about \$100 per ton. The main incline is 850 feet long, with an angle of about 33° . The greatest horizontal extent of the development was only 300 feet, but the total cuttings amounted to 2,000 feet. It was the opinion of many who were familiar with the mine that the dip of the incline was away from the ore chute. The mine had small hoisting works which cost about \$12,000. The total product was not known, even by the original owners, as they divided the proceeds after the sale of each lot. By one it was placed somewhat over and by another somewhat under \$1,000,000.

The Mono Tunnel site is in the ravine 800 feet below the Mono mine. Work was begun in 1872 or 1873. The tunnel is about 1,100 feet in length. Burleigh drills and an air-compressor were used. Only assessment work has been done for some time.

The Kearsarge mine, located half a mile west of Jacob City, was discovered in 1871, and has been idle for a few months. The ore-bearing formation is a stratum of limestone, in which the ore occurs in chimneys and exceedingly irregular masses. The overlying stratum or hanging wall is a very compact siliceous limestone. One chimney began at the surface and went down 500 feet. In this there was a chamber 70 feet long, 30 feet wide, and from 10 to 25 feet high. Three or four other bodies were found near the main chimney. In one of them several tons of \$10,000 chloride ore were encountered. The ore is a soft ocher, similar to that of the Hidden Treasure, but much richer. The mine was opened by a 945-foot incline, having a dip of 30° to 35° . It was not prospected over 100 feet horizontally, but contained at least 3,000 feet of cuttings. The ore continued in the bottom of the incline 20 inches in width, but water had stopped the work. The hoisting rig consisted of a whim with a $\frac{3}{4}$ inch steel-wire rope. The total product was unknown; perhaps \$1,000,000 had been received. Belonging to this property is the Jennie claim, having a 350-foot incline and 650 feet of other cuttings. A few hundred tons of 40-ounce ore were produced.

The Deseret group consists of the Deseret, Shoo Fly, Azure Queen, Ivanhoe, American Flag No. 2, and Thad. Stevens, overlapping claims. They were located in 1870-71. Work on them was begun in 1874, and discontinued January 1, 1879. The Deseret claim has a 750-foot incline, following the chimney at an angle of 45°. There was little drifting. There are small, neat hoisting works, containing a 50 horse-power engine, and a Bowers air-compressor was used to run two Woods drills. The ore has a lime gangue, containing very little iron, oxide of lead, and assayed 70 ounces silver and a trace of gold. The Thad. Stevens has a 380-foot incline and about 250 feet of drifts. The ore of this chimney averaged about a foot in width, and assayed 35 per cent. lead and 30 ounces silver. The total production of the group was estimated at \$30,000.

The other mines of Dry cañon are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Wandering Jew	4,200		Little work done.....	A few hundred tons of 30-ounce silver and 35 per cent. lead ore extracted.
Utah Queen	900		Assessment work done...	Large amount of ore extracted.
Sacramento	800		Idle	Considerable ore taken out formerly.
Mountain Savage and I. X. L.	1,000	2,100 tons.....	Assessment work done...	Ore assays 40 ounces silver and 25 per cent. lead.
Emporia	1,600	\$30,000.....	Leased.....	
Fourth of July.....	a440	1,000 tons.....	Assessment work done...	Ore assays 30 ounces silver and 35 per cent. lead.
Evening Star.....	350		do	Some good grade ore shipped.
Magnolia.....			do	Several hundred feet of incline and drifts. Much money spent, little received.
Rattler.....			Idle	Few hundred feet of work done.
Brooklyn.....			do	Do.
Elgin.....			do	
Noyes			do	

a Incline; also other cuttings.

There are many other claims having considerable development which are not mentioned, as they were not represented at the time of the writer's visit.

CAMP FLOYD DISTRICT.

[November, 1880.]

The Camp Floyd district is south of the Ophir district, and is on the same range. It is an irregular rectangle, from 7 to 9 miles on a side, the mines themselves, however, being included within an area of a square mile. Five hundred and ninety-five locations had been made, of which but twenty-five were held at the time of the writer's visit. Aside from those employed by the Carrie Steele Company, not ten men had been working in the district during the preceding twelve months. The formation is a blue-black limestone, dipping from 10° to 25° NE. An exception to this is a stratum of quartzite or siliceous limestone (locally called a "reef"), from 25 to 75 feet thick, on which all the claims are located. Lewiston, the town of the district, is 18 miles southeast of Stockton, with which it is connected by a good wagon road. The Carrie Steele mine is about one-quarter of a mile from Lewiston, and is 7,000 feet above sea-level. It was discovered in 1873 by Leandro Steele; was worked from 1876 to July, 1879, when it was sold to the Carrie Steele Mining Company, of New York. This company has a capital stock of \$1,000,000, in 100,000 shares. A working capital of \$30,000 was raised by the sale of 20,000 shares. The ore in this reef outcropped in a single spot upon the hillside. The workings so far have been through three tunnels, and have explored a space not to exceed 50 feet in depth and 200 by 274 feet. The levels and drifts amount to 1,420 feet. One large body of antimonial ore, 20 feet thick and 60 by 70 feet in extreme width and length, was found at the surface. The richest ore averaged \$700, and occurred in a seam from 8 to 10 inches wide, next to the roof. There are three crevices a few inches wide, parallel, and 30 feet apart, which ran NE. and SW. through the "reef". The secondary small bodies of ore were found on the northwest side and adjacent to these crevices. The ore is a hard, tough siliceous limestone, rarely soft and fine, sometimes much broken, and containing seams of oxide of iron and crystals of quartz and calcite. The silver is in the form of horn-silver, except in the case of the antimonial ore. This last ore seems to be an argentiferous stibnite, and assays from \$100 to \$500 per ton. The great mass, however, is low grade, from \$15 to \$50, until sorted, and is free milling. No water is found. In the census year about eighteen men were employed, and 1,500 tons of unsorted ore were produced. The sales of ore prior to the purchase by the present company amounted to about \$80,000.

The mill is a wet-crushing 20-stamp silver mill, having eight pans and four settlers. It was built by an English company in 1872-73 to work the ores of the Sparrowhawk mine, and was said to have cost \$80,000. It was purchased by the Carrie Steele Mining Company in 1879, and ran from May 10 to August 15, 1880, since which time it has been idle. The mill is a quarter of a mile from the mine. The cost of hauling ore was 75 cents per ton. Owing to scarcity of water, which was brought 2½ miles in a pipe, it was pumped from the settling tanks and flowed again through the battery. Ore was worked with salt and sulphate of copper. This method is said to save 83 per cent.

of ordinary ore and 60 per cent. of the antimonial ore. Tailings assayed \$6. The cost of milling per ton was said to be only \$5. Probably a long run would materially raise these figures. The mill had an Aiken furnace, which was not used.

The other mines of the Camp Floyd district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Sparrowhawk	0,000	\$300,000.....	Idle	Ore similar to that of the Carrie Steele.
Star of the West.....	500	None	do	No ore shipped.
Silver Circle	1,000	Small	do	In 1873 many thousand dollars spent in prospecting.
Silver Cloud	800			Formerly shipped a few hundred tons of \$30-ore.
Mormon Chief	1,000		Idle	Little done since 1875.
Elkhorn	550	\$50,000.....		

Cinnabar.—Above the ore-bearing quartzite stratum is a 30-foot stratum of siliceous limestone. This contains cinnabar in seams, cavities, and in the solid rock. Reports conflicted as to the thickness of this bed, the estimates varying from 12 to 40 feet. Some very rich specimens had been obtained, but it was not thought that the mass would average over 1 to 2 per cent. of quicksilver. There are several claims, the principal of which are the Geyser and the Jenny Lind. The developments are very limited, no attempts having been made to reduce the ore. This district and Marysville, Pi Ute county, are the only localities in the territory where cinnabar has been discovered.

TOOELE MINING DISTRICT.

[November, 1880.]

The Tooele district is situated on the western slope of the Oquirrh range opposite the West Mountain district. It was organized in 1870, and contained 120 claims. The organization, however, has not been preserved, and all claims are abandoned except the Clipper, Rob Roy, and a few others. The Clipper consists of a single pipe of ore in quartzite, from 2 inches to 5 feet thick, and from 2 to 10 feet wide, and has been developed by a 600-foot incline. The total yield is estimated at \$10,000. The Rob Roy has 300 feet of openings, from which a few tons have been shipped. Both these mines are worked irregularly.

In the neighborhood of Tooele City there are 12 stone bee-hive kilns, constructed at intervals between 1874 and 1880. They are run irregularly by Mormon owners, who sell the charcoal produced to Stockton smelters.

GRANTVILLE, OSCEOLA, GREELEY, BOULDER, COLUMBIA, OASIS, DESERET, GRANITE MOUNTAIN, CLIFTON, AND LAKESIDE DISTRICTS.

The Grantville district is situated on the eastern slope of the Onaqui range and was organized in June, 1875. There are but few claims, mostly undeveloped. The Third Term is the principal mine. It is 8 or 10 miles southwest of Grantville. So far as known, it consists of a large chimney, 14 feet square in places, of "hard carbonate" low-grade ore in limestone. Work was begun in 1877, and \$15,000 has been spent in prospecting the claim. It has a 450-foot incline and 600 feet of drifts, and a 600-foot tunnel (not completed) is being run to cut the chimney at a great depth. The ore is a smelting ore carrying from 10 to 15 ounces silver. A few hundred tons have been sold, yielding \$2,000. There are several thousand tons of low-grade ore in sight. In the census year, fourteen men were working six months. The Osceola has several hundred feet of cuttings, showing some copper and silver ores.

The old Osceola, Greeley, and Boulder districts, situated south of the Camp Floyd district, had but few locations, and were abandoned some years ago.

The Columbia district is 9 miles southwest of Vernon, and was organized in 1871. There was some excitement here in 1871 and 1872, and again in 1875 and 1876. In 1875 an Ohio company spent a large amount of money very recklessly and failed. The country rock is limestone, quartzite, and slate. The veins are usually large, averaging from 3 to 4 feet; but the ore is too low grade to pay at that distance from a market. It was said to average from 10 to 25 ounces silver and from 30 to 40 per cent. lead. Several hundred tons have been shipped. The developments are, as a rule, very limited. Only about ten claims have kept up assessment work.

The Oasis district was called North Tintic in 1873, Caledonia in 1875, and was given its present name in 1879. There are, probably, twenty locations in force. The ore is milling and smelting of varying grade. There is very little development. Wood and water are plenty.

The Deseret district, in the desert west of Columbia and Oasis districts, contains one strong copper vein, from 1 foot to 3 feet wide, in granite. The ore is low-grade in copper and silver, and the developments are nominal.

The Granite Mountain district is on a mountain in the same desert as the above district, and still farther west. There are said to be a few very narrow veins of rich silver ore in granite. There are three good springs of water in the district. A California company did considerable unprofitable work here years ago.

The Clifton district is situated on the borders of Nevada and Utah, 3 miles northeast of the Deep Creek Indian reservation, and 70 miles southeast of Toano, Nevada. It was organized in 1869 or 1870. A smelter was built in 1871, and was moved in 1876 to a spot 6 miles distant by the Saint Louis Consolidated Company. Probably 150 tons of bullion were produced in the various runs. The country rock is said to be limestone and granite. There are numerous veins of gold quartz from 2 to 10 feet wide, claimed to average \$15 per ton, and some small veins containing galena and pyrite ore. About 50 claims, of over 500 located, are still worked occasionally. Little has been done since 1877.

The Lakeside district is situated on the southern and western shore of Great Salt lake. The excitement here was from 1871 to 1874. Little has been done since. There are a number of mines, about 2 miles from the lake and on a ridge 500 feet above it, which contain large bodies of ore assaying from 6 to 15 ounces silver and from 50 to 70 per cent. lead. The country rock is limestone. A large amount was mined and shipped across the lake, but not profitably.

JUAB COUNTY.

TINTIC DISTRICT.

[September, 1880.]

The Tintic district is situated on a range of high hills, a continuation of the Oquirrh mountains, about 70 miles S.W. of Salt Lake City. It extends 10 miles east and west and 15 miles north and south, and contains the three mining camps of Silver City, Eureka, and Diamond. It was organized December 13, 1869, and the records showed 3,000 locations. Probably not over 500 are claimed, and less than 100 are developed to any extent. The elevation of the claims will vary from 5,500 to 7,000 feet. The winters are very mild, and mining operations can be conducted during the whole year. The country rock is porphyry on the east, and limestone and quartzite on the west. There are three prominent mineral belts: the Mammoth-Eureka, Sunbeam, and Julian Lane, besides many smaller veins or disconnected deposits. This district was quite active prior to 1876, but most of the work since has been upon a half dozen large mines. The total production of the district can hardly be estimated, owing to the number of old and abandoned reduction works and the numerous changes in their management. A rough estimate would place it at something less than \$2,000,000. The reduction works in the district have been as follows:

Clarkson smelter.—Two stacks. Erected at Homansville in the summer of 1871. Smelted ore from the Scotia, Swansea, and Eureka. Produced a few hundred tons of bullion. Shut down in 1872 and moved away. Dump has been sorted over two or three times with good results.

There were two smelters at Diamond, long since removed; one made a successful run of several hundred tons of bullion.

One smelter, copper and lead, was erected in 1873 near the present Crismon-Mammoth mill. It worked about 1,000 tons.

Eureka mill.—12 stamps. Erected at Homansville in 1871-72. Very little work done. Removed.

Miller mill.—10 stamps. Erected in 1872. Ran a year and a half. Dismantled.

Copperopolis mill.—15 stamps. Built in 1872-73.

Copperopolis copper smelters.

Shoebidge mill.—15 stamps. Built in 1873.

Wyoming mill.—10 stamps. Built in 1873.

Crismon-Mammoth mill.—27 stamps. Built in 1879.

Latham's furnaces (2).—Erected at Goshen in the fall of 1874. Ran at intervals for six months, producing 7½ car-loads of bullion and one of copper matte. Were unsuccessful and are dismantled.

Leaching works.—Built at the same place in the spring of 1876. Worked about 250 tons of ore, only averaging 40 per cent. of assay value.

Leaching was unsuccessfully attempted in the spring of 1879 in small, rude works fitted up in the old Miller mill.

At the period under review most of the mines shipped their ore from 20 to 30 miles to Santaquin, a station on the Utah Southern railroad, at a cost of from \$2 75 to \$3 50 per ton, and thence by rail to the Sandy smelters. Owing to the absence of some owners complete statistics and descriptions cannot be given.

The Mammoth-Copperopolis mine was discovered in 1870, and was sold the following year to an English corporation, the Mammoth-Copperopolis Mining Company, for a large sum; reports vary from \$60,000 to \$600,000. A large amount of copper ore was shipped to England, and a 15-stamp mill and two copper smelting furnaces were erected in 1873 7 miles south of the mine. The mill ran a few months, and then shut down. The copper smelters made matte for some months longer, and have made occasional campaigns since. The company failed in 1873, and the property was sold for debt. It was redeemed by Lord Hamilton, and the British Tintic-Mammoth Mining Company (limited) was formed in the fall of 1878. The property has been worked irregularly since. It was idle at the time of the writer's visit, but from information given by the foreman the writer is enabled to give the following brief description: The mine is patented, and is 1½ miles north of Silver City. It is a mineral belt, from 50 to 100 feet in width, dipping 70° W., between strata of dolomite or limestone. The gangue is a siliceous limestone, usually strongly impregnated with oxide of manganese. The ore occurs in bodies of all shapes and sizes from an inch to 20 feet in width. Five large deposits have been found, the largest one, which began at the surface, being from 10 to 25 feet wide by from 60 by 70 feet. The ore is hard, tough, and siliceous, containing malachite and, in the lower workings, some sulpharsenide or sulphantimonide of copper. The ore is supposed to average from 5 to

8 per cent. copper, from \$8 to \$11 gold, and from \$15 to \$35 silver. This is but a mere guess, not being based on actual working tests of large lots of ore as it comes from the mine. At all events, there were in the mine large lots of low-grade ore. Besides surface work, the mine is opened by two tunnels, 350 and 270 feet, through the hanging wall of the belt. The total cuttings do not exceed 2,000 feet. No water has been found. The total product is unknown. It is estimated that about 5,000 tons were shipped. The mill, containing fifteen 750-pound stamps, eight small pans, and four settlers, was built in 1873, and, at the period under review, was in fair condition. The water supply was, however, not sufficient to run it.

The Crismon-Mammoth mine was discovered in 1870, and has been worked, at least by a small force, continuously since. The mine was considered a copper mine only until the summer of 1875, when silver was discovered. In August, 1876, gold was also found in the bullion. Copper ore was shipped to Baltimore prior to 1874. Between July, 1876, and September, 1877, ore was shipped to the Homansville mill. The company's mill was then built. The mine is situated on a steep hillside at the head of a short ravine a mile and a half north of Silver City. It is supposed to be the continuation of the Mammoth-Copperopolis belt. The known dimensions of the ore-bearing formation, extreme limits, are 70 feet wide, 450 feet deep, and 500 feet long. The belt is in dolomite, dipping 75° W. The ore occurs very irregularly in the vein, in all shapes and sizes less than 25 feet in extent. There seem to be three veins in the belt, with barren spaces or horses between them. About half the ore is a coarse, tough siliceous rock stained with malachite and azurite in seams and cavities. The remainder is firm, and consists of crystals of calcite with oxides of iron and manganese. Very little of the silver contents is in the form of a chloride. At the time of the writer's visit the ore was worked for the gold contained, which was nearly equal to the silver value. There are large masses of ore, many thousand tons, exposed by the various openings in the mine. Until lately few timbers have been used. For several years the mine had worked rather with a view to its present prosperity, only the richest ore being taken out. Timbering was being done with square sets. Round timbers were employed from 9 to 12 inches in diameter; 8-foot posts, 8-foot ties, and 7-foot 6-inch caps. The mine is dry, and is worked entirely through two tunnels, 100 and 440 feet long, which cut the belt 80 and 240 feet below the croppings. The total openings are about 4,000 feet in length. About ten men were employed during the census year, and 3,448 tons were sent to the mill by four- and six-horse teams at a cost of \$4 50 per ton. The production in early times is unknown. A rough estimate places it at from \$50,000 to \$75,000 for the copper ore sold. Between June, 1874, and June, 1880, \$301,430 87 was received over and above the express charges and bullion discount. Of this amount \$81,000 was estimated to be for silver, \$189,000 for gold, and the remainder for copper. In addition to this it was claimed that \$100,000 in gold specimens was stolen when a fabulously rich band of gold ore was found. The dividends paid between June, 1874, and June, 1880, amounted to \$109,205 16.

The mill is situated in Tintic valley, 8 miles south of the mine. It is a 27-stamp mill, consisting of 5 stamps from Ophir, 10 from the Miller, and 12 from the old Eureka mill. It was constructed between December, 1876, and February, 1879, and crushed wet until March, 1880. A White & Howell furnace was then added, but was soon shut down. Wet-crushing was again begun in August, 1880. But little systematic assaying has been done, and but few records kept. The apparatus of the mill consists of seventeen 750-pound stamps, ten 550-pound stamps, a rock-breaker, five pans, three settlers, a White & Howell furnace, and a retort. Twelve of the stamps are in batteries of four each. The drop is 6 inches, single discharge, Nos. 50 and 60 brass-wire screen, speed 90, and capacity from 30 to 40 tons in twenty-four hours. The pans are charged with bluestone and salt, and run from six to eight hours. The bullion is very base, containing much copper. The tailings, of which there were several thousand tons on hand, are said to assay \$9 and over in gold and silver. The White & Howell furnace is a very fine one. It has a 24-foot cylinder, 60 and 50 inches in diameter, with flue-dust chambers 60 by 14 by 9 feet. It ran but a short time, and, while giving good results in chloridizing the silver, is said to have "rendered the gold less free". No reliable data could be obtained.

The Eureka Hill mine was discovered in 1870. In 1871-'72 a 12-stamp mill, without a furnace, was erected, which would not work the ore. In 1873 the property was sold for several hundred thousand dollars. Final payments, however, were not made, and the property reverted to the original owners. There have been many legal complications about the ownership of this property, and a stone fort was once regularly garrisoned to defend it. In early times ore was worked at the Homansville smelter and at the Shoebridge and Wyoming mills. Later it was sold to the smelters at Sandy. Since July, 1880, much of it has been shipped to the Tintic mill at Homansville. The property comprises two patented claims, the Eureka and the Montana, 2,200 by 200 feet each, and was owned, at the period under review, by a close corporation called the Eureka Mining Company. These claims are on two nearly parallel veins, about 100 feet apart, which dip from 80° to 85° W., and strike nearly north and south. Between them are found connecting pipes and ore bodies, and together they constitute a mineral belt which is supposed to be a northern extension of the Crismon-Mammoth, but separated from it by a great fault. This belt runs along a spur from a high steep ridge, on which the ore outcropped in several places many feet long and wide, and running under a narrow valley outcropped again on the opposite ridge several thousand feet distant. About 300 feet north of the southern boundary of the company's ground these two veins unite. From the point of junction northward for several hundred feet there is an extremely hard compact horse or block of dolomite country rock between the two veins. At the north end of this horse the gangue is much broken, and chimneys and seams of ore running in all directions are

found. This gangue is a tough siliceous limestone, much of which is impregnated with oxide of manganese. Apparently the lime and magnesia have been replaced in part by silica and oxide of manganese from solutions. The ore is very similar to the gangue, but is generally stained with carbonates of copper and some oxides of iron. In one part of the lower works oxide, carbonate, and sulphide of lead are found with traces of pyrite and zincblende. A small percentage of the silver is chloride. Gold occurs in places. There is one large chimney of hematite. In general, the ore and gangue shade insensibly one into the other. If the ledge matter is compact it is low grade, but if it is open and seamy it is good ore. There are large breasts of ore in the mine, which, it was claimed, would average from \$30 to \$40 silver per ton, and some gold. Most of the ore contained a small percentage of copper. In the old dumps on the ridge there are several thousand tons of ore, rejected in early days, that would probably assay \$25 per ton. On the surface some wonderfully rich ore was found, and large bodies in the mine have averaged from 60 to 100 ounces in silver. Comparatively little ore is being extracted, considering the many thousand tons of ore in sight, and that only of the highest grade. The company intends to prove the mine and to see how much and what kind of ore has to be dealt with before erecting reduction works. The bodies of ore found are of all shapes. Several upon the surface are from 2 to 20 feet wide, from 15 to 75 feet long, and from 10 to 50 feet deep. Few of the bodies in the recent workings have been developed to any extent. They show ore from 10 to 20 feet wide. The extreme limits of the explorations on the belt are 680 feet of depth below the croppings, 100 feet of width, and 1,000 feet of length on the surface. No water is found. The mines are developed by several tunnels upon the belt and by two vertical shafts. The main shaft is a two-compartment shaft on the edge of the valley between the two veins. It is 230 feet deep, and is well timbered, but only a horse-whim is used on it. The total cuttings are estimated at 5,400 feet. About twenty-five men were employed during the year, working 10-hour shifts, at \$3.

The No. 5 or Walton claim, and the Nos. 6, 7, 8, and 9 on the ridge, are southerly extensions of these claims. They contain over 1,000 feet of irregular work, and shipped considerable high-grade ore in early times.

The Ely mill was built by the Shoebridge company in the fall of 1873. It ran irregularly as a custom mill until February, 1877, when the company failed. The Hunt & Douglas process was introduced in 1876. The property was bought by S. P. Ely in 1878, who ran it as a custom mill between October, 1878, and September, 1879. It had been idle since that time, but the superintendent expects to resume work shortly. The machinery consists of an 80 horse-power engine, a Blake rock-crusher, a drying floor, fifteen 750-pounds stamps, six pans, three settlers, a clean-up pan, an Aiken furnace (not used), a Stewart five-hearth reverberatory, and a complete plant for the Hunt & Douglas process. The battery is double-discharge, dry-crushing, 8 inches drop, speed from 85 to 90, No. 40 screen, and 20 tons capacity. The guides are peculiar. They consist of hollow cylindrical iron tubes having a perforated screw-cap fitting the upper end. The tubes are filled with rawhide rings, and the cap is screwed down as the hide wears. They give satisfaction. The five-hearth reverberatory is 66 feet long and 12 feet wide, having a fire-box at each end and the flue on one side at the center. On the other side at the center is a projection like a bay window, and over the center is a hopper filled by a screw-conveyer, from which ore is fed into the furnace. The five hearths are separated from each other by a jog the thickness of a brick; the "warming hearth" in the center; two "oxidizing hearths", one on each side; and two "chloridizing hearths" between the "oxidizing hearths" and the fire-box. The arch over the "warming hearth" is 10 inches, that over the "oxidizing hearth" 18 inches, and that over the "chloridizing hearth" 36 inches high. The charges are 1,200 pounds every one and a half hours. The "warming hearth" has a new charge every one and a half hours, and the others every three hours. Hence the capacity of the furnace is $9\frac{1}{2}$ tons per day. Ten per cent. salt is added one and a half hours before drawing the charge. The labor required is two men per shift. The process used at the mill, to a limited extent, is to crush dry, roast with salt, treat by Hunt & Douglas's method for silver and copper, and then amalgamate in pans for gold. Sometimes amalgamation is performed first, and the tailings, if assaying over 12 ounces per ton, are then treated by the Hunt & Douglas process. The theoretic and practical details of the process have been published many times, and it is not necessary to repeat them here. (See U. S. Mg. Comm. Report, 1876, page 395.) No complete and reliable data relating to the actual treatment of large quantities of ore by this process can be furnished in this case, as such data were not kept and the mill is not run regularly. The Hunt & Douglas plant at this mill has a capacity of about 10 tons per day, and consists of the following: The building, 80 by 45 feet; six agitator tanks, 9 feet in diameter and 5 feet high; six leaching tanks, same size; five store tanks above agitators, 7 feet in diameter and 6 feet high; three box vats for filters, $2\frac{1}{2}$ feet square and 14 feet long; fourteen silver-precipitating tanks, 4 feet in diameter and 26 inches deep; and sixteen copper-precipitating tanks, same size. The floor of the tank-room is made tight and smooth by cement, so as to catch the drippings, which are conducted in a gutter to a cemented cistern in the ground. The amount of solution in use is about 30,000 gallons. The silver and copper left in the tailings is 4 ounces and less than 1 per cent., respectively. A pump attached to the lower part of the leaching tanks shortens the time required. After working some Golden Treasure ore, which was known to contain considerable bismuth, the solution became very cloudy and bad, and did not clear for a month. The necessary force is six men per shift, two leachers, two roasters, and two roustabouts. The mill offers to purchase or work ore at the following rates: 80 per cent. of the assay value of the ore in silver and copper, plus 50 per cent. of the assay value of the gold, if over \$5 per ton, less \$25 for working. The above amount is given in bullion, or the bullion is bought at the market price. These rates seem very liberal when compared with those in some

other districts, but they were not quite low enough to suit the miners. There are large bodies of low grade ore in the district containing gold, silver, and copper, and free from objectionable minerals as far as known. The writer does not know of a process more suitable for these ores. The copper usually wasted, which this process saves, would ordinarily pay more than half the expense of milling.

The Golden Treasure mine is on the northeast slope of Chloride hill, 2 miles southeast of Silver City. It was discovered in 1871. Owing to lawsuits with the Mayflower, Lillian, and Gold Hill claims, little was done until 1875. It was then extensively worked until the spring of 1879. It was idle until July, 1880, since which time it has been worked by three men. The claim is located on a belt of quartzose rock, 100 feet or more in width, in a porphyritic rock or, at least, adjacent to it on the west. The dip is 80° E.S.E., and the prominent quartzite croppings extend several thousand feet. The ore is found in chimneys, five of which occurred near the hanging wall. One body came within 20 feet of the surface, one was exposed, and the others were not within 150 feet of the grass. One body was 60 by 70 by 20 feet, and one was 150 by 100 by 5 feet. The chimneys were from 1 foot to 10 feet (average 3 feet) wide, from 10 to 40 feet long, and were known to extend from 150 to 250 feet in depth. They dipped in all directions in the belt. On the east side of this belt is a vein of ocher from 1 foot to 10 feet wide, which gives assays of from 10 to 32 ounces silver, and from \$5 to \$15 gold. The ore is a very soft, fine-grained, light yellow clay ocher, which is said to mill freely. Average assays of first and second class show 65 and 35 ounces silver, respectively. All the ore contains a few dollars in gold. Occasionally, small bodies of a few pounds each of a soft, light-blue substance, assaying from 20 to 50 per cent. bismuth and several hundred ounces in silver, are found. The bismuth is doubtless in the form of an oxide or carbonate, and results from the decomposition of some sulphide compound. The mine is dry, but from the water-level in adjacent claims it was judged that water would be encountered in 50 feet. The property is developed by a 380-foot incline, from which levels and some cross-cuts have been run every 100 feet. The drifts on the belt extend 528 feet. The cuttings aggregate 2,570 feet. Ore is raised by a whim. The total product was estimated at 5,500 tons, containing 45 ounces silver per ton.

The other mines of Tintic district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Bullion	315	\$10,000	Worked irregularly	
Bonanza	800	.....	.....	During census year 80 tons were sold at about \$55 per ton; ore assays \$96 27 silver and 10 per cent. lead.
Banuer	305	1,500	Idle	
Woodmansee		100 tons .....	.....	Developments limited.
Kinsey Ground	900	.....	Idle	Worked continuously from 1869 to 1877. Average assay of ore, \$50 to \$70 per ton.
Sunbeam	^a 310	.....	Eight men at work	Several hundred tons of ore shipped.
Blmer Ray	1,500	\$20,000	Nine men at work	Average assay of ore, \$10 silver and \$20 gold.
Julian Lane	3,000	4,000 tons	Idle	Much of the ore assayed \$200 per ton.
Tesera	530	\$200,000 .....	.....	Ore assays 25 to 80 ounces silver, \$20 and under gold, and 10 to 15 per cent. copper.
Golden Bell .....		.....	.....	A few hundred feet of workings. Some ore shipped. In fall of 1870, 600 pounds shipped to Europe assaying \$105 silver and 50 per cent. bismuth; sold for 75 cents per pound.
Lady Aspinwall	1,000	.....	Idle	Many hundred tons extracted in early times.
Windigo M. Co		Very small	Little done	Vein wide, but little ore found.
Silver Spar	610	\$15,000	Idle	Ore assays 75 ounces silver and 22 per cent. lead.
Shower	800	.....	Worked on lease	Product, several hundred tons. Ore assays 50 ounces silver and 45 per cent. lead.
Morning Glory	650	.....	Active	A few hundred tons have been produced.
Sunbeam No. 2		None	Idle	Many hundred feet of openings. Many thousand dollars expended.
Parke	2,000	40 or 50 tons	Eight or ten men at work	Ore assays: first class, \$30 silver and 45 per cent. lead; and second class, \$20 silver and 25 per cent. lead. But little ore has been shipped.
Swansea	2,400	1,000 tons	Three men at work	Average of assays, 70 ounces silver and 38 per cent. lead.
Carson	425	25 tons	Four men at work	Ore assays 70 ounces silver, 12 per cent. lead, and \$7 gold.
Rising Sun	680	30 tons	One man at work	Thirty-four assays averaged \$63 per ton.
Lucky	700	.....	Idle	Shipped considerable ore.
Endino .....		.....	.....	Much work done and much ore extracted in the past.
North Star	350	.....	.....	Average assay of vein, \$20 per ton.

^a Shaft.

In addition to the above claims, there are many others, having several hundred feet of developments, which had shipped ore, but were idle at the time of the writer's visit. (For a description of the Tintic mill see Utah county, page 446. The mill belongs to this district, but is situated a few miles over the county line.)

TINTIC IRON MINES.

Large deposits of hematite and limonite iron ore are found in this district, on Black Dragon hill, three-fourths of a mile east of Silver City; and in Black Stallion gulch, 6 miles east of Silver City. Formerly the Sandy smelters obtained their iron flux from near Rawlings, Wyoming. In late years, however, it has all been obtained from the two above-mentioned localities. The business is managed in the following manner: The Utah Forwarding Company pay \$1 25 for Black Stallion ore and \$1 50 for Black Dragon ore on the dump. Mormon teamsters from the adjacent settlements haul Black Stallion ore 16 miles to the railroad at Santaquin for \$2 50 per ton, and Black Dragon ore 25 miles to the same station for \$3 25 per ton. The Forwarding Company then sell it to the smelters at private rates, varying from \$7 to \$8 per ton. The mine owners lease the mines at a royalty of from 25 to 50 cents per ton, or hire miners, giving from 75 cents to \$1 per ton for extraction. The miners make from \$2 to \$2 50 per day. An average of eighty men were employed during most of the census year, and seventy-five teams for ten months. Black Dragon ore contains about 55 per cent. iron, and is called first class. Black Stallion ore had only 45 per cent. iron, and is known as second class. Each kind contains traces of gold and silver. During the census year 2,112 tons of first class and 10,611 tons of second class ore were shipped.

BLACK DRAGON HILL MINES.—There are many places on the south side of the hill where the ore, principally hematite, comes to the surface in a "blow-out" 200 feet or more wide. It is here in open cuts that the iron is obtained. A tunnel 600 feet long was run from the ravine at the base of the hill, in the expectation of finding a body of silver ore. The iron vein, where it was cut, was from 25 to 30 feet wide, between limestone and porphyry. Between the iron and the porphyry is a stratum or vein of kaolin from 20 to 100 feet wide. In places it has a blue or yellow tinge, but for many feet it is almost milk-white.

BLACK STALLION GULCH MINES.—These mines are in an area three-fourths by one mile in extent. The belt trends east and west, and is on the line of contact between limestone and porphyry country. The following notes were furnished by one of the owners:

Black Stallion.—This mine had shipped ore for eight years, sometimes 300 tons per month. It had an open cut 70 feet long, 25 feet wide, and 30 feet deep, and plenty of ore at each end.

Iron Queen.—Continuation of the Black Stallion. Cut, 35 feet deep. Had shipped ore for five years.

Red Chief.—Developed by a surface cut 300 feet long, 30 feet deep, and from 4 to 15 feet wide.

Mountain Chief.—Developed 200 feet in length, 15 feet in depth, and 10 feet in width.

Future.—Large open cuts; 200-foot tunnel; vein, 30 feet wide.

Borriesson.—Surface cut, 200 feet long and 30 feet deep.

Sailor Boy.—Surface cut, 200 feet long, 15 feet deep, and 30 feet wide.

Snell.—Open cut, 300 feet long, 30 feet deep, and from 10 to 12 feet wide.

Iron Star.—Open cut, 250 feet long, 15 feet deep, and 15 feet wide.

All of these mines had shipped large quantities of flux during the year. There were also thirty other flux mines of smaller size which had shipped small quantities.

WEST TINTIC, DUGWAY, AND MOUNT NEBO DISTRICTS.

[September, 1880.]

The West Tintic district is situated from 16 to 20 miles west of Tintic district. It was organized in 1870. Considerable work was done in 1872 and 1873. There have been a hundred or more locations, of which about twenty are held. The country rock is limestone, quartzite, and granite. The veins are usually large, and contain low-grade galena and carbonate ore, assaying from 12 to 20 ounces silver and from 25 to 40 per cent. lead. Very little has been done on any of the claims except the Scotia. In early times this mine shipped to Homansville and Stockton several hundred tons of 70-ounce ore. Wood and water are plenty. The country is a good stock range, and about fifteen men divide their time between mining and pastoral pursuits.

The Dugway district is 60 miles or more west of Tintic district. It was organized in 1872. A few years later a smelter was erected. There are said to be large quantities of galena ore, low grade in silver. There are few locations, and the district is practically abandoned.

The Mount Nebo district was organized in 1870. It is situated on the western slope of Mount Nebo and the adjacent portions of the Wasatch range, extending 15 miles north of Salt Creek. About 130 locations have been made, 10 of which have received considerable attention, and are still held by yearly assessment work. The country rock is limestone. The ore is an ochery carbonate and galena, assaying from \$10 to \$30 silver and 55 per cent. lead, and occurs in narrow-bedded veins. The principal claims are the Olive Branch, Mount Queen, Germania, and Centennial, each having a few hundred feet of cuttings. Only 30 tons of ore have ever been shipped, but, as a Mormon said, "there must be a big ledge there somewhere, for the country is just covered with croppings."

ROCK-SALT MINES.

In Salt Creek cañon, 7 miles northeast of the town of Salt Creek, is the Salt Cave mine. It was a small cave from which Indians formerly obtained their salt. The mine consists of an open cut from the level of the bed of the ravine into the bank, 30 feet deep, 75 feet wide, showing a face of impure salt 25 feet high. From short tunnels and shafts through the adjacent drift this had been proved to be a bed of salt having an unknown dip and thickness. The salt is sometimes crystallized in transparent cubes several inches on a side, but it is usually contaminated with a very fine brick-red clay, and would not show over from 75 to 80 per cent. of pure salt by analysis. The overlying stratum is a fine, blue, sandy clay. The salt is mined with a gad and sledge or by blasting with black powder. It is sold for \$4 per ton on the dump to the mills at Pioche, Silver Reef, Tintic, and formerly Park City. About 5,000 tons had been sold. There is another similar rock-salt deposit 6 miles farther up the cañon, which had produced considerable salt. There are also a few salt springs in the neighborhood which are worked irregularly in a small way by boiling down in a vat or by solar evaporation.

GYPSUM.

This mineral is very abundant in Utah. There are small hills of it near Fillmore, Millard county, and beds of it in Sevier, Iron, and Beaver counties; but it is only mined about 1 mile east of the town of Salt Creek. At this place a bed of it, from 50 to 60 feet thick, dipping 75° W. between strata of calcareous shale, is cut into by a cañon, and exposed for 170 feet in height. It is of the fibrous variety, and is in some places pure and white. It is used for the manufacture of plaster of paris in Salt Lake City. Sixty tons, worth \$5 per ton at the railroad, were shipped during the census year.

SEVIER COUNTY.

ROCK-SALT DEPOSITS.

In a space of 16 miles along the eastern edge of the Sevier River valley, opposite the town of Salina, there are several places where rock salt is found at the surface of the ground—at Willow creek, Salt Gap, Salina cañon, and Lost creek. The Willow Creek salt bed, 7 miles north of Salina, is the most important, and has been known and occasionally worked since 1850. It is an irregular group of low red mounds, 400 feet wide and 900 feet long. These mounds are made up of the fine brick-red clay, sometimes containing fragments of sand and gypsum, remaining after the large masses of salt have dissolved. Sometimes this red clay is many feet thick over the salt, and at others the peculiar icy feeling of salt can be noticed after striking a pick into the hills. The country rock overlying and underlying this salt bed is a sandy shale. Salt has only been mined in two places, 30 feet square and 20 feet high, on a small hill. It seemed to be of the best quality, and was obtained by blasting. The other beds are similar, but not so extensive. Doubtless there is a great salt stratum extending along the side of this valley, but only cropping out in the above-mentioned places. These salt beds are not even claimed, but the roads to them are owned, and a charge of from \$1.50 to \$2 per ton is made for blasting out the salt and the use of the road. The crude material, as it stands in the bank, is supposed to average from 60 to 75 per cent. salt. Only the best, that containing from 70 to 90 per cent., is shipped. The market has been Pioche, Nevada, and Silver Reef, Utah. The total production is estimated at 1,200 tons, and that of the census year at 300 tons. There are some salt springs in the neighborhood, and some small rude salt works, where the rock salt is dissolved, settled, and boiled down, producing 30 tons of table salt per year.

MILLARD COUNTY.

SOLAR SALT MARSH.

The Solar salt marsh is in the northwestern corner of the county, 80 miles west of Deseret station, on the Utah Southern railroad extension, and is 6 miles long and from a quarter of a mile to 1½ miles wide. It has been owned and worked since 1872. The salt has been shipped to Pioche, Ward, and Cherry Creek, Nevada. In the spring the marsh is covered with water, which, upon evaporation, leaves an efflorescent crust of salt several inches thick. It is shoveled into wagons without cleaning. The average yearly yield is said to be 500 tons.

Considerable salt is also collected in dry seasons on the borders of Sevier lake.

SALTPETER.

Saltpeter occurs in caves in lava near an old crater 14 miles west of Fillmore. There are five or six caves 25 feet wide, 100 feet long, and from 8 to 15 feet high. The floors are covered with a guano, in one place of a thickness of 3 feet, which analyses have shown to contain from 7 to 20 per cent. of niter. There is a small spring 1 mile from this place, but no attempts have been made to work it. Some niter was made by Mormons in 1855 from guano in similar caves in Washington county.

SULPHUR BEDS OF GORDON MINING DISTRICT.

The Gordon mining district is in the southeastern corner of Millard county. Cove Creek Fork, the town of the district, is 25 miles north of Beaver. It was organized in 1872. A few locations, showing traces of silver, had been made. No work of consequence was done on them, and at the period under review it was solely a sulphur district. The sulphur beds are 22 miles east of Black Rock, on the Utah Southern railroad extension, and are 6,500 feet above sea-level. The first sulphur discovery was the Cleveland claim, in 1870. It is situated on a small flat 3 miles south of the other claims, and is said to contain a small mound having large quantities of crude alum. It is 50 acres in extent. The remaining fourteen claims are 1,500 by 600 feet each, and were discovered in 1872. They all occur in a triangular area, $1\frac{1}{2}$ miles on a side, where the slope of the hillsides terminates in small flats. The beds seem to extend into or under the adjacent hills of quartzite and siliceous limestone. There is an old crater about 4 miles to the southwest of the group of claims. Only three outcropped, the remainder being discovered by the whitish appearance of the surface, which the scarcity of vegetation disclosed. The sulphur is found from 2 to 12 feet below the surface, covered by surface gravel and a layer of whitish earth (acid-eaten rock), containing fragments of quartzite and gypsum. In some places it is quite pure, and to all appearances the beds should average 50 per cent. sulphur. In two beds there are crevices through which issue streams of warm air containing much sulphurous acid gas. The size of these deposits, as far as proved by small openings, is from 2 to 20 acres; but they may extend several hundred feet beyond the known limits. A shaft had penetrated the sulphur in one bed 16 feet, but in no place had it been bottomed. The developments consisted of a few cuts and holes at each deposit, done as assessment work. No sulphur had been shipped, except a few tons for sheep-dip and for local leaching works.

DETROIT, SEVIER LAKE, AND SAW BACK DISTRICTS.

The Detroit mining district was organized in the fall of 1872 as Drum district, but was abandoned until reorganized under the name of the Detroit in the spring of 1879. There are large copper veins in limestone and granite, the ore containing a few dollars per ton in silver and copper. The claims are the Howard, Gray Eagle, and Mammoth. The first mentioned had several hundred feet of cuttings and had from five to ten men employed during the census year. The camp is 30 miles northwest of Deseret station.

The Sevier Lake and Saw Back districts, in the range west of Sevier lake, were organized in 1872. They contained few locations and had been practically abandoned.

PI UTE COUNTY.

OHIO DISTRICT.

The Ohio mining district is a few miles square and includes several precipitous ridges and deep gorges on the eastern face of the Mount Baldy range, 90 miles south of Juab. It was organized in 1868 or 1869, and reorganized in August, 1872. There were one hundred and thirty locations on the records, but not a quarter of that number are still owned. Marysville, 6 miles from the mines, in the valley of the Sevier river, is the district post-office and the settlement from which supplies are obtained. The veins are mostly bedded veins lying almost horizontally between strata of limestone and quartzite; but some fissure veins in granite or porphyry are found. In general, they are of medium size and grade, and undeveloped. About twenty-five men were prospecting in the district in the census year. Water is abundant and agricultural products are cheap. The altitude of the claims varies from 6,500 to 8,500 feet. In 1872 a 2-stamp mill was erected by the Pi Ute company, but owing to the inexperience of the managers it was a complete failure. Its machinery has long since been scattered over the country, and the district is without reduction works.

The following are the principal mines of the Ohio district:

Mines.	Total length of openings.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>		
Copper Belt	280	Active.....	Ore assays \$200 gold and about 200 ounces silver; 20 tons shipped prior to June, 1880; much since.
Webster and Homestead.....	^a 200	Idle	Ore assays \$12 gold and \$58 silver, average.
Great Western	^b 150	..do	Ore assays \$20 to \$150 per ton.
Morning Star Group	300	.....	Ore high-grade mill; few tons shipped in census year sold at \$120 per ton.
Beecher	500	.....	Ore averages \$25 per ton.

^a Shafts; also cross-cuts, etc.

^b Shaft.

The Chattanooga, Belle of the Vale, Mohawk, Belle of Monroe, Fillmore, Silver King, and others are for the most part "blanket" veins, between limestone and quartzite, containing from 6 inches to 2 feet of smelting ore, assaying \$40 on the average. These had from 100 to 250 feet of cuttings, but had never shipped any ore.

Cinnabar float has been discovered in this district, but no veins have ever been found.

MOUNT BALDY DISTRICT.

[August, 1880.]

The Mount Baldy district adjoins the Ohio district on the north, and extends along the precipitous eastern face of the same mountain range for 8 miles. The general features of the country, topographical and geological, are the same as those of the Ohio district. It was organized September 18, 1878, and the records show one hundred and ninety locations. Aside from the ore of the Deer Trail and Pluto, no ore has been shipped, only a small amount of prospecting having been done. Wood and water are very abundant, and on the whole the district is a very promising one. On the bench at the base of the range and above the river bottom lands, there are extensive banks of drift gravel and bowlders, which, it is said, will give the color of gold anywhere. A little was washed out by Mormons as early as 1862. It probably would not pay to hydraulic it at present.

The Deer Trail mine is situated on a very steep mountain side, 1,500 feet above the Sevier River valley, 5 miles southwest of Marysvale. It was discovered in September, 1878, by a piece of float ore found on a deer's trail, and was the first location in the district. It was worked steadily until July, 1880, when it was bonded. It has been idle most of the time since. The property consists of the Deer Trail, Green-eyed Monster, and Cliff claims on the same vein; the Pi Ute and Red Pine claims on a parallel vein on the bluff 1,000 feet above; two 5-acre mill sites and a saw-mill site. The vein is both a contact and a bedded vein, between a limestone hanging and a quartzite foot wall, dipping southwest from 7° to 20°. The dip increases with the distance from the face of the mountain. The vein is continuous for a distance of 4,500 feet. One body of first-class ore, from 1 foot to 4½ feet thick, outcropped at the surface. Its shape is that of an equilateral oblique-angled parallelogram, 120 feet on a side, having one corner cut off. In the center of this there is a barren triangular space 75 feet long and 50 feet wide at one end. The ore is a soft, friable, greenish-yellow ocher, containing the products from the oxidation of lead, iron, and copper sulphides. It assays about \$8 gold, \$150 silver, and 35 per cent. lead. The second-class ore is a hard quartz, assaying about \$2 gold and \$48 silver, and is still on the dump. The mine is opened by five tunnels, which explore the ground only 120 feet horizontally. The total openings are about 1,200 feet. The exact product cannot be stated, but was a few hundred tons. The cost of shipment to Salt Lake City is \$21 per ton.

The Green-eyed Monster is the northern extension of the Deer Trail. In this claim the vein suddenly enlarges and the ore is of lower grade. The dimensions of this body, as far as known from the large amount of prospecting done, are: Thickness, 35 feet; length, 280 feet; and width, 160 feet. This body of ore is an iron-stained, seamy quartz, with clay and much talcose matter. From a large number of assays that have been made it is estimated that the entire mass would average from \$20 to \$25 per ton, one-third of the value being gold. There were about 2,500 tons of this ore on the dump, which had been taken out in prospecting; and it is estimated that there were 75,000 tons in sight in the mine. There is a fine water-power, but capital is needed to build a mill. In this ore body, as also in that in the Deer Trail, there are crevices from 1 inch to 10 inches wide, which furnish excellent ventilation to the mine. The sides of these crevices are frequently covered with an earthy oxide of manganese and beautiful crystals of wulfenite. The claim is developed by a 120-foot shaft and a 285-foot main working tunnel. The extreme extent of development is 330 feet north and south, and 280 feet east and west. The cuttings aggregate 1,850 feet. No ore has been shipped. During the census year about twenty-five men were employed at from \$2 50 to \$3 50 per day. On the ground claimed by this company there are several undeveloped bedded veins showing from 6 inches to 3 feet of an ocherous lead ore assaying \$45 per ton.

The Pluto mine is on the mountain side above the Deer Trail. It was located in June, 1879. It is a 20-inch vein in limestone. The ore contains horn-silver in which particles of gold are visible. Seven tons of the sorted ore had been shipped and averaged about \$100 gold and \$200 silver per ton. It was only developed by a 40-foot incline and an open cut 6 feet wide and 240 feet long on the face of the bluff.

The Lucky Boy claim on the side of this mountain contains small bunches of selenide of mercury in limestone. This is a rare mineral.

Other promising prospects in the district are the Alma, Plata de Mina, Uncle Sam, Rothschild, Clyde, Crystal, and Monte del Rey.

COPPER.

Beds or "reefs" of copper ore, from 1 foot to 7 feet wide in calcareous sandstone, are reported in Rabbit valley, 80 miles east of Marysvale. Specimens assayed 35 per cent. copper, with no gold or silver.

ANTIMONY.

The writer was not able to visit the antimony mines. The following information, however, has been gathered from various sources, and is considered reliable. There are eleven locations, eight of which have yielded ore, on a flat bedded vein in calcareous sandstone and shale, near the summit of a table mountain or bench, on Coyote creek, 9 miles from Clover Flat, and 40 miles southeast of Marysvale. They were located in May, 1879, and work was begun in the following September. The vein or bed is 8 inches thick, and contains pure fibrous stibnite, somewhat

oxidized in places. This assays only about a dollar in silver. The first lots of ore were gathered from the surface of the great heaps of *débris*. The only work consists of a few tunnels from 10 to 20 feet long. About 100 tons have been shipped. It was said to sell in New York or San Francisco for \$85 per ton. The cost of transportation to Salt Lake City is \$26 per ton.

BEAVER COUNTY.

SAN FRANCISCO DISTRICT.

[August, 1880.]

The San Francisco district is situated in the center of Beaver county, about 225 miles south-southwest of Salt Lake City and 98 miles northeast of Pioche, Nevada. The district is about 7 miles square, and lies upon both flanks of a small range called the San Francisco mountains. It was organized August 12, 1871, but was of little importance until 1876, a year after the discovery of the Horn-Silver mine. Frisco, the town and post-office, has about 800 inhabitants, and is the terminus of the Utah Southern railroad extension.

The country rock of the range consists of crystalline dolomitic limestone on the south, granite in the center, and a light-red quartzite on the north. The entire eastern slope is overlaid by a volcanic rock, which has perhaps erroneously been called trachyte, a short distance above the level of the valley. Still farther east are extensive beds of tufa. The water in the district is very bad and scarce. Boilers with flues cannot be used, or at most but a few days, owing to the great quantity of scale formed. Drinking water is brought on the railroad from Black rock, from 30 to 40 miles distant, or hauled 10 miles from springs in the Walwah range.

About seven hundred and forty locations had been made in the district, but not over two hundred were claimed at the time of the writer's visit, and not over thirty had \$500 worth of work upon them. The principal mines of the district are the Horn-Silver and the Carbonate.

THE HORN-SILVER MINE.—This remarkable body of ore was discovered September 24, 1875, by James Ryan and Samuel Hawkes. They sank a short shaft 30 feet in the ore, which came within 10 feet of the surface, and, fearing that the ore would fail, sold for \$25,000 to A. G. Campbell, Matthew Cullen, Dennis Ryan, and A. Byram, on February 17, 1876. These persons sold ore, erected smelting works, developed the ore body in the mine, and in 1879 sold the greater part of their interest at the rate of \$5,000,000 for the whole property. The Horn-Silver Mining Company was incorporated under the laws of Utah on February 17, 1879. The capital stock is \$10,000,000 in 400,000 shares. The property of the company consists of the Horn-Silver claim, 1,440 by 600 feet, patented; two 5-acre smelter sites in the town of Frisco, also patented; a complete three-stack smelting plant; refining works at Chicago, Illinois; some iron flux mines near Frisco; charcoal kilns; a 40-mile telegraph line to Beaver; two large stores in Frisco; and other minor property. Two very elaborate reports were made upon the property in March, 1879, one by W. A. Hooker, E. M., and one by Henry Cummins. The following are extracts embracing the principal portion of Mr. Hooker's report:

The vein is traceable for about 2 miles from the southeastern end of the Grampian mountain to the point where the dolomites give place to granite, with a general course of N. 10° W. Six locations have been made within these limits, but no extensive or valuable body of ore has as yet been found, except within the lines of the Horn-Silver claim, although comparatively little work has been done upon the others. In addition to these is a claim called the Grampian, adjoining the Horn-Silver on the west, an earlier location upon a vein in the lime rock, from which valuable ore has been taken.

The width of the vein on the Horn-Silver property is somewhat obscured at the surface. At the point of discovery, however, it has a width of from 40 to 60 feet, and croppings of galena were seen throughout the length of the claim and beyond. On the extensions north and south no considerable amount of ore has been discovered up to the present time, the few shafts and tunnels which have been driven disclosing principally oxides of iron. Float ore has, however, been found all along the surface, especially on the south extensions. The general course of the lode, as was said, is N. 10° W., but the limits of the ore in the few places where they have been reached in the workings of the mine do not always conform to this direction. The lode dips to the eastward (N. 80° E.) at an angle of about 70° from the horizontal, so far as can at present be determined. Its foot wall thus consists of layers of quartzites and dolomites, while the hanging wall is a partially decomposed [so-called] trachytic material. With these circumstances it would be anticipated that variations in the dip and direction of the wall would occur at various points; especially is this true of the foot wall, the softer parts of which—the dolomites—are more readily decomposed and eroded than the quartzites, causing variations in its lines. The width of the lode is therefore found to vary at different points. The shortest distance that can be measured between walls in the present workings is 23 feet, but on the same level to the northward it widens shortly to upwards of 60 feet, and in the lowest level, the fifth, as will be seen, it is probably even greater. Both walls are covered with a dry ferruginous clay which serves to indicate the approach to the wall-rock. The foot wall has not been penetrated by any of the workings, but the hanging wall has been pierced for a distance of 200 feet or more by a drift connecting the third level with the new shaft. It discloses the following material: Adjoining the ore from 20 to 25 feet of clay, stained with oxide of iron, followed by 30 feet of tough blue clay which required the use of chisel-pointed picks in driving through it; this blue clay becomes gradually harder, finally merging into a decomposed trachytic mass which continues to the end of the drift. The new shaft is sunk throughout in this last material. Its color is a reddish-gray, and it disintegrates somewhat on exposure to the air. It contains rounded pebbles or fragments of trachyte in size from that of a nut to masses several feet in diameter. At one or two points in the drift hard unaltered trachytic rock was met, but such appeared to be rather fragments than rock in place. Undoubtedly, at a greater depth, the country rock will be reached compact and dense, separated from the ore by selvage clay.

As to the lode itself, the ore filling this immense fissure is of two general kinds or classes. The larger portion, which is distinguished as smelting ore, is soft and earthy, consisting of sulphate, oxide, and carbonate of lead, all carrying silver. The smaller portion is heavy spar (sulphate of baryta) carrying chloride of silver, sulphide of silver, and ruby silver—the richest silver minerals. This sparry ore is

found on the side of the hanging wall in the upper part of the lode, and has been protected somewhat from the decomposition which has affected the remainder of the ore by its position and the refractory nature of the material. With this exception, and one other, which will be noted beyond, the entire deposit of ore within the present limits of the mine has undergone oxidation and rearrangement of its component parts.

It is a very noticeable fact that up to the present time no wall fragment, "horse," or waste rock of any extent has been encountered in the deposit of ore. The material filling the vein is silver-bearing from wall to wall. There is no waste dump at the surface, and none of the contents of the lode as yet broken down have been so poor in silver as to be thrown away or used for gobbing up. The mine is entirely dry, and likely to remain so for a considerable depth.

DESCRIPTION OF THE MINE.

The principal working shaft is near the center of the claim, at the discovery. It extends vertically 113 feet 6 inches to the bottom of the third level. The first level is at a distance from the mouth of the shaft of 46 feet. At 27 feet 8 inches below, or 73 feet 8 inches from the surface, is the second level, and 39 feet 10 inches below this, or 113 feet 6 inches from the surface, is the third level. The fourth level, 91 feet 3 inches below the third (or 204 feet 9 inches from the surface), is connected with it by three winzes. The fifth level is 50 feet 4 inches below the fourth, or 255 feet 1 inch from the mouth of the working shaft. The old shaft lies 145 feet to the northward of the working shaft. It was continued down to the line of the second level and connected with it by a drift. The length of the old shaft is 100 feet 7 inches, the surface being higher here than at the working shaft, and if the depth of the fifth level be measured through the former it will show a gain of 26 feet 11 inches, or a total depth of 232 feet.

The ore thus far removed has been taken from between the first and third levels (the lower levels having been driven merely to explore the vein), and the space thus left vacant has been timbered up securely by 12-inch timbers in square sets 5 feet by 5 feet 8 inches, center to center, and 6 feet 10 inches high, except the track floors, which are 7 feet 2 inches in height.

The first level is 46 feet below the track at the surface. It is entirely in ore, no wall or indications of wall appearing. From the northern side a drift is run 42 feet, from which a short elbow extends 21 feet in length. On the southern side a crooked drift has also been driven 56 feet. This exposes for the most part sparry ore, which has its greatest development in the southeast portion of the mine. In this neighborhood the ore referred to is crystallized and compact, and when in this condition its limits are quite distinct. The length of the first level from end to end in a straight line is 122 feet.

The second level is 73 feet 8 inches from the track at surface. On the northern side is a drift 148 feet in length. This connects with the old shaft, and at the end of the drift a winze connects with the third level. Here is observed the ferruginous clay and other signs denoting probable proximity to the hanging wall. It is the only point on this level where any such indications are afforded. The southern end of the level likewise consists of a short drift, having a course of S. 40° E., 21 feet; near its entrance occurs crystallized sparry ore merging gradually towards the north into a partially decomposed mottled ore, carrying more or less lead with silver; the remainder of the material exposed in this level is smelting ore. The total length of the second level, from end to end, measured in a straight line, is 295 feet, or following the sinuosities of the drift, 325 feet.

The third level is 113 feet 6 inches from the surface at the working shaft. The shaft is lagged at the bottom as elsewhere, but the foot wall was undoubtedly reached by it; indeed it is probable that the foot wall is quite near to the timbering all along the western side of the level. This could not be absolutely determined, as the boundary is concealed by lagging. A drift in the northern end of the level has a length of 99 feet. The southern end connects by a winze with the second level. In the ends of both the main and side drifts are signs of proximity to the foot wall. As was remarked, the hanging wall is indicated at the top of the winze referred to on the second level. If these indications are correctly interpreted the vein would have a width here of from 35 to 38 feet, but I do not consider it as definitely settled that such are the limits of the ore body in this part of the mine. Excellent ore is exposed throughout in the above winze. The southern end of the third level consists of a drift 56 feet 6 inches in length. Near the beginning of it, on the western side, is apparently foot-wall clay, and in the end of the drift is a similar material, probably marking the approach to the hanging wall. This level is connected with the fourth by three winzes, numbered 1, 2, and 3. Near the latter commences the drift already described, connecting with the new shaft. Its course is S. 86° E., 190 feet, and S. 61° E., 24 feet. A commodious station is built here, 16 feet by 20 and 12 feet high. Between winzes No. 2 and No. 1 occurs the white mottled ore, which merges near winze No. 1 into sparry ore, continuing beyond for seven sets of timbers. The material in the north drift consists largely of mottled ore.

The total length of the third level in a straight line is 300 feet, or taking into account the irregularities in the drifts, 310 feet. These measurements have of course no reference to the drift connecting with the new shaft.

The fourth level is 204 feet 9 inches below the surface at the working shaft. Fourteen sets of timbers have been placed in the south end of the level, the rest consists of irregular galleries, all in ore. The sparry ore, before described, does not appear on this level, but we have in place of it, *i. e.*, occupying the same relative position on the east or hanging-wall side of the lode, an ore differing in several respects from any before mentioned. From the fact that a small amount of it—about 100 tons—was treated in the leaching works in Frisco, it has been designated at the mine as leaching ore. It carries a very fair amount of silver, and its characteristics will be described in detail beyond. The main drift of the fourth level has been driven on the boundary line between the smelting and the leaching ores. From the south end of the timbering a drift has been started in the direction of the new shaft, 40 feet 8 inches, which penetrates the hanging wall from 6 to 10 feet from its end. We have, at this point, the opportunity of measuring the exact width of the vein—one of the few places in the mine where this can be done. It has here a width of 45 feet horizontally. At this end of the level and adjoining the foot-wall clay the smelting ore has a thickness of only 6 feet in the narrowest point. It widens out, however, to the northward, and near winze No. 2 is some 25 feet thick—soft, pure, oxidized ore. The so-called leaching ore comprises perhaps half of that exposed in this level.

Between the north end of the level and winze No. 1, on the east side of the drift, is a considerable amount of sulphide of lead and antimony. This material has been preserved from the oxidation which the greater part of the ore contained in the mine has undergone. It carries about 60 per cent. of lead, from 6 to 10 per cent. of antimony, some iron, considerable zinc, and but little silver.

How extensive this deposit is cannot be determined without further exploration. Two or three pieces only of the mineral were observed in the upper workings, although it was carefully searched for, and these pieces no larger than the fist, and as it has not appeared on the fifth level it is to be hoped that it will be found to confine itself to small limits. It is interspersed with lead ores carrying considerable silver, as will be seen hereafter.

The length of the fourth level, in a straight line, is 220 feet, or, following the curves of the main gallery and southeast drift, 245 feet 6 inches. The fourth level is connected with the fifth by a winze, starting 42 feet 5 inches easterly from winze No. 2. It has a vertical depth of 50 feet 4 inches below the fourth level. It begins in leaching ore, but runs shortly into soft smelting ore, which continues down to within a short distance of the bottom.

The fifth level consists of a single drift which has been started in the direction of the new shaft, having a course of S. 75° E., and a length, at present writing, of 68 feet 10 inches. It does not run directly across the lode, but diagonally, yet it proves the vein to have a thickness here equal or greater to its widest extent above. The west end of the drift is in foot-wall clay, but it does not penetrate the hanging wall, and only reaches leaching ore some 10 feet from the end. Should this leaching ore have the same thickness here as on the level above, the width of the vein would be some 90 feet; whether it will attain such dimensions remains to be proved. The greater part of the drift discloses excellent smelting ore, which, near the bottom of the winze, merges into foot-wall clay.

The Horn-Silver ores are distinguished at the mine as milling ore, smelting ore, and leaching ore. The latter, however, is properly also a smelting ore, but as it has certain features different from the rest, the name, although not altogether a correct one, will be retained in this report.

The name milling ore has been applied to that portion of the ore consisting essentially of heavy spar carrying chloride of silver, sulphide of silver, and ruby silver. It includes both the sparry ore so frequently mentioned and that described as mottled ore, besides certain other varieties found adjoining or interspersed with these.

The term of milling ore has been adopted because, being for the most part free from lead, it is adapted to the milling process. It may, however, be smelted also, and is thus treated at Frisco. While the crystallized sparry ore consists wholly of sulphate of baryta, except of course the silver minerals contained in this gangue, the mottled ore contains more silica, and, as will be seen, the gangue of some varieties of the milling ore is made up principally of silica. The milling ores constitute the richest portions of the deposit, carrying from 75 to 200 ounces in silver per ton in quantity, while smaller samples run into the thousands.

The smelting ores proper comprise the greater portion of the ore mass. These are soft and earthy, consisting essentially of sulphate of lead, with some plumbic ocher and carbonate of lead, all carrying silver. They have no gangue rock or vein stone, unless the silica, oxide of iron, and alumina (forming a sort of clay) be reckoned as such. The amount of lead and silver contained in these ores varies somewhat between certain limits, the lead running from 30 to 60 per cent., and the silver from 30 to 75 ounces per ton. In order to determine the relative proportions of the different ingredients and impurities of this ore, a sample was submitted to Mr. S. B. Newberry, E. M., of the School of Mines, New York, for analysis, who reports as follows:

ANALYSIS OF HORN-SILVER ORE NO. 1.

	Per cent.
Moisture	Undetermined.
Silica	15.17
Sulphate of barium	0.49
Sulphate of lead	74.51
Sesquioxide of iron	4.80
Sesquioxide of alumina	1.71
Sulphide of antimony	0.37
Sulphide of arsenic	1.12
Lime and magnesia	0.50
Carbonic acid	0.62
Silver (by fire assay 78.33 per ton =)	0.33
	99.62

"No zinc was found; the quantity is certainly very small and did not show itself, although a special determination was made to ascertain it. The metallic lead, arsenic, and antimony in the ore are as follows:"

	Per cent.
Lead	50.90
Arsenic	0.93
Antimony	0.26
	52.09

The amount of moisture in the ore is very small, the average of the run-of-mine being less than 3.5 per cent., and the sample analyzed above had been thoroughly dried.

The so-called leaching ore has been referred to as occurring on the fourth and fifth levels. It is somewhat distinct from any of the ores previously described, and quite different in appearance. It is more or less hard and compact; red, white, and yellow in color. A partial analysis of a sample of this ore was also made by Mr. Newberry, showing its principal ingredients. The following are the results:

PARTIAL ANALYSIS OF HORN-SILVER ORE NO. 2.

	Per cent.
Silica	47.95
Sulphate of barium	2.71
Sulphate of lead	28.80
Sesquioxide of alumina	12.55
	92.01

"In addition to these constituents the ore contains a little zinc, carbonic acid very little, more arsenic and antimony than ore No. 1, a trace only of lime, and a small but quite noticeable amount of magnesia."

While these are the main distinctions in the character of the Horn-Silver ores, the lines between them cannot always be drawn so closely. They vary greatly in different parts of the mine, sometimes in very short intervals, rich ores alternating quickly with leaner ones, and pure smelting ores with those containing no lead. That which has, for convenience, been designated as mottled ore often carries considerable lead, and is more properly a smelting than a milling ore; and much of the leaching ore contains less lead than is shown in the above analysis.

The ore coming from the mine has, with the exception of the sparry ore, a yellow color due to sulphate and oxide of lead, the more siliceous portions somewhat hard, but the bulk of the run-of-mine is quite soft. It is difficult to make an estimate of the relative amounts of the different kinds of ore found in the different workings, and impossible to give an exact one. The amount of pure crystallized heavy spar ore at present disclosed may be stated at about 2,000 tons; that described as mottled ore occupies much more space, and the so-called leaching ore comprises at least half of the ore disclosed on the fourth level.

The following figures were taken from the company's books:

LOTS (AVERAGING 400 TONS EACH) ASSAYED AT THE SMELTER FROM JANUARY 1 TO FEBRUARY 14, 1879.

Date.	Lot.	Description.	Silver per ton.	
			Ounces.	Per cent.
Jan. 2	No. 30.....	Milling ore.....	97.20	21.00
Jan. 21	No. 31.....	Lead ore.....	43.74	45.00
Jan. 22	No. 31.....	Milling ore.....	89.91	6.00
Feb. 4	No. 32.....	Lead ore.....	41.31	47.00
Feb. 4	No. 32.....	Milling ore.....	136.08	7.00
Feb. 14	No. 33.....	Lead ore.....	98.88	40.00
	Average of all ores.....		74.52	29.16
	Average of milling ores.....		107.73	11.88
	Average of smelting ores.....		41.31	47.00

The average of 1,271.585 tons reduced by the Frisco Smelting Company up to March 1, 1878, was: Silver, 44.56 ounces per ton; 41.11 per cent. lead.

The average amount contained in 5,611.864 tons reduced by the same company from March, 1878, to February 1, 1879, was: Silver, 44.48 ounces per ton; 40.83 per cent. lead.

The ore reduced in the company's smelting works from December 15, 1877, to January 1, 1879, comprising 8,696.546 tons, contained an average of: Silver, 49.86 ounces per ton. The average of the three lots last given, a total of 15,580 tons, is: Silver, 47.75 ounces; lead, 38.25 per cent.

The quantity of ore extracted up to February 1, 1879, is given as 22,712 tons. During February about 90 tons daily were raised, making a total of 25,000 tons of ore. The extraction of this 90 tons was barely enough to keep the mine in good shape and prevent the breasts of ore from crowding too much upon the timbers. The present expense of mining is low. We have as the cost of taking out 90 tons daily:

Labor.....	\$144 00
Timbering, 90 tons, at 82 cents per ton.....	73 80
Superintendence.....	6 00
Supplies and incidental expenses.....	50 00
Total.....	273 80
Cost per ton.....	3 05

The expense of mining the 22,712 tons up to February 1 was, of course, somewhat higher, amounting to \$4 46 per ton. This expense included surveying and application for patent, mail service, the initiatory expenses of the enterprise; in short, all the expenditures of the mine up to that date.

Of the 25,000 tons mined about 5,500 tons have been sold to various parties; the remainder has been treated in Frisco by the Frisco Smelting Company and in the company's own works.

THE SMELTING WORKS.—The smelting plant of the company consists of three shaft furnaces with 40 horse-power engine and bailers, one No. 6 Root's blower, a Blake crusher, and other necessary appurtenances.

The furnaces are placed in line with four dust chambers between stacks, or eight in all (6 feet by 5 feet 9 inches by 6 feet 2 inches each). The furnaces are circular, the hearths being built of a fire-stone of excellent quality (*volcanic tufa*) found in the immediate vicinity. Two of the furnaces have the following principal dimensions, the third being somewhat smaller:

Tuyere line to charging door.....	12 feet 4 inches.
Diameter of hearth.....	38 inches.
Diameter of bosh.....	60 inches.
Diameter at throat.....	53 inches.

The furnaces are provided each with five water tuyeres, 3-inch nozzle. The hearth below the tuyeres is protected by cast-iron plates arranged hexagonally. The stack is built of fire-brick and common brick, supported by cast-iron pillars. The average campaign is sixty days. A single furnace only has been run at a time owing to the scarcity of water. The smelting of the ore is preceded by a calcination or roasting in heaps with wood, and, although it is far from being a complete roasting, it nevertheless puts the ore in good shape for charging into the furnace, and has the great advantage of economy. The fuel used for smelting is an inferior quality of charcoal. The principal flux used is iron oxide from various mines in the neighborhood, and at present about one-sixth of the ore smelted consists of milling ore. The product is from 6 to 9 tons of lead bullion per stack per diem, carrying an average of 150 ounces silver to the ton. About 1½ tons of matte are also produced daily, which, after a partial roasting, is charged back into the furnace. From 1,200 to 1,500 pounds of flue-dust are saved daily. The following is the work for January, 1879:

Amount of ore smelted.....	tons.. 723.1125
Bullion produced.....	do.. 202.1507
Ratio of ore to bullion.....	3.56
Iron ore used.....	tons.. 329.425
Or 50.73 per cent of the ore.	
Amount of charcoal used.....	bushels.. 33.286
Or 46 bushels per ton of ore.	
Wood for roasting and fuel.....	cords.. 239
Or three-tenths of a cord per ton of ore.	
Wear and tear per ton of ore.....	\$1 72
Pay-roll per ton of ore.....	4 75
Total cost per ton of ore.....	18 31
Cost per ton of bullion produced.....	65 05

THE REFINING WORKS.—The refining works are located in Chicago, at the junction of Lumber and West Twelfth streets. They have a capacity of about 15 tons daily. The plant consists of:

Two zinc-mixing furnaces, one 6 feet 8 inches by 10 feet, and the other 4 feet 6 inches by 6 feet.

One lead-refining furnace 6 feet 6 inches by 9 feet.

Four retort furnaces (Faber du Faur).

One small cupola furnace for reducing dross, etc.

Two cupel furnaces.

One small sweating furnace.

A 5 horse-power engine and boiler.

A Sturtevant blower, No. 4.

Assay office, etc.

The fuel used is Laurel Hill coal.

The works are under the control of Mr. A. Byram, and Mr. R. S. Payne is superintendent, and while the capacity of the plant is inadequate to the requirements, the work accomplished is excellent, and reflects credit on the judicious management of these gentlemen, as the following figures show. The refined lead produced runs from clear to 4-10 ounce, and is generally altogether clear. The silver bullion runs from 990 to 995 fine, and is said to be the purest bullion received at the New York assay office.

The loss in zinc is less than 33 per cent.; the loss in lead amounts to 7.52 per cent, and the loss in silver 1.65 per cent., or about 2½ ounces per ton of bullion treated.

The following is the expense of treatment:

Coal	\$3 28
Zinc	1 01
Labor	5 10
Incidental	1 90
Total expenses of refining per ton of bullion.....	<u>11 29</u>

The refined lead sold in January for \$72 per ton.

Between the time of this report and that of the writer's visit, in August, 1880, but few changes had taken place. Mr. Hill had just been appointed manager, and many changes were expected. The explorations had not been extended further. A large amount of ore had been extracted and the number of square sets necessarily increased. A three-compartment vertical shaft, 200 feet east of the croppings, had been sunk 200 feet and cross-cuts run to the ore body. The total cuttings, not including stopes, then amounted to 1,900 feet. Fine hoisting works, equal to any in the territory, were nearly completed. They consisted of two horizontal engines of about 70-horse power. They were coupled by a clutch, or worked independently. The two boilers were of 60 horse-power, and of the Babcock & Wilcox pattern. Sheaves 40 feet high, a flat steel-wire cable, 8½ inches by ½ inch in section, cages, and safeties were used. The machinery was supposed to be capable of sinking 1,200 feet. A great cave into some of the stopes below had occurred, leaving a crater-like opening on the surface 40 by 70 by 25 feet. The force employed during the census year was about forty miners (10-hour shifts), at \$3 50, and fifteen other workmen. It was the intention to extract the ore in the future by contract at so much per car-load. The amount raised during the year was 16,053½ tons. The total product of the mine to the end of the census year was given at 29,380 tons. Its average product or value was unknown; but a rough estimate placed the assay value at 45 ounces silver and 35 per cent. lead.

THE SMELTER.—Besides Mr. Hooker's description of the furnaces, there are a few items which may be mentioned. Before smelting, the ore is roasted in heaps of varying size, about 30 feet wide and 140 feet long being an average. Cedar cord-wood is piled 4 feet high, 20 inches of ore is spread upon it, another layer of wood 1 foot, and a final 1 foot of ore. This requires two or three weeks to burn. One cord of wood for 3 tons of ore is used. Wood costs \$2 50 per cord. As the ore which comes from the mine is already oxidized, it is difficult to see how this roasting effects it, except to volatilize some arsenic and antimony and to burn off some sulphur still unoxidized. In proof of this, the furnaces still continued to form large quantities of matte, as when treating unroasted ore. In further proof, also, the following partial analyses, made in the company's laboratory, indicate the same result. They are averages of several analyses made. The samples were not necessarily from the same lots of ore:

	Raw smelt- ing ore.	Calcined or roasted ore.
	Per cent.	Per cent.
Lead.....	30.2	36.7
Sulphur	7.8	6.7
Sesquioxide of iron.....	5.5	6.0
Silica.....	24.2	19.8
Baryta.....	8.0	.....
Sulphate of barium .....	.....	7.6
Lime	1.5	5.3
Alumina.....	6.1	10.7
Arsenic and antimony.....	5.1	.....

Two of the furnaces are lined with a tufa found in the district. The lining is 16 inches thick, and extends 3 feet high. It usually lasts thirty to forty days. A new lining costs \$130. The third furnace is a cast-iron water-jacket, vertical for 15 inches, and having a batter at the boshes of 6 inches per side in the remaining 13 inches. These furnaces run with a closed front. A varying quantity of limestone and iron flux is used. The limestone is quite pure, and costs \$2 50 per ton. The iron flux is a limonite and hematite averaging from 55 to 64 per cent. iron. It comes from the Wahwah range, Iron Springs, Star, Beaver Lake, and San Francisco districts, and costs about \$8 per ton. The charcoal used is about 25 per cent. of the smelting charge. It is an inferior quality compared with that used in the northern part of the territory, and costs 18 cents per bushel for kiln and 16 cents for pit coal. Heretofore no flue-dust has been saved. The lead and iron matte, which was quite abundant, is roasted in heaps and resmelted. It is said that there is considerable difference in the silver and lead contents of the mattes from the stone and water-jacket furnaces. No regular assays have been made, but the average of a few showed results in favor of the water-jacket of 24 ounces silver and 7.5 per cent. lead. Whether the charge in each furnace was exactly the same or not is unknown. The furnace lead was quite hard, and contained several per cent. of antimony. Since the completion of the railroad cost of shipping to Chicago has been reduced to \$33 50 per ton. Some partial analyses of slag made at the company's office are as follows:

	1878.	March 28, 1880.	May 2, 1880.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Silica	82.8	86.1	20.8
Oxide of iron	46.0	44.1	45.6
Alumina	5.0	11.7	13.2
Lime	7.0	4.2	10.4
Lead	8.6	0.5	(?)

During the census year 10,573½ tons of ore were smelted, producing 2,886½ tons of bullion. Besides this about 4,000 tons of ore were sold to the Frisco company.

Owing to the high price of labor, lack of water, poor quality, and constantly increasing price of charcoal, the company intended to shut down these furnaces and erect others at South Cottonwood. During the time of the writer's visit one furnace was being run in accordance with a new smelting theory of one of the superintendents. The experience of three years had proved that a large percentage of iron was necessary to flux the Horn-Silver ores. It was required as a base to unite with the silicic acid, and also as a base to prevent the formation of rich lead matte by forming a poorer iron matte. The new theory grew out of the desire to use less iron flux. It may be briefly stated as follows: "Smelting by chemical affinities is all wrong; the true theory is to melt the material and let the elements separate by specific gravity." In accordance with this theory very little iron flux was added to the charge. As a result, a very large proportion of rich lead matte was formed. The furnace lead, however, was so lumpy and contaminated with partially desulphurized galena that about half of it had to be returned to the furnace in the following charges. The exact percentage of loss during the run, as compared with the other furnace running on the "chemical affinity" plan, could not be ascertained; but the "specific gravity" theory was not adopted. It is but just to the local manager and the superintendent of the smelters to say that they were opposed to such experiments; but the indorsement of the theory by some of the principal eastern owners or officers overcame the opposition.

A "draft furnace" to work Horn-Silver ore was built in 1877 by a private company. It was built like an ordinary furnace, but had a flue extending up the side hill several hundred feet. It was hoped that this would create sufficient draft to dispense with an engine and blower. A few tons of bullion was made, but the draft could not be regulated. The fire would approach the surface of the charge and the bottom would "freeze".

A small leaching plant erected by a private company was completed in the spring of 1878. Some Horn-Silver ore was worked raw, and from 40 to 80 per cent. obtained. A roasting furnace was erected, and the works then did much better. The tailings were reworked, yielding 82 per cent. The leaching works were not altogether successful and were shut down after a few months, having treated less than 150 tons.

The Grampian is a prospect in the dolomite on the hill above and beyond the Horn-Silver. In March, 1880, it was sold to a Chicago company, the Grampian Silver Mining Company, for a round sum, and a considerable force of men have been prospecting since. A vein of ocherous lead ore assaying about \$50 silver and some gold was found near the surface, and followed down 80 feet, showing from 1 foot to 8 feet of ore. It then contracted, as is frequent with ore bodies in limestone, and in subsequent prospecting had not widened again. Little stoping had been done. The mine is developed by a tunnel and an incline having a windlass. The total cuttings amounted to 515 feet. Less than 200 tons have been shipped.

The Frisco Mining and Smelting Company was incorporated in September, 1879, and is a reorganization of the Frisco Smelting Company. It has a capital stock of \$2,000,000 in 80,000 shares. The company's property consists of one smelting plant in Frisco, the Carbonate group of mines in San Francisco district, stone quarry, wood ranches, charcoal kilns, furnace site, barns, wagons, and animals in the same district, the Cave mine and its group in Bradshaw

district, and an iron flux mine in Rocky district. The smelting furnace was built in the summer of 1877. It is situated in the town of Frisco and has usually run as a custom furnace, or bought ore from the Horn-Silver. The plant is a complete one and consists of a Blake rock-breaker, a No. 5 Baker blower, two horizontal boilers, one 40 horse-power horizontal engine, several pumps, a shaft furnace and flue-dust chamber, a reverberatory flue-dust slagging furnace, 10 by 36 feet, and five charcoal kilns adjacent to the works. The Horn-Silver ore which the company smelted was roasted in heaps in the same manner as by the Horn-Silver Company. The company worked the ore for \$20 per ton, guaranteeing 80 per cent. of the silver and lead contents. The ore was smelted with an iron flux from the Cave and other iron mines, and required about 30 per cent. flux and 46 bushels of charcoal per ton. About 5 per cent. of flue-dust was caught, assaying 35 per cent. lead and 30 ounces silver. The matte, of which from 5 to 10 per cent. was formed, assayed about 20 per cent. lead and 30 ounces silver. It was roasted in heaps and resmelted. The slag assayed about 1½ ounces silver and 2½ per cent. lead. The furnace force consists of eighteen men on 8- to 12-hour shifts, receiving from \$3 to \$4.

The Carbonate mine is situated on nearly level ground on the eastern side of the San Francisco mountains, 2½ miles northeast of Frisco. It was discovered in the autumn of 1878. Campbell, Burke & Donaldson bought it in February, 1879, for \$10,000, sunk a shaft to the depth of 212 feet, and sold the property to the Frisco Mining and Smelting Company in September, 1879, for \$100,000. The group of flanking and overlapping locations consisted of seven claims, 1,500 by 600 feet each, viz, the Carbonate, Ingomar, Rattler, Stepmother, Homestake, North Side, and South Side. Some showed ore, but little had been done on any except the Carbonate. This was discovered by trenches dug on the surface of the ground in the search for the source of rich float. It is apparently a fissure vein in so-called trachyte, but the hanging wall has never been found, no cross-cuts having been run. The gangue upon this side is a soft "trachyte" and talcose clay, which swells in the mine and slacks to a powder when brought to the surface. The vein dips 45° for the first 75 feet; below that its dip is 85° N., having a smooth, hard, regular foot wall. The ore is next the foot wall, and averages about 6 feet in width, although much greater and much smaller dimensions have been found. It is a conglomerate, composed of pebbles of trachyte from 1 to 6 inches in diameter, and an occasional one of quartzite, cemented together by talcose clay and argentiferous galena. This ore, except the quartzite pebbles, slacks readily to the size of fine gravel when brought to the surface. It was impossible to learn the average grade of the ore. One hundred and forty tons were smelted by the company, but the value was not given. About 700 tons of low-grade ore were raised during the census year and are now upon the dump. From various assays, the average value of the ore was estimated to be from 30 to 45 ounces silver and from 15 to 25 per cent. lead. The mine is opened by a single-compartment vertical shaft, 5 feet 10 inches by 4 feet 10 inches, to a depth of 330 feet. The shaft was sunk 40 feet north of the croppings. At 80 feet a little water was found (at the period under review 50 gallons per hour was hoisted with a bucket), and the ore changed from carbonate to galena. Drifts had been run every 100 feet, but the extreme limit of horizontal development was 225 feet. The total cuttings amounted to 1,315 feet. Every drift was timbered with 8- by 10-inch or 10- by 10-inch posts and caps, and 2- to 3-inch plank. It was found necessary to ease them once each month. No stoping had been done. All work had been to prospect the mine. There were small steam hoisting-works, containing a 12 horse-power engine, supposed to be capable of sinking the shaft 500 feet. About twenty men had been regularly employed. Owing to the low grade of the ore, no attempt was intended to be made to smelt it until after concentration. At the time of the writer's visit the company was erecting a 30- by 96-foot building in which to concentrate the ore, by means of Paddock's pneumatic separators. These were a new invention. They had been tested for several months on copper and lead sulphurets in Maine, and had also worked several tons of this ore at the Butterfield Cañon concentrating works, in West Mountain district, and had given satisfaction. The machinery to be employed was to consist of one rotary drier, one rock-breaker, three sets of Cornish rolls, six elevators, five revolving screens, having a 35 to 110 mesh, ten Paddock's separators, and one Frue concentrator. It was thought this apparatus would concentrate 50 tons in twenty-four hours.

The other mines of the San Francisco district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Makalola and Summit	860	1,414 tons.....	Worked irregularly.....	1,314 tons assayed 75 ounces silver and 55 per cent. lead, and the other 100 tons one-third of this.
Cerro Gordo and Minnesota Consolidated Silver Mining Company.	800	.....	A small force prospecting.	Ore assays \$40 to \$50 per ton.
Frisco Consolidated Silver Mining Company.	1,000	100 tons.....	Some prospecting done ...	Ore sometimes assayed as high as \$200 per ton.
Chicago and Frisco Consolidated Silver Mining Company.	.....	.....	do	Property consists of twelve locations, having a limited amount of development.
Yellow Jacket.....	250	10 tons.....	.....	High-grade ore.

COPPER.—In the northern part of the San Francisco district there are several very large ledges of pyrite and chalcopyrite ore. Some work was done upon them, and a small amount of very high grade silver ore was mined several years ago. The principal claims are the Comet, Cactus, and Copper Chief.

MARBLE.—Fine marble quarries have been located in this district; but little work, however, has been done on them. The marble is light-bluish to milk-white in color, takes a good polish, and can be obtained in slabs 8 inches thick.

FIRE-ROCK.—There are several fire-stone quarries, all within $2\frac{1}{2}$ miles of Frisco. The stone is found in beds a few hundred feet in thickness. It is a very porous yellowish-white volcanic tufa. It is very soft, and is easily turned into shape when fresh from the quarry, but hardens on exposure to the air. It is of local importance only, owing to the siliceous character of the Horn-Silver ores and the cost of transportation of imported material. It is not comparable with the siliceous rock found near Salt Lake City.

CHARCOAL BURNING.—Thirty-six bee-hive charcoal kilns (*a*) supply the furnaces of the district with fuel. They were in eight groups, under separate individual management, at places where wood was accessible, and at distances of from 6 to 18 miles from Frisco. Some pit coal is burned in the Wahwah mountains, but it is sold for 1 or 2 cents per bushel less than the kiln coal, as the latter is cleaner and of better quality. The kilns are made of granite float found in the neighborhood and a lime mortar. They are of various sizes, from 16 to 26 feet in diameter. It is the rule in this section to make the height of the kiln equal to the diameter. The thickness varies from 18 to 30 inches at the base and from 12 to 18 inches at the summit. There are two openings, closed by sheet iron doors, one at the ground level, 4 by 6 feet, and the other in the side two-thirds of the distance to the apex, 3 by 4 feet. There are also three rows of vent holes, 3 by 4 inches, near the ground. The lower row is at the surface of the ground. The rows above are 18 inches apart, having vent holes 3 feet apart in each row. The kilns cost from \$500 to \$1,000 each, and lasted a very long time if used regularly. The 16-foot kiln holds about 15 cords of wood and the 26-foot kiln 45 cords. Sometimes the wood is piled radially, but generally very closely in cord-wood fashion. The wood is all piñon pine, and is cut at all seasons by Mormons at \$1.25 per cord. It is brought from 1 to 4 miles by sledges or wagons to kilns for from \$1.50 to \$2.50 per cord. The kilns are fired in the center at the bottom (though sometimes at the top), and the fire is drawn to the top by leaving a small unsealed space around the upper door. This is then closed entirely, and the fire is regulated by the vent holes. The duration of burning is from three to seven days, and of cooling from three to six days. Charring, which includes packing the wood in the kiln and drawing the coal, is usually done by contract, and costs from $2\frac{3}{4}$ to $3\frac{1}{2}$ cents per bushel. About 50 bushels are produced per cord charred. The coal is bought by weight, 17 pounds making a bushel. It is shipped to the smelters in racks, at a cost of from 3 to $5\frac{1}{2}$ cents per bushel for hauling, depending on the distance. The price received is 18 cents per bushel. Kiln hands are paid from \$2 to \$2.75. The labor required averages one man per kiln per twenty-four hours.

PINE GROVE, WASHINGTON, STERLING, AND PREUSS DISTRICTS.

[August, 1880.]

The Pine Grove district is situated on a well-wooded and watered range 40 miles west of the San Francisco district. It was organized in 1873, but no work was done until the reorganization in 1879. There were at the period under review about 20 locations. Little had been done except by the Pine Grove Consolidated Mining Company, which owns the Carrie, Lucille, Crystal Palace, and Pinafore claims. These are from 2- to 4-foot veins of fair-grade ore in quartzite, having inclines but 70 feet deep.

Washington district is southwest of Pine Grove. It was organized in 1879, and has but few locations.

Sterling district is an iron district in the Wahwah range west of Frisco. It was organized in February, 1880, and contained at the period under review about 25 locations.

The Preuss district is an old district, and was reorganized in August, 1880. It contained at the period under review 25 claims. Among the fair prospects having some development are the Good Hope, Champion, and Silver Hill.

THE STAR DISTRICTS.

[August, 1880.]

The original Star district, 12 miles square, situated on the Picacho range, a few miles southwest of Milford, was organized July 8, 1870. On November 11, 1871, the northern portion was reorganized as North Star district, and the two districts, called respectively North Star and South Star, have kept up their organizations since. In the South Star the books showed 1,046, and in the North Star 581 locations, but probably not over 350 were owned at the period under review. The country rock of these districts is granite along a portion of the eastern border, distinct strata of quartzite, underlaid by limestone and siliceous limestone, in the central portion, and "trachyte", a portion of the same flood seen in the San Francisco district, along the western side. In the central portion of the district

a It is said that this style of kiln was first made by J. C. Cameron, in Marquette county, Michigan, in 1868.

beds of gypsum are also found. The mines occur entirely in the limestone and quartzite, and are usually bedded veins and pipes of ore, dipping with the stratification from 40° to 70° east or southeast. The mines are at an altitude of from 5,000 to 6,000 feet above sea-level, in ridges a few hundred feet above the Beaver River bottom lands. Water is very scarce, and costs from 5 to 9 cents per gallon. For this reason the mines are worked mostly in the winter season, when there is about a foot of snow on the ridges. The prosperous days of the district were in 1872, 1873, 1874, and 1875. Then there were the thriving mining camps of Shauntie, Shenandoah City, Elephant City, and South Camp. Shauntie contained forty houses, but was destroyed by fire in the summer of 1876. Few have been rebuilt. The work in the district has been done for the most part by poor men upon their own claims. Hence there are a host of rudely-worked prospects, with very little development. During the census year forty men were working and prospecting in the two districts.

Most of the ore produced was treated at the Shauntie smelter. Two small stacks were built at the town of Shauntie in the summer of 1873. In the following spring these were torn down, and one stack of 20 tons' capacity was built. This was burned in June, 1875, was rebuilt in the following autumn, and was shut down in the summer of 1877. A short run was made in 1878. It had been idle since. The furnace is quite dilapidated. About 12,000 tons of ore were worked, which produced about 3,000 tons of bullion, containing \$325,000 in silver and \$10,000 in gold.

The Troy furnace, erected in 1875 on the Beaver River bottoms, 5 miles south of Milford, to smelt Mammoth mine ore, ran but a few months. It had been idle since, and was burned in June, 1880.

The Latey & Williams smelter is a single-stack custom smelter, and was erected at Milford, east of the districts, in the autumn of 1876. The owners had worked about 500 tons of Star ore, 1,500 tons from the Horn-Silver, and 400 tons from the Cave mines, which had produced about 770 tons of bullion. The smelter had been idle for over a year, but was started again August 17, 1880. The plant consists of a stone shaft furnace, a No. 4½ Baker blower, a horizontal boiler and engine, and a small flue-dust chamber.

The Milford 10-stamp mill is in a fair state of preservation. It is in the town of Milford, and was erected in the fall of 1873, at a cost of \$45,000, by a Scotch and Canadian company, called the Harrington & Hickory Consolidated Mining Company, to work the ores of the old Hickory mine, which had been sold to it for about \$100,000. The mill ran a few months on about 35-ounce ore in the winter of 1873-'74, and produced from \$9,000 to \$12,000 in base bullion. It was then idle until leased by the Cave company in August, 1876. This company ran about five months, and produced \$19,000 in very fine bullion. The mill has been idle since. The watchman sued for his wages and took the property in 1878. The machinery consisted of a fine 60 horse-power engine, two horizontal boilers, a Dodge rock-crusher, ten 750-pound stamps, six small wooden pans, three iron settlers, and a retort. At the time of the writer's visit a sampling mill was being erected. It was to be completed and ready to receive consignments of ore in a few months.

MINES OF NORTH STAR DISTRICT.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Rebel	600	4,000 tons	Idle	Ore assays average 85 ounces silver and 65 per cent. lead.
Hickory	525	1,000 tons	Active	Ore, porous quartz, with stain of oxides of copper and iron.
Osceola	200	50 tons	Worked irregularly	Ore assays 40 ounces silver and 20 per cent. lead.

MINES OF THE EASTERN FOOT-HILLS OF STAR DISTRICT.

The Vulcan, an iron-flux mine, situated 6 miles southwest of Milford, was discovered in the spring of 1872, but serious work was not begun until April, 1879. It was regularly worked by the owners, and the product sold to the Horn-Silver Company for \$8 per ton. The mine consists of large bodies of ocher on the hanging wall of a small contact vein between a dolomite hanging and a granite foot wall. There are several of these extremely irregular bodies from 1 foot to 15 feet wide, already prospected 75 feet horizontally and 125 feet on a dip of 60°. The ocher shows traces of gold, silver, and cerussite. Occasional bunches of 45-ounce ore are found. The total cuttings are 400 feet. About 900 tons of the flux had been shipped in the year; very little previously. The cost of transportation, which the mine paid, was \$4 per ton.

The Vicksburg mine was discovered in 1872. It has been idle since 1877, except assessment work. It is an N. and S. vertical vein, from 5 to 10 feet wide, in limestone near granite. An ocherous ore, containing from 15 to 50 ounces of silver and from 15 to 50 per cent. lead, was encountered in a chimney dipping about 40° N. Several tons of pure granular sulphur were found in a layer from 2 to 20 inches thick beneath the richest portion of the ore. Crystals of gypsum also occurred with the ore. The mine is opened by a 220-foot incline and 150 feet of other cuttings. Probably 200 tons of all grades have been shipped. There are several thousand tons of a soft low-grade ocher upon the dumps and in sight in the mine.

The Golden Era is a nearly vertical N. and S. vein, from 16 inches to 5 feet wide, in limestone. One chimney, 9 feet wide and 20 feet long, dipping 40° N. in the vein, has been followed over 200 feet. The ore is an ochery carbonate assaying as high as 55 ounces silver, 40 per cent. lead, and \$5 gold. There is a 245-foot incline on the vein, also 100 feet of other cuttings. A whim is used for hoisting. Three men have been working during the year. The total product has been about 250 tons, principally an iron flux.

MINES OF WESTERN STAR DISTRICT.

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Burning Moscow Hill Group	2,500	500 tons 20-ounce ore	Idle.....	Ore: first class, 100 ounces; second class, 15 ounces.
Mammoth and Incomo.....	1,050	\$80,000	Assessment work only....	Ore assays 20 to 120 ounces (average, 50 ounces) silver and 55 per cent. lead.
Hoesier Boy and Savage....	1,070	4,000 tons	Idle.....	Ore assays 15 to 50 ounces silver and 32 per cent. lead.
Flora and Wild Bill.....	850	800 tons.....	Worked by small force....	Ore assays 20 to 25 ounces silver and 30 to 40 per cent. lead.

MINES OF SOUTH STAR DISTRICT.

The Wasco mine is at South Camp, 7½ miles southwest of Milford, on one of the spurs of the highest peak of the Picacho range. It was discovered in the fall of 1874. It was worked until March, 1875, was idle for a year and a half, and was worked again until June, 1879, since which time it has been idle. It consists of a single pipe of a soft, yellowish limonite and carbonate ore, bedded in limestone, and dipping from 35° to 40° NE. One chimney began at the surface and has been followed 833 feet, and still continues. There are two or three contracted places or slight faults in it, and it varies in size from 1 foot to 10 feet thick, and from 10 to 30 feet wide, but is continuous. A tunnel 180 feet long cuts the pipe 300 feet from the surface, and is used to lessen the windlass work. The ore, when sorted, contains from 30 to 40 ounces silver, from \$4 to \$10 gold, and 40 per cent. lead. The assay value of the total product is estimated at 40,000 ounces silver and \$5,000 gold.

The Harrisburg Hill Mining Company was incorporated in April, 1880, and was a consolidation of the interests of the mine owners on the hill to develop their property. The mining property is at South Camp, near the Wasco, and embraces eleven overlapping locations, which cover an area of about three full claims. They are all in a dolomite or limestone country rock, and, with the exception of the Harrisburg and Mountaineer, have but limited developments. The ore is a low grade ochery carbonate, which, when sorted, will assay from 25 to 150 ounces silver, from \$3 to \$5 gold, and 30 per cent. lead. It occurs in chimneys, pipes the size of a barrel, and irregular deposits.

The entire hill is seamed with small veins containing ochre. The principal work has been done on one chimney in the Harrisburg claim, in a bedded vein dipping from 40° to 65° E. A very irregular incline follows this chimney 225 feet on the dip, and explores it horizontally 75 feet. The ore is found in irregular deposits from 6 to 20 inches wide. The first-class ore, when sorted, assays \$100 silver, 60 per cent. lead, and \$4 gold. In the vein, on either side of the ore-body, is a band of fibrous gypsum from half an inch to 3 feet thick. Sometimes layers of mud alternate with the gypsum. In the lower works from 1 foot to 3 feet of "black spar", a calcareous rock containing a large percentage of oxide of manganese, is found. In general the country is much broken in the vicinity of this vein, one horizontal fault of 20 feet being found 90 feet from the surface. The total product of the mines of the group is estimated at 700 tons, averaging 50 ounces silver and 50 per cent. lead. There is much low-grade ore upon the dumps.

The other mines of South Star district are :

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Elephant	650	75,000 ounces silver	Idle.....	Ore assays 40 to 90 ounces silver (av. 55 ounces), and 50 per cent. lead.
Crossus	400	30 tons, of 800 ounces silver.	.....	.....
Saint Mary's	1,000	1,000 tons 10 ounces flux; 50 tons 80 ounces ore.	Worked regularly by a small force.	Has produced a large amount of iron flux for the Shanttic and Frisco smelters.
Monitor	600	800 tons .....	.....	Ore averages 30 ounces silver and 30 per cent. lead.
Garden City Silver Mining Company.	.....	.....	.....	A consolidation of claims; most of them have from 100 to 300 feet of cuttings.
South Silver Mining Company.	.....	160 tons.....	.....	A consolidation of 7 claims; two have considerable development.

In addition to the above-mentioned mines of the Star districts there are very many claims with less development which have shipped from 10 to 80 tons.

As can be seen from the preceding pages, there have been many large bodies of rich ore found; but there are treble the number of medium-size bodies of low-grade ore that have only been shown and not developed on account of the great cost of transportation and the lack of concentrating apparatus. Ore of lower grade than 20 ounces will not pay to mine unless it can be sold for flux. The ore is a soft ocher, and doubtless would concentrate finely. Owing to the scarcity of water in the district the same character of ore will in all probability continue many hundred feet in depth; this seems therefore to be an excellent field for some kind of pneumatic concentrating machinery.

ROCKY DISTRICT.

[August, 1880.]

Rocky district is about $1\frac{1}{2}$ by 3 miles in extent, and includes a small isolated range north of the Star district and east of the San Francisco. It was organized in 1872 and had, at the period under review, about 25 locations, although six times that number have probably been made. The country rock is granite, quartzite, and limestone. The principal work has been done upon the following claims:

Big Mountain tunnel.—On the side of a mountain there is an E. and W. vein 10 feet wide in granite. From a 100-foot shaft about 31 tons of assorted ore were shipped to Salt Lake City, which, it is said, averaged 30 per cent. copper, 25 ounces silver, and \$12 gold. A tunnel to cut this vein at a depth of 400 feet was begun in June, 1878. The five owners have worked irregularly since then. The tunnel is a fine straight one 7 by $4\frac{1}{2}$ feet and 573 feet long. Another 150 feet, it is thought, will reach the vein.

June iron mine.—This mine had shipped 1,500 or more tons of flux to Frisco in the previous few years.

Rocky iron mine.—This claim was owned by the Frisco Mining and Smelting Company, and is said to have shipped 2,000 tons of flux since its discovery. It is worked through great open cuts upon the surface.

Copper mine.—This is an immense vein of copper ore with croppings 100 feet wide. The ore is a carbonate stain in the joints of a siliceous rock, and taken together is of very low grade; but 30 per cent. copper ore, assaying \$12 silver and \$10 gold, can be sorted from it. Some has been shipped. There is to all appearances a 50-foot vein of an impure magnetic ore one side of this vein of copper. Shafts 75 and 55 feet deep have been sunk.

BEAVER LAKE DISTRICT.

[August, 1880.]

The Beaver Lake district is situated north of the Star and Rocky districts, and was organized in August, 1871, upon the discovery of a belt of copper veins from an inch to 2 feet in width. Some work was done in 1872 and 1873, and a few tons of ore were shipped assaying 30 per cent. copper, 16 ounces silver, and \$12 gold. These copper veins have been idle since. In September, 1872, lead and silver ores were discovered. The leading mine is the San Francisco, which was sold for \$10,000. About \$8,000 worth of high-grade silver-lead ore has been extracted from a 110-foot shaft. It has been idle since 1873. The Dexter and Mountain King are iron mines, and shipped 400 tons of flux each between 1873 and 1877. A small vein containing graphite (or molybdenite) was also discovered. Little work has been done in the district in the last few years. The Riverside smelter was erected in 1873 at a point 7 miles north of Milford to work the copper ores of this district. It produced a few tons of copper matte and also a few tons of lead bullion in the few months that it ran. It has long been abandoned.

BRADSHAW DISTRICT.

[August, 1880.]

The Bradshaw mining district is southeast of Milford on the southern end of the Granite range. It was organized April 24, 1875, and contained at the time of the writer's visit about 100 locations. The country rock is mainly limestone, and the ore an ocher containing carbonate of lead and considerable gold.

The Cave mine, the principal mine of the district, is about 8 miles southeast of Milford and northwest of Minersville on a steep mountain side, about 4,300 feet above the Beaver river, and over 6,000 feet above sea-level. The cave in which the mineral was first found was discovered in 1859. The discoverer, a Mormon, is said to have dreamed for three successive nights of great wealth in that locality. It was not located, however, until 1871. Little was done until 1875 and 1876, when some ore was worked at the Milford mill. The mine became financially involved, and was mortgaged for \$8,000. The mortgage was foreclosed in April, 1878, and in September, 1879, the mine became the property of the Frisco Mining and Smelting Company. The property has been worked continuously since April, 1878. The ore occurs entirely on the bottoms of caves in limestone or dolomite. Five large caves and fifteen smaller ones had been found. They are all connected by seams of ocher, or by holes which serve as run-ways for mountain rats. Beyond the caves already known there are doubtless others, as holes and other seams lead outward. The largest cave is 120 feet long, 30 feet wide, and 20 feet high, extreme dimensions. One of average size is not over 12 feet in extent. All have an extremely irregular outline. The roofs of some are covered with a thin coating of copper carbonate and silicate. There is usually a vacant space from 1 foot to 10 feet

between the roof and the ore. On the ore is usually a mass from 1 foot to 3 feet thick of blocks of limestone, which have fallen from the roof. The upper portions of the deposits are generally softer, more earthy, and less valuable than the lower, where the carbonate of lead occurs. In some places the fine ocher changes into a hard massive limonite, with cavities having botryoidal and stalactitic surfaces. In spots pure granular or crystallized sulphur is found, though not frequently. In places the ore has been very rich, assaying as high as \$500 to \$800 per ton. Ore of the lowest grade assays \$5 in gold and silver. All the limonite and ocher, without regard to its grade, was shipped to the smelter at Frisco, it being worth from \$8 to \$10 for flux alone. The average grade of all the ore shipped could not be ascertained, but for several hundred tons recently shipped it was given at from 5 to 7 per cent. lead, \$22 50 silver, and \$7 50 gold per ton. The mine is perfectly dry, and the indications are that it will remain so for several hundred feet. The mine is opened by two tunnels, one 140 feet below the other. The lower or main working tunnel runs 300 feet in country rock before striking the cave deposits. There are only 1,400 feet of cuttings. The space partially explored and known to contain caves of ore is 300 feet long, 240 feet wide, and 150 feet deep. The method of working is to drive drifts and raises to the bottom of each cave. The ore is then stoped out overhead, the sides being timbered by square sets. The timbers are round, 1 foot in diameter and 5 feet long. Ore is dumped by mine cars into bins on the surface. These dumped into wagons, each drawn by ten mules, by which the ore is taken 23 miles to the Frisco smelter for \$7 per ton. During the census year about 17 men were employed at \$3 50 per day. The total assay value of the ore produced prior to June 1, 1880, is estimated at \$270,000, one-quarter of which was gold.

The Jolly Boy is in the northern part of the district, and was discovered in the fall of 1879. The developments do not exceed 220 feet. Four tons of selected ore, a soft ocher, averaged \$12 silver and \$333 gold. The vein is said to be 1 foot wide in limestone, and to be faulted in the bottom of the shaft by a porphyry dike.

The Nip-and-Tuck, Reliable, Mountain Maid, and Promontory are prospects of value, but of limited development.

M'GARRY AND ANTELOPE DISTRICTS.

[August, 1880.]

The McGarry and Antelope districts are located on the western slope of the Granite range to the north of Bradshaw. They were organized in 1876 and 1877, and contain a few iron locations.

LINCOLN DISTRICT.

[August, 1880.]

Lincoln district is on the eastern slope of Granite range, northeast of Bradshaw district. It was organized January 16, 1871. About one hundred and seventy-five claims had been recorded, but not over thirty were worked at the period under review.

The principal claim in the district is the old Rawlings or Rollins mine. It is claimed by the Mormons that it is the oldest mine in the territory. They worked it in 1860, 1861, 1862, and 1863, and made a few tons of lead in a primitive way. The mine was sold in 1875 to the Lincoln Silver Mining Company. A 15-ton furnace was built in the fall of the same year. The company worked both the mine and the smelter for two years. The managers, however, were inexperienced in metallurgy; and this, in addition to the finding of a body of water which the pump was unable to raise, resulted in the works and mine being shut down. The incline was sunk 220 feet, and showed a 6-foot vein at the bottom. One-fourth of this was pyrites and the remainder galena. In the upper works the ore body was from 8 to 12 feet wide. The average assay of the ore was \$40 silver and \$15 gold. About 100 tons of bullion, worth \$165 per ton, were produced.

The December group of mines had been recently sold to the December Mining Company of Chicago. The principal vein is from 1 foot to 4 feet wide, carrying a smelting ore which assays \$100 per ton when selected. A few tons have been shipped. There are 200 feet of cuttings.

The Coral Reef, Yula, and Richmond are a group on one vein, said to be from 3 to 5 feet wide, containing a low-grade smelting ore, 20 ounces silver, 30 per cent. lead, and some zincblende and pyrite. The developments consist of 310 feet of cuttings. About 80 tons had been sold formerly. The mines were being prospected by fifteen men.

GRANITE AND NORTH GRANITE DISTRICTS.

[August, 1880.]

Granite and North Granite districts are situated northeast of Lincoln district and northwest of the town of Beaver. It is stated that they were organized in 1863 and 1865. The first mentioned has "thrown away the books and lost the recorder", but nevertheless contains a mine of considerable note in the neighborhood. This is the Bismuth mine. It was discovered about 1865, and has been owned by almost every energetic miner in the region, the principal work having been done about sunrise on January 1. It was, at the time of visit, known as the Major lode. The vein is from 5 to 7 feet wide, and contains a tough quartz or gangue. In this some pyrite, galena, and,

it is said, 3 per cent. of metallic bismuth are found. A few tons were shipped years ago which were said to have averaged from 7 to 10 per cent. bismuth. There is a 130-foot shaft, besides shorter ones and drifts, which aggregate 210 feet.

North Granite district has about 25 undeveloped prospects on narrow veins containing low-grade smelting ore.

IRON COUNTY.

IRON SPRINGS IRON MINING DISTRICT.

[July, 1880.]

The Iron Springs district is 8 miles west of Cedar City. In 1851 or 1852 the Mormons erected rude furnaces at Cedar City and attempted to reduce the ore. The attempt was a complete failure, and so work was discontinued in 1857. Old settlers said that it cost about \$200,000 to produce 25 tons of iron. The district was organized in 1871 and reorganized in March, 1879. There were at the time of the writer's visit about 30 claims of 1,500 by 600 feet each, 14 of which showed immense croppings of magnetite and hematite. The mines are all within an area of 2½ miles wide and 5 miles long. Nothing has been done in the district except the assessment work necessary to hold the claims. During the census year several hundred tons of float were hauled to Frisco for flux. Near the mines is a fine spring.

PINTO IRON MINING DISTRICT.

[July, 1880.]

The Pinto iron district is a few miles southwest of the Iron Springs district and 20 miles west of Cedar City. The town consists of a few houses and the old furnaces, and is called Iron City. The district was organized in June, 1868. There were, at the period under review, 23 iron claims, 1,500 by 600 feet each, in an area 1 mile wide and 4 miles long, beginning 3 miles northeast of the town. These claims show immense croppings of hematite several hundred feet in length and breadth. The developments are merely nominal, only enough work being done to hold them and to entitle the owner to apply for a patent. The country rock in immediate contact with the hematite is sandstone, limestone, and granite. Piñon and cedar are moderately abundant on the adjacent hills.

In 1868 the Great Western Milling and Mining Company was organized by five Mormons. A rude furnace, a foundery, charcoal kilns, and the various necessary buildings for the manufacture of small cast-iron wares, were erected. It soon became a typical Mormon co-operative company. The church favored the enterprise and the settlers accepted stock for labor, material, and money advanced. In 1875 or 1876 the works were shut down, and the entire property was sold by the United States marshal. The company made only four runs, in all about nine months, and produced 400 tons of pig iron. This was made into castings, principally shoes and dies for the mills at Pioche, and was considered of excellent quality. The company expended about \$100,000.

Professor J. S. Newberry visited these iron districts in the summer of 1880. The following is an extract from his article in the *School of Mines Quarterly* for November, 1880, on "The genesis of our iron ores":

During the past summer, which I spent chiefly in Utah, I visited the deposit of crystalline iron ore of Iron county, in the southern part of the territory. These ore beds have been long known and were to some extent utilized by the Mormons in their first advent, thirty years ago, but no satisfactory description of them has ever been published. As they constitute, perhaps, the most remarkable deposit of iron ore yet discovered on this continent, I have thought that some facts in regard to them might not be an unimportant addition to what is known of the economic resources of our country. The iron region referred to lies nearly 300 miles directly south from Salt Lake City, and is situated in what is really the southern prolongation of the Wasatch mountains. The iron ores occur in the northern portion of a subordinate range, which attains its greatest height in Pine Valley mountain, near Silver Reef. Thirty miles north of this point the ridge breaks down into a series of hills from 1,000 to 2,000 feet in height, which consist chiefly of gray fine-grained granite, with dikes and masses of trachyte and here and there outcrops of highly metamorphosed limestone. The ore beds form a series of protruding crests and masses set over an area about 15 miles long in a northeast and southwest direction, and having a width of from 3 to 5 miles. Within this belt the iron outcrops are very numerous and striking; perhaps 100 distinct claims having already been located upon them, each one of which would make the fortune of a mining company if situated anywhere in the Mississippi valley or the eastern states. The most impressive outcrops are in the vicinity of Iron Springs, Oak Springs, and Iron City, of which localities the first and last mentioned are about 12 miles apart. Near Iron Springs the Big Blowout, as it is called, is a projecting mass of magnetic ore, which shows a length of perhaps 1,000 feet by a width of 500, and rises in castellated crags 100 feet or more above its base.

At Iron Springs a still more striking exhibition is made by the Blair mine, which is a ragged crest of magnetite, black as jet, formed by the upturned edge of the thickest of a series of sheets of ore, which rises like a ledge of bedded rock 200 or 300 feet above the adjacent lowlands. This outcrop is visible as a conspicuous black hill at a distance of several miles. The connections between the ore bodies of this great iron belt are obscured by the *débris* from the easily-decomposed trachyte and granite. It is evident, however, that for some miles the iron-ore deposits are continuous or separated by very short intervals, as the outcrops occur within a stone's throw of each other, and the surface is everywhere strewn with blocks of rich magnetic ore, enough in themselves to supply all the furnaces of the country for years. It would seem that the iron forms a number of distinct and closely approximated belts, which are the outcrops of beds that stand nearly vertical, and go down into the earth like huge walls.

There is considerable diversity in the character of the ore, though it is about equally divided in quantity between hematite and magnetite. Some of the beds of both are exceedingly dense and compact, while others, though rich in iron, are soft, and can be mined with the pick. Most of the ore is apparently very pure, containing a small amount of earthy matter and no foreign minerals. Some of the ledges, however, contain a large quantity of silica, the magnetite being mottled with white quartz; and one of the largest outcrops,

though showing many millions of tons of ore apparently quite pure, is thickly set along certain zones, evidently strata of deposition, with crystals of apatite from a quarter to half an inch in diameter and 2 or 3 inches in length. At this location many of the fragments are highly magnetic, and loadstone as strong as any known can be obtained there in great abundance. A few rods from this great outcrop is another of equal dimensions, in which the magnetite is apparently quite free from all impurities, showing neither quartz nor apatite. Near by is another exposure, perhaps a continuation of the last, of which the mass is half magnetite and the other half fine-grained and dense hematite. Across a narrow valley from this group the hillside is covered with fallen fragments of a rich but soft and dark hematite, and at no great distance the soil is colored blood-red by the decomposition of a hematite so soft as to make no other show above the surface. Near this latter location I noticed a line of outcrop of a very jaspersy hematite, in some places only a ferruginous jasper closely resembling some of the more siliceous ores of the Marquette district.

As to the age of this remarkable series of iron-ore deposits I cannot speak with absolute certainty, though they are apparently Lower Silurian.

The granite of the hills which contain the iron is fiber-grained and less compact than that which forms the great granite axis of the Wasatch, and I suspect is the metamorphic condition of the quartzite beds which rest upon the Wasatch granite. Some of the iron-ore beds in this granite are distinctly interstratified with it, and are certainly, like it, metamorphosed sediments. This is plainly shown at the Blair mine, where the principal crest of the hill is a distinct sheet of stratified, regularly bedded magnetite, from 30 to 40 feet in thickness, dipping toward the north at an angle of about 80°. Parallel with this principal layer are other sheets of magnetite separated by strata of granite and varying from $\frac{1}{4}$ inch to 10 feet in thickness, as perfectly parallel and regular as any series of sedimentary beds ever seen.

On the whole, the Blair mine is the most interesting and instructive outcrop of iron known to me, and furnishes the most striking proof of the sedimentary origin of these wonderful ore beds. None of the other outcrops are so distinctly stratified, but the Big Blowout at Iron City affords an equally conclusive argument against the eruptive theory; for while it appears to be a huge amorphous mass, like a hill of basalt, on examination it is found to be in large part composed of metamorphosed limonite; that is, magnetite, which has the botryoidal and concretionary aspect and radiated structure of limonite, and was plainly deposited from water.

At the period under review the old Silver Belt district was included in the Pinto district. The former was cut off in 1873, and joined again in 1875. It is located north of Pinto district, and contained at the time of the writer's visit 60 locations. The ore is quartzite, with some copper stain and lead, and assays from \$40 to \$60 silver per ton. The veins are from 2 to 4 feet wide. The developments are limited.

SALT.—Salt is obtained from the shores of Little Salt lake, near Parowan. It is shipped to the mills at Bullionville, Nevada, and to the Mormon settlements. During the census year about 100 tons were collected. Once when the lake was very low some long fibrous crystals were taken out with a pitchfork. They were sent to some New York chemist, and pronounced to be niter.

WASHINGTON COUNTY.

HARRISBURG OR SILVER REEF DISTRICT.

[July, 1880.]

Harrisburg district, better known as Silver Reef, is in the eastern part of the county, and covers an area of about 5 miles square. The old Mormon town of Leeds was the settlement nearest the mines in early times, and also gave a name to the region. As the mines were developed, the town of Silver Reef was built. It is about a mile north of Leeds, 20 miles northeast of Saint George, and 90 miles south of the town of Milford, on the Utah Southern railroad extension. Daily stages connect it with different points. Wood and water are plenty, provisions are cheap and easily obtained from the Mormon settlements in the Virgin River valley, and the mines are profitable; all of which tends to make the camp a thriving mining town of several hundred inhabitants. Silver was discovered in 1869 by John Kemple, who found, near Harrisburg, a piece of float which assayed \$17,000. He filled up his small shaft and left the country, but returned with others and organized the district June 22, 1874. He worked his claims for a few months, when, becoming discouraged, he returned to Star district, and was never benefited by the discovery. The district owes its development entirely to Mr. W. T. Barbee, who went there in the summer of 1875. He discovered very rich ore on the Tecumseh mine, and shipped 10 tons of \$500-ore to Salt Lake City in the following November. He continued the shipment of ore to Salt Lake City and to Pioche during the following year. This caused the rush to the district, principally from Pioche, in the summer and fall of 1876. The recorder's books showed 640 locations, but probably not over 150 claims were owned at the period under review. The country rock of this district is composed entirely of strata of sandstone and shale. The upper strata, which have been eroded and are only seen in the distant bluffs, are of a brick-red color. The lower ones, those adjacent to the ore, are pale red or yellowish. The mines are between 3,500 and 4,200 feet above sea-level, and are located wherever these strata of sandstone outcrop. These strata (locally called "reefs") are named White reef, Buckeye reef, and East or River reef. There seems to have been a slight anticlinal fold of the strata, which has been eroded several hundred or thousand feet in depth and many miles in length along its center line, exposing the ore-bearing reefs. The White reef is the most prominent, its outlines, disguised somewhat by weathering and erosion, being traceable for 20 miles. The valuable mines, however, are all within a mile of its northern outcrop. Its general trend is north and south, dipping from 20° to 40° W. The Buckeye reef lies to the east of the northern portion of the White reef, making an angle of about 30° with it. Its dip is from 12° to 25° W. It is less than a mile in length. At its southern extremity, at the Emily Jane works, the silver-bearing strata are only 50 feet apart vertically and 80 feet horizontally. Stratigraphically, without measurements, they appear identical. Hence, from a cursory examination,

it seems as if the Buckeye reef were a triangular piece of the White reef which had been faulted and thrown down. Probably this cannot be better explained than by quoting from the reports of Mr. R. P. Rothwell and Professor J. S. Newberry on the Stormont property, who gave much time and thought to the subject. Mr. Rothwell says:

The remarkable general resemblance between the beds of these two reefs; the curious coincidence of a series of red and gray sandstones and sandy shales, with bands of greenish and red clay shales of the most marked characteristics occurring in precisely the same stratigraphical order in each reef, and, above all, the occurrence of fossil plants and silver ores in certain beds of similar appearance in each, naturally lead to the supposition that these reefs are composed of the same beds cut off between the reefs by a great fault. A closer examination, however, reveals a certain dissimilarity between the ore-bearing beds, and the most careful search has failed to find any data to confirm this theory of a break or fault between the reefs. I have, therefore, concluded that the beds forming the Buckeye reef run under the White Reef.

Professor Newberry says:

* * * These questions are: 1st. What is the geological age of the silver-bearing sandstones? What is the source of the impregnation? Are there two reefs, or is one broken down and duplicated by a fault? The first of these questions has been left unanswered by all who have written on the geology of the district; but I was enabled to obtain conclusive evidence that the sandstones are of Triassic age, and are a part of the great sheet of Triassic rocks which extends through southeastern Utah, southern Colorado, New Mexico, the Indian Territory, etc. In the Cedar mountain, which reaches down from the north nearly to Silver Reef, I found the complete succession of the rocks of this region—Carboniferous, Permian, Trias, Jura, and Cretaceous, each containing its characteristic fossils. I also found some representatives of the sandstones which form the reefs everywhere present in the Triassic group and everywhere containing silver and copper. The question is then finally settled.

In regard to the source of the silver impregnation I had, before going to Silver Reef, accepted and repeated the theory promulgated by those who have written on the subject, namely, that silver solutions coming up through fissures where the volcanic rocks have broken the sedimentary formations, had spread through and more or less perfectly saturated the more porous strata, the sandstones, converting them into sheets of ore. I am now inclined to believe, however, that the silver, like the copper which the sandstones contain, was deposited with them and not introduced subsequently. The evidence of this is furnished by the facts that the extension of the sandstones through the unbroken table lands east of Silver Reef and along Cedar mountains as far north as Beaver *all contain silver*, though rarely more than 7 or 8 ounces to the ton.

Another fact which seems irreconcilable with the theory of the recent diffusion of the silver solution is that some of the richest ore is in the fine clay-shale that lies in sheets and lenticular masses in the sandstone. This material is nearly impervious, and it seems improbable that a solution flowing through the sandstone should have made any considerable deposit of silver in it.

This question has, perhaps, little bearing on the value of your mines—for the diffusion of silver would be sufficiently extensive according to either theory—but the view that the impregnation extends in greater or less richness over hundreds of square miles is in the strongest contrast with that entertained by some, that the ore is local and exhaustible. By whatever means introduced, I am thoroughly satisfied that the ore will be found to extend, not uniformly, but in patches, as hitherto met with, as far as the sandstone ledges can be penetrated.

The question whether there are two silver-bearing beds at Silver Reef, or whether the lower or Buckeye reef has been broken off from the upper or White reef by a fault, has divided the inhabitants of the town into two parties, and is just now quite warmly discussed. As it seriously affects the value of all the mines located on Buckeye reef, and is of vital consequence to the Stormont mine, I gave special attention to it.

If there are two reefs, the Stormont, Last Chance, and Buckeye mines can be profitably worked, perhaps, for a mile down the dip of the reef; but if there were but one, they could be worked only to the line of the fault—perhaps 1,500 feet at the Buckeye and not more than 300 feet at the Stormont. This would render the Stormont comparatively worthless and greatly reduce the prospective value of the Buckeye and Last Chance. I am able, however, to allay any fears that may have been excited by this theory of a faulted reef, for, at the Stormont mine, I found both reefs exposed in the same cliff, and an unbroken series of sandstone and shale beds filling the space between them, thus establishing the fact claimed by Messrs. Rothwell and Conch that there are two reefs.

The River reef, so called because it lies near the Virgin river, is about 4 miles east of the White reef, and has also a north and south strike, but an easterly dip of about 30°. The mines upon this are comparatively unimportant as yet. A few miles southeast of the district several small craters and floods of lava are to be seen upon the extensive sandstone table-lands. In all the mines the ore is found in impregnations of sandstone and clay shale, having an irregular lenticular shape, but usually bedded in distinctly marked strata. The silver usually occurs as chloride and sulphide (about half being chloride), but will doubtless all be sulphide below the permanent water line. There are considerable quantities of carbonized plants, leaves, chips, and limbs usually found in layers a few inches thick, but occasionally distributed promiscuously through the ore. These carbonized fragments are generally exceedingly rich in horn-silver, silver glance, and sometimes a few flakes of native silver, selected pieces of which assay several thousand dollars per ton. But, as with most other ores, appearances are deceptive, and these carbonized organic remains are sometimes valueless. Good ore in the mine cannot be distinguished from waste by color, softness, or granular structure, but the minute flakes of silver can be seen. Freshly broken ore will not show them, but in an hour or so after blasting the gunpowder smoke containing sulphide of potassium has acted upon the colorless flakes on the newly exposed surfaces of the rock and covered them with a film of sulphide of silver having a glistening metallic luster, which is distinctly visible to those accustomed to look for it. The relative number of these small lead-colored specks indicates approximately the grade of the ore. Traces of copper carbonate and sulphide occur in the ore. It is said to be the universal rule that an increase of copper (judging by the carbonate stain) is accompanied by a decrease in the silver value. Professor Newberry reports small quantities of selenium in these ores. The average of four analyses made at the School of Mines gave 0.23 per cent. selenium.

Mills have been erected in the district in the following order: Leeds, February, 1877; Pioneer, 3-stamp, demolished fall of 1877; Christy, January, 1878; Barbee & Walker, March, 1878; Stormont, July, 1878. In 1877

and 1878 many rude leaching works were erected, but, except in cases where the ore was rich and was bought for a trifle, they were unsuccessful. The ore was crushed in arrastras. The percentage saved was from 30 to 60, averaging about 45. Not over \$25,000 was extracted in this way.

The total production of the district has been as follows:

Bullion from leached ore and by private conveyance, prior to the establishment of Wells, Fargo & Co.'s office, in 1877, and value of ore shipped (estimated).....	\$90,000 00
Assay value of bullion shipped by—	
Wells, Fargo & Co. in 1877	480,665 16
Wells, Fargo & Co. in 1878.....	1,141,911 19
Wells, Fargo & Co. to June 1, 1879	517,444 73
Wells, Fargo & Co. during the census year.....	1,013,717 84
	<hr/>
Total to June 1, 1880	3,243,738 92
	<hr/> <hr/>

A large amount has been paid as dividends by the mill companies, but the exact figures were not obtainable. Beginning at the northern extremity of each reef the important mines are located in the following order:

White reef.—Barbee & Walker, 2,450 by 600 feet; Pinkham & Dodge; Leeds; Thompson & McNally, 1,313 by 600 feet and 1,490 by 600 feet; and Gisborn.

Buckeye reef.—Silver Flat, 1,498 by 577 feet; Manhattan, 1,500 by 600 feet; Tecumseh, 1,496 by 595 feet, all three belonging to the Christy Company; Kinner, 493 by 300 feet; Buckeye, 1,366 by 489 feet; Last Chance, one-third of a full claim, both owned by the Stormont Company; Maggie, 1,281 by 496 feet; California, 1,422 by 600 feet, both belonging to the Christy Company; 1,497 by 570 feet, and Emily Jane.

East reef.—Vanderbilt, Duffin, Dykes & Stapeley, Toquerville, Maud, and Dixie.

The Stormont Silver Mining Company is a New York corporation having a capital stock of \$1,500,000 in 150,000 shares. The early history of the mining property could not be ascertained. The Stormont Company was incorporated July 19, 1879, since which time the mines have been worked steadily. The property consists of the Stormont, the Buckeye, and the Thompson & McNally, patented mines; the Last Chance and part interests in nine unpatented and slightly developed claims; two 5-acre mill sites; and a mill on the Virgin river, 5 miles from the mines.

Buckeye and Last Chance.—The dip of the strata here varies from 14° to 25°. There are several folds or small vertical faults. There is no separation, no distinctly-marked line of fault, but the ore is sometimes thrown from 2 to 6 feet. The extreme limits of the workings, at the period under review, were 148 feet in vertical depth, or about 500 feet on the dip of the reef, and 1,480 feet horizontally. The ground had not been stoped out or even explored, except in some places. The ore had been found in four irregular chimneys, two of which began at the surface. These had a lenticular cross-section, varying from 18 inches on the edges to 16 feet, or even 20 feet, in the center. In general, however, the thickness of the ore stratum was not over 8 feet. The ore stratum is rarely worked when less than 18 inches thick. The total cuttings in these mines were less than 4,900 feet. The company has fine new hoisting works on the Buckeye mine, over a vertical two-compartment shaft 148 feet deep, situated about 500 feet west of the crest of the reef, including a Copeland & Bacon 21 horse-power engine, $\frac{3}{4}$ inch steel-wire rope, cages, safeties, etc. These are the only hoisting works on any considerable scale in the district. At the Last Chance there are small steam hoisting works with a 7 horse-power engine. These mines employed about 60 men during the census year; shifts 10 hours and wages \$4 per day. The ore is hauled to the mill at a cost of \$2 20 per ton.

The Stormont mine—This mine was worked to October, 1879, when the machinery was moved and the work was discontinued. There was a 180-foot incline, 80 feet of which was in water. The other cuttings amounted to 550 feet. One ore body was found from 8 to 15 feet thick in the center and "feathering out" to 18 inches on the edges.

Thompson & McNally.—This claim is on the White reef. The silver-bearing stratum is not over 60 feet from the surface, and has been worked by six short shafts and a tunnel over 200 feet long under the crest of the reef. The extent of the workings is 60 feet in depth from the surface, 400 feet in length, and 350 feet on the dip of the reef. The total cuttings amount to 1,220 feet, besides large open cuts. The ore is found in several lenticular bodies. Many thousand tons have been produced. About 38 men were employed during the first half of the census year, since which time the mine had been idle.

The Stormont mill is situated in the ravine of the Virgin river, from which it obtains water by a ditch 1 mile in length. The mill was completed July 4, 1878, and has been running most of the time since. The mill plant consists of a 40-inch turbine water-wheel; a boiler to generate steam for pans; a Blake crusher; 2 self-feeders of local invention; 10 750-pound stamps, double-discharge, wet-crushing batteries, No. 40 brass wire screen, drop 6 inches, speed 94; 24 settling tanks, 5 by 7 feet 8 inches by 3 feet 6 inches; 13 pans, 6 feet 4 inches by 2 feet 8 inches; 7 settlers, 7 feet 10 inches by 2 feet 10 inches; 3 retorts; 2 melting furnaces; and 120 feet of blanket sluices, having six compartments 13 inches wide. The whole cost about \$55,000. The turbine has been running almost steadily for a year and a half, and has given great satisfaction. It has become much worn, using one-third more water than formerly, and is soon to be replaced by another of the same make. The head of water

is 20 feet, the penstock is 8 feet 2 inches square, and the flume is 8 feet 2 inches wide, and 24 inches deep. The average amount crushed per day is from 70 to 75 tons. Sometimes the battery is hung up for one or two hours at a time, because the tanks and pans are full. Battery shoes and dies last about 40 days, about two-fifths of a pound of iron being worn off per ton of ore crushed. Screens last two weeks. The battery sands flow into a single settling tank at a time, the overflow passing through all the others. The heavy sands are shoveled out upon a platform, and thence into the pans. The lighter sands or slimes are pumped into the pans to give the required consistency. About 10 per cent. of the ore passes off in slimes and settles in three slime ponds, which are from 50 to 80 feet square and 1½ feet deep. These slimes assay about \$35. When nearly dry, they are wheeled to an elevator, taken to the pan floor, and mixed with the ore and concentrations. The pan mullers make 62 revolutions per minute. A charge is a ton and a half and is worked six hours. The temperature, as observed at the time of the writer's visit, was 136°, 140°, and 153°. Grinding is never done. At the time of charging 200 pounds of mercury, from 20 to 50 pounds of salt, and from one-half pound to 4 pounds of sulphate of copper are added per pan. The difference in the quantity of chemicals employed is due to the difference of the ore from different mines, experience having determined these quantities. There is a peculiarity of construction of these pans, which is of considerable advantage. The driving rod, which runs through the center of the pan and carries the muller, is prolonged upward 4 feet beyond its usual length, and bears the thread of a large screw. On one side the entire length is a key-seat. The muller, provided with a screw, as usual, moves upon the rod, and, by means of the key and key-seat, can be securely fastened at any height. This is of great advantage in cleaning up the pans. The muller is screwed up and fastened, and the labor of hoisting it was thus avoided. The settlers make 12 revolutions per minute, and retain a charge three hours. They are run half an hour, and run down in two and a half hours. The mill is thoroughly cleaned up once a month, and the quicksilver weighed. The loss is from three-quarters to one pound per ton of ore worked. The retorts are cylindrical, 1 foot in diameter and 4 feet long, and hold about 800 pounds of amalgam. They last about 90 charges. The bullion is 0.820 to 0.980 (average, 0.850) fine, the remainder being copper. The tailings, which assay from \$3 14 to \$8 copper, are concentrated on blanket sluices having a grade of about 8 inches to the rod. The blankets are washed twice in 24 hours, and about 20 tons, assaying from \$20 to \$60, are caught in three weeks. These concentrations are allowed to weather from three to four months, and are worked in pans mixed with other ore. The tailings from the blanket tables run off into the Virgin river. Battery samples are taken every hour, one pint from the spout at the rear of the screens, care being taken not to run the dipper over. These are settled and made a 12-hour sample. Tailing samples are taken in the usual manner. Very complete estimates of costs and percentages are made each month, but they were not given for publication. Besides working the ore from the company's mines, this mill does considerable custom work. The company charged \$12 per ton for milling, deducting 3 per cent. for moisture; pays 80 per cent. in bullion for ore assaying \$60 and upward, 75 per cent. in bullion for ore below \$60, and cashes the bullion at 20 per cent. discount if so desired. The cost of treating ore by this water-power mill is about a dollar per ton greater than if the mill had been erected at the mines and steam-power used; this is owing to the expense of hauling the ore. The mill force consists of:

Class.	Number employed.	Length of shift.	Wages per shift.
		<i>Hours.</i>	
Amalgamators.....	4	12	\$5 00
Dumpmen.....	6	12	4 00
Tankmen.....	8	12	4 00
Battery feeders.....	2	12	5 00
Slime-pit men.....	4	12	4 00
Blanket washers.....	2	12	4 00
Watchmen (ditch).....	2	12	4 00
Laborers.....	2	12	4 00
Blacksmiths.....	2	12	5 00
Carpenter.....	1	12	6 00
Assayer and foreman.....	1	12	5 00
Clerk.....	1	.....	3 33
Superintendent.....	1	.....	.....

The Christy Mining and Milling Company owns the Tecumseh, Silver Flat, Silver Crown, Silver Point, Chloride Chief, Maggie, and California, all patented claims; 18 others, unpatented; and 19 acres of land, including a water right and a mill and mill site in the town of Silver Reef. The company was incorporated in the fall of 1877, having a capital stock of \$6,000,000 in 60,000 shares. The following claims were the only ones which have been developed to any extent:

The Manhattan, Silver Flat, and Tecumseh.—These are situated at the northern end of the Buckeye reef on an almost level surface. The ore is found here, from 4 to 15 feet below the grass, in comparatively small bodies, from 1 to 3 feet thick and from 40 to 50 feet wide and long. There are 800 feet of cuttings and a large amount of

surface work. Several faults of from 4 to 6 feet and wave-like formations were noticed by Professor Maynard, who made a report on the property in the summer of 1880. The company employed about 26 miners during the census year, and produced over 13,000 tons of ore from all its mines. The cost of transportation to the mill was 80 cents per ton.

The California and the Maggie.—These are at the other extremity of the same reef. They have small steam hoisting works (8 horse-power engine), at a 200-foot incline on the dip of the stratum (25° W.). A small quantity of water was encountered at 75 feet from the surface, and was raised by steam pumps. Below the water line the ore was not so free. The drifts and levels extend 800 feet horizontally, and amount to about 2,100 feet. One ore body began at the surface and extended to the 150-foot level. Others have been found which extended below the existing workings. The ore bodies are rarely more than 30 inches in thickness. About 18 men were employed during the census year.

The Christy mill.—The plant comprises one 40 horse-power engine; one Blake crusher; one Hendy self-feeder; five 850-pound stamps (double discharge, wet crushing battery, drop from 5 to $7\frac{1}{2}$ inches, speed 95, No. 40 brass-wire screen); 12 settling tanks (8 are 3 feet 8 inches by 8 feet 10 inches by 2 feet 10 inches deep, and 5 are 8 feet square and 2 feet 10 inches deep); 6 pans, 5 feet 6 inches by 3 feet (2 more were to be added soon); 3 settlers, 8 feet by 3 feet 4 inches (1 more to be added soon); 2 retorts; and 2 smelting furnaces. This mill began operations January 8, 1878, and, with few interruptions, has been running steadily since. Its capacity is about 40 tons per day. According to the foreman, about one-fifth of a pound of iron is worn from the battery shoes and dies per ton of ore crushed. Cams and stems begin to break after twelve months' wear. Screens last seven days. It is estimated that about 15 per cent. of the ore passes from the mill as slimes. These are caught in four large slime pits, about 75 feet square and from 3 to 5 feet deep, and are treated as at the Stormont mill, *i. e.*, mixed with one-third of a charge of the coarsest sandy ore and put through the pans. In working slimes more mercury is lost and a lower percentage (estimated at 3 per cent.) obtained than in working the regular ore. The pans work a charge of $1\frac{1}{2}$ tons in six hours, making seventy revolutions per minute. The temperature, as observed, is from 160° to 170° . About 30 pounds of salt, 2 pounds of bluestone, 1 pound of lye, and 250 pounds of mercury are added per pan at the time of charging. A few ounces of cyanide of potassium are also added every two or three days to clean the mercury. The settlers make thirteen revolutions per minute and run three hours, two to settle and one to discharge. The mill is cleaned up once per month. The loss of quicksilver is $1\frac{1}{2}$ pounds per ton of ore treated. The bullion is about 0.930 fine.

The following peculiar action of the bullion was noticed in this district, and especially at the Christy mill, when working on some Tecumseh ore, which contained a number of minute yellow specks. After the bullion was poured from the pot into the mold and had apparently solidified, it would begin to swell (not sprout) and rise slowly in the mold until the spongy surface was from 3 to 4 inches above the first surface. The melter noticed that this action was prevented, or at least diminished, by keeping the molten silver in the pot a considerable time before pouring. A person, said to be connected with the laboratory of Hamilton College, New York, while visiting at Silver Reef, took some samples of these yellow ores, and, on returning to the east, reported that they contained phosphate of uranium. This statement has not been authenticated, but is given for what it may be worth.

Assays are regularly made at the Christy as at the Stormont, but all data were confidential.

The Barbee & Walker Silver Mining Company was incorporated June 1, 1880, with a capital stock of \$1,000,000 in 100,000 shares. The company owns two patented claims, embracing 2,450 by 600 feet of ground along the White reef, a 5-stamp mill, and 14 acres of agricultural land to insure a water supply. The company has small steam hoisting works on a 400-foot incline, which began on the crest of the reef. The engine is of 21 horse-power and the rope $\frac{7}{8}$ -inch steel wire. A giraffe is used. The plant is thought capable of sinking 600 feet on the present dip of 40° . The ground has been prospected 706 feet horizontally, and the total cuttings amount to 2,180 feet. No water has been yet encountered. The ore is found usually on the hanging-wall side of three beds, about 12 feet apart, and dipping 30° to 45° W. One body came to the surface, and was 200 feet long, 60 feet wide, and from 2 to 20 feet thick. Several others of much smaller size have been encountered. One vertical fault of 6 or 8 feet and several smaller faults of the ore in the beds have been met with. The beds are not worked, except when prospecting, when the ore is less than 12 inches in thickness. About one-tenth of the drifts require timbering. Black powder is used almost exclusively. The volume of a ton of ore or waste in place is estimated at $12\frac{1}{2}$ cubic feet, and of a ton broken at from 18 to 23 cubic feet. The mine was idle, owing to the destruction of the mill by fire, except during the last three months of the census year, when about forty-four men were employed. Night shifts are nine hours and day shifts ten, and the wages are \$4 per shift. Drifting is done by contract, the company furnishing and sharpening the tools, and paying \$7 50 per linear foot. The ore is not weighed, but estimated in bulk by the tally-board of the car-loads hoisted. The cost of mining ore per ton for the month of June, 1880, was \$5 29. The total assay value of bullion produced from ores of this mine, between April, 1878, and June 1, 1880, was \$244,577 90.

The company's mill is on the side of the reef below the hoisting works. Ore is taken in a wheelbarrow 100 feet or less from the mine dump into the mill. The mill was built in the spring of 1878, and was accidentally burned June 23, 1879. It was rebuilt and began running again February 23, 1880. It has been in operation continuously since. The machinery consists of a 25 horse-power boiler and engine, a home-made self-feeder, a Blake crusher, five 650-pound stamps (double-discharge, wet-crushing battery, $5\frac{1}{2}$ - to 6-inch drop, speed 90 to 95, No. 40 screen),

three settlers 7 feet 10 inches by 2 feet 10 inches, two retorts, and two melting furnaces. The capacity of the mill is about 35 tons per day. The stamps could crush more, but there is not sufficient pan capacity. About 10 per cent. of the ore passes off as slimes and is caught in three slime ponds 50 by 65 feet and from 3 to 5 feet deep. These slimes for the month of June, 1880, assayed \$54 per ton. When dry they are added to the regular pan charges, 200 pounds to each charge. The pans hold about a ton and a half each, make 55 revolutions per minute, run six hours without grinding, and have an observed temperature of from 182° to 188°. Immediately after charging and heating up the pans, 180 pounds of quicksilver, 30 pounds of salt, 6 pounds of bluestone, and an ounce or so of cyanide of potassium and lye are added to each charge. The settlers run one hour before discharging. The mine is cleaned up on the first of every month. The loss of quicksilver is 1.4 pounds per ton of ore. The bullion is 0.860 fine. The tailings for June, 1880, averaged \$8 52. They are all saved in reservoirs below the mill. Assays are carefully and regularly taken, as in the previously-mentioned mills of the district. The average assay of battery samples from December, 1878, to June, 1879, was 20.3 ounces. The average in June, 1880, was \$33 06. The cost of the mill was \$26,000. The cost of milling ore in June, 1880, was \$6 40 per ton. No custom ore is worked. About 1,015 tons were treated in June, 1880, yielding \$26,334 53. The mill force was 17 men, working 12-hour shifts, at \$4 and \$5 per shift.

The Leeds Mining Company, capital \$6,000,000 in 60,000 shares, was organized in the autumn of 1877. The company's property consists of four adjoining claims on the White reef, one mill and mill site, and 15 acres of land and its water right. The mines have been opened by a tunnel running under the crest of the reef and by six shafts. The extreme extent of the workings is 900 feet on the dip (20°) and 900 feet horizontally. The total cuttings probably exceed 5,500 feet. There is only a whim on one of the shafts. Several bodies have been found from 1 to 15 feet (average, 6 feet) thick. The richest ore is usually on the foot wall or floor. About eighteen men were employed during the census year, and 4,923 tons of ore were extracted. The mine had been idle several months.

The Leeds mill was originally the Magnet mill, erected at Bullionville, Nevada, years ago, and was moved to Silver Reef in the winter of 1876. It is about a tenth of a mile from the mines of the company. The plant consists of a 35 horse-power engine and boiler, a Blake crusher, a self-feeder, ten 750-pound or 800-pound stamps (double-discharge, wet-crushing battery, 6½-inch drop, speed 95, No. 40 screen); ten settling tanks, ten pans, 4 feet 6 inches by 2 feet 2 inches; five settlers, 7 feet by 2 feet 2 inches; two retorts, and two melting furnaces. It was one of the old-style mills, and showed the effects of a move and hard work. It had been idle for some months. There is nothing about the mill or its working results so different from those previously described as to require particular mention. Besides working the company's ore, much custom work has been done. The price charged was \$12, lately reduced to \$8 per ton. The mill guarantees 80 per cent. in bullion, and buys bullion at 20 per cent. discount. The total assay value of bullion produced by this mill to June 1, 1880, including that from custom ore, was \$768,321 58.

The Kinner mine, on Buckeye reef, has small steam hoisting works (10 horse-power engine) over a vertical shaft. The limit of explorations is 250 feet horizontally and 450 feet on the dip, or 175 feet vertically. The cuttings amount to 1,200 feet. Some water, 300 to 400 gallons per hour, was encountered at 350 feet on the dip. Several bodies have been found having an average thickness of about 5 feet. The richest ore occurs within from 10 to 15 inches of each wall, *i. e.*, near the overlying and underlying strata. The strata are folded in one place in the mine something like a letter "S", and are also said to be faulted and thrown 40 feet. During the census year 32 men were regularly employed, and about 2,700 tons of \$40-ore were extracted. The former product was \$15,000. The ore was milled at custom mills, but, owing to the high price of milling and lack of economical hoisting machinery, even high-grade ore did not pay, and the mine has been idle several months.

The other mines of the Harrisburg or Silver Reef district are:

Mines.	Total length of openings.	Total product.	Condition at the close of the census year.	Remarks.
	<i>Feet.</i>			
Pinkham & Dodge.....	727	No ore shipped.....	Assessment work only....	Large bodies of \$16 ore.
Emily Jane.....		280 tons.....	Worked on lease.....	Ore, \$20 and \$30. Developments limited.
Vanderbilt.....		240 tons.....		Average of ore produced, \$100. Incline of 60 feet.
Duffin.....	900			Total product, many hundred or thousand tons of \$80 to \$100 ore.
Tocquerville.....	1,000		Worked by chloriders.....	Several hundred tons of \$50 ore have been shipped.
Maud.....	440	\$33,980.....	Worked irregularly.....	Ore assays from \$30 to \$100.
Dixie.....	100	400 tons.....		Ore produced valued at \$35 per ton.
Gisborn.....		500 tons.....		Value of ore produced, \$20 to \$25 per ton.

SANTA CLARA DISTRICT.

[July, 1880.]

The Santa Clara district is situated 10 miles west of Saint George on what seems to be a continuation of the Silver Reef silver-bearing sandstone strata. It was organized in the spring of 1880. There are a few locations which have about 100 feet of cuttings each. The pay stratum is said to be 8 feet thick, assaying from \$10 to \$15 per ton. Around Saint George, and between it and Silver Reef, there are several districts, Volcanic, Gunlock, and others, covering miles of sandstone country, and containing many locations. Little work, however, has been done and no ore shipped.

Sulphur in considerable quantities is found near Toquerville. The Mormons claim that a vein of graphite from 1 to 3 feet wide exists in the mountains northwest of Saint George. There is also said to be graphite in Kane county.

The Pahria excitement occurred in the early part of 1879, and was occasioned by the report that a reef of silver-bearing sandstone had been discovered about 125 miles east of Silver Reef. This mythical reef, according to the report, was many miles long and averaged \$50 per ton, not counting the rich spots which assayed among the hundreds. Over 500 men, including some capitalists from Salt Lake City, rushed off to the new camp. Nothing was found but reefs of sandstone assaying a few dollars, although bearing a strong resemblance to the rich ores of the Silver Reef mines.

The Grand Gulch copper mine, in Bentley district, is 40 miles south of Saint George and 15 miles north of the Colorado river. Geographically it belongs to Arizona; but, if ever worked, it will necessarily obtain its supplies from Utah. The district was organized in 1871. Wood is plenty. Water, however, is scarce and 8 miles distant. A few copper locations have been made. Of the mine little can be said, as the reports are so conflicting. Considerable 30 to 50 per cent. copper ore has been found in sandstone. In 1877 the property was leased to men from Salt Lake City, who sank a 100-foot shaft, built a reverberatory and a shaft furnace, and ran out 10 or more tons of copper bullion. Nothing has been done since.

MORGAN COUNTY.

MILL CREEK DISTRICT.

Mill Creek district is 10 miles southwest of Weber, on the Union Pacific railroad, and contains a few iron claims having traces of gold and silver. The Norway Iron Mining and Milling Company owns three claims here, which are said to contain large quantities of high-grade iron ore. This company was incorporated November 19, 1879, with a capital stock of \$1,000,000 in 100,000 shares. The work on the claims is limited in extent, and no iron furnaces have been erected owing to the lack of capital.

WEBER COUNTY.

WEBER DISTRICT.

[January, 1881.]

The Weber mining district is on the Wasatch range, 2 miles northeast of the city of Ogden. Junction district formerly covered this ground, but its organization was abandoned about 1860. Weber district was organized in February, 1878, and contained at the period under review about 130 locations. The claims were mere prospects, few having over 100 feet of cuttings. The country rock is limestone and quartzite. The ore is an ocher, low grade in silver and lead, and a quartz said to average \$20 in gold. There are two arrastras and one small reverberatory roasting furnace in this district. From 3 to 8 miles north of Ogden there are said to be large deposits of hematite and magnetite ore. In 1874 a company was organized to work this iron ore. It built a furnace and ran a week in 1876. There is also considerable rolling-mill machinery upon the ground. It was said that \$125,000 was spent by the old company.

BOX ELDER COUNTY.

WILLARD DISTRICT.

[January, 1881.]

Willard district was organized about 1874. Little was done until the spring of 1880. There were, at the period under review, 40 prospects. The Iron King is a very large mass of iron ore, 3 miles northeast of Willard. Only assessment work had been done to hold it. Antimony ore occurs in reniform masses, from nut to bushel-basket size, in a quartz vein about 4 miles north of Bingham City. There have been no developments and no ore has been shipped.

LUCIN DISTRICT.

[January 1881.]

Lucin district is 8 miles long and 2 miles wide, and is located partly in Nevada. The mines, however, are entirely in Utah, about 8 miles southeast of Tecoma, on the Central Pacific railroad. It was organized in 1869. About 200 locations had been made, but not over 15 were claimed at the period under review. Very little has been done since 1876. The country rock is limestone.

The English Tecoma company, or the Tecoma Mining Company of Utah (limited), owns several claims, two of which, the Gladstone and the Shanly, were patented, upon which much work was done in 1873, 1874, and 1875; since which time they have been idle. This was the same company that bought the Flagstaff and the Last Chance. About 1,000 tons of low-grade ore (30 per cent. lead and from 10 to 25 ounces silver) was extracted, which was shipped to the company's furnace at Truckee, California, about 500 miles distant. The total cuttings aggregated possibly 1,500 feet.

The American Tecoma Company, or the Tecoma Mining Company, owned eight patented claims. A furnace was erected in 1871; and while the mines were looking well the property was sold to Howland & Aspinwall, of New York, in 1872. The latter owners extracted several thousand tons of ore (averaging about 35 ounces silver and 45 per cent. lead) from two well-defined surface bodies, and shut down in 1875 or 1876. The claims have been idle since. In the lower parts of the ore bodies much wulfenite was found. Their total cuttings amounted in the aggregate to about 1,200 feet.

In 1874 about 40 tons of horn-silver ore were collected on the Black Warrior claim from surface deposits by gopher-hole work, which were said to have yielded \$16,000. Little has been done since.

There are a few other claims, the Buchu, the Central Pacific, the Lady Franklin, and others, which have a few hundred feet of work and have produced a small amount. Five men were chloriding and prospecting in the district in the census year.

NEWFOUNDLAND, SILVER ISLET, ROSEBUD, ASHBROOK, AND FREMONT ISLAND DISTRICTS.

[January, 1881.]

Newfoundland district is situated in a small mountain range in a marshy desert 15 miles south of Terrace, on the Central Pacific railroad. It was organized in 1872. Many locations had been made, though few claims were owned at the period under review. It is said that the formation comprises all the sedimentary rocks and some porphyry. The veins are narrow (18 inches), and contain milling ore assaying from 100 to 150 ounces silver and some copper. Assessment work has been kept up on a few claims having from 150 to 250 feet of cuttings each.

Silver Islet district is on another mountain in the same desert. There are a few claims having high-grade copper ore which have been comparatively idle since 1873.

Rosebud district, 10 miles northwest of Terrace, was organized in the fall of 1873, and contains probably 200 locations, of which 25 were still worked at the period under review. The country rock is said to be limestone, quartzite, and porphyry. The ore is an ochreous carbonate of lead containing a few dollars in gold and from 60 to 100 ounces in silver. The Thompson Consolidated Mining Company owns four claims, and is doing the principal work. There is a 300-foot shaft and incline; also 400 feet of other cuttings. Eight men have been working during the year. Other claims in the district having a few hundred feet of cuttings are the Talco Consolidated, Silver Reef, Mayflower, and Delmonte. Very little ore has ever been shipped.

The Ashbrook district, organized in 1874, is about 30 miles northwest of Terrace, in the extreme northwestern corner of Utah, and contains a few narrow veins of high-grade free-milling silver ore. Thirty tons were shipped in September, 1880.

About 20 miles northwest of Terrace, on Grouse creek, there are two belts of coal croppings. There are seven seams of coal and shale from 3 inches to 4 feet thick about 20 feet apart. Ten tons of a fine quality have been shipped. At the period under review a few men were prospecting the beds in the interest of the Central Pacific railroad.

Fremont district, which includes the whole of the island of that name in Great Salt lake, was organized in 1871. Small veins carrying gold, silver, copper, and lead were found. Nothing was done, and the organization has been abandoned. There is said to be a great abundance of very good roofing slate on the island.

GREAT SALT LAKE.

The Great Salt lake has an area of 2,360 square miles (including islands), is 4,218 feet above sea-level, and has a maximum depth of 60 feet and an average depth of about 20 feet. The water-level has varied several feet within the memory of the old settlers. Between 1847 and 1856 it filled 5 or 6 feet and receded to its old level. In the few years following 1863 it filled again, and has maintained that depth since. In consequence of this the percentage of solid matter in solution is variable. An analysis made in 1869 gave 14.8 per cent. of solid matter,

of which 11.8 per cent. was sodium chloride. Salt has been collected by the Mormons since their arrival in the country in 1847 from small ponds on the shores, which became dry in the autumn. It is, however, only within the last few years, since a demand for it has arisen at the new mills in the adjacent territories, that any systematic arrangements have been made for gathering it.

There are six places on the lake shore where salt is obtained, Monument Point, Willard, Plain City, Hoopersville, Farmington, and near Salt Lake City. Sometimes the lake water is pumped into artificial ponds by steam or horsepower, and sometimes a dam is built across the entrance to a small cove on the lake shore. In either case the salt is obtained by solar evaporation. The most extensive works are those of Jeremy & Co., near Salt Lake City, to whom the writer is indebted for the following particulars relating to the process and the costs: The dam across the cove must be solidly built; earth will wash away and plank will not bear the weight of the waves of heavy salt water. Experience has proved that it must be made of earth and covered with lattice, willows, and tule. Posts are driven 2 feet apart in two rows 7 feet apart. A lattice work of willows is woven on these posts and backed by several inches of tule, the center being filled with earth. Such a dam costs about \$1 per foot. There is a gate through this dam, or around one end of it, through which the water flows when it is raised in waves by a strong west wind. These salt ponds are from five to a hundred acres in extent. The season is from May to October, the first three months being required for the evaporation of the water. The salt will be found in crusts from 1 to 4 inches thick. It is scraped into conical heaps with a square-edged shovel. The men receive from 50 cents to a dollar per ton, and make wages of from \$2 to \$2 25 per day. A cubic foot of salt in the heap is estimated at from 65 to 74 pounds. The price of salt per ton at the ponds varies with the demand, but is usually between \$2 50 and \$4. This firm estimates the product of its works during the census year at 10,000 tons. At the other ponds about 4,700 tons were gathered. From inquiry the writer estimates that only about 7,000 tons were shipped to mills, by rail, and used for domestic purposes during the same time; hence the remainder is still standing in the conical piles, dissolving and washing back into the lake with every rain.

COAL FIELDS.

The supply of coal in Utah is apparently inexhaustible, but only a few beds in the most accessible localities have been worked. The coal is a "brown coal", like all that has been discovered in the Rocky Mountain region.

The records of the Salt Lake City land office show that between 1870 and 1879 the following acreage of coal land was returned on the plats of public surveys:

	Acres.
Kane county	49,384
San Pete county	34,332
Sevier county	11,013
Iron county	6,240
Wasatch county	2,840
Summit county	19,931
Total	<u>123,740</u>

This does not include it all. Much land was surveyed between 1856 and 1870, of the character of which no mention was made; and vast tracts in the southeastern coal region are unsurveyed. But a few thousand acres are either located or patented.

In the following localities comparatively limited developments have been made:

THE COALVILLE DISTRICT, SUMMIT COUNTY.

[November, 1880.]

In the valley of the Weber river 2,000 or 3,000 feet of the overlying sandstone has been eroded, thus exposing the coal series of the Green River basin near its western border. This coal series belongs to the Laramie group of the Cretaceous period. (a)

The purely Mormon town of Coalville is situated 5 miles south of Echo, up the valley of the Weber river. Two parallel streams, Chalk and Grass creeks, flow from the northeast into this river, the former at Coalville, and the latter a few miles further down. It is on these two creeks, or in their side ravines, where the coal was almost or quite in sight, that the Coalville mines are situated. The altitude is from 6,500 to 6,800 feet. The coal croppings are principally found in a region 15 miles east and west by 8 miles north and south, but the mines actually worked are in a much smaller area. The country is considerably broken, most of the mines showing one or more faults, although the distance of the throw is usually not great. To the eye the surface of the country presents a succession of three sandstone ridges, with strata dipping from 20° to 30° between north and west. This indicates three extensive faults, which will be found when two of the coal beds are worked to great depths. There are two principal beds of coal,

the upper or 5-foot seam, having a red ash, and the 11-foot seam, which is worked at present. The perpendicular distance between these beds is said to be 800 feet. In the period between 1864 and 1874 the other principal mines were discovered and work was begun. Since then operations have been irregularly continued, usually in the winter. In general the mines have been worked by poor men. The machinery used has been very small and imperfect, the system of working very short-sighted, and the profits little or nothing. The mines have usually been leased at a royalty of 25 cents per ton. Much trouble has occurred regarding this royalty and as to titles.

There are eight openings, hardly entitled to be called mines, from which coal had been extracted, in the Grass Creek cañon, viz, Cupley's opening, Bull Hollow claim, Hodgdon & Fletcher's claim, The Bishop's mine, Grass Creek mine, Muir & Co.'s mine, and the Robinson or Church mine. Only the four last mentioned have been worked to any considerable extent.

The Bishop's mine is on the 11-foot seam. It was opened about 1870, and has yielded 10,000 tons or more of coal. In 1877 it was sold for \$60,000 to the Union Pacific Railroad Company, which now owns it. It was idle at the period under review.

The Grass Creek mine, 6 miles from Coalville, is a new opening on the Bishop's mine. Work was begun May 20, 1880. The Union Pacific Railroad Company was placing machinery able to work 2,000 feet or 3,000 feet on the dip of the bed, and was making preparations for a large and permanent yield. The size of the claim is 640 acres. The seam is 10 feet thick, and the dip is from 30° to 39° N., 25° W., and increases with depth. No faults had been found in the 220 feet of main slope. Water was encountered 40 feet below the surface, but not in large quantities. The machinery is to consist of one very large horizontal engine, coupled, power unknown, drum 10 feet, and steel-wire rope 1½ inches in diameter; three horizontal boilers of 150 horse-power, and steam pumps. An ordinary broad-gauge track connects the mine with the branch of the Union Pacific railroad running from Echo up the Weber river. Only 50 tons are raised per day.

Muir & Co.'s mine was opened in 1874 on ground leased from the Robinson claim. It is worked through two tunnels. Coal has been extracted in an area 600 feet deep and 1,000 feet long. It was idle at the period under review.

The Robinson or Church mine is situated at the head of Grass Creek, 8 miles northeast of Coalville. It has an area of 320 acres, and is owned by the Mormon church or some of its leaders. It has been leased to Mr. Robinson at a royalty of 25 cents per ton extracted. It is worked through a 300-foot tunnel and has no machinery. There are several faults of 4 or 5 feet running north and south, and one vertical fault of 150 feet, which separates it from the Muir ground.

The total coal product of the Grass Creek mines prior to June 1, 1879, is rather vaguely estimated by old residents at 50,000 tons.

The mines of Chalk Creek have been worked far more extensively than those mentioned above, and are all within 2½ miles of Coalville. They are the Spriggs, Black Diamond, Wasatch, Crismon, and Allan.

The Spriggs mine is in the town of Coalville, and has been worked yearly, yet somewhat irregularly, chiefly by lease, for twelve or fourteen years. The mine was once operated vigorously by Buel & Bateman. The property consists of 160 acres of patented land, a small 15 horse-power engine, and three Knowles steam pumps. There is but one coal seam, from 10 to 11 feet thick, dipping 25° NW., underlaid and overlaid by clay and a light-yellow, fine-grained, fossiliferous sandstone. One fault of 10 feet, running SW., is known to exist. The old Buel & Bateman workings extended 600 feet on the dip and 1,200 feet horizontally. They had caved in, been on fire, and are now walled up. The new works have a 450-foot incline and a horizontal development of 310 feet. Part of the roof has caved, owing to the removal of the pillars. In the busy season 60 men are sometimes employed.

The Black Diamond Coal and Coke Company is a Salt Lake company that had leased a part of the Wasatch ground. Work was begun a few years ago, but the present company did not buy the lease until the spring of 1880. It owns the Allan mine and several coal prospects on 5,000 acres of unpatented coal land. In this mine the coal is 10 feet thick. The machinery consists of a horizontal engine of 12 horse-power, with friction gearing, ¾-inch steel-wire rope, and two Knowles No. 4 steam pumps. The main incline is down 400 feet on a dip of 25°, and the horizontal workings extend 350 feet.

The Wasatch mine is a claim of 160 acres. It has been worked through a tunnel at irregular intervals since 1866, and has yielded well. In July, 1879, a vertical working shaft was begun, which struck the coal bed at 92 feet. The mine is hardly opened, but few levels having been driven. The machinery consists of a vertical 11 horse-power engine and a Blake No. 4 steam pump.

The Home Coal Company was incorporated November 1, 1880, with the object of controlling and insuring the supply of coal to the Ontario mine and mill. The property comprises the Wasatch, Spriggs, and Crismon mines.

The Crismon mine was discovered in 1870, and has been worked since. There are several old tunnels from which large amounts of coal have been taken. The machinery in use at the period under review was erected in 1874, and consisted of one very old 12 horse-power engine, one No. 4 Crane steam pump, and a ¾-inch steel-wire rope. The size of the claim is 40 acres. The coal seam is from 9 to 14 feet thick, dipping 13° W. of N. One fault of 2 feet, running southeast, and a "ditch" of 10 feet has been found. The extreme development, not including old workings, is 600 feet on the dip and 1,200 feet horizontally. The pillars are 30 feet wide, and the "stalls" or "rooms" are 16 by 100 feet. The mine has been on fire on the east side of the main slope above the 420-foot level for seven years, but the burning part is walled off from the rest and gives no trouble.

The Allan mine was opened in 1864. A fault was encountered in 1870, and the mine was idle for two years. A second fault was found in 1877, and the mine was abandoned. An attempt is to be made shortly by the owners to find the faulted bed. The main incline is down 600 feet, and it is estimated that three acres had been worked out before the mine shut down. The seam is of clean coal, 12 feet thick, which is generally conceded to have been of better quality than that of any other mine in the neighborhood.

This completes the list of the mines in the Coalville district. There are a few prospects in the vicinity and considerable coal croppings 10 miles up Chalk creek, and also near Wanship. Little, however, has been done. In all the mines of this district the coal is a non-coking "brown coal". Occasionally thin scales of pyrites and gypsum are found, but no resins or iron ore. It checks considerably when exposed to the sun. In mining about one-quarter is slack. Water is found near the surface in all the mines, but the quantity does not usually exceed from 500 to 600 gallons per hour. There is no marked change in the quality of the coal at the water line.

The following are some analyses made by O. D. Allen in 1869. (a)

Mine.	Specific gravity.	Water.	Total volatile matter.	Fixed carbon.	Ash.	Carbon corresponding to volatile matter.	Total carbon.	Units of heat.
Spriggs.....	1.32	1.08	47.27	48.78	3.95	20.44	60.12	5,585
Wasatch.....	1.31	8.38	47.06	49.08	2.26	20.40	76.17	6,154
Allan.....	1.29	9.89	47.34	49.35	3.31	20.05	70.00	5,950
"Church".....	1.32	9.42	48.21	48.27	3.32	25.05	74.12	5,989
Crismon.....	1.31	9.83	47.46	48.91	3.60	20.70	66.70	5,632

In working the mines no safety lamps are used. The rooms and pillars are usually 20 by 100 feet each. From 8 feet to the entire thickness of the coal bed is worked. A row of timbers is required in the center of each room. About one-half the coal was left standing at the period under review, very little "working-out" having been done. The work is done almost entirely by contract, the miners furnishing their own supplies and receiving 90 cents per ton of 2,000 pounds for breaking down the coal and loading it into cars. In drifting or sinking, "yardage" is given in addition to the coal extracted. "Yardage" is 75 cents in the galleries and \$4 on the main slope. Average workmen make \$2 50 per day. The cost of each of the four small hoisting works was from \$3,000 to \$6,000. The cost of mining coal is about \$1 25 per ton, not including the royalty of 25 cents. The selling price at the mines is from \$2 to \$2 25 per ton. The market for the coal raised in this district is local domestic use, Salt Lake City, Union Pacific railroad locomotives, and the Park City mines and mills. Heretofore two- and four-horse Mormon teams have hauled the coal to Park City—distance 22 miles—for about \$8 per ton; but a branch of the Union Pacific railroad, called the Summit County railroad, and a narrow-gauge road known as the Utah Eastern railroad, are to be completed to Park City in a few weeks, which will have the effect of lowering the price about one-half. This coal sells for \$8 50 in Salt Lake City, and is transported partly by the Union Pacific railroad via Ogden, and partly 45 miles across the country in Mormon wagons.

The total production of coal by this district prior to June 1, 1879, as near as it could be obtained from the several mines, has been only about 190,000 tons. The product during the census year was about 30,000 tons.

THE PLEASANT VALLEY COAL MINES.

Pleasant Valley is in San Pete county, southeast of Springville. Many thousand acres of coal lands have been located and several mines opened, but the railroad company's mine is the only one worked. There are two, and, perhaps, three different beds of coal. The upper one, which has not been worked, is a 5-foot bed of very resinous coal. A few hundred feet below this, in various places, beds of clean coal, 11, 16, and 30 feet thick, have been found. It is not known whether these belong to the same bed or not, as the croppings are several miles apart. The surface of the country is covered with low, gently-rolling hills. The mines are reached by a narrow-gauge road, the Utah and Pleasant Valley railroad, 54 miles long, through Spanish Fork cañon. This road begins at Springville, on the Utah Southern railroad, 4,550 feet above sea-level, and gains the summit (altitude, 7,917 feet) in 44 miles. It then descends into the valley (altitude, 7,550 feet) and finally ascends a short ravine to the workings.

Coal was discovered here in 1876 by Mark Oranda. He and one Packard started the railroad and sold out to the present company, which completed it in the autumn of 1878. The Utah and Pleasant Valley Railroad Company and the Utah and Pleasant Valley Coal and Coke Company, which own the mines, are controlled by stockholders in New York.

The bed worked by this company dips about 3° NW. and outcrops in a ravine. The coal strata consist of 1 foot of clay, 9 feet of clean coal, and 18 inches of clay, and 2 feet of coal. These are underlaid and overlaid by a fine-grained buff sandstone. No faults have been found, but two dikes of metamorphic rock, from 8 to 10 feet wide and 20 feet apart, cut through the coal bed without faulting it. The coal shows scales of gypsum and of pyrite and occasional specks of resin. It is considered the best of the Utah coal as yet marketed in Salt Lake City. Several

a See Geol. Expl. 40th Par., Vol. III, page 473.

attempts have been made to coke it by native and imported burners, but, although a fair article is produced, none has yet been made that will bear the burden of the blast-furnace like the Pennsylvania coke, and only a small amount of it has been used by the Salt Lake smelters.

The mine is opened by a tunnel 576 feet long, running in coal the entire distance. The lateral drifts, or "cross-entries," only extend 220 feet. The system of working is by "pillars and stalls," each 18 feet wide, with rooms 150 feet in length. Only the 9-foot seam is worked. About one-sixth is slack. Thirty men were employed at the period under review. They were supplied by the company and received 80 cents per ton for mining the coal. The product during the census year was only 2,000 tons, but the mine will be regularly worked hereafter and the product greatly increased. The coal finds a market at Springville and the Mormon towns of Utah valley.

The other coal mines of importance in Pleasant valley are the Springville (7 feet), Mammoth (30 feet), and Pondtown (4 feet). The first two mentioned had shipped several hundred tons, but were idle at the period under review.

Fourteen miles south of Pleasant valley, near Connellsville, a 6-foot and an 11-foot bed were worked years ago by the Fairview Coal and Coke Company, and afterwards by the Utah Coal and Coke Company. It erected ten or fifteen coke ovens and made many hundred tons of coke, but the cost of transportation was very great, and in 1878 it failed after expending a large amount. Nothing had been done since.

SAN PETE COAL FIELD. (a)

The San Pete coal field is on the eastern slope of the Wasatch mountains and on the western side of the Sam Pitch valley, near Wales, 28 miles from Salt Creek station, on the Utah Southern railroad. Coal has been worked at this place in a small way since 1855. An English company, the Central Pacific Coal and Coke Company, owns 4,080 acres, together with small coke works comprising crusher, rollers, jigs, and nineteen coke ovens. The bed is $3\frac{1}{2}$ feet thick and dips from 15° to 20° W. In each of two cañons, where erosion had exposed it, there are a tunnel and an incline, in all 550 feet of incline and 1,150 feet of tunnel. Very little coal has been extracted. Almost nothing has been done upon the mines for two years, the capital of the company having been expended in the construction of a narrow-gauge railroad to connect with the Utah Southern railroad at Salt Creek. At the period under review the road bed was ready for the ties, except a few bridges and culverts.

From the United States Mining Commissioner's report for 1875, page 357, the following is taken:

The coal is pronounced by H. S. Poole, F. R. S., Professor F. A. Genth, of the University of Pennsylvania, and Mr. Shone, of North Wales, to be bituminous.

Analyses by Professor F. A. Genth show the following percentages:

Moisture	1.16
Volatile matter	32.91
Fixed carbon	54.75
Ash	11.18
Sulphur	2.88
By H. S. Poole:	
Volatile matter (including H ₂ O)	33.70
Fixed carbon	55.54
Ash	11.50
Percentage of coke	66.13

Dr. Genth says that "the coking qualities of this coal are not inferior to those of the best Pittsburgh coal, and the coke made of the same is apparently of excellent quality, and sufficiently dense to bear the burden of a blast-furnace."

CASTLE VALLEY COAL FIELD.

In the summer of 1873 Professor J. E. Clayton visited this region. From his report the writer has gathered the following:

This field is situated in Sevier county, near the eastern base of the Wasatch range, about 50 miles east of Salina, which is 140 miles south of Salt Lake City. The erosion of 3,000 or 4,000 feet of sandstone and shale from a great anticlinal fold by the headwaters of Dirty Devil river has exposed a coal series for an area of about 4 by 20 miles. The stratigraphical arrangement of the coal measures, beginning at the top, is as follows:

40 to 60 feet of coal. This bed has been burned out in an area of many square miles, and is still on fire.

40 to 60 feet of sandstone.

10 to 15 feet of alternate strata of coal and shale.

21 feet of clean coal.

20 to 30 feet of argillaceous matter.

5 to 8 feet of coal.

The lower bed is composed of a very hard compact coal, which, even when exposed for ages, shows very little tendency to slack. This coal gives only from $3\frac{1}{2}$ to 4 per cent. of a very white ash, and shows no trace of sulphur. The 21-foot bed is not so hard as the former, but is still a good quality of coal.

Nothing has ever been done in this region aside from a number of locations made several years ago and allowed to lapse, and an equal number covering several thousand acres made in December, 1880.

^a This is said to belong to the Tertiary. See E. E. Howell, explorations west of 100th mer., 1875, Vol. III, page 278.

CEDAR CITY COAL MINES. (a)

A few miles south of Cedar City, Iron county, there is an elevated plateau. On its precipitous bluffs, and in the cañons where erosion has cut through many hundred feet of the upper sandstone strata, there are some important but little worked coal mines.

The Leyson mine was one of the first coal discoveries, having been worked at intervals in a small way by the Mormons since 1852. General Fremont visited it in 1853. In 1878 the Leyson brothers located 160 acres. The bed is $6\frac{1}{2}$ miles east of Cedar City, and outcrops at the base of a precipitous sandstone bluff, 500 feet high, near the head of a short steep cañon. The coal series consists of six coal seams inclosed between strata of sandstone. They are in the following order, beginning at the top:

Sandstone.	
Clay	7 feet.
Coal	6 inches.
Clay	3 inches.
Coal	7 inches.
Clay	$\frac{1}{2}$ inch.
Coal	8 inches.
Clay	$\frac{1}{2}$ inch.
Coal	4 inches.
Clay	$1\frac{1}{2}$ inches.
Coal	$4\frac{1}{2}$ feet.
Clay	2 inches.
Coal	2 feet.
Clay	15 inches.
Sandstone.	

Only the $4\frac{1}{2}$ -foot seam is worked. Shells are found in the clay over the coal, and also in a bed $2\frac{1}{2}$ feet thick which outcrops for miles near the summit of the mountain. The bed dips about 2° NE., and is dry. The coal is a "brown coal" containing some gypsum, but no pyrites or resin. No analysis was obtainable. Some has been coked in rude ovens and worked well, but it was not known how it would stand in the blast-furnace. The mine is rudely developed by two inclines, 250 and 325 feet in length, and cross-drifts extending 900 feet. Pillars 10 feet square are left, and rooms are worked out from 18 to 30 feet wide. Three men are employed. Probably 5,000 tons have been extracted to date. Its market has been Cedar City, Pioche, and Silver Reef, respectively $6\frac{1}{2}$, 110, and 45 miles distant. It is retailed in those places for \$3 50, \$35, and \$15 per ton. The product in the census year was not over 300 tons.

In this region, but on the opposite side of the gorge, is the Walker mine. It is developed still less than the Leyson, and is apparently a portion of the same bed which has slipped from the plateau above and is much tilted and faulted. There are a dozen other coal prospects in the neighborhood, but only four of them could be dignified with the name of mines, even according to the above standard.

The Kanawha coal mine, or the Phoenix Coal and Coke Company's property, depending on the determination of the ownership, contains 960 acres, and is situated 9 miles south of Cedar City. It was discovered in 1873, and has been worked occasionally since. It is said that its outcrop can be traced several miles along the crescent-shaped bluff of an elevated plateau and a few hundred feet below the summit. Beginning at the top, the coal series is said to be made up approximately of the following strata:

Clay containing shells	5 feet.
Alternate small seams of clay and coal	7 feet.
Coal	2 feet 4 inches.
Clay	1 inch.
Coal	4 feet 6 inches.
Clay	1 inch.
Coal	1 foot.
Alternate seams of clay and coal	3 feet.

This bed has been worked to a very limited extent, having only 350 feet of openings. It is nearly level and is supposed to be far below the one found at Cedar City. The developments are not sufficient in extent to reach beyond the poor surface coal, and there has been no great demand for it. Perhaps 1,000 tons have been shipped.

In the Pahria country, Kane county, about 100 miles east of Silver Reef, beds of coal 20 feet thick are said to be exposed in several places on the cañon sides. With no roads and no market they are for the present of no economical importance, and are probably not even located.

^a See Explorations W. of the 100th Mer., Capt. G. W. Wheeler, 1875, Vol. III, page 278:

"The data collected indicate that the coal bed or beds of this region have extended, with but little, if any, interruption, from the western border of the plateau, near Cedar City and Kanara in Utah, to the Rio Grande in New Mexico, a distance of over 500 miles, * * * and belong to the Lower Cretaceous."