

UNITED STATES DEPARTMENT OF THE INTERIOR  
Harold L. Ickes, Secretary  
GEOLOGICAL SURVEY  
W. C. Mendenhall, Director

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Professional Paper 178

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GEOLOGY AND ORE DEPOSITS  
OF THE  
MONTEZUMA QUADRANGLE, COLORADO

BY  
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Prepared in cooperation with the  
STATE OF COLORADO, COLORADO METAL MINING FUND  
COLORADO MINING ASSOCIATION, AND GEOLOGICAL  
SURVEY BOARD OF COLORADO



UNITED STATES  
GOVERNMENT PRINTING OFFICE  
WASHINGTON : 1935

the use of the seismic methods, and as the topography and small size of the ore bodies make it impossible to use the torsion balance or pendulum apparatus, and as the abundance of magnetite in the country rock would give misleading results with a magnetometer, the electrical methods are the only ones that offer much hope of success.<sup>19</sup>

#### FUTURE OF THE DISTRICT

With the exception of the placer gold found in the valley of the Swan River, in the southwestern part of the quadrangle, most of the production of Summit, Park, and Clear Creek Counties has come from mines outside of the Montezuma quadrangle, and that of the quadrangle has come largely from a few productive veins. About 15 mines have produced more than 1,000 tons of ore, but most of the mines described on pages 68-116 have produced much less. Although the low production figures are in part due to the small size of most of the ore shoots thus far explored, many veins have proved unprofitable because of the high cost of transportation and mining or the lack of successful ore treatment by adequate mills. The reserves of high-grade shipping ore are small, but there are many veins that will yield comparatively small but profitable amounts if mined by lessees. There are probably no veins in the quadrangle rich enough to repay investors in a heavily capitalized stock company.

It is probable that several veins contain sufficient ore of milling grade to warrant their exploitation. Some of the quartz-barite-lead-zinc ores, although previously exploited at a loss when treated in a gravity separation mill, could be profitably concentrated in a flotation mill, as proved by the successful operation of the Whale flotation mill. There may be some bodies of milling ore in or near McClellan Mountain that are sufficiently extensive to justify consideration, although the deep snow of the long winters in this region and the difficulties of avoiding mill-tailing contamination of the streams are factors which must be considered in addition to the grade of ore and the cost of transportation and milling. Much of the ore in the veins of the Montezuma quadrangle has a comparatively low proportion of gangue. Although this is very favorable to mining and permits quick and easy hand sorting of the high-grade ore, the scarcity of extensive bodies of gangue containing disseminated sulphides suggests that much of the ore that may be milled in the future will be the mixed sulphide ores that are almost valueless as mined but may be separated by differential flotation. Most of the few flotation mills that have been built to treat the ores of the Montezuma quadrangle are of the same design and have been notably unsuccessful, although tests on these ores in the standard types of flotation units, such as those in the experi-

mental mill of the Colorado School of Mines, have been entirely successful.

The most notable occurrences of low-grade ores are the auriferous disseminated zinc-lead ores found in the stockworks west of Tiger. The average grade of these ores is low, however, and they have not been commercially successful. As they must be mined by underground methods and crushed to small size before treatment at the mill, it is impossible to exploit them as cheaply as the low-grade "porphyry coppers" with which they are supposed to be comparable. Thus far the cost of producing a pound of ore from the low-grade disseminated ores near Tiger has been more than its selling value. Until the cost of mining and milling can be materially decreased, or until the price of lead, zinc, silver, and bismuth becomes higher than it was from 1915 to 1930, there is little reason for believing that the low-grade disseminated gold-silver-zinc-lead-bismuth ores of the stockworks can be profitably worked.

#### HISTORY OF MINING

The first wave of prospectors that rushed through the east side of the Front Range in 1859 and 1860 was intent on the discovery of gold, and only gold. Most of the early production came from placers, and it was not until the rich oxidized gold ore of the lodes near Central City had been mined for some time that silver was reported in them. As silver became of more and more economic importance as a part of these gold ores, prospectors began to hunt for argentiferous lodes. In 1863 a prospector named Coley left Empire and went south to Kenosha Pass, thence northwest to Georgia Pass, and up the North Fork of the Swan River to Glacier Mountain, where in the spring of 1864 he found the first silver lode to be discovered in Colorado. On his return to Empire he mentioned his discovery, and in September of that year a party of three men set out from Empire with the avowed purpose of finding silver in the high mountains between them and Breckenridge. According to Hollister,<sup>20</sup>

Early in September 1864, Gov. R. W. Steele, James Huff, and Robert Layton started out of Empire in search of silver, "which", says Governor Steele, "we supposed to exist in and around the range near the heads of the southwestern branches of Clear Creek, where the same interlock with the heads of the Snakes." Two or three days found them in camp on Huff Gulch, where the Argentine cabins now stand. Next morning Huff went directly up the long eastern slope of McClellan Mountain, Steele and Layton going up Huff Gulch to the right, and all intending to meet on the summit somewhere, and if they should find nothing, seek a pass through on to the Snakes. It happened that Huff passed over the "cropping" of what was afterward called the "Belmont lode", which occurs well up on the ridge and is scattered over a considerable area. He picked some of it up, and upon exhibiting it to his comrades, they all agreed that it was silver ore or blossom and that they need go no further. Opening the ground slightly, they got a few pounds from the vein in place, took it to Central City, and had

<sup>19</sup> Helland, C. A., *Geophysical methods of prospecting*: Colorado School of Mines Quart., vol. 24, pp. 1-163, 1920.

<sup>20</sup> Hollister, O. J., *The mines of Colorado*, pp. 232-233, Springfield, Mass., 1867.

it assayed, with results varying from \$200 to \$500 per ton. \* \* \* Next year there was a rush to the spot. A district embracing the sources of the south fork of South Clear Creek and the north branch of North Platte was laid out and called "Argentine." The lodes generally assayed high in silver, and during the succeeding (last) winter, several eastern and some home companies were organized rather for the purpose of prospecting and acquiring property by discovery than for working the mines for their profits.

The discovery of silver in the Argentine district caused widespread prospecting in the region nearby and led to the discovery of the highly productive deposits at Silver Plume and Georgetown, as well as those on McClellan Mountain and Kelso Mountain and those in the Snake River drainage basin, to the west. The Baker and Belmont were the most important mines opened in the Argentine district at this time and were worked successfully for many years. Furnaces were built at Graymont and Georgetown to treat their ores, and after a few years of discouragement the developments of these two mines encouraged a second rush to the district in 1869 and 1870. The Stevens vein was probably found in 1869 and commenced a long period of productivity in spite of the high cost of transportation. The completion of a railroad to Graymont in 1885 further stimulated mining in the Argentine district, but the panic of 1893 caused silver mining to become almost dormant throughout the quadrangle. However, the mines on McClellan Mountain were again producing a moderate amount of ore by 1900, and for several years they shipped ore over a narrow-gage railroad that had been built from Silver Plume to the top of McClellan Mountain, primarily as a scenic route for tourists. This railroad was abandoned when automobiles became common, and little mining has been carried on here since.

After the first intensive search for silver ore in 1865 comparatively little was done in the western part of the Argentine district until 1879, when two settlements, Chihuahua and Decatur, were made in the valley of Peru Creek, a few miles northeast of Montezuma. In 1882 Chihuahua, at the mouth of Chihuahua Gulch, had 54 buildings and was the home of many prospectors who were exploring veins in Cooper Mountain, Brittle Silver Mountain, and Morgan Peak. The lack of important discoveries in the next few years discouraged the men, however, and after the town was destroyed by a forest fire in 1889 it was never rebuilt. Decatur, about a mile east of Chihuahua, is in the path of snowslides from Ruby Mountain, and in 1930 only two houses were intact, but the piles of crushed and broken lumber marking the former location of buildings suggested that the town may have been as large as Chihuahua. During the eighties a small furnace was built here and some ore from the mines in the Horseshoe Basin was treated. It was closed about 1889, and since that time the town has been almost abandoned. The Pennsylvania mine, directly south of Decatur, has been one of the most

productive in the quadrangle. The vein was discovered in 1879, and the mine reached the zenith of its production about 1893 and was one of the few properties that were steadily operated during the lean years that followed the panic of 1893. The mines in the Horseshoe Basin have never been operated continuously for more than a few years at a time, but intermittent work at different mines has resulted in some activity in this region every few years since 1865.

Although the first silver ore discovered in Colorado was found on Glacier Mountain early in 1864, no further prospecting was done there until 1865, when the Argentine rush carried a wave of eager prospectors into this region. The Comstock and many other veins were found, and in the next few years mills and smelters were erected for treating the ores. The long haul necessary to take the ore to Denver or Blackhawk induced the mining companies to build a toll road up the Snake River to Webster Pass and down Handcart Gulch and Hall Valley to the North Fork of the Platte River. For many years this road was the chief freight route from Denver to the Snake River mining district. In 1869 a toll road was built from Georgetown to Montezuma by way of Argentine Pass, and a few years later another toll road was completed over Loveland Pass. The latter road was abandoned about 1883. All these roads were supported by charges against wagons and stock using them. The tolls ranged from 5 cents a head for loose stock or pack trains to \$1 for a team and wagon. About 1883 the counties bought the Argentine Pass toll road for a public highway, but little money was spent on its upkeep, and it was soon impassable for teams and wagons. The completion of a railroad to Dillon in 1883 simplified the problem of transportation greatly, and most of the freighting since has been done on the valley road between Dillon and Montezuma.

The first settlement at Montezuma was made in 1865, and the town has been continuously occupied ever since. It was incorporated in the fall of 1881 and was the center of much activity during the next few years. According to the first issue of its local newspaper, the Montezuma Mill Run, June 24, 1882,

We now have two commodious hotels—the Summit House, by L. C. Preston, and the Rocky Mountain House, by J. R. Newman; several restaurants and boarding houses; three stores; three saloons; two blacksmiths; one shoemaker; and mechanics in abundance. \* \* \*

Montezuma claims the first discovery of silver in Colorado. As early as 1863 a prospector by the name of Coley living in Empire, near Georgetown, made prospecting trips over Kenosha Pass and then over Georgia Pass; up the North Swan, over the pass at the head of Bear Creek, and on Glacier Mountain made the discovery of silver.

The lode from which he took the first silver is now the property of the Sts. John or Boston Silver Mining Co. The crude furnace in which he smelted the ore is still to be seen on Glacier Mountain, within 1,000 feet of the Sts. John property.

altitudes of 12,000 and 12,500 feet. It was located in 1873 and yielded about 50 tons of silver-bearing galena ore before 1883, but very little has been shipped from it since that date. The total production is probably about 75 tons. The Atlantic is said to be a quartz vein from 4 to 18 inches wide and contains galena locally. The shipping ore assayed about 60 percent of lead and from 50 to 100 ounces of silver to the ton. The vein trends northeast toward the Sarsefield mine, a short distance away, and may be the southwestern continuation of the Sarsefield vein.

#### BAKER

The Baker lode is on the east slope of Kelso Mountain,  $6\frac{1}{2}$  miles northeast of Montezuma, west of the Stevens mine, at an altitude of about 12,000 feet. No work has been done on it since about 1885, but the mine was one of the most productive in the Argentine and Silver Plume mining districts in the seventies. The lode was discovered in 1865, during the rush caused by the discovery of silver in this region late in 1864. In spite of the desertion of the district in 1867, 1868, and 1869, the Baker was developed steadily, and during the winter of 1869-70 communication was maintained with Bakersville (Graymont) without difficulty, and a team and sled was able to make frequent trips between the town and the mine. The use of teams instead of pack trains reduced the cost of transportation about \$3 a ton. In 1869 the Baker Co. completed its reduction works at Bakersville, and in 1870 two shoots of good ore were opened, and for a short time the reduction works smelted from 15 to 65 tons a month. In July 1871 the Bakersville smelter was completely destroyed by fire. This was at the height of its activity, and production fell off immediately. The Baker was listed by Raymond as one of the chief mines worked during 1873, but little ore was shipped after 1874, and the mine was idle during the later seventies. Some work was carried on in the early eighties by the British Queen Mining Co., but no production is recorded for this time. According to the Georgetown Miner for January 19, 1871, the total bullion produced in 1870 was \$27,567.97, or about 21,321 ounces of silver. In January 1872 the total bullion produced in the past year was reported to be \$4,509, or about 3,487 ounces of silver. Incomplete records for 1874 indicate that over 1,000 ounces of silver was produced in that year.

According to Hollister,<sup>22</sup> the two principal veins, called the north and south crevices, strike N. 72° E. and N. 60° E. and dip 65° and 85° N.

"They are traced and disclosed by many prospecting pits, showing bodies of uncommonly rich ores, varying in width from 20 inches to 20 feet. The crevices consist of sulphuret and bromide of silver and argentiferous galena, all these ores being more or less interspersed within the vein matter of quartz and feldspar. Samples of ore taken from these crevices yielded by assay as high as \$800 to \$2,000 per ton. At the junction of the north and south crevices a tunnel has been commenced which shows a large body of ore 7 feet in width. \* \* \* Samples of all the different tunnels and surface pits, pulverized, and equal weights of each mixed together. This average ore yielded by assay gold \$6.11, silver \$69—\$75.11 per ton of 2,000 pounds. \* \* \* Two tons of the ore, unselected, undressed, and without roasting, was smelted last winter, yielding 25 pounds of silver, coin value \$422.90, and 1,500 pounds of lead, at 10 cents a pound, \$150. About 3 miles above the right fork and 2,000 feet up from the creek occur the John Brown, United States Coin, and Mammoth Lodes, parallel and within 50 feet of each other, standing above the surface, the Mammoth assaying \$60 a ton for 30 inches, the Coin \$200 a ton for 18 inches in width, and the Brown \$350 for 16 inches. Some ore from the Brown has been smelted—they are all argentiferous

<sup>22</sup> Hollister, O. J., *Mines of Colorado*, p. 260, Springfield, Mass., 1867.

galena—and the lead riches, of which the yield is nearly one-half the weight of the dressed ore, assays about \$1,000 per ton."

In 1869, according to King,<sup>23</sup> the Baker was one of the most thoroughly developed properties in the region, but the amount of ore found had been disappointing. The width of the vein averaged about 3 feet and locally was as much as 15 feet, but the ore seam was not continuous. The ore consisted of galena, sphalerite, and silver minerals and occurred in pockets and chimneys. The chief gangue mineral was quartz, but fluorite was abundant in all but the uppermost of the three levels.

In 1871, according to Raymond,

"The Baker \* \* \* opened to a depth of 320 feet; worked by three adits, 187, 212, and 420 feet long, all connected by a shaft, extending to a depth of 168 feet below the third level. The mine is in good ore above the first level. The ground between the first and second levels is entirely worked out, and between the second and third levels nearly so. Though nine-tenths of all the ore found in the lode was on the footwall, the deep shaft has been sunk on the hanging wall, and no ore was found beyond a depth of 60 feet. This summer a crosscut was started toward the footwall, which, at a distance of 10 feet from the hanging wall, struck a vein of solid ore  $2\frac{1}{2}$  inches in width and assaying \$650 per ton. Here again, as in all instances where true fissure veins have been sunk upon to greater depth, it has been proven that the ore continues downward, though of

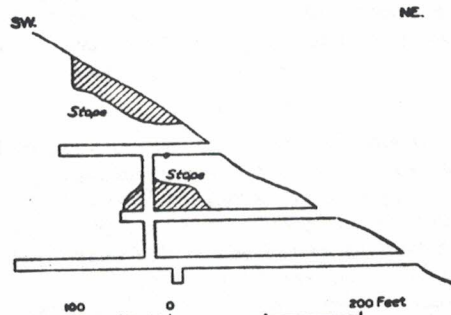


FIGURE 8.—Longitudinal section of Baker mine, 1869.

course varying in richness as well as thickness, and sometimes pinching up entirely for some distance. In the stope above the first level there is a vein of ore, varying from 2 to 10 inches, yielding ore of \$200 (mill assay). The stope between the second and third carries from 1 to 6 inches of \$130 mill ore. Below the third level no ore has been taken out except in sinking the shaft. The driving of levels preparatory to taking out ore was just contemplated when the company's mill was destroyed by fire. This accident stopped operations for a considerable period. Next year a deep tunnel, gaining over 400 feet below the third level, is to be started to facilitate cheap working."

In 1883 the mine was developed by four levels, all connected by a 200-foot shaft. A partial section of the workings taken from Raymond's report for 1869 is shown in figure 8.

The country rock of the mine is Silver Plume granite, quartz-biotite schist, and injection gneiss cut by many dikes of granite and rhyolite porphyry. The average width of the Baker vein is said to be about 16 inches, and the ore a short distance below the surface consisted of stephanite, silver-bearing galena, and chalcopyrite in a quartz gangue.

#### BALTIC AND REVENUE

The Baltic and Revenue veins are opened by the Britannic tunnel, on the southwest slope of Revenue Mountain at the head of West Geneva Creek, 3 miles east of Montezuma. There are several other workings on the veins of this group, including a shaft on the Revenue vein that has its collar on the Continental

<sup>23</sup> King, Clarence, *U.S. Geol. Expl. 40th Par. Rept.*, vol. 3, pp. 599-560, 1870.

flattened, and thus it is not surprising that in general the solutions found the more gently dipping parts of the vein more open and accessible than the steeply dipping parts. The dip of the vein in the Spelter King adit is steeper than in the Wing, and the localization of ore seems directly related to the occurrence of cross fissures.

The study of the Bell vein brings out the discontinuous character of the ore shoots common in the veins of the Montezuma quadrangle. The occurrence of many shoots separated by weakly mineralized or barren places on the vein is evident from the maps, and it is probable that several ore shoots similar to those already worked exist between the Wing adit and the Bell mine.

The available production figures are given below, but they are fragmentary and incomplete prior to 1902.

*Production from Bell and California groups*

|                        | Ore (short tons) | Gold (fine ounces) | Silver (fine ounces) | Lead, wet assay (pounds) | Copper, wet assay (pounds) | Zinc (pounds) |
|------------------------|------------------|--------------------|----------------------|--------------------------|----------------------------|---------------|
| Prior to and including |                  |                    |                      |                          |                            |               |
| 1882                   | 1,000            |                    | 28,000               | 900,000                  |                            |               |
| 1883                   | 300              |                    | 7,500                | 270,000                  |                            |               |
| 1884                   | 40               |                    | 1,000                | 36,000                   |                            |               |
| 1885                   | 90               |                    | 2,250                | 81,000                   |                            |               |
| 1886                   | 155              |                    | 3,875                | 139,000                  |                            |               |
| 1887                   | • 125            |                    | 3,831                |                          |                            |               |
| 1888                   | • 100            |                    | 1,468                | 85,765                   |                            |               |
| 1889                   | (?)              |                    | 1,342                | 83,428                   |                            |               |
| 1890                   | (?)              |                    | 2,941                | 187,556                  |                            |               |
| 1891                   | (?)              |                    | 1,253                | 49,960                   |                            |               |
| 1925                   | 281              | 3.45               | 3,220                | 159,772                  | 527                        | 178,249       |
| 1926                   | 768              | 10.06              | 12,640               | 420,957                  | 3,812                      | 441,668       |
| 1927                   | 31               | .30                | 610                  | 34,006                   |                            |               |
| 1928                   | 37               | .38                | 649                  | 37,802                   |                            |               |

• Estimated.

No record available for 1892-1900; no production in 1901-24.

**BELMONT (GUS BELMONT, JOHNSON)**

The Gus Belmont was the first recorded lode in Colorado, although it was discovered several years after mining became active in the Central City district. It is close to the crest of McClellan Mountain, a few hundred yards northwest of the Santiago mine and 6½ miles northeast of Montezuma. The mine is well above timber line and lies at an altitude of about 13,000 feet. Rumors of the existence of silver-bearing lodes in this region, caused by the discovery of silver on Glacier Mountain, south of Montezuma, early in the summer of 1864, led to systematic prospecting for silver in September of the same year. Gov. R. W. Steele, James Huff, and Robert Layton left Empire in search of silver and on September 14 discovered the outcrop of the Belmont vein, from which they took several pounds of ore that averaged \$827.48 a ton in gold and silver, chiefly silver. The next year there was a rush to the region, and many other veins were discovered. After a year of only moderate success most of the prospectors deserted the district, but both the Belmont and the Baker mines worked steadily through this period of depression. In 1870 their developments encouraged a second rush to the district, and nearly all the known veins in the Argentine district were discovered before the end of the following year. A small custom stamp mill, driven by water power, was built on Leavenworth Creek, about 3 miles southeast of the Belmont vein, and operated intermittently for many years. Although known as the International mill and built to treat the ores of both the International and the Belmont lodes, most of the ore put through the stamps in the years from 1870 to 1872 was bought from the Belmont. According to the Georgetown Miner for November 10, 1870, 11½ tons of ore from the Belmont yielded \$113 at the coinage value of silver, and in February 1871 this paper noted that the "Belmont was in a large body of ore running \$694 a ton." In his report for

1873 Raymond noted that "this, one of the principal mines of the district, worked during the year."

The Belmont was not patented under its original name, and there has long been a dispute over the exact location of the original Gus Belmont lode. An excerpt from the Georgetown Courier for April 3, 1884, definitely indicates that it was relocated as the Johnson: "The Johnson \* \* \* has been leased and will commence work as soon as snow melts and the building is repaired. This is an excellent piece of property and produced a great deal of fine ore when worked as the Belmont." The same paper on February 19, 1885, noted that the Johnson had from 2 to 3 inches of ore on the lower level, which was sorted into two grades of ore. The first-class ore ran 200 ounces of silver to the ton, and the second-class ore 100 ounces. Some ore from 1 to 6 inches wide was reported as present in the upper levels. The property was worked steadily by lessees until 1893 and produced a few tons of ore running from 100 to 200 ounces of silver to the ton. The vein had not been worked for many years when visited by the writer in 1927 and was inaccessible. The lode probably strikes northeast and is near the southeast side of a small stock of Silver Plume granite, but so far as known is lies entirely within the granite.

According to the Colorado Mining Directory the mine had produced prior to 1883 \$300,000 from "galena and sulphurets in a quartz gangue", which assayed, when sorted, from 50 to 200 ounces of silver to the ton. In 1883, according to the same authority, it was developed by 4 tunnels aggregating 976 feet and by 2 shafts aggregating 163 feet.

**BLANCHE**

The Blanche vein is on the southwest slope of Collier Mountain, a short distance north of the Silver Wave mine, and lies between 11,000 and 12,250 feet above sea level. It was located in 1874 and yielded some ore during the eighties but has not been worked since 1890. The known production has been 3 carloads (about 40 tons) in 1883, averaging \$50 a ton; 30 tons in 1885, netting \$1,950; and an unknown amount in 1888, netting \$544.23 in lead and silver. The mine was worked during 1884 and produced about 40 tons of ore; it is not listed as a producer in 1886 or 1887 by the Montezuma Mill Run and was probably idle during those years. Its total production is about 125 tons of lead-silver ore, averaging about 35 ounces of silver to the ton and 35 percent of lead. It was opened by two adits aggregating about 400 feet and a shaft 85 feet deep. The shipping ore was 14 inches wide and contained quartz, gray copper, galena, and sphalerite. The vein where exposed in the lower workings, a quarter of a mile north of the wagon road to Webster Pass, strikes N. 57° E. and dips 58° NW. Here it is about 2 feet wide and contains abundant quartz and a seam of sulphide 3 inches thick. Galena is slightly more abundant than either chalcopyrite or sphalerite, which are present in nearly equal amounts. The vein swings northeast a few hundred feet from the lower adit and strikes N. 35° E. as far up the slopes of Collier Mountain as it has been traced. The available figures for production are as follows:

*Production from Blanche vein*

|      | Ore (short tons) | Silver (fine ounces) | Lead, wet assay (pounds) |
|------|------------------|----------------------|--------------------------|
| 1883 | 40               | 1,400                | 28,000                   |
| 1884 | 40               | 1,400                | 28,000                   |
| 1885 | 30               | 1,050                | 21,000                   |
| 1888 | (?)              | 196                  | 4,765                    |

No record available for 1886-87.

**BOND**

The Bond is a small prospect in Warden Gulch about three-quarters of a mile south of Peru Creek. The vein contained

grooves on the walls of the vein in the upper adit dip 10° E. and suggest that most of the displacement was horizontal. The movement along the Ida Belle fissure formed a gougy, sheeted zone from 2 to 6 inches wide in the shale, a crushed and sheeted zone from 24 to 60 inches wide in the breccia, and a fissured zone from 12 to 45 inches wide in the overlying gneiss. The mineralization of this vein, as would be expected, was strongest in the thrust-fault breccia and weakest in the shale. The ore observed in the thrust-fault breccia close to the contact of the shale was much better than that 50 feet above and was commonly about 24 inches thick. Both galena and zinc blende are present, and there is little waste in the ore close to the contact. The character of the ore 50 feet above the shale and breccia contact is shown in figure 15. Most of the ore between the shale walls is pyritic, but some galena ore occurred in places close to the contact of the thrust-fault breccia. Although it is possible that other ore bodies are present in the baked shale east of the present workings, the geology of the region suggests that the best ore will probably be found close to the contact of the shale and the overlying breccia and will pitch about 15° or 20° W.

INDEPENDENCE

The Independence vein is on the southeast slope of McClellan Mountain, a few hundred feet northwest of the Santiago mine and about 6½ miles northeast of Montezuma, at an altitude of about 12,300 feet. The workings were inaccessible in 1927. The date of the discovery of the vein is not known, but in 1877 it was located as the Independence and subsequently patented under that name. According to the Colorado Mining Directory for 1883 the Independence had produced about \$300,000 prior to that year, and it is known to have been productive from 1883 to 1890.

The amount of development work is indicated by Burchard's report for 1883, as follows:

"The Independence has been one of the best-paying mines in this locality and is developed by a main tunnel 710 feet in length, having a depth of 400 feet at the breast. On this tunnel are four shafts 35 to 80 feet in depth. In one shaft, at a depth of 60 feet, is a drift 100 feet west, showing in a streak of mineral 4 to 8 inches of galena, which mills 70 ounces of silver per ton. The best-paying ore just now comes from a stope about 125 feet from the tunnel mouth and 60 feet above it, now under lease to J. B. Johnson. At 440 feet is a pay streak from 6 to 12 inches wide that mills from 216 to 316 ounces of silver per ton. Four hundred feet from the mouth of the tunnel is a winze connecting the main level with the next level, 110 feet above. In this level the streak is from 3 to 5 inches, milling about 80 ounces per ton."

The vein is mentioned frequently by the Georgetown Courier in the eighties, and the comments suggest that it was one of the best shippers in the East Argentine district during that period. Shipments of 1 to 12 tons at a time are often mentioned, and the average tenor of the ore was apparently well above \$100 a ton. Silver was the chief valuable constituent, but in some places the gold content was also noteworthy.

The vein has been worked several times since 1890, but very little is known of these later operations. As shown in figure 16, the vein has been cut several hundred feet below its outcrop by drifts from the Tobin and Waldorf adits. According to A. A. Atkins, formerly general manager of the Imperial Mines Co., no ore was found in the vein where it was cut on the Waldorf tunnel level at an altitude of about 11,650 feet, although ore had been mined from it on the Tobin tunnel level, about 300 feet above.

The vein strikes northeast and dips about 80° NW. The vein is in Silver Plume granite and is a sheeted zone from 4 to 12 inches wide carrying galena, pyrite, and a small amount of sphalerite in a quartz gangue. The ore shipped in the eighties assayed from 70 to 300 ounces of silver and from a quarter of an ounce to 3½ ounces of gold to the ton. If the mine has produced since 1904, the figures of production are probably included in those of the Waldorf group.

IOWA

The Iowa is on the north slope of Teller Mountain, about 2½ miles south of Montezuma. It was discovered in 1880 and developed by several shallow shafts. It is credited with a production of 50 tons in 1883 by the Colorado Mines Directory, and in 1885, according to the Montezuma Mill Run, it shipped 10 tons of ore, which netted \$500. No other production is recorded for the property. The shipping ore is said to have come from a vein 17 inches wide carrying galena in a quartz gangue and assayed, when sorted, 50 percent of lead and 25 ounces of silver to the ton.

JERRY, EQUITY, DENVER, AND CELTIC

The Jerry tunnel is on the northeast face of Glacier Mountain, about a quarter of a mile southwest of Montezuma, at an alti-

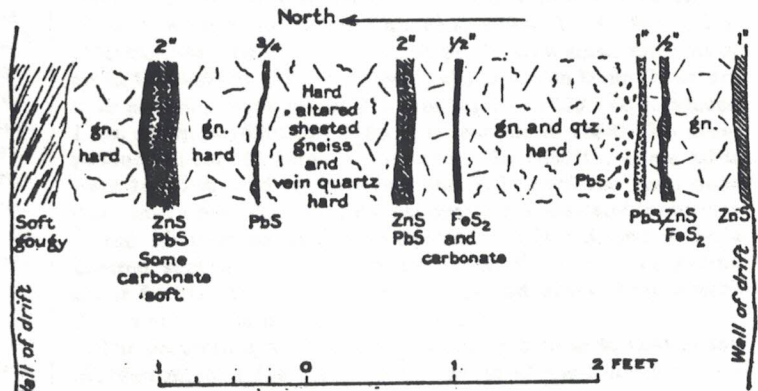


FIGURE 15.—Diagrammatic section of Ida Belle stope.

tude of about 10,450 feet, and the Equity adit is about 265 feet above it. These tunnels were started in the eighties to cut the Mark Twain Extension at depth, but most of the development work was done by the Jerry Mining Co. and the Washington Gold Quartz Mining Co. in 1922 to 1925. As shown on plate 26, the only vein that was stoped to any extent was the eastward-trending vein cut by the Equity adit, although a few carloads of ore was shipped from the northeasterly vein found in the lower workings. The production of the property is given below.

Production of Jerry, Equity, Denver, and Celtic veins

|                               | Ore (short tons) | Gold (fine ounces) | Silver (fine ounces) | Lead, wet assay (pounds) | Copper, wet assay (pounds) | Zinc (pounds) |
|-------------------------------|------------------|--------------------|----------------------|--------------------------|----------------------------|---------------|
| 1900 (Jerry group).....       | 3                | -----              | 171                  | 2,935                    | -----                      | 406           |
| 1903.....                     | 3                | -----              | 744                  | 2,007                    | -----                      | -----         |
| 1904 (Jerry group).....       | 4                | 0.08               | 278                  | 1,533                    | -----                      | -----         |
| 1908 (Jerry group ?).....     | 2                | .03                | 154                  | 719                      | -----                      | 283           |
| 1918.....                     | 14               | .34                | 467                  | 2,078                    | 28                         | -----         |
| 1919.....                     | 11               | .20                | 351                  | 3,334                    | 31                         | -----         |
| 1921.....                     | 51               | 1.60               | 1,239                | 18,599                   | -----                      | 1,626         |
| 1923 (Denver and Celtic)..... | 46               | .60                | 1,190                | 12,606                   | -----                      | -----         |
| 1924 (Denver and Celtic)..... | 16               | -----              | 92                   | 807                      | -----                      | -----         |
| 1925 (Denver and Celtic)..... | 32               | 1.40               | 1,267                | 16,869                   | -----                      | -----         |

## Production of Philadelphia Mining Co.—Continued

|               | Ore to<br>concentrating<br>mills<br>(short<br>tons) | Concen-<br>trates<br>pro-<br>duced<br>(short<br>tons) | Gold<br>(fine<br>ounces) | Silver<br>(fine<br>ounces) | Lead,<br>wet<br>assay<br>(pounds) | Copper,<br>wet<br>assay<br>(pounds) | Zinc<br>(pounds) |
|---------------|---|---|--------------------------|----------------------------|-----------------------------------|-------------------------------------|------------------|
| 1914.....     | 180   | 64  | 2.06                     | 632                        | 20,768                            | 486                                 | 32,683           |
| 1915.....     | 800   | 162   | 7.71                     | 1,332                      | 43,513                            | 830                                 | 74,000           |
| Waterloo..... |   | 13  | .88                      | 138                        | 8,162                             |                                     |                  |
| 1916.....     | 5,658   | 943   | 35.46                    | 7,065                      | 193,678                           | 2,802                               | 444,094          |
| 1918.....     | 490   | 27  | .81                      | 113                        | 1,246                             | 108                                 |                  |
| Waterloo..... |   | 20  | 1.65                     | 269                        | 3,180                             | 182                                 |                  |

No production in 1901-13, 1919-28.

## KELSO

The Kelso mine is on the north slope of Kelso Mountain at an altitude of 10,800 feet, about 6¼ miles north-northeast of Montezuma. The early history of the property is not known, but in 1926-29 it was worked by the Kelso National Mining Co., of Georgetown. At the time of the writer's visit no ore had been produced, but several tons of silver-lead ore was shipped in 1927 and 1928. As shown in plate 28, the country rock of the mine is schist and injection gneiss.

The ore occurs in northwestward-trending veins and is much better where the walls of the veins are gneiss than where they are schist. Although the workings expose many fissures and faults striking from north-northeast to east, the only ore seen by the writer was in fissures belonging to a branching vein system striking N. 10°-40° W. Some of the north-northeast faults are younger than the northwest veins. The ore was from 1 to 8 inches wide and contained chiefly galena and pyrite and minor amounts of light-colored sphalerite in a quartz and ankerite gangue. The upper tunnels were not accessible at the time of the writer's visit, but the veins which they followed are probably the same as those exposed in the southeastern drifts of the lower tunnel workings, the southern drift following the Kelso vein, and the drift 75 feet to the northeast following the National vein. As these two veins dip toward each other they probably join about 150 feet below the level, and an ore shoot may occur at this junction. No ore shoot was found where the National vein branched from the North Kelso on the tunnel level, however, but at this place, as shown on the map, the two veins were in schist, which is a less favorable wall rock than the gneiss.

## Production of Kelso mine

|                            | Ore<br>(short<br>tons) | Gold<br>(fine<br>ounces) | Silver<br>(fine<br>ounces) | Lead,<br>wet<br>assay<br>(pounds) | Zinc<br>(pounds) |
|----------------------------|------------------------|--------------------------|----------------------------|-----------------------------------|------------------|
| 1920.....                  | 2                      | 0.24                     | 15                         | 2,090                             |                  |
| 1921 (Mount Kelso).....    | 6                      | .32                      | 41                         | 3,720                             |                  |
| 1925.....                  | 43                     | 8.42                     | 831                        | 47,844                            |                  |
| 1926 (Kelso National)..... | 15                     | 7.60                     | 310                        | 17,414                            | 1,612            |
| 1927 (National).....       | 32                     | 8.80                     | 636                        | 46,032                            | 1,931            |

No production in 1901-19, 1922-24, 1928.

## KITTY OWSELEY

The Kitty Owsley vein is on the east slope of McClellan Mountain, about 1¼ miles north of the Waldorf mine and 7¼ miles northeast of Montezuma. The portal of the lower tunnel has an altitude of about 11,850 feet. The mine was inaccessible in 1927, and little is known of its history. The vein is said to be parallel to the Kitty Owsley claim and if so strikes about N. 20° E. The ore on the dump is chiefly brecciated sphalerite in a quartz-barite gangue and came from a vein at least 7 inches wide in places. The country rock is Silver Plume granite, but the strike of the vein would carry it into the Idaho Springs

formation a few hundred yards north of the tunnel. Incomplete production figures follow.

## Production of Kitty Owsley mine

|           | Ore<br>(short<br>tons) | Gold<br>(fine<br>ounces) | Silver<br>(fine<br>ounces) | Lead,<br>wet<br>assay<br>(pounds) | Copper,<br>wet<br>assay<br>(pounds) | Zinc<br>(pounds) |
|-----------|------------------------|--------------------------|----------------------------|-----------------------------------|-------------------------------------|------------------|
| 1912..... | 49                     | 6.28                     | 372                        | 27,528                            |                                     | 28,115           |
| 1913..... | 28                     | 2.05                     | 165                        | 12,661                            |                                     | 11,430           |
| 1917..... | 6                      | 1.47                     | 129                        | 6,141                             |                                     |                  |
| 1918..... | 36                     | 8.21                     | 788                        | 29,725                            | 72                                  |                  |
| 1921..... | 1                      | .11                      | 18                         | 616                               |                                     |                  |

|           | Ore to<br>concentrating<br>mills<br>(short<br>tons) | Concen-<br>trates<br>produced<br>(short<br>tons) | Gold<br>(fine<br>ounces) | Silver<br>(fine<br>ounces) | Lead,<br>wet<br>assay<br>(pounds) | Copper,<br>wet<br>assay<br>(pounds) | Zinc<br>(pounds) |
|-----------|---|--|--------------------------|----------------------------|-----------------------------------|-------------------------------------|------------------|
| 1907..... | (?)   | 427  | 68.21                    | 3,032                      | 106,503                           |                                     | 245,000          |
| 1913..... | 39  | 15   | .88                      | 172                        | 730                               | 88                                  | 12,808           |

No production in 1901-6, 1908-11, 1914-16, 1919-20, 1922-28.

## LANCASTER

The Lancaster vein is on the southwestern spur of Tiptop Peak, about half a mile east of Montezuma, and was developed by three adits at altitudes of about 11,400 to 11,700 feet. The property has long been idle, but it produced a small amount of ore in the eighties. It is credited by the Colorado Mine Directory with a total production of 210 tons prior to 1883 and produced 1 ton of ore in 1886 and \$185.11 in lead ore in 1888. No other production for the mine is on record. In 1883 the three adits were 165, 260, and 15 feet long, and little work has been done since that time. The vein strikes nearly due east and is entirely in the Montezuma quartz monsonite. It is reported to be a fissured zone about 4 feet wide, containing a vein of galena about 5 inches thick. The ore, when sorted, assayed 55 percent of lead and 34 ounces of silver to the ton.

The occurrence of the ore was probably similar to that of the Morgan mine, a few hundred feet south of the Lancaster, described on pages 90-91.

## LUCKY BALDWIN

The Lucky Baldwin claim is immediately southwest of the Silver Wave claim (see p. 108) and is probably on the extension of the Silver Wave vein. It has two adits on it at altitudes of 12,000 and 12,060 feet. The upper adit was not accessible in 1929, but both adits are driven northeast to the end line of the claim, and the lower one was examined and is shown on plate 16. It is 425 feet long and follows the vein for 310 feet of this distance. The country rock of the vein comprises Idaho Springs formation and Silver Plume granite; both quartz schist and quartz-biotite-muscovite schist are present and strike about N. 10° E. and dip steeply west. The vein strikes northeast and dips steeply northwest or southeast. It was first cut about 110 feet from the portal in quartz schist and is thin and poorly defined until it passes into Silver Plume granite, 160 feet from the portal. The vein gradually widens in the next 30 feet, and there is a stope about 25 feet high and 30 feet long 200 feet from the portal. There are no other stopes on this drift, but the vein is well marked and is from 6 to 12 inches wide. Most of the vein is quartz, however, and the chief sulphide is pyrite; some chalcopyrite occurs, and in places the walls of the drift are copper-stained. Small amounts of galena and sphalerite were noted in the drift, and some lead-zinc ore was found on the dump.

## MAID OF ORLEANS

The Maid of Orleans vein is on the southeastern spur of Lenawee Mountain, and the chief workings are at the foot of the mountain, in the valley of Peru Creek about 1¼ miles north-

abundant in ore that carried only a small amount of galena. The ore south of this shoot was chiefly galena with little sphalerite and a small amount of tetrahedrite. In vein no. 7 north-east of the junction of the main tunnel level, native silver was found in ore that was chiefly galena. This rich silver ore did not continue above the next level, however, and probably changed into a mixed sphalerite-galena ore in a quartz-barite gangue. The ores on the main tunnel level show no oxidation or evidence of enrichment, and few veins in this region are appreciably oxidized more than 50 feet below the surface. It is very unlikely that the silver ore shoots in the Sts. John mine are related in any way to the action of surface waters.

The available production figures of the Sts. John mine are shown below.

Production of Sts. John mine

|                                   | Ore (short tons) | Gold (fine ounces) | Silver (fine ounces) | Lead, wet assay (pounds) | Copper, wet assay (pounds) | Zinc (pounds) |
|-----------------------------------|------------------|--------------------|----------------------|--------------------------|----------------------------|---------------|
| 1870, August to December          |                  |                    |                      | 28,720                   |                            |               |
| 1882                              | 80               |                    |                      |                          |                            |               |
| 1884                              | 25               |                    |                      |                          |                            |               |
| 1885                              | 200              |                    |                      |                          |                            |               |
| 1886                              | 35               |                    |                      |                          |                            |               |
| 1887                              | 94               |                    | 2,284                | 22,174                   |                            |               |
| 1890                              | 44               |                    | 1,650                | 29,785                   |                            |               |
| 1891                              | 805              |                    | 22,274               | 1,293,267                |                            |               |
| 1892                              | 628              |                    | 24,773               | 607,618                  |                            |               |
| 1893-99                           | 1,523            |                    |                      |                          |                            |               |
| 1900                              | 80               |                    | 2,936                | 79,200                   |                            | 9,600         |
| 1901                              | 1                |                    | 126                  |                          |                            |               |
| 1904                              | 5                |                    | 126                  | 4,000                    |                            |               |
| 1914                              | 181              | 0.99               | 6,942                | 110,294                  | 327                        |               |
| 1915                              | 23               |                    | 1,088                | 12,128                   | 78                         |               |
| 1916 (Tiger extension)            | 3                |                    | 683                  | 639                      | 67                         |               |
| 1917                              | 17               |                    | 720                  | 12,828                   | 70                         |               |
| 1918 (old Comstock dump)          | 27               | .10                | 1,045                | 4,814                    | 261                        |               |
| 1919                              | 67               | 2.11               | 2,952                | 24,914                   | 175                        |               |
| 1920                              | 29               | .20                | 857                  | 22,822                   | 22                         |               |
| 1922 (old Comstock mine and dump) | 21               | .20                | 407                  | 12,273                   | 22                         |               |
| 1923                              | 93               | .40                | 1,615                | 97,462                   |                            |               |
| 1924                              | 94               |                    | 2,174                | 101,874                  |                            |               |
| 1928                              | 12               | .20                | 411                  | 11,694                   |                            |               |

|                                   | Ore to concentrating mills (short tons) | Concentrates produced (short tons) | Gold (fine ounces) | Silver (fine ounces) | Lead, wet assay (pounds) | Copper, wet assay (pounds) | Zinc (pounds) |
|-----------------------------------|---|------------------------------------|--------------------|----------------------|--------------------------|----------------------------|---------------|
| 1910                              | 330                                     | 33                                 |                    | 482                  | 21,455                   |                            | 17,000        |
| 1911                              | 2,730                                   | 273                                | 1.15               | 8,086                | 241,621                  |                            |               |
| 1913                              | 7,400                                   | 74                                 | .26                | 2,754                | 79,176                   |                            |               |
| 1914                              | 50                                      | 12                                 |                    |                      |                          |                            | 7,200         |
| 1916 (Tiger extension and others) | 530                                     | 53                                 | 1.09               | 1,586                | 32,279                   | 174                        |               |
| 1917                              | 1,200                                   | 127                                | 1.42               | 2,229                | 53,176                   | 493                        |               |
| 1918 (Old Comstock dump)          | 1,120                                   | 112                                | .55                | 3,405                | 83,092                   | 108                        |               |
| 1926                              | 3,000                                   | 200                                | 1.20               | 4,987                | 78,424                   | 114                        | 122,378       |
| 1927                              | 4,000                                   | 340                                | .20                | 2,229                | 58,015                   | 23                         | 226,632       |

\* Base bullion.

No record available for 1871-75, 1877-80; no production in 1876, 1881, 1883, 1888-90, 1902-3, 1905-9, 1912, 1921, 1925.

SANTIAGO-COMMONWEALTH-CENTENNIAL

The Santiago mine is on the southeast slope of McClellan Mountain, at an altitude of about 12,000 feet. It is about half a mile northwest of the Waldorf tunnel and 6½ miles northeast of Montezuma. The vein is opened by five tunnels and an underground shaft 300 feet deep on level 5. At the time of the writer's visit tunnels 3 and 5 were partly accessible, and they are shown on plate 36. The mine can be reached by automobile from Georgetown, although the road was in poor condition in 1927 and had many steep grades. The lower tunnel is connected by an aerial tram with the Waldorf mill, 450 feet below and half a mile southeast.

The Santiago mine is on the southern part of a vein that has been productive for nearly a mile in length and 800 feet in depth. The Santiago ore shoot is about 1,100 feet long and

has been explored to a depth of about 700 feet below its top. As shown in figure 26, the top of the ore shoot is well below the surface, and, though some ore along the north side cropped out in the steep-walled glacial cirque where the mine is situated, the ore is virtually in a "blind" shoot.

Little is known of the history of the mine, but unlike most of the veins nearby, the Santiago has yielded the bulk of its production since 1900, and the figures given below probably give a fair approximation of the entire output.

Production of Santiago mine

|                  | Ore (short tons) | Gold (fine ounces) | Silver (fine ounces) | Lead, wet assay (pounds) | Copper, wet assay (pounds) | Zinc (pounds) |
|------------------|------------------|--------------------|----------------------|--------------------------|----------------------------|---------------|
| 1901             | 300              | 292.62             | 9,627                | 61,924                   |                            |               |
| 1908             | 40               | 20.00              | 1,200                | 5,176                    |                            |               |
| 1905             | 1,037            | 528.74             | 22,066               | 202,028                  | 16,044                     |               |
| 1906             | 715              | 202.30             | 11,785               | 120,826                  |                            |               |
| 1908             | 1,253            | 645.18             | 25,419               | 162,372                  | 44,361                     | 26,644        |
| 1909             | 1,200            | 799.00             | 32,000               | 356,322                  | 81,067                     | 56,020        |
| 1913             | 944              | 561.24             | 10,833               | 223,455                  | 41,988                     |               |
| 1916             | 60               | 15.89              | 707                  | 24,976                   |                            |               |
| 1917             | 68               | 81.07              | 1,084                | 30,565                   | 4,405                      |               |
| 1918             | 67               | 10.60              | 506                  | 33,124                   | 434                        |               |
| 1927             | 23               | 11.28              | 283                  | 10,675                   | 896                        | 1,893         |
| Dry ore:         |                  |                    |                      |                          |                            |               |
| 1902             | 175              | 90.00              | 7,189                |                          |                            |               |
| 1904             | 494              | 280.87             | 7,060                |                          | 2,831                      |               |
| 1917             | 17               | 8.18               | 155                  | 717                      | 784                        |               |
| 1919             | 2                | .03                | 135                  | 157                      |                            |               |
| Copper ore:      |                  |                    |                      |                          |                            |               |
| 1910             | 1,871            | 2,288.32           | 40,801               | 12,295                   | 205,821                    |               |
| 1911             | 2,713            | 1,961.15           | 26,452               | 9,832                    | 187,920                    |               |
| 1914             | 731              | 894.93             | 12,804               | 18,657                   | 72,185                     |               |
| 1915             | 20               | 42.80              | 717                  |                          | 2,864                      |               |
| 1916             | 626              | 950.76             | 23,823               | 68,199                   | 116,671                    |               |
| 1917             | 20               | 9.35               | 221                  | 1,037                    | 2,143                      |               |
| 1918             | 54               | 20.20              | 954                  | 4,447                    | 5,278                      |               |
| 1919             | 213              | 208.63             | 4,209                | 12,427                   | 39,025                     |               |
| 1920             | 85               | 97.20              | 2,746                | 8,296                    | 19,796                     |               |
| 1922             | 49               | 20.15              | 837                  | 4,002                    | 5,668                      | 2,136         |
| 1924             | 17               | 16.00              | 328                  | 1,683                    | 2,024                      |               |
| Lead-copper ore: |                  |                    |                      |                          |                            |               |
| 1912             | 1,577            | 802.41             | 26,507               | 578,650                  | 105,153                    |               |
| 1915             | 1,070            | 1,228.65           | 15,266               | 53,668                   | 96,157                     |               |
| 1916             | 113              | 100.80             | 2,944                | 27,696                   | 16,233                     |               |
| 1917             | 439              | 439.02             | 9,529                | 52,826                   | 57,801                     |               |
| 1918             | 21               | 8.90               | 405                  | 5,102                    | 1,358                      |               |
| Commonwealth:    |                  |                    |                      |                          |                            |               |
| 1888             | (?)              | .78                | 527                  | 15,247                   |                            |               |
| 1889             | (?)              | 2.33               | 1,873                | 51,215                   |                            |               |
| 1890             | (?)              | 44.00              | 9,765                | 241,549                  |                            |               |
| 1907             | 1,060            | 279                | 208.66               | 5,668                    | 4,728                      | 15,421        |
| 1918             | 5                | 2                  | 1.77                 | 34                       | 2,917                      |               |

No record available for 1891-1900; no production in 1928.

The vein is a fissured zone that strikes N. 15°-35° E. and dips 70°-85° W. It is from 3 to 8 feet wide on the third level and from 2 to 5 feet wide on the fifth level, where the writer saw it, but neither level was open to the breast. In the widest parts of the vein on the third level the filling is coarsely brecciated granite which has been strongly silicified and pyritized. This silicification and pyritization was earlier than the lead-zinc-copper metallization and does not indicate the presence of pay ore; the lead-silver-gold tenor was so low in a place where the pyritic silicified breccia was 8 feet wide that no stoping was done. The ore on the third level and above it is chiefly galena containing moderate amounts of chalcopyrite; but pyrite is usually present in small quantities, and sphalerite is common, though it rarely makes up more than 5 percent of the ore. On the fifth level sphalerite is the most abundant sulphide in those parts of the vein that remain unstoped; galena and pyrite are present in nearly equal amounts but are much less abundant than the sphalerite; chalcopyrite is common but is less abundant than on the third level. Although some of the gangue on the



third level is manganiferous ankerite, quartz greatly predominates over the carbonate, but on the fifth level the relative proportions of the two gangue minerals are reversed, and the ankerite is much more abundant than the quartz. In most places where the ankerite is wide the ore is thin. The sixth and seventh levels were not accessible at the time of the writer's visit, but according to a miner who had worked in the lowest level the mineralization was not as strong there as it was on the upper levels, and sphalerite and pyrite were the predominant sulphides, although galena and chalcopyrite were locally abundant. The gold content on the lower levels was reported to be

the vein is also opened at about 11,650 feet by the Waldorf or Wilcox tunnel. The relation of the tunnels and the general geology are shown in figure 16. Where the Commonwealth vein is cut by the Waldorf tunnel it strikes N. 25° E., dips about 70° SE., and carries small amounts of lead, zinc, and iron sulphides. About 300 feet northeast of the crosscut tunnel the vein swings north and strikes N. 12° E. and dips steeply to the northwest. Here the ore is of much better grade and was stoped, although the extent of the stoping is not known. The ore in this part of the vein is chiefly galena carrying moderate amounts of sphalerite and some pyrite. Some of the ore left

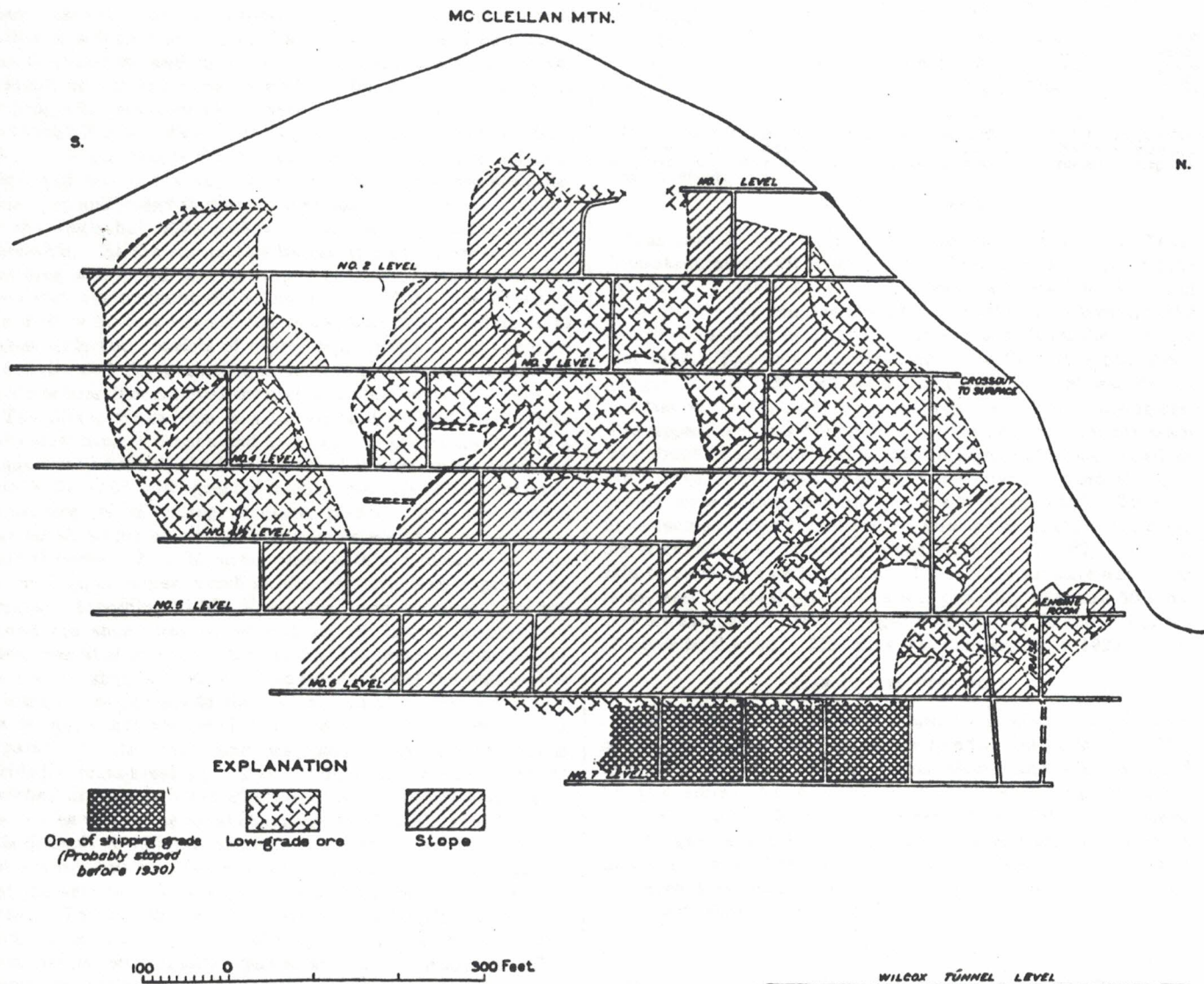


FIGURE 28.—Stope map of Santiago mine, looking west. (From map by F. Ricci.)

directly related to the presence of light-colored sphalerite, or "rosin jack."

About a quarter of a mile north of the Santiago mine a few dilapidated buildings cluster about the caved entrance to the Commonwealth tunnel. This part of the Santiago-Commonwealth-Centennial vein was worked in the seventies and eighties, but little is known about the production or the developments prior to 1900. The Georgetown Courier for December 6, 1888, reports a shipment of 4 to 5 tons of ore, which ran 68 ounces of silver to the ton and 61 percent of lead, and the same paper mentions the mine again in 1889 and 1890. The altitude of the Commonwealth tunnel is about 12,000 feet, but

is from 3 to 5 inches wide and contains very little gangue. The vein becomes barren about 1,000 feet north of the crosscut tunnel, and when the writer visited it in 1926 the drift was caved a short distance beyond. According to A. A. Atkins, who had charge of the Waldorf tunnel when the last work was done prior to 1926, the Commonwealth vein was followed about 800 feet farther, but no ore shoots were found. This barren segment of the vein is on the Centennial claim, but little work has been done at the surface in this ground, and some ore may be present. The wall rock of the vein is Silver Plume granite, Idaho Springs schist, and granite gneiss, and, as shown on plate 3, the schist becomes increasingly abundant to the north.

before the ore was cut, the ore shoot was entered near its north-east end and a drift was driven back southwest for 50 feet, to a point where the ore abruptly pinched to a thin, unprofitable quartz seam. This ore shoot is about 70 feet long on level 5 and is reported to have about the same length on level 6, but the drift was caved 10 feet beyond the southwestern limit of the shoot on the lower level, and the distance could not be measured. According to Jack Ryan, who was a lessee in 1917, the ore shoot was followed below level 6 by a winze 104 feet deep, but the ore pinched suddenly about 5 feet from the bottom. The writer was able to descend this winze only about 15 feet because of the thick coating of ice on the ladders; at this place the vein was well exposed, however, and contained 22 inches of sulphide ore. Over half of the ore was zinc blende, but chalcopyrite and pyrite were abundant, some galena was present, and in the siliceous walls of the main sulphide seam arsenopyrite was common. Here the vein strikes N. 35° E. and dips 85° NW. For about 150 feet northeast of this ore shoot on level 5 the vein is chiefly fine-grained quartz 6 to 8 inches wide and contains many ramifying veinlets of arsenopyrite. It is open and vuggy in many places, and late barite is common in the vugs, but little galena, sphalerite, or other sulphides were seen. At the end of this barren stretch an ore shoot 190 feet long was found and is stoped both above and below the level and was undoubtedly reached by level 6. The breast of the drift is 50 feet beyond the stope, and here the vein is 12 inches wide and consists of nearly equal parts of light-colored sphalerite and fine-grained quartz, but a moderate amount of barite occurs disseminated through the other minerals.

The Silver Wave vein is a mineralized sheeted zone whose individual fissures branch and intertwine or gather together in a single strong fissure. In many parts of the barren stretches the vein is followed with great difficulty because of the common occurrence of diverging fracture planes. The ore shoots studied all widen abruptly from narrow seams of ore to commercial bodies 12 to 24 inches wide within a distance of 5 or 10 feet and, of course, pinch as abruptly into lean unprofitable streaks. According to Mr. Ryan, the lower termination of the second ore shoot was as abrupt as its lateral termination. There was little evidence on level 5 of the presence overhead of the first ore shoot of level 4. The schistosity of the wall rock is in some places parallel to the vein and in other places makes a decided angle to it; the vein is nearly barren on level 5 wherever it is parallel to the schist, and ore occurs wherever the vein is decidedly cross-breaking. The termination of an ore shoot sketched in plate 16 illustrates the character of the fissuring in the vein as well as the rapid change in width of the sulphide ore. It is difficult to estimate the depth to which a given ore shoot will extend, but the chimneylike longitudinal section suggests that the vertical extent is generally greater than the horizontal extent. The ore in the upper levels was largely galena and contained moderate amounts of gray copper, and the ore on the lower levels was chiefly sphalerite and chalcopyrite. The known production is given below.

*Production of Silver Wave mine*

|                                  | Ore (short tons) | Gold (fine ounces) | Silver (fine ounces) | Lead, wet assay (pounds) | Copper, wet assay (pounds) |
|----------------------------------|------------------|--------------------|----------------------|--------------------------|----------------------------|
| 1885.....                        | 70               |                    |                      |                          |                            |
| 1886.....                        | 908              |                    |                      |                          |                            |
| 1887.....                        | 75               | 22.18              | 5,715                | 153,253                  |                            |
| 1888.....                        | (?)              |                    | 2,407                | 8,798                    |                            |
| 1889.....                        | (?)              |                    | 447                  | 24,101                   |                            |
| 1890.....                        | (?)              | 22.20              | 3,857                |                          |                            |
| 1910.....                        | 22               | 2.67               | 746                  | 11,319                   | 4,011                      |
| 1911.....                        | 30               | 4.35               | 983                  | 12,309                   | 1,983                      |
| 1912.....                        | 291              | 19.66              | 8,714                | 91,672                   | 10,074                     |
| 1913 (see also milling ore)..... | 310              | 26.67              | 7,367                | 93,185                   | 7,323                      |
| 1914 (see also milling ore)..... | 143              | 8.47               | 4,041                | 100,580                  | 3,401                      |
| 1916 (see also milling ore)..... | 18               | 1.66               | 888                  | 18,588                   | 808                        |
| 1917 (see also milling ore)..... | 28               | 1.38               | 530                  | 21,945                   |                            |

*Production of Silver Wave mine—Continued*

|                    | Ore to concentrating mills (short tons) | Concentrates produced (short tons) | Gold (fine ounces) | Silver (fine ounces) | Lead, wet assay (pounds) | Copper, wet assay (pounds) | Zinc (pounds) |
|--------------------|---|------------------------------------|--------------------|----------------------|--------------------------|----------------------------|---------------|
| Lead concentrates: |   |                                    |                    |                      |                          |                            |               |
| 1913.....          | 171                                     | 24                                 | 2.15               | 1,243                | 37,825                   |                            |               |
| 1914.....          | 75                                      | 32                                 |                    | 915                  | 29,876                   |                            |               |
| 1915.....          | 1,560                                   | 72                                 | 9.16               | 2,875                | 79,464                   | 1,147                      |               |
| 1916.....          | 3,231                                   | 305                                | 15.47              | 10,769               | 304,252                  | 8,581                      |               |
| 1917.....          | (?)                                     | 4                                  | .25                | 130                  | 3,511                    | 74                         |               |
| 1922.....          | (?)                                     | 20                                 | .50                | 549                  | 3,704                    | 421                        |               |
| Zinc concentrates: |   |                                    |                    |                      |                          |                            |               |
| 1913.....          |   | 49                                 |                    | 1,330                |                          |                            | 43,040        |
| 1914.....          |   | 40                                 |                    |                      |                          |                            | 30,923        |
| 1915.....          |   | 100                                | 7.00               | 3,330                |                          |                            | 74,000        |
| 1916.....          |   | 54                                 |                    | 2,081                | 9,214                    |                            | 36,856        |
| 1917.....          |   | 5                                  | .06                | 148                  | 479                      | 212                        | 3,734         |

No record available for 1891-1900; no production in 1901-3, 1918-21, 1923-28; production in 1909 probably included with that of Silver King mine, as both that mine and the Silver Wave were then being operated by the Silver Princess Mining Co. (See pp. 107-108.)

STAR OF THE WEST

The Star of the West mine is on the west slope of Teller Mountain, about 2¼ miles south of Montezuma, at an altitude of about 11,800 feet. The vein was discovered in 1874, and according to the Montezuma Mill Run, the lower level in 1882 comprised a crosscut 218 feet long and a drift on the vein 200 feet long. The vein was reported to be "a soft light-colored gangue matter" 30 feet wide. The middle level was driven 225 feet on the lode, which carried from 1 to 6 feet of paying ore. The upper level was 60-foot long on the vein, and the ore seam was about 1 foot wide and contained high-grade gold and silver ore. Free gold, gray copper, chalcopyrite, bismuth, and galena were found, and high assays were reported. There is little recorded production for the mine prior to 1886, but some ore is known to have been shipped in 1875 and 1882, and ore is said to have been shipped about 1898. The tonnage was never large, and the total production was probably less than 50 tons. The ore shipped in 1887 averaged 5 ounces of gold and 40 ounces of silver to the ton. The mine was inaccessible in 1929.

STAR OF THE WEST NO. 2

The Star of the West no. 2 is about a quarter of a mile west of the Star of the West and a few hundred feet below it. The lode was located in 1880 by Oliver Milner and was developed by two adits. No production is recorded for the property. The vein in places is said to have carried from 10 to 15 inches of quartz, galena, and gray copper and assayed from half an ounce to 1 ounce of gold and 75 to 125 ounces of silver to the ton and 40 percent of lead. The geology of the lower adit of this prospect is shown in plate 23.

STEVENS

The Stevens mine is in Stevens Gulch, about 6¼ miles northeast of Montezuma, at an altitude of about 11,400 feet. It can be reached by automobile from Silver Plume, 7 miles distant by road. In 1927 the roads were in poor condition and had so many steep grades that supplies were hauled to the mine by wagons.

The Stevens mine has been one of the most productive in the Montezuma quadrangle, although its output has been small since 1910. The lode was discovered in the late sixties, but the exact date is unknown. The mine is mentioned by the Georgetown papers much more frequently than any other in the quadrangle and apparently was a steady producer from 1870 until 1893 and has been intermittently productive since that time. The total production is not accurately known, but the figures given below indicate the tenor of the ore and suggest the general order of magnitude of the tonnage that has been produced.

The record of the mine's early shipments suggests that the surface ore was not exceptionally rich but carried considerable lead and silver. The Georgetown Miner for October 13, 1870, reports that the Crescent Silver Mining Co., operating the Stevens mine, had produced 40 tons of ore which yielded \$200 a ton simply in drifting on the vein. Raymond's report for 1872 says:

"The Stevens lode has been constantly and profitably worked during the year, yielding an average of 30 tons per month of good ore, averaging 150 ounces of silver per ton, with a high percentage of lead. This lode is owned by a company who are conducting their operations with economy and ability."

The Georgetown Miner for February 12, 1876, reports that 20 men were working at the Stevens and that the mine was producing ore assaying from 80 to 100 ounces of silver to the

for almost 400 feet, although on the level 100 feet higher, ore was stoped continuously for 350 feet of this distance. Where the ore comes down to the main tunnel level at the south end of the shoot, it continues about 120 feet along the drift. A few small pockets of ore have been found south of this shoot, but the mineralization spread along branching fractures, and the ore bodies are small. Plate 38 shows the mineralization of the branching and intersecting fissures in the southern part of the mine. On the level 100 feet above the main tunnel level, where extensive stopes overlie barren vein matter in the lower level, the ore left on the walls of the stopes, in the pillars, and in the gob is invariably much higher in lead than the ore found on the main tunnel level. Much of the ore seen in the upper level was essentially clean galena, although some sphalerite and chalcopryrite were found in the bottom of the drift near the north end of

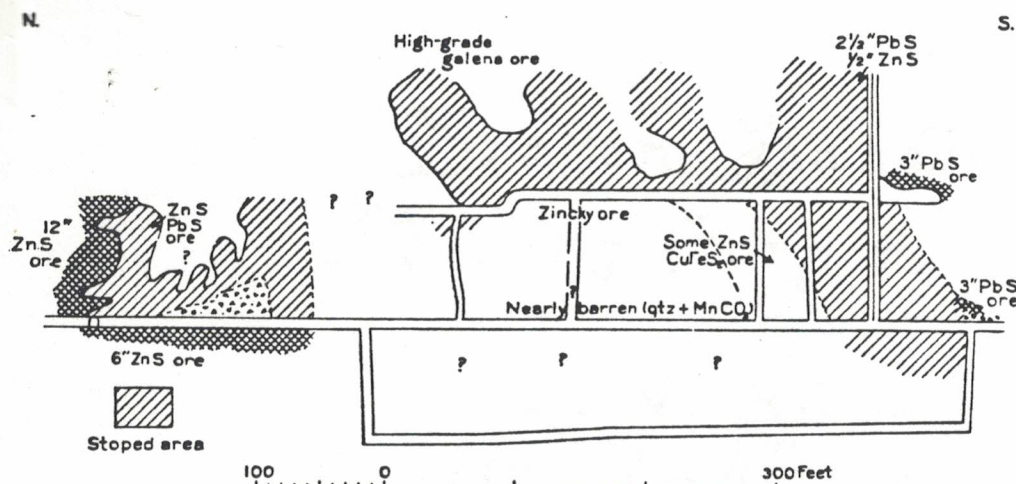


FIGURE 29.—Approximate relations of stopes along main tunnel level, Stevens mine. Sketched by T. S. Lovering.

ton and averaging about 65 percent of lead. Ten years later the tenor of the ore being shipped was somewhat poorer, a 10-ton mill run on September 16, 1886, assaying 1.1 ounces of gold and 44 ounces of silver to the ton and 47 percent of lead. During 1888 several hundred tons of ore was shipped, averaging about 1.1 ounces of gold and 26 ounces of silver to the ton and 50 percent of lead. In 1891 seven carloads of ore averaged 0.1 ounce of gold and 24 ounces of silver to the ton and 66 percent of lead. A gradual decrease of silver with depth is indicated.

The mine was opened by several adits and by winzes sunk from some of the levels. Most of the portals of the upper levels have been obliterated by snowslides or caving, and it is impossible to tell how many tunnels were driven. The main tunnel level is known as the fourteenth level, and the next tunnel level above was called the ninth level and is supposed to be about 300 feet above the main level, suggesting that the levels were numbered every 10 fathoms in depth. At the time of the writer's visit the main tunnel level and part of the next level above it were accessible. Two winzes have been sunk from the main tunnel level and are reported to be 80 feet deep and to be connected by a drift. They were filled with water in 1927, however, and this information could not be verified by observation.

As shown on plate 38, the ore occurs in branching fissures whose general trend is slightly west of north and whose general dip is 60°-75° E. Most of the ore found on the main tunnel level contains more sphalerite than galena and has a moderate amount of pyrite and manganiferous ankerite. Ore of this character, 4 to 10 inches wide, occurs in a shoot about 200 feet long just south of the main tunnel where it cuts the vein. As shown in figure 29, no more ore is found in the vein on this level

rest on much more zinciferous material pitching southward at a low angle. This is shown in figure 29. Available production figures for the Stevens mine are given below.

#### Production of Stevens mine

|           | Ore (short tons) | Gold (fine ounces) | Silver (fine ounces) | Lead, wet assay (pounds) | Copper, wet assay (pounds) | Zinc (pounds) |
|-----------|------------------|--------------------|----------------------|--------------------------|----------------------------|---------------|
| 1870..... | 40               | .....              | .....                | .....                    | .....                      | .....         |
| 1873..... | 300              | .....              | 25,000               | 200,000                  | .....                      | .....         |
| 1877..... | (?)              | 54.12              | 12,947               | 390,696                  | .....                      | .....         |
| 1888..... | .....            | 91.91              | 21,185               | 857,663                  | .....                      | .....         |
| 1889..... | .....            | 108.34             | 17,890               | 811,106                  | .....                      | .....         |
| 1892..... | (?)              | .....              | 42,666               | 2,601,203                | .....                      | .....         |

No record available for 1872, 1877-80, 1884, 1893-98; unknown production in 1871, 1874-76, 1883, 1885-86, 1890-91, 1899-1900; no production in 1881-82, 1901, 1921-28; for 1902-20 see Waldorf group, p. 112.

#### TIGER, TIGER EXTENSION, ST. CLOUD, AND WINDSOR

The Tiger and Tiger Extension claims are on the crest of Glacier Mountain, about a mile southwest of Montezuma, and are developed by several shafts. The deepest shaft is about 100 feet deep, and its collar is at an altitude of 11,775 feet. The property can be reached by a steep trail that leads up the west slope of the mountain from the Sts. John mine. It was discovered before 1870, and ore was sold to the Sts. John smelter prior to 1880. The mine is not mentioned as an active property by the Montezuma Mill Run until 1885. The shipments are shown in the table below. The mine has been inactive since 1890.