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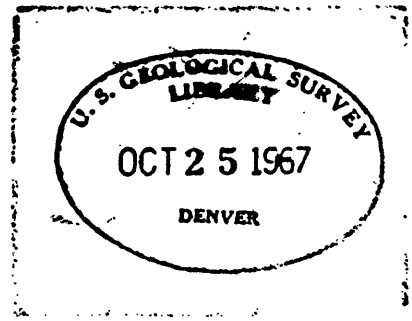
UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

MINES AND PROSPECTS, LAWSON-DUMONT-FALL RIVER DISTRICT, CLEAR CREEK COUNTY, COLORADO

By C. C. Hawley and Frank Baker Moore

Prepared on behalf of the U.S. Atomic Energy Commission



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GEOLOGICAL SURVEY

OPEN FILE REPORT 1967

Mines and prospects, Lawson-Dumont-Fall River district

Clear Creek County, Colorado

By

C. C. Hawley and Frank Baker Moore

Prepared on behalf of the U.S. Atomic Energy Commission

Introduction and summary of geology

The Lawson-Dumont-Fall River district is in the Front Range mineral belt. It is west of the Central City district, which has been described by Sims, Drake, and Tooker (1963); west of the Idaho Springs district, described by Moench and Drake (1966); and north of the Freeland-Lamartine district and Chicago Creek area, described by Harrison and Wells (1956; 1959). Locations of these districts are shown on figure 1. This report supplements U.S. Geological Survey Bulletin 1231 on the general geology and ore deposits of the Lawson-Dumont-Fall River district by C. C. Hawley and Frank Baker Moore (1967).

The task of obtaining accurate information about an old mining district is a difficult one. It was made easier in the Lawson-Dumont-Fall River district by many residents and former miners. Mel White, Frank Jones, Ed Rice, and the late P. P. Barbour and Henry deLinde furnished us with maps and other useful data on the mines, and J. Price Briscoe furnished us with records from the Idaho Springs Sampling Works. Others, particularly Joseph Allaria, W. E. Anderson, E. B. Dingle, and Arthur McCrea, helped us with names and histories of many old properties.

Gold, silver, copper, lead, zinc, and uranium ores valued at more than $3,675,000 have been produced from the district. The production data that are recorded in the tables are, unless otherwise noted, from the U.S. Bureau of Mines, and are published with their permission.

The Lawson-Dumont-Fall River district is largely underlain by metamorphic and igneous rocks of Precambrian age (table 1). The gneissic rocks which comprise the metamorphic series were folded, strongly metamorphosed, and locally faulted in Precambrian time. The youngest of the Precambrian igneous rocks are only locally deformed.

During the formation of the Rocky Mountains in early Tertiary time, more than 1 billion years later than the main Precambrian events, the district was elevated, strongly faulted, and intruded by a complex series of igneous rocks commonly called porphyries (table 2 and fig. 2).

Near the close of the period of formation of the igneous rocks, veins containing gold, silver, and base-metal minerals were deposited in the fissures which had largely formed in the Tertiary Period.

The veins of the area can generally be assigned to three groups (fig. 2): (1) pyritic veins valued chiefly for gold and generally of low grade, (2) galena-sphalerite veins valued for base metals and silver, and (3) veins of mixed mineralogy, termed composite, which locally contain gold, silver, or base-metal ores. Another group, the veins of unknown type, are the limonitic veins formed by oxidation of sulfide veins; they are exposed only in shallow workings, and the original sulfide minerals are unknown. Some other veins, particularly those at the fringe of areas containing the galena-sphalerite veins, are nearly barren. In general, the galena-sphalerite veins are exposed in the western and northern parts of the district, where they crudely bound a large area containing veins of pyritic or composite type which are exposed in the southeastern part of the district.

Some veins of pyritic, composite, or galena-sphalerite type contain pitchblende and secondary uranium minerals. The most important uraniferous veins are exposed in the Almaden, Golconda, and Mary mines in the Fall River area, and in a few mines near Lawson, particularly the Jo Reynolds and Bellevue-Hudson.

Table 1.--Precambrian rocks of the Lawson-Dumont-Fall River district, listed in probable order of decreasing age

Rock units	Description	Remarks
1. Biotite gneiss--	Gray, fine to medium grained. Most common varieties are biotite-quartz-plagioclase gneiss and sillimanitic biotite-quartz gneiss. Less common types are garnetiferous biotite gneiss and hornblende-biotite gneiss.	Interlayered on a small scale; locally layers of a mineralogic variety, such as biotite-quartz-plagioclase gneiss, are thick enough to map separately.
2. Quartz gneiss---	Light gray to greenish gray, fine grained, poorly foliated.	The biotite gneiss, quartz gneiss, and calc-silicate gneiss together are approximately lithologically equivalent to the Idaho Springs Formation of Ball (1906). In many places the biotitic units contain thin layers of granitic material.
3. Calc-silicate gneiss.	Three main varieties are distinguished: one contains abundant epidote, locally with garnet; a second variety is hornblendic; and the third, termed garnetiferous gneiss, is composed mainly of quartz, garnet, hornblende, and magnetite.	The garnetiferous gneiss forms the walls of uranium-bearing veins in the Fall River area.
4. Amphibolite-----	Dark greenish black to black and white, poorly foliated. Consists mainly of hornblende and plagioclase.	Closely associated with the microcline gneiss.
5. Microcline-quartz-plagioclase-biotite gneiss (termed microcline gneiss).	Leucocratic quartzofeldspathic gneiss, medium grained.	Granite gneiss or quartz monzonite gneiss of previous reports on the area. Relations diagnostic of any age difference of units 1 through 5 are unknown.

Table 1.--Precambrian rocks of the Lawson-Dumont-Fall River district, listed in probable order of decreasing age--Continued

Rock units	Description	Remarks
6. Quartz diorite gneiss.	Gray, fine to medium grained; granoblastic.	Forms phacolithlike bodies to the Lawson and Bald Mountain synclines, and is inferred to be a metaigneous rock.
7. Granite gneiss and pegmatite.	Leucocratic, medium to coarse grained; equigranular to pegmatitic in texture.	Forms conformable layers and lenses, particularly with the biotite gneiss. Biotite gneiss with abundant granite gneiss and pegmatite was mapped as migmatite.
8. Granodiorite----	Bluish-gray, medium- to coarse-grained, equigranular to porphyritic rock. Moderately foliated.	Probably correlative with the Boulder Creek Granite of Lovering and Goddard (1950).
9. Quartz diorite.	Dark-gray equigranular rock, moderately to poorly foliated.	
10. Biotite-muscovite granite.	Tan to brown, fine to medium grained, seriate, porphyritic. Medium-grained tabs composed of Carlsbad-twinned microcline. Poorly foliated.	Correlative with the type Silver Plume Granite.
11. Granite pegmatite.	Probably several varieties.	

Table 2.--Tertiary porphyries of the Lawson-Dumont-Fall River district, listed in order of decreasing age

[Classification and data on radioactivity from Wells (1960)]

GROUP 1 Hornblende granodiorite porphyry and related rocks	GROUP 2 Quartz monzonite porphyry and related rocks	GROUP 3 Bostonite porphyry and related rocks
Hornblende granodiorite porphyry: Gray, seriate porphyritic texture. Plagioclase tabs as much as 1 inch long, smaller phenocrysts of potassic feldspar, augite, and hornblende. Average radioactivity, 0.0020 percent eU. Stock and small dikes in the Fall River area.		
Biotite granodiorite porphyry: Light greenish gray, seriate porphyritic texture. Phenocrysts of plagioclase, quartz, and biotite. Average radioactivity, 0.0023 percent eU. Stock in Fall River area and small dikes.	Quartz monzonite porphyry: Gray, scattered gray and white plagioclase phenocrysts as much as three-fourths inch long in an aphanitic groundmass. Average radioactivity, 0.0037 percent eU. Numerous dikes.	
Biotite-quartz monzonite porphyry: Light-gray rock characterized by quartz and plagioclase phenocrysts. Average radioactivity, 0.0020 percent eU. Dikes north of Dumont.		Garnetiferous bostonite porphyry: Spotted white and reddish brown, white feldspar phenocrysts and small dark phenocrysts of garnet and pyroxene. Average radioactivity, 0.004 percent eU. Small dikes. Bostonite porphyry: Pink, sparsely porphyritic rock. Average radioactivity, 0.0016 percent eU. Small pluton in upper York Gulch area and small dikes. Trachytic granite porphyry: White and light red; rounded feldspar phenocrysts about peanut size. Average radioactivity, 0.0047 percent eU. Small dikes near the mouth of Fall River; one large partly concordant pluton and large dikes in the part of the area west of Dumont.
Biotite-quartz latite porphyry: Tan to gray, small biotite phenocrysts. Average radioactivity, 0.0061 percent eU. Small dikes in the southwestern part of the district.		Quartz bostonite porphyry: Lilac; small white feldspar phenocrysts. Average radioactivity, 0.011 percent eU. Irregular pluton southeast of Dumont; related dikes trend west as far as Lawson and east nearly to Trail Creek. Other dikes in the Fall River area and northwest of Lawson.

Production

Total production of the district cannot be accurately determined because of lack of records for many years. We have, however, gathered data from all available sources, so that the records are as complete as possible. Of these sources, the only government records showing yearly production by individual mines are those of the Director of the Mint for the years 1887-92 (Kimball, 1888-89; Leech, 1890-93) and of the U.S. Bureau of Mines from 1901. In addition, the mint reports for the years 1881-85 (Burchard, 1882-85) give production for small lots of ore shipped from various mines. Other sources of information include Corbett (1879), Callbreath (1899), and records of the Idaho Springs Sampling Works furnished by J. Price Briscoe. Fossett (1880) gave interesting accounts of some of the mines of the district and adjacent districts, and gave production figures for all mines that to 1880 had produced over $500,000. Callbreath (1899) reviewed the mines of Clear Creek County and gave estimated total production to 1899 for a considerable number of mines. These estimates were apparently made on the basis of reports from mine managers and mine owners and, in most cases, are believed to be fairly reliable. Bastin and Hill (1917) estimated production for many mines from data available at the time of their survey.

Where the production was given in pounds or ounces of metal, or where it could be converted to weight, we recalculated the value on the basis of $35.00 gold, $0.90 silver (both per Troy ounce); and $0.30 copper, $0.15 lead, and $0.12 zinc (per pound). As recalculated, the value of production reported in government records exceeds $3,675,000. The total value of production probably exceeds $7,000,000.

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Mine descriptions

About 300 mines, prospects, or veins are described in this report; this total includes most of the large well-known mines. Probably at least as many small, inaccessible, or historically unidentified mines are not described. The amount of geologic and historical material in the text on any particular mine depends on the importance, accessibility, and historical records of the mine. Because most mines are at least partly caved and their production records incomplete, most of the geologic and historical descriptions are likewise incomplete.

The mine workings in the district most likely to be accessible are the long crosscut adits (locally and in this report called tunnels) and the drift adits which have only small amounts of stoping. Most of the shafts are now caved.

The mines are grouped by area, and the larger and more important in each area are described first. Data on some small mines and prospects are summarized in tables 4, 11, 13, 16, and 20. The locations of all mines discussed, together with those of most other mines or prospects, are shown on figure 2, on which the mines are listed by coordinates. An alphabetical list follows the list of illustrations. This list shows the names of mines, prospects, or veins, and their coordinate locations on the district map, the pages of this report on which their descriptions start, and the numbers of the illustrations, if any, referring to them. Mine names which have been assigned from indefinite reports are queried; unnamed mines described in the text are given the field mapping station number (for example, Unknown No. C6-45).

Lawson area, north of Clear Creek

Larger mines in the Red Elephant group

The major mines in the Red Elephant group are the Boulder Nest-Free America, White, Tabor, and St. James. The largest of these, the Boulder Nest-Free America and White mines, yielded a large production of high-grade silver ore from 1877 to about 1885, and have yielded smaller amounts since that time. The total value of production from the mines recorded in government records is more than $300,000. The total, based on estimated production, is more than $1,600,000, and this estimate is believed to be conservative--Callbreath (1899, p. 195) estimated production at $2,000,000.

The major period of development of the mines near Lawson began in 1876, when D. E. Dulany traced rich silver-bearing float to the Boulder Nest-Free America vein (Fossett, 1880, p. 383). The other important veins were discovered or developed soon afterward. The Boulder Nest-Free America mine was producing ore in 1877, and the White mine, after litigation (Fossett, 1880, p. 384), in 1878. The Tabor was opened and productive at least by 1881 (Burchard, 1882, p. 373). The veins were mined rapidly, however, and so the major period of production was short lived--for the Boulder Nest and White, 1877-85; for the Tabor, 1881-92.

The oldest and most productive workings of the Red Elephant group are shafts and adits on Red Elephant Hill, north of Lawson. Two long crosscuts, the Commodore and Tabor tunnels, were driven to intersect the veins at depth.

The driving of the Commodore tunnel began in 1900, following the consolidation of the large and small mines of the area into the Red Elephant group. The tunnel was completed in 1907 (Charles Johnson, oral commun., 1954). Small shipments of good-grade ore were made from 1907 to 1911, and larger shipments from 1938 to 1947. Ore shipped from the Commodore tunnel came from various veins on the tunnel level, but mostly from the connecting 13th level of the Schwarz shaft (White vein). The upper shafts and adits have been worked to only a small extent since 1900.

The workings of the major mines of the Red Elephant group are known to be fairly extensive, as there is at least 2 miles of underground workings on the White and Boulder Nest-Free America veins. Coverage by engineers' maps ranges from nearly complete on the tunnel workings to nothing on the Boulder Nest-Free America shaft workings. Figure 3 is a compilation from several sources, and shows plans of adits and tunnels, locations of shafts, and locations of some of the more important claims. No longitudinal sections are available for workings on the White or Boulder Nest-Free America veins.

Boulder Nest-Free America vein

The Boulder Nest-Free America vein was opened by four main shafts and several short crosscuts. From west to east, the main shafts are the Bush Willis (B-III, 1), Boulder Nest (B-III, 2), Free America (B-III, 3), and Free America Extension (B-III, 4). (See fig. 2.) Information on these shafts is summarized below:

Shaft	Altitude of collar (feet)	Depth (feet)	Number of levels	Remarks
Bush Willis---	9,016	-----	------	
Boulder Nest--	9,023	500	8	Level at 500 feet by Fossett (1880, p. 384).
Free America--	8,985	550	8	Levels at 100, 160, 220, 280 feet by Corbett (1879, p. 149); at 550, 600 feet by Fossett (1880, p. 382 and 384).
Free America Extension.	8,782	350	4	1st level connects with 3d or 4th level of the Free America shaft.

The vein was also cut in the Commodore tunnel at about 2,730 feet from the portal. As far as known, the shaft workings and the tunnel workings on the vein are not connected. The only places where the vein is now exposed are in a caved stope just west of the Boulder Nest shaft and in shallow shafts west of the Bush Willis.

Two of these shafts or mines, the Boulder Nest and Free America, were particularly productive. According to Fossett (1880, p. 383-385), the Boulder Nest-Free America vein produced large amounts of ore from 1877 to 1880: In 1877 the Free America mine yielded ore valued at $100,000; in 1878, at $60,000. The Boulder Nest's yield in 1877 "was $116,133 currency value, or nearly $110,000 coin." This production came mainly in the 3 months at the close of the year from 718.5 tons of ore averaging $137.50 per ton, and 391 tons averaging 37.5 oz silver per ton (more than 113,000 oz silver). In 1878 the "actual yield of silver from the Boulder Nest must have exceeded $230,000 for the receipts from sales of ore were $157,000." The total yield to March 1, 1879, of both the Free America and Boulder Nest mines "is given as $508,980 currency: an average of 144 1/8 tons of ore and $29,940 monthly. Of this, the Free America gave 31 4/5 tons monthly, averaging 150 ounces of silver." The total production of both mines for 1877-80 was estimated at $650,000 (Fossett, 1880, p. 584). It is likely that this figure was based entirely on the value of the silver produced.

Other mine workings on the vein also produced ore. For example, the Free America Extension, which at the time of Fossett's report was under separate ownership, produced ore valued at $28,000 in sinking 140 feet and drifting 40 feet.

From 1880 to 1885, the production from the vein must have been large, but data are not well documented. The Boulder Nest, Bush Willis (the shaft west of the Boulder Nest), Free America, and Free America Extension shafts are mentioned in various reports by the Director of the Mint (Burchard, 1882-85) as producing ore, but no production figures are given. Still later mint reports, for the years 1888 (Kimball, 1889) and 1890 (Leech, 1891), recorded a small production from the Red Elephant mines (12,509 oz silver and 63,543 lb lead), which probably included some production from the Boulder Nest-Free America vein.

The value of production from the vein during the period 1877-1900 is estimated to have been at least $800,000. Since 1900, production has been negligible. Some ore may have been produced in the 1930's from a short crosscut that goes into the vein from the west side of the Boulder Nest dump, but little ore has been mined from the Boulder Nest-Free America vein on the Commodore tunnel level.

Wallrocks along the Boulder Nest-Free America vein, judged from exposures near the vein and from rock fragments in the dumps, are

mainly microcline gneiss, biotite gneiss, biotite-muscovite granite, and amphibolite. Judged from the surface exposures, the rock exposed in the upper levels of the Boulder Nest and Bush Willis shafts was dominantly microcline gneiss, and that in the upper levels of the Free America shaft, biotite gneiss. Bastin and Hill (1917, p. 334) showed "granite gneiss" (probably microcline gneiss) along the vein on the Commodore level.

In shallow shafts west of the Bush Willis shaft the Boulder Nest vein strikes N. 50°-55° E. and dips from 70° N. to vertical. East of the Boulder Nest shaft the strike swings more to the east. On the Commodore level the vein strikes nearly N. 55° E. and dips steeply north.

The vein exposed in the shallow workings west of the Bush Willis is a fracture zone 3-4 feet wide. In the caved stope just west of the Boulder Nest shaft it is at least 10 feet wide, and consists of altered wallrock cut by several oxidized veins. Apparently the vein in the Free America workings was much wider, but the high-grade vein or smelting streak was generally smaller. The Colorado Directory of Mines (Corbett, 1879, p. 134, 149) says that the vein in the Boulder Nest was 4 feet wide and that the high-grade part ranged in width from 1 to 3 feet. The Free America vein was as much as 35 feet wide, and the high-grade part ranged from 4 to 20 inches in width. Fossett (1880, p. 383) reported that a crosscut driven in vein material on the second level of the Free America for a distance of 36 feet penetrated no vein walls.

The widening of the vein in the Free America may have been due to the change in strike of the vein. The vein swings eastward between the Boulder Nest and Free America shafts at a place very near the projected contact of biotite gneiss and microcline gneiss, suggesting, perhaps, that the change in strike and widening of the vein were caused by the different competencies of the two types of gneiss.

Production figures and dump specimens suggest that the ore was a galena-rich lead-zinc type. It resembled other Lawson ores in having a carbonate-quartz and, locally, barite gangue, but the ore was probably richer in galena than were some veins, such as the American Sisters and Jo Reynolds. The silver content was high, probably averaging more than 100 oz per ton. Discrete silver minerals (members of the polybasite-pearceite series) occurred in the veins along with argentiferous chalcopyrite, tennantite, sphalerite, and galena(?). Polished sections of specimens from the Free America and Bush Willis dumps show the following paragenetic sequences:

Free America dump:	Pyrite, sphalerite, chalcopyrite, tennantite, and galena.
Bush Willis dump:	Sphalerite, chalcopyrite, tennantite, and polybasite-pearceite, some chalcopyrite, and galena.

In addition to galena-rich silver ores, the Boulder Nest-Free America vein locally contained low-grade pyrite-carbonate-quartz-rich vein material, and only small amounts of galena and sphalerite. This material is abundant in the dumps west of the Bush Willis shaft, and probably was the chief constituent of the vein on the Commodore level (vein D and vein in west drift at 2,730 feet (Bastin and Hill, 1917, p. 335)).

White vein

Little of the undoubtedly extensive production of the White vein is recorded. It is known that both the Schwarz shaft on Red Elephant Hill and the Wheeler shaft east of Young America Gulch produced ore, and Fossett (1880, p. 384) reported production for 1878-79 as more than $100,000. Burchard (1882-85) noted that lease blocks in the White were producing good-grade ore, and he (1884, p. 261) cited one lease block as producing $20,000 worth in 1883.

According to Charles Johnson (oral commun., 1954), of Lawson, part of the White vein was stoped in about 1912 from the 13th level to probably the 10th, and at least 1 carload of good smelting ore was shipped per month. Evidently much or all of this production was not recorded. At least some of the recent (post-1937) production from the Commodore tunnel came from the White or closely related veins on the 13th level of the Schwarz shaft; ore valued at about $53,000 was produced from this level of the Schwarz shaft in 1942. The total production of the workings on the White vein is estimated to be at least $500,000.

The White vein was developed by the Schwarz shaft (B-III, 9) on Red Elephant Hill, a connecting drift adit (6th level or Cleary adit) in Young America Gulch (B-III, 10), and by the Wheeler shaft (B-III, 11) and the Desbro or Horatio Parker crosscut (B-III, 34) east of Young America Gulch. A rather large dump between the Schwarz shaft and the Boulder Nest vein is probably from a second shaft on the White vein on Red Elephant Hill, and a Desbro shaft is reported, but was not found, in Young America Gulch. The most easterly workings on the vein are a shallow shaft(?) and short drift adit about 100 feet southeast of the Wheeler shaft.

The Schwarz shaft is about 585 feet deep, and has 13 main levels; the 13th is 135 feet vertically above the Commodore tunnel level, and is connected with the tunnel workings by three raises. The White vein is presently accessible only in the 6th-level adit (fig. 4) and in the Desbro(?) crosscut (fig. 5).

The wallrock on the hanging wall of the White vein in the 6th-level adit is predominantly biotite gneiss, but contains some granite gneiss and pegmatite. The rock on the footwall is highly altered, but is most likely biotite gneiss. The rock in the Desbro or Horatio Parker mine is likewise predominantly biotite gneiss.

The White vein is on a strong generally west-northwest-striking fracture zone. On maps of the Commodore level, it seems to cross the strong northeast-striking Boulder Nest-Free America vein; the westward continuation of the White possibly is the Lulu vein.

The White vein as exposed in the 6th-level adit (fig. 4) strikes generally N. 75° W., and dips 39°-75° NE. As shown on Bastin and Hill's map (1917), the vein strikes east to N. 55° W. on the 13th level, and the White vein in the Desbro or Horatio Parker mine (fig. 5) strikes N. 62° W. and dips 46°-64° NE.

The vein in the 6th-level adit is metalized to some extent throughout its exposed length (340 feet), but most of it consists mainly of fine-grained quartz, carbonate, and highly altered wallrock. The veins exposed on the hanging wall from the portal to the winze are as much as 1 foot wide; they are partly oxidized, and contain remnants of galena--sample 4 (fig. 4) assayed 83 oz silver per ton over a 1-foot width. A thin vein that joins the main and hanging-wall veins at a distance of 65 feet from the portal is composed of solid galena, chalcopyrite, and sphalerite, and thin veinlets in the main-vein zone between 70 and 120 feet show the same mineral assemblage. The vein was overhand stoped, and hence is poorly exposed from 260 feet to the caved part at 340 feet.

The vein as exposed in the Commodore tunnel and on the 13th level of the Schwarz shaft was described by Bastin and Hill (1917, p. 335-336). At the time of their survey the White vein on the tunnel level was exposed in two short drifts and was barren. The vein on the 13th level "* * * is a fracture zone varying from 3 inches to 4 feet in width * * *. In places the vein consists wholly of crushed wall rock, but elsewhere it shows galena, pyrite, and some chalcopyrite and sphalerite in a gangue of quartz, siderite, and barite. The sulfides and their gangue form in places sharp-walled veinlets but elsewhere grade gradually into altered wall rock. Small amounts of gray copper intergrown with galena as an original mineral are reported from this vein. Some bornite is reported from the thirteenth level.

"Although the ore from this level * * * is in general very fresh in appearance it is interesting to record the occurrence of crystals of secondary chalcopyrite and of a black brittle sulfide, which is probably pearceite." Bastin and Hill (1917, p. 336) also reported several sampling-works assays for ore from the 13th level. Average grade for these samples, which totaled about 100 tons, was 114 oz silver per ton, 19.5 percent lead, and 9.4 percent zinc.

At least two veins in addition to the White vein are exposed in workings on the 13th level of the Schwarz shaft. An east-northeast-striking vein, which has been called the Flat Iron, is exposed in a short crosscut west of the Schwarz shaft (fig. 3, and inset on fig. 8), and a west-striking vein is exposed in a crosscut east of the shaft and also farther north in the Flat Iron(?) crosscut. This second vein was mined in 1942 (William Huleatt, oral commun., 1955); it probably is

a split off the hanging wall of the White vein. The grade of ore mined was considerably lower than that reported by Bastin and Hill for the 13th level: the average grade of the milling ore from the hanging-wall vein was 4.88 oz silver per ton, 4.28 percent lead, and 0.77 percent zinc; a small lot of smelting ore assayed about 33 oz silver per ton, 30.3 percent lead, and 8 percent zinc.

St. James vein

The St. James vein was opened by a series of shafts, now completely caved, a drift adit, and the Tabor and Commodore tunnels. The oldest workings are two of the shafts (B-III, 36, 37), which, according to Callbreath (1899, p. 210), were 168 and 300 feet deep. The vein was accessible at the time of this survey only in the St. James adit (B-III, 33) (fig. 6) and in the Tabor tunnel (B-III, 30) (fig. 7).

The production of the St. James vein is not known. Webster (1924) estimated from company records that it was $100,000. Probably some of the production recorded from the Commodore Tunnel in 1907-11 came from a lateral on the St. James vein west of the tunnel.

The rock exposed in the St. James adit is highly altered; it apparently is biotite gneiss, variably migmatized, and granite gneiss and pegmatite. The biotitic layers generally strike slightly west of north; biotite-quartz-plagioclase gneiss and granite gneiss and pegmatite layers are displaced by the vein fissure. The wallrock along the vein in the Tabor tunnel is mainly biotite gneiss.

The strike of the St. James vein ranges from about N. 56° W. to due east; the vein dips steeply to the north and thus belongs to the same fracture set as the northwest-striking White and Tabor veins. As shown by displacement of rock layers (fig. 6), the vein is definitely in a fault; the apparent motion is north wall west relative to the south wall. This apparent motion could have resulted from gravity-type faulting, but, because the vein is stronger in its more west-striking parts, lateral motion in the direction of apparent displacement seems likely. In the Tabor tunnel the vein is intermittently mineralized for 130 feet east and 100 feet west of the tunnel, where it strikes about N. 64° W., but is barren in both the east and west ends of the drift, where it strikes N. 56°-60° W. In the St. James adit the vein is well mineralized near the portal, where it strikes N. 80° W., and again at about 350 feet from the portal, where it strikes about due west, but is less well mineralized where the strike of the vein is more northerly.

The well-mineralized vein exposed near the portal of the St. James adit is as much as 1 1/2 feet wide, and contains solid veinlets of galena, sphalerite, and chalcopyrite as much as several inches wide; it is partly oxidized. Two samples from this part of the vein (see fig. 6 for locations) assayed:

Sample No.	Width	Equivalent uranium	Gold	Silver	Copper	Lead	Zinc
		(percent)	(oz per ton)		(percent)		
2	1.0 ft	0.001	0	0.70	0.03	2.49	0.88
3	5 in.	.001	.10	32.84	.72	1.96	.49

The vein at 350 feet from the portal is largely stoped out, but a 3-inch vein in the hanging wall near the west end of the stope consists entirely of intergrown chalcopyrite, galena, and sphalerite. One sample assayed 0.14 oz gold per ton, 22.78 oz silver per ton, and about 5 percent copper, 20 percent lead, and 9 percent zinc. The part of the vein between the well-mineralized parts consists of minor amounts of galena, sphalerite, and chalcopyrite in small pyrite- and carbonate-rich veins.

On the Commodore tunnel level, the St. James vein is cut 2,240 feet from the portal in the presently inaccessible part of the mine. An old map of unknown origin shows a 200X40-foot stope on the vein west of the tunnel. A vein exposed in the crosscut that leaves the tunnel 1,830 feet from the portal has been considered as being the St. James, but it is more likely the Tabor.

Tabor vein

The Tabor vein was opened by a shaft that had three main levels (B-III, 29), and by a sublevel that is connected to the Tabor tunnel (B-III, 30) (fig. 7); a second shaft, known as the Tabor East, may be in the area of the Young America West shafts (B-III, 28).

Production of the Tabor mine, as given in mint reports (Kimball, 1888-89; Leech, 1891, 1893), was:

Year	Gold	Silver	Lead
	(ounces)		(pounds)
1887-----	----	15,520	64,736
1888-----	2.5	5,000	10,000
1890-----	----	12,628	39,900
1892-----	----	125,000	------
Total--	2.5	158,148	114,636

The only recorded recent production from the mine was for 1922 and 1923, when 15.24 tons of ore shipped to sampling works contained 0.03 oz gold, 384 oz silver, 3,705 lb lead, and 2,205 lb zinc. Value of all recorded production is about $161,000, and the production of the mine is estimated to have been at least $200,000.

The wallrock exposed at the collar of the Tabor shaft is quartz-diorite gneiss, and this rock probably was the major rock unit in the upper shaft workings of the mine. On the tunnel level, biotite-muscovite granite forms most of the north wall of the vein, and quartz

diorite gneiss the south wall.

The Tabor vein as exposed in the Tabor tunnel strikes N. 49°-58° W., and dips 50°-60° NE. It is poorly exposed on the tunnel level, but contains dark sphalerite in a quartz-carbonate gangue near the west end of the drift. The vein in the Tabor East shaft was reported (W. E. Anderson, oral commun., 1954) to contain a good body of sphalerite-rich ore which was not mined.

Near the west end of the now inaccessible second level of the main shaft, a short crosscut is supposed to go to the Silver Coin vein (fig. 3).

Commodore tunnel

The Commodore tunnel (B-III, 52) is a straight crosscut about 3,500 feet long that trends about N. 41° W.; short laterals have been driven both east and west of the tunnel (fig. 8). The portal is at an altitude of about 8,165 feet. At the time of the survey (1954), the tunnel was accessible for only 1,950 feet. The Commodore tunnel intersects the previously described Boulder Nest-Free America, White, and St. James veins, possibly the Tabor vein, and also several unnamed veins or faults. The composite mine map, figure 3, shows most of the tunnel workings; figure 8 shows the geology of the accessible part of the tunnel, and an inset on figure 8 shows the vein geology of the now-inaccessible and more important part of the tunnel as mapped by Bastin and Hill (1917). The veins in the tunnel level have not been very productive. Some ore has been mined from the St. James vein, the Tabor(?) vein, a small vein 820 feet from the portal, and probably the Boulder Nest vein, but most of the ore mined came from the White vein and other veins exposed on the 13th level of the Schwarz shaft (table 3). The old shaft workings on the St. James, Tabor, and Boulder Nest-Free America veins are not connected with the Commodore tunnel level. If the shaft depths previously given are correct, then there is about 350 feet of back from the tunnel level to the bottom of the Boulder Nest shaft, and about 200 feet to the bottom of the Free America shaft.

The wallrock in the first thousand feet of the Commodore tunnel is composed predominantly of massive to poorly foliated quartz diorite which is cut by small discordant bodies of pegmatite. From 1,000 to 1,950 feet, the wallrock is predominantly microcline gneiss and interlayered amphibolite. Foliation in the gneiss and amphibolite dips generally northwest, in contrast to the northeast dip of the poorly developed quartz diorite foliation.

Several veins and faults are cut in the accessible part of the tunnel (fig. 8), but only two have been mined to any extent. One of these is cut at 820 feet from the portal; the second is exposed in the northeast-trending crosscut that leaves the main tunnel at 1,830 feet. The 820-foot vein is about 6 inches wide, and, as seen in the back, consists

Table 3.--Production from the Commodore tunnel, 1907-48

[---, No production figures reported]

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Remarks
1907	1	-------	1.92	16	212	-------	-------	
1908	1	-------	.04	40	------	-------	-------	
1909	73	-------	1.36	10,121	------	23,497	13,279	Possibly some ore from St. James.
1910	77	-------	3.18	3,786	------	27,695	16,900	Do.
1911	29	-------	1.38	3,181	------	10,088	2,895	Do.
1912	16	-------	.40	825	------	4,252	1,988	
1913	10	-------	.17	276	------	-------	-------	
	10	-------	.33	796	------	4,312	3,181	
1938-	125	-------	6.02	11,641	201	69,067	13,521	Some from 13th level, Schwarz shaft, White vein.
1948	5,756	529	42.00	28,071	5,566	388,122	64,879	
Total	6,098	529	56.80	58,753	5,979	527,033	116,643	

mostly of dark sulfides; the same vein is barren in a short crosscut driven from 860 feet. The second vein strikes N. 66° W., and dips steeply to the north. As now exposed, it is mainly fault gouge containing fragments of galena, but, according to Charles Hull (oral commun., 1955), the vein to the east contained sulfides in a zone as wide as the drift, but pinched down again in an overhand stope. This vein is thought by the authors to be the Tabor.

Suggestions for prospecting

The history of mining in the district and several features of the vein and wallrock geology suggest that the major Red Elephant veins possibly contain unmined or undiscovered ore bodies. During a period of "tunnel fever," shaft operations were slowed or suspended pending driving of deep tunnels to provide cheap drainage and haulage of ore. Many of the planned tunnels were never driven, and most of those that were driven penetrated low-grade parts of veins, so that capital to drive laterals and raises to connect with old workings was unavailable. Mining and shaft sinking on the Boulder Nest-Free America vein stopped abruptly about 1885, but the Commodore tunnel was not finished until about 1907, and then the shaft and tunnel workings were not connected.

Both the White and Boulder Nest-Free America veins continue to the east and west of the mine workings; their total lengths are unknown. In general, the western parts of the veins, particularly of the White vein, are not believed to be as favorable as the eastern parts, because both veins likely grade westward into nearly barren quartz-carbonate-rich veins. (It should be noted, however, that at least some ore was mined from the Kanawha vein, the westernmost probable continuation of the Boulder Nest-Free America.) The Boulder Nest-Free America vein has not been prospected east of the Free America Extension shaft, because the vein is buried under thick glacial debris. The White vein has not been traced eastward from the shallow mine workings just east of the Wheeler shaft. Projected eastward, it should be penetrated by extending the Tabor tunnel not more than 100 feet. In the Commodore tunnel workings, the White vein has not been explored to any extent east of the tunnel, and the "hanging wall" split of the White, which was mined in 1942 on the 13th level of the Schwarz shaft, probably has not been explored at all on the tunnel level. Projection of ore bodies in the Boulder Nest-Free America vein to the tunnel level is more speculative, because little is known of the lower shaft workings on this vein. Near the surface the vein widens eastward as it changes strike from about N. 55° E. to nearly east. The change in strike and widening of the vein takes place near the intersection of the vein with the east-dipping contact of the biotite gneiss with microcline gneiss, thus suggesting a control of the ore shoot by the change in rock type. If the shoot is controlled by this change, then the projection of the shoot along the dip of contact to the tunnel level would be under the Free America Extension shaft, far to the east of any of the tunnel workings. Ore bodies on the St. James and Tabor(?) veins are found both near the surface and in

the tunnel workings, suggesting that the unexplored ground between the old shafts and adits and the Commodore tunnel is favorable for prospecting.

Other mines on Red Elephant Hill and in Young America Gulch

Cleveland(?) mine

The Cleveland(?) mine (A-II, 2), developed by a drift adit and winze (fig. 9), is about 1,700 feet N. 30° W. of the Boulder Nest shaft, at an altitude of about 9,390 feet. A shaft west-southwest of the adit (fig. 2) exposes the same vein, and a shallow shaft (B-II, 3), 450 feet to the northeast, probably is on the same vein on the Dunderburg claim. The mine has no recorded production.

The drift adit penetrates, successively, overburden, biotite-muscovite granite, a layer of amphibolite about 100 feet thick, and microcline gneiss. Foliation in both amphibolite and microcline gneiss strikes northwest and dips steeply to the northeast. The vein, followed by the adit, strikes about N. 60° E. and dips on an average 75° NW.; it ranges in width from about 1 inch to 1 foot, and consists mainly of fine-grained quartz and carbonate. Scattered grains of pyrite and galena are visible megascopically in the gangue, and polished sections show, in addition, tennantite and chalcopyrite. The vein exposed in the shaft west of the adit is about 1 foot wide, and is composed of manganese-stained limonite and quartz.

Flat Iron vein

The Flat Iron vein is opened by a shallow shaft (B-III, 12) on Red Elephant Hill, about 250 feet northeast of the Schwarz shaft, and by a tunnel or adit (B-III, 13) in Young America Gulch, south of the Free America Extension shaft. As previously noted, the vein is also considered as being present north of the White vein, on the 13th level of the Schwarz shaft. The adit in Young America Gulch was not certainly located; according to old maps (fig. 3), it has two drifts--one (the southernmost) on the Flat Iron vein, and the other on the Boulder Nest or a branch vein in the footwall of the Boulder Nest. The vein exposed in the shallow shaft strikes N. 43° E. and dips 55° N.; the vein in the adit strikes more easterly. Apparently, the strike of the Flat Iron vein is subparallel to that of the Boulder Nest, but the dip is appreciably flatter, so the Flat Iron should join the Boulder Nest at depth.

Mines east of Red Elephant Hill

The mines east of Red Elephant Hill in the Lawson area, like those farther to the west, are on galena-sphalerite-type veins. The mines have not been as productive as those on Red Elephant Hill; probably the two most productive mines were the Orient and Young America.

Central America (Tinker) mine

The Central America (Tinker) mine (B-III, 5) is in Black Gulch, about 750 feet northeast of the Little Giant mine, at an altitude of about 9,000 feet. It is opened by an adit that crosscuts S. 76° E. for 117 feet, and then swings S. 30° E. for another 40 feet to the vein, which is followed for more than 200 feet by an east-trending drift (fig. 5). The east end of the drift is now inaccessible. The only recorded production for the mine was in 1936, when 2 tons of ore averaging 0.1 oz gold per ton, 51 oz silver per ton, and 26 percent lead was shipped. A small part of the vein, about 175 feet east of the crosscut-drift intersection, has been overhand stoped.

The vein cuts through microcline gneiss interbedded with thin amphibolite layers. For about 110 feet from the crosscut, the vein strikes about N. 82° W.; it then swings nearly east, and continues on this trend to the caved east end of the drift. The vein is narrow, ranging in width from 2 to 6 inches, but in most places it contains galena and other metallic minerals. A galena-rich veinlet 1/2-2 inches across, containing small quantities of chalcopyrite and sphalerite, forms the footwall of the vein for about 125 feet. Assays of two samples of the galena-rich vein material are given on figure 5. Polished sections of this ore indicate the common paragenetic sequence: sphalerite, chalcopyrite, and galena; but a section of a specimen from the dump shows other minerals, and more complex relations. Galena in this specimen is replaced by three sulfosalt minerals; one is isotropic, has a brownish cast, and is probably tetrahedrite; the other two are highly anisotropic, and have slightly different hardnesses--the softer of the two is probably polybasite, and the harder, pearceite. The complete paragenetic sequence shown in the polished section is sphalerite, chalcopyrite, galena, and nearly contemporaneous pearceite(?), and then polybasite(?) and tetrahedrite(?).

Comstock vein

Workings on the Comstock vein consist of two groups of mines separated by a covered unprospected interval of about 1,000 feet. One group (B-III, 8), about 400 feet north of the Panama tunnel, consists of two short crosscuts to the vein (shown in relation to the Panama tunnel on fig. 15); the second group consists of shallow shafts and the Sutro tunnel (C-III, 1) (fig. 10). The Puzzler vein (C-III, 2), opened by a shallow shaft, is probably the eastern continuation of the Comstock vein.

The Comstock was one of the first veins discovered in the area; Fossett (1880, p. 385) noted that it was producing ore from a shaft and an intersecting tunnel, but did not give production figures. The mine was apparently idle from 1900 to 1952, when 52 tons of concentrate containing 53 oz silver, 6 lb copper, and 2,315 lb lead was shipped. (According to the miners (Charles Hull, oral commun., 1954), some silver was lost in milling.)

The Sutro tunnel consists of a 350-foot crosscut, which is partly on a barren fault, and a drift on the Comstock vein. The drift extends more than 100 feet west of the crosscut, but is caved and inaccessible to the east. A raise has been excavated 65 feet west of the crosscut, and a small overhand stope extends about 40 feet west of the crosscut.

The tunnel exposes a variety of rock types. Most of the wallrock is microcline gneiss and associated amphibolite. Near the portal the foliation in the gneiss strikes about east, and dips north; about 250 feet from the portal the strike of the foliation swings to northeast. The amphibolite and microcline gneiss are cut by biotite-muscovite granite of Precambrian age, and by trachytic granite porphyry of Tertiary age. Both Precambrian and Tertiary rocks are displaced by the Comstock vein fissure, and also by the barren faults exposed along the crosscut.

The Comstock vein exposed in the Sutro tunnel strikes generally N. 46° W., and dips 38°-61° NE. In most places it is barren. A hanging-wall split exposed near the crosscut contains fine-grained galena in white quartz, and the small stope at the crosscut possibly was near the intersection of this split and the footwall vein. The vein in the western part of the drift is about 1 foot wide, but is filled mainly with carbonates. Mining in 1952 was from the raise 65 feet west of the crosscut; according to J. E. Harrison, of the U.S. Geological Survey (oral commun., 1954), the vein was stronger where the vein fissure was relatively steep.

Minor anomalous radioactivity was noted in both the Sutro tunnel and surface prospects: Parts of the drift in the tunnel are slightly radioactive, owing to the Tertiary porphyry, and oxidized vein material in the pit almost due north of the Sutro portal is very weakly radioactive.

The Comstock vein where exposed in the western group of workings (fig. 15) is much stronger than in the Sutro tunnel. In the accessible western adit (crosscut), the vein zone, which strikes about N. 72° W. and dips 54°-60° NE., is about 4 feet wide, and consists of distinct footwall and hanging-wall veins separated by altered wallrock cut by galena-sphalerite veinlets. The footwall vein averages about 2 feet across, and consists of abundant limonite and numerous remnants of sphalerite and galena. The locations of three samples and assay results are shown on figure 15.

Dexter mine

The Dexter mine, just east of Lawson, was opened by three adits. The lower adit, or Dexter tunnel (B-III, 22), probably about 400 feet long and at an altitude of 8,194 feet, and a short upper adit at approximately 8,330 feet were caved in 1954. The middle adit (B-III, 21; also approximate location for upper adit), at an altitude of about 8,300 feet, was open; it has about 250 feet of workings on two veins (fig. 11).

Quartz diorite gneiss probably constitutes most of the wallrock in all three adits.

The portal of the middle adit is about on the intersection of two veins, the Orient and the Dexter. The Orient vein strikes about N. 85° E., dips steeply northward, and has been followed by a drift about 130 feet long; it contains ore minerals only in places. The Dexter vein strikes about N. 62° W., dips 45°-57° NE., and has been followed by a drift about 100 feet long; it has two distinct branches, and one or the other contains sulfide minerals along most of the drift. The northern branch of the Dexter vein is about 1 foot wide near the portal, and consists of a partly oxidized galena-bearing veinlet on the hanging wall, separated from a 1- to 2-inch galena-quartz veinlet on the footwall by wallrock cut by thin carbonate-galena veinlets. A chip sample (sample 3, fig. 11) of this vein, taken across 1.1 feet, assayed 0.001 percent equivalent uranium, a trace of gold, 5.96 oz silver per ton, 13.19 percent lead, and 1.69 percent zinc. The northern branch becomes small and poorly mineralized toward the west, but the southern branch contains galena-rich vein material for at least 30 feet farther west. A 4-inch chip sample (sample 2) of the southern branch, containing fine-grained galena, assayed 0.001 percent equivalent uranium, a trace of gold, 0.50 oz silver per ton, 15.10 percent lead, and 1.04 percent zinc. A grab sample (sample 1) of the Orient vein assayed 0.004 percent equivalent uranium, a trace of gold, 0.92 oz silver per ton, 9.75 percent lead, and 3.42 percent zinc.

Johnson group

Several adits, prospects, and shallow shafts on unpatented claims north of Black Gulch are known locally as the Johnson group (B-II, 4). Three caved adits, which are probably crosscuts, constitute most of the mine workings. The dump of the first adit, at an altitude of about 9,220 feet, shows some altered rock and carbonate vein material. The second adit is at about 9,260 feet, and the dump shows thin veins of galena and sphalerite in a light- and dark-colored carbonate gangue. The third adit is at an altitude of approximately 9,440 feet, and is probably the longest, having an estimated 250 feet of workings. Partly oxidized vein material noted in this dump contained galena.

Two veins are exposed in the claims. A 3- to 12-inch oxidized vein that strikes N. 85° E. and dips 85° NW. is exposed in a shallow shaft just north of the second adit, and a tight limonitic vein that strikes N. 70° E. is exposed in a short adit 130 feet northwest of the shaft. Presumably the middle adit crosscuts to the vein that strikes N. 85° E.

Last Chance mine

The Last Chance mine (fig. 12), a short adit (B-III, 23) driven in microcline gneiss and exposing two small veins, is about 750 feet

southwest of the Panama tunnel. Both veins strike about N. 60° W., and dip northeast. The first, intersected 85 feet from the portal, contains a thin (1/2-inch) veinlet of galena and sphalerite, and is cut off in the tunnel by a barren fault that strikes N. 35° E. The second, cut 140 feet from the portal, is composed mostly of gouge, but contains a small pod of ore that has been almost mined out. About 3 1/2 tons of ore shipped in 1915 and 1917, presumably from this pod, contained 0.13 oz gold, 638 oz silver, and 842 lb lead.

Little Giant mine

The Little Giant mine (B-III, 15) is on the east side of Young America Gulch, at an altitude of 8,823 feet, and is accessible by jeep road from Lawson. Workings consist of a shaft and an adit driven at the collar level; according to Bastin and Hill (1917, p. 336), the shaft had four levels and was 270 feet deep.

Production from the Little Giant mine is recorded in mint reports for 1888 and 1889 (Kimball, 1889; Leech, 1890), and in records of the Idaho Springs Sampling Works for 1919 and 1920:

Year	Gold	Silver	Lead	Zinc
	(ounces)		(pounds)	
1888-89---	49.5	11,625	17,654	-----
1919-20---	1.0	883	6,021	3,127
Total---	50.5	12,508	23,675	3,127

The recorded production has a value of about $17,000.

The portal of the adit and the collar of the shaft (fig. 5) are in biotite gneiss. The foliation of the gneiss strikes generally northeast and dips to the southeast. About 100 feet from the portal, the adit enters quartz diorite gneiss, which continues to the face. The strike of the foliation in the quartz diorite gneiss changes from northeast, through northwest to east along the drift; the change in foliation strike marks the axis of one of the minor east-northeast-trending folds of the Lawson area.

Two small and poorly mineralized veins are exposed in the adit. The vein at the portal strikes about N. 83° W., and dips steeply to the south. At about 30 feet, this vein breaks up into tight fractures that go out into the walls. A second vein, intersected at about 60 feet, strikes N. 49°-57° W., and dips 55°-61° NE. It is partly oxidized, but near the face contains very small crystals of galena and sphalerite in a quartz-carbonate gangue. The last mineral deposited was a somewhat amethystine quartz.

The following description of the vein in the shaft is taken from Bastin and Hill (1917, p. 336):

"The Little Giant vein strikes from N. 70° E. to N. 80° W., and dips about 60° N. As exposed on the 140-foot level for about 500 feet east of the shaft it consists in most places of sericitized granite gneiss cut by veinlets of quartz and siderite, which in some places form an intricate network through 2 feet of gneiss. The largest of these, 1 inch or so in width, locally carry some sulphides."

Little Superior (Jack Rabbit) mine

The Little Superior (Jack Rabbit) mine (C-III, 3) is the easternmost silver mine in the part of the Lawson area north of Clear Creek. The mine is about 1 mile northeast of Lawson, and is accessible by a jeep trail leading from Mill Creek. Workings (fig. 13) consist of a drift adit and shaft (altitude 8,588 feet), a shallow prospect shaft 50 feet to the northeast, and a crosscut adit 225 feet to the southeast (altitude approximately 8,470 feet). No production from the mine is recorded, but some silver ore probably was produced from the shaft workings.

The upper workings (adit and shaft) and lower tunnel workings bracket the main layer of quartz diorite gneiss in the Lawson area. The lower contact of the layer is exposed near the portal of the tunnel, and the upper contact is exposed in the drift adit. A 2- to 3-foot layer of biotite gneiss is exposed just above the quartz diorite gneiss layer, and an amphibolite layer rests on the biotite gneiss. The two branches of the Little Superior vein exposed in the drift adit follow the contacts of the thin layer of biotite gneiss. Projecting the vein downdip to the altitude of the tunnel level, the two branches project 100 and 135 feet northwest of the drift adit (fig. 13). The upper contact of the quartz diorite gneiss, however, apparently flattens downward, so if the branches continue to parallel the contact they may project north of any of the tunnel workings.

Both branches of the Little Superior vein are somewhat metalized in the drift adit. The hanging-wall branch, which is as much as 3 feet thick, contains scattered galena and sphalerite; the footwall branch contains scattered galena crystals in a carbonate gangue.

In all, seven veins are cut in the tunnel level, but only the veins cut at 255 and 385 feet from the portal contain sulfides. The vein at 385 feet strikes about N. 65° E., and is followed by a drift 65 feet long; it is as much as 10 inches wide, and contains scattered crystals of pyrite, galena, and sphalerite.

Orient mine

The Orient mine, northeast of Lawson, is about 700 feet east of the Young America shaft workings, at an altitude of approximately 8,487 feet. It is opened by a main shaft (B-III, 25), reported to be 300 feet deep (W. E. Anderson, oral commun., 1954), and a shallow shaft 80 feet west

of the main shaft. Of five reported levels, only the first level and part of the second were accessible in 1954 (fig. 14).

Production valued at about $29,000 was reported by Kimball (1889) and Leech (1890):

Year	Silver (ounces)	Lead (pounds)
1888-----	8,000	8,036
1889-----	14,293	53,368
Total--	22,293	61,404

According to Mr. Anderson, the mine produced about $200,000 worth of silver-rich ore; Callbreath (1899, p. 184) estimated production to 1899 at $50,000.

The 1st level of the mine is entirely in quartz diorite gneiss, which strikes generally northwest and dips northeast. The accessible part of the 2d level is in a partly discordant body of the biotite-muscovite granite. Judged from the fragments in the dump, most of the mine is in the quartz diorite gneiss and granite.

On the 1st level, the Orient vein is nearly vertical, and strikes N. 81° E.; on the 2d level, the dips range from 65° to 85°, and the strike varies from N. 83° E. to almost east. The vein apparently continues to flatten below the 2d level. In most places on both the 1st and 2d levels the vein is narrow and partly oxidized, but a branch vein exposed in the south drift west of the shaft, on the 1st level, contains a 5-inch galena-bearing barite vein that assayed 14.96 oz silver per ton. West of the shaft, on the 2d level, the vein widens and has been extensively stoped; the stope probably extends upward from the 4th level, or possibly the 5th, to between the 1st and 2d levels. After mapping was completed (1954), ladders were repaired to the 3d level, and Dick Shelton, of Lawson, collected a sample of galena 25 feet west of the shaft that contained, by semiquantitative spectrographic analysis, 0.3 percent silver.

Panama group

The Panama (or Teddy Bear) tunnel (B-III, 19) (fig. 15) was driven to develop a group of unpatented claims north of the village of Lawson. The portal of the tunnel is at an altitude of about 8,806 feet, and is 1,500 feet northeast of the Orient shaft. The Panama No. 2 and No. 3(?) (fig. 15) veins were developed by a shaft and adit, respectively, northwest of the tunnel. The previously mentioned western workings of the Comstock vein are about 100 feet north of the Panama No. 2 shaft (B-III, 18).

The production of the group is small. Some ore has been produced from a vein intersected at 340 feet in the tunnel, but its value is not recorded.

The rocks exposed in the tunnel are microcline gneiss and amphibolite, and, near the portal of the tunnel, a Tertiary trachytic granite porphyry. Changes in dip and strike of the foliation in microcline gneiss and amphibolite, and in the attitude of their contacts, show that the Precambrian rocks have been folded into a series of gentle anticlines and synclines that trend about N. 65° E.

The tunnel is approximately 600 feet long, and intersects nine veins. Veins 1 and 2 are limonitic fractures. Vein 3, which is intersected about 180 feet from the portal, strikes N. 69° W., and dips 43°-55° NE.; it contains a thin carbonate-limonite vein. Vein 4, intersected 245 feet from the portal, is followed by a 140-foot drift. It strikes about N. 86° W. at its intersection with the tunnel, and N. 73° W. in the west end of the drift; it is partly oxidized, but locally contains dark sphalerite and a smaller amount of galena. Vein 5, cut 340 feet from the portal, strikes from about N. 80° W. to N. 85° E., and is developed by short drifts driven east and west of the tunnel. According to Bastin and Hill (1917, p. 336), this vein contained native silver and polybasite, and several assayed samples averaged about 120 oz silver per ton. It has been stoped to a minor extent in both drifts, and, as exposed in the back of the west stope, appears to be about 4-5 inches wide, and contains about 2 inches of dark sulfides. Two small veins (6 and 7) are intersected at 415 and 435 feet, respectively. Both are developed by short drifts east of the tunnel, and the vein at 415 feet, according to Bastin and Hill (1917, p. 336-337) (fig. 60, this rept.), is developed by a 200-foot drift west of the tunnel. Vein 6 strikes N. 86° E. in the accessible part of the drift, but, as shown by Bastin and Hill, strikes about N. 65° W. and dips 65°-75° NE. in the western drift. At the west face, the vein is composed of "three subparallel stringers 1 inch or less in width of white quartz carrying some siderite and a few bunches of galena" (Bastin and Hill, 1917, p. 337). Both veins 8 and 9 strike northwest and dip northeast. It is possible that vein 9 (now inaccessible) is the Comstock. Vein 8 is very small, and no sulfide minerals were noted. According to W. E. Anderson (oral commun., 1954), of Lawson, who drove the crosscut from vein 8 to vein 9 as well as to the drift on vein 9, vein 9 is also small, but contained some sulfide minerals.

Young America vein

The Young America vein crops out on the prominent ridge formed by quartz diorite gneiss just north of Lawson. It has been exposed in several mines; from west to east, the vein is opened by three shafts on the Young America West claim (B-III, 28), and two shafts (B-III, 27), a drift adit (B-III, 26), and a short crosscut (B-III, 51) on the Young America claim. In 1954 only the easternmost of the two

shafts and the drift adit on the Young America claim were open.

The Young America was one of the first veins discovered near Lawson, and it was known before the major discoveries of silver ore on Red Elephant Hill. The vein has been stoped from the shafts on both the Young America West claim and the Young America claim. The value of ore produced is not recorded, but Callbreath (1899, p. 225) estimated production at $110,000.

The East shaft (fig. 16), at an altitude of approximately 8,536 feet, is open to about 60 feet, where there is a drift that extends 180 feet to the east and at least 10 feet to the west. The drift is mostly in biotite-muscovite granite that is in conformable contact with quartz diorite gneiss at the shaft. The drift adit, about 1,150 feet to the east, is also in biotite-muscovite granite and quartz diorite gneiss, but here the granite occurs as a dike that is displaced slightly by the Young America vein (fig. 12).

Two veins are exposed in the drift in the East shaft (fig. 16). The Young America vein strikes about east, dips steeply north, and leaves the drift about 80 feet east of the shaft. Fifty feet east of the shaft, the Orient vein comes in from the north and joins the Young America vein; the Orient vein has been followed for more than 100 feet east of this juncture. The Young America vein is composed of white quartz, sparse carbonates, and scattered crystals of galena and sphalerite. Along the drift it ranges in width from 2 to 6 inches, but as exposed in a pillar near the collar of the shaft it is about 1 foot thick. The Orient vein is barren for 60 feet east of its junction with the Young America; from this point eastward to the face it contains quartz or carbonates and sparse sulfides or limonite.

Mines west of Red Elephant Hill

Amboy mine

The Amboy mine (A-III, 4) is in the gulch north of Hidden Valley, about 2,600 feet S. 60° W. of the Boulder Nest Shaft. The mine is opened by two adits that are driven into biotite-muscovite granite and microcline gneiss (fig. 17).

The western adit, at an altitude of approximately 8,625 feet, is about 100 feet long, and trends generally S. 49° W., following a vein. At the portal, the vein is about 10 inches wide and is composed mainly of limonite; to the southwest, the vein splits into two smaller veins. Twenty feet from the portal, the hanging-wall split is 3 inches wide and is composed mainly of chalcopyrite and tennantite; it is metalized to about 50 feet from the portal. The footwall split contains some pyrite, but is smaller than the hanging-wall branch. From 50 feet to the face, both splits are tight gougy fractures. The paragenetic sequence in a polished section from the hanging-wall vein is: pyrite, quartz, carbonate, sphalerite, tennantite, chalcopyrite, galena, and covellite.

The eastern adit, at an altitude of approximately 8,620 feet, trends generally N. 62° E., and follows a vein set that shows evidence of at least two periods of fracturing. The strongest vein, which consists of crystalline and chalcedonic quartz, carbonate, and small amounts of sphalerite, is apparently cut off by a steeply dipping, north-trending fracture about 25 feet from the portal. In turn, the north-trending fracture is cut off by a fracture that strikes N. 66° E., or almost parallel to the quartz-carbonate vein exposed near the portal. A short crosscut that leaves the drift about 35 feet from the portal trends north and intersects a vein that strikes N. 65° E. and dips 75° N. This vein is about 3 feet wide, and is composed of fine-grained quartz and carbonate cut by stringers containing galena and sphalerite. The vein is lightly copper stained.

The northeasterly striking veins exposed in both adits are apparently closely related, and can be thought of as forming the Amboy vein zone. This vein zone is the probable southwestern continuation of the Boulder Nest-Free America vein, and the probable northeastern continuation of the Kanawha vein.

Girard mine

The Girard mine (B-III, 44) is about three quarters of a mile west of Lawson and 180 feet S. 50° W. of the Oshkosh mine, at an altitude of about 8,430 feet. The workings consist of a crosscut tunnel that trends N. 14° E. for 125 feet and then N. 21° E. for 60 feet, and a drift and winze on a low-angle vein intersected about 70 feet from the portal.

Wallrocks are biotite gneiss, microcline gneiss, and biotite-muscovite granite. The rock at the face appears to be an amphibolitic phase of the microcline-bearing gneiss.

The vein cut 70 feet from the portal strikes about N. 64° W., and dips 24°-37° N.; at a point just east of the crosscut it is about 1 1/2 feet wide and is composed mainly of crushed rock containing carbonate veinlets on the footwall and a thin sphalerite-bearing veinlet on the hanging wall.

Kanawha vein and the Doctor tunnel

The Kanawha vein (A-III, 3), the probable western continuation of the Amboy and Boulder Nest-Free America veins, is exposed in three inaccessible shafts and in the Doctor tunnel (A-III, 6). The tunnel, at an altitude of 8,290 feet, is about 352 feet long, and trends about N. 26° W. (fig. 18). It intersects the Kanawha vein about 348 feet from the portal. A drift follows the vein, but is caved at an overhand stope 25 feet east of the tunnel.

The tunnel is predominantly in the biotite-muscovite granite of Precambrian age; a Tertiary quartz monzonite porphyry dike exposed at

the face of the tunnel occupies a fracture subparallel to the Kanawha vein.

As exposed in the tunnel, the vein strikes about N. 57° E., and dips 78°-82° NW.; it is as much as 2 feet wide, and consists mainly of gouge that contains brecciated fragments of galena-rich sulfide vein material. Dump samples show the presence of pyrite, chalcopyrite, sphalerite, and tennantite in addition to galena. The vein exposed in the shafts about 500 feet northeast of the portal is strong, and is composed mainly of light-brown carbonate cut by veinlets of galena and sphalerite.

No production records have been found for this mine, but the vein has been stoped and so is assumed to have produced some ore.

Marshall and Russell tunnel

The caved Marshall and Russell tunnel (A-III, 7) is a long crosscut whose portal is under the highway east of the highway 6 and 40 junction, west of Lawson. The tunnel was driven to cut the veins in north Empire Creek at depth. The mine was visited by Bastin and Hill (1917, p. 331-333), and the following information is taken from their report: The tunnel trends about N. 23° W. and is about 6,000 feet long; it intersected four veins, several barren fractures, and eight porphyry dikes. Two veins are cut about 1,850 feet from the portal. An older vein, which strikes N. 40° E. and dips 80° NW., is cut without displacement by a younger vein that strikes N. 82° W. and dips 80° NE. The older vein contains pyrite and chalcopyrite; the younger vein contains siderite, sphalerite, chalcopyrite, and some pyrite and galena, and "appears to belong to the Lawson type of silver veins." The third and fourth veins are intersected at nearly 5,450 feet. The third vein strikes about N. 65° E., and consists of pyrite and chalcopyrite in altered granite; the fourth strikes about N. 25° E., and is composed of pyrite and quartz in altered granite.

New England and Sunburst(?) mines

The exact locations of the New England and Sunburst mines (B-III, 3) are not known; both mines are supposed to be in the gulch north of the Oshkosh mine. The New England mine is mentioned with the Oshkosh in Raymond's (1873, p. 277) report for 1872. The Sunburst and New England claims, which are subparallel and overlap, are probably on the same lode system. A strong silicified vein that is possibly the Sunburst can be traced northeastward from the gulch for several hundred feet (fig. 2).

United tunnel

The United tunnel (A-III, 5) is about 1 mile west of Lawson and about 300 feet south-southeast of the Amboy mine, at an altitude of about 8,500 feet. Workings (fig. 17) consist of a northeast-trending

tunnel that in part follows a fault or barren vein. Although there are drifts on two other veins, no production from the mine is recorded.

Rocks exposed in the tunnel are microcline gneiss, amphibolite, and biotite-muscovite granite, all of Precambrian age, and quartz bostonite, of Tertiary age. The quartz bostonite occurs as a dike that is about 40 feet thick, strikes N. 55°-70° W., and dips about 55° N.

Veins exposed in the tunnel are the northeast-striking United vein or fault, two veins that are respectively on the footwall and hanging wall of the Tertiary dike, and a small northeast-striking vein exposed about 10 feet from the portal of the mine. The vein on the hanging wall of the dike is as much as 2 1/2 feet wide, and is composed of quartz cut by sulfide-bearing veinlets. The vein on the footwall of the dike consists of thin veinlets containing pyrite, galena, and sphalerite. The barren United vein or fault displaces the dike and the two northwest-striking veins.

Unknown No. C4-3

Unknown mine C4-3 (A-II, 1) is northwest of the Lulu shaft, and is accessible by a good trail leading to that mine. The workings consist of an adit at an altitude of about 9,655 feet, and short drifts on three subparallel veins (fig. 9).

Most of the wallrock is biotite-muscovite granite, which has some inclusions of microcline gneiss and amphibolite. The last 50 feet of the south drift is in gneiss.

The three veins strike east-northeast to northeast, and generally dip steeply to the south; they are partly oxidized, and are composed mainly of limonite plus remnants of quartz and carbonate. The south vein contains some pyrite in a flinty quartz gangue near the face. The north vein, the strongest of the three, is as much as 1 foot wide, strikes N. 67° E., and dips 75°-86° SE. Two samples taken (see fig. 9 for locations) are almost barren. Sample 2, however, shows considerable anomalous radioactivity.

Sample No.	Width	Equivalent uranium	Uranium	Gold	Silver	Lead
	(inches)	(percent)		(oz per ton)		(percent)
2	11	0.011	0.002	0	0	0.02
3	7	.003	0	0	0	.01

[Analysts: C. Angelo, M. Finch, E. Mallory, and D. Skinner]

Other mines or prospects--tabular summary

Data on some other mines or prospects north of Clear Creek, in the Lawson area, are summarized in table 4. At least three of the mines listed, the Bedford, Black, and Boston, have produced small amounts of ore. Maps of the Oshkosh mine, Pumpkin mine, and Silver Coin drift, respectively, are shown on figures 18, 12, and 3.

Lawson area, south of Clear Creek

Larger mines

American Sisters mine

The American Sisters mine, which developed the American Sisters (B-IV, 8) and La Crosse (B-IV, 7) veins, is in the abandoned mining camp of Silver Creek, about half a mile south of Lawson, and is one of the largest mines in the district. The mine comprises six main adits, called the No. 1 (9,064 feet in altitude), No. 2 (9,149 feet), No. 3 (9,308 feet), No. 4 (9,398 feet), No. 5 (9,496 feet), No. 6, or Native American discovery level (9,652 feet), and workings turned from surface and underground shafts. The upper shaft, the La Crosse discovery shaft, is at an altitude of 9,835 feet; a second shaft, the Native American Engine shaft, is at 9,686 feet; and two shafts, the Kauffman (B-IV, 9) and Engine shafts, were sunk from the altitude of the No. 1 adit. The location and extent of the old workings are shown on a map and section dating from about 1900 (fig. 19) furnished us by Mel White, of Georgetown, Colo. In 1954 the American Sisters vein was accessible to view only near the underground Engine shaft in the No. 1 adit of the American Sisters mine and on the Elida level in the Jo Reynolds mine.

The American Sisters mine resulted from the consolidation in 1890 of the Native American and the Two Sisters mines. Records of production from the mine are incomplete, but the reports by the Director of the Mint (Kimball, 1888-89; Leech, 1890-93) indicate that there was considerable production from 1887 to 1892:

Year	Mine	Gold (ounces)	Silver (ounces)	Lead (pounds)
1887-----	Two Sisters-------	----	43,633	77,133
1888-----	Native American---	5	3,492	79,131
1889-----	Two Sisters-------	7	99,400	112,000
1890-----	American Sisters--	41	68,752	-------
1891-----	----do----------	----	77,519	-------
1892-----	----do----------	----	55,813	-------
Total----------		53	348,609	268,264

Bastin and Hill (1917, p. 340) indicated that ore was shipped from 1893 to 1898, but gave no amounts. Since 1902, Bureau of Mines production records show that a total of 5,943 tons of ore was shipped, and that it contained 80.55 oz gold, 71,387 oz silver, 8,621 lb copper, 166,096 lb lead, and 128,809 lb zinc (table 5). The value of all production is estimated to be at least $500,000.

Table 5.--Production of the American Sisters mine, 1902-38

[---, no production figures reported]

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1902------	20	---	---	1,400	---	8,000	4,000
1906------	36	---	---	4,173	---	7,200	10,607
1907------	1,262	112	10.55	8,611	1,170	26,416	---
	238	---	11.75	2,618	7,140	19,040	---
1908------	600	60	8.22	4,325	---	15,509	---
	91	---	1.83	4,096	---	36,400	---
1909------	3,000	260	27.00	26,000	---	15,595	78,000
1911------	14	---	1.77	626	117	2,167	1,883
1912------	17	---	2.60	549	---	159	485
1919------	1/ 109	12	1.89	428	---	1,689	4,623
	34	---	.68	1,717	---	5,744	10,373
1920------	32	---	.93	2,113	---	6,899	11,306
1921------	(2/)	---	---	---	---	---	---
1924------	(2/)	---	---	---	---	---	---

Table 5.--Production of the American Sisters mine, 1902-38--Continued

Year	Crude ore	Concentrates	Gold	Silver	Copper	Lead	Zinc
	(tons)		(ounces)		(pounds)		
1925------	20	4	0.50	109	---------	969	1,834
1934------	210	12	6.72	8,716	106	2,293	2,811
1935------	117	10	2.97	3,876	---------	15,757	330
	7	----------	1.91	1,213	---------	----------	---------
1936------	77	4	.83	606	---------	1,721	2,000
1938------	59	2	.40	221	88	538	557
Total---	5,943	476	80.55	71,387	8,621	166,096	128,809

1/ Estimate.

2/ See table 7.

The plan map of the mine (fig. 19) indicates that in the northeastern part of the workings the American Sisters vein strikes about N. 64° E. and dips 70° NW.; in the southwestern part of the workings the strike seems to change to N. 50°-55° E. As exposed in a high back in the No. 1 adit, the American Sisters seems to be a strong sulfide-bearing vein. On the Elida level of the Jo Reynolds, the vein is 1-2 1/2 feet wide, and is mostly gouge including some dark sphalerite and chalcopyrite. Specimens from dumps contain galena, sphalerite, siderite, and quartz, and lesser amounts of chalcopyrite and pyrite. One hand specimen shows siderite, white crystalline quartz, and pyrite to be younger than galena and chalcopyrite. Bastin and Hill (1917, p. 340) reported secondary proustite and pearceite in fractures and in vugs.

Bellevue-Hudson mine

The Bellevue-Hudson mine is about 1 mile west of Lawson, just south of Clear Creek. It developed two main veins, the Bellevue and the Giesicke, and mine workings consist of three adits or tunnels, an underground shaft that has eight levels, and interconnecting raises, stopes, and underground crosscuts. The upper adit, called the Upper Bellevue (A-IV, 3), is at an altitude of 8,970 feet; the middle, or Annamosa, tunnel (A-IV, 2) is at 8,605 feet; and the lower, or Bellevue-Rochester, tunnel (A-III, 8) is at 8,253 feet. The Bellevue underground shaft connects the three adits; the Annamosa level is the 6th shaft level (fig. 20). At the time of this survey (1954), only about 685 feet of the Bellevue-Rochester tunnel and 450 feet of the Annamosa tunnel were accessible. However, considerable data on the lower mine workings were available from several sources, and descriptions of inaccessible parts of the mine are based on these data.

Production.--According to Bastin and Hill (1917, p. 333), high-grade silver ores were produced from the upper levels between 1886 and 1896. Mint reports (Leech, 1891; 1893) indicate that the Bellevue produced 71,363 oz silver and 4,826 lb lead in the years 1890 and 1892. Sampling-works assays showed that 88 tons of ore shipped in 1890-91 averaged 206 oz silver per ton and 15 percent lead. Callbreath (1899, p. 124) stated that the total production of the mine was valued at $750,000.

From 1907 to 1948, more than 17,000 tons of ore was produced that contained about 1,217 oz gold, 138,703 oz silver, 3,976 lb copper, 815,249 lb lead, and 220,408 lb zinc. (See table 6.) Using post-1900 production data and Callbreath's estimate of earlier production, the total value of ore produced is estimated at about $950,000. Shipments made from 1901 to 1924 contained from 27 to 100 oz silver per ton; shipments after 1924, with the exception of one small (less than 1/2 ton) lot, contained less than 19 oz silver per ton. Tenors of several lots of ore shipped between 1901 and 1924 believed to be representative of pre-1924 production are as follows:

Year	Tons	Gold	Silver	Copper	Lead	Zinc
		(ounces per ton)		(p e r c e n t)		
1908--	156	0.038	100.0	------	13.0	5.0
1912--	170	.123	27.5	0.1	19.4	11.1
1920--	191	.024	60.3	------	12.5	10.9

Longitudinal sections of the Bellevue and Giesicke veins (fig. 20) show considerable stoping in both veins, but suggest that most of the more recent production, which came from the lower levels of the mine, was from the Giesicke vein.

Vein geology.--The Bellevue-Rochester tunnel (fig. 20) was driven S. 25° E. for about 1,050 feet, and thence on an average S. 50° E. for about another 460 feet. In the part of the tunnel accessible in 1954, a series of east-striking veinlets, dipping 60°-70° N., is cut at distances of 97, 220, 412, 462, 512, and 530 feet from the portal. All contain a little pyrite, but the veinlets at 462 and 530 feet also contain galena and sphalerite and have been drifted on for short distances.

The main Bellevue vein (strike N. 55° E., dip 70°-80° NW.) is intersected at 910 feet, and shows but little mineralization at this point (Bastin and Hill, 1917, p. 333). However, it has been stoped near the tunnel and drifted on for a distance of more than 700 feet to the west. Geologists of the Atomic Energy Comm. (K. E. Baker, L. E. Smith, and T. P. Anderson, written commun., 1951) stated that the vein "consists of from several inches to four feet of sheared and slightly brecciated wall rock with small amounts of vein-filling material of pyrite, quartz, carbonates, galena, sphalerite, and some pitchblende. In the Bellevue West drift, pitchblende occurs in a small stringer along the foot wall of the Bellevue vein for a distance of about seven feet." Two veins that parallel the Bellevue and dip 70° N. are intersected at 900 and 930 feet. Possibly these veins are splits from the main vein; both contain 1-2 inches of galena and sphalerite, and have been drifted on for short distances.

A vein known as the Giesicke (strike N. 70° E., dip about 70° NW.) is cut at 840 feet. Aside from a stope map prepared by P. P. Barbour (fig. 20), no information concerning this vein is available. The map shows that considerable stoping was done after Bastin's examination in 1911-12. Another vein (strike N. 40° E., dip 80° S.), reported by K. E. Baker, L. E. Smith, and T. P. Anderson (written commun., 1951) as being intersected about 1,460 feet from the portal, "consists of a three to five foot shear zone with pyrite, quartz, carbonates, galena, sphalerite, and pitchblende. Calcite, dolomite, siderite, [and] barite are also present. Pitchblende occurs as a sooty coating and earthy deposit along fractures in the vein." This vein has been drifted on for about 50 feet to the southwest.

The mineralogy of the Bellevue and nearby veins appears to be

Table 6.--Production of the Bellevue-Hudson group,[1] 1907-48

[---, no production figures reported]

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1907-------	1,000	(?)	256.38	-------	------	-------	-------
	2,360	--------	740.48	-------	------	152,000	-------
1908-------	156	--------	5.90	15,600	------	40,560	15,600
1909-------	238	--------	12.00	15,062	------	80,920	-------
1910-------	17	--------	.87	1,150	57	4,357	-------
1912-------	170	--------	20.83	4,678	275	65,909	37,857
1913-------	45	-------	2.41	4,212	------	20,425	-------
1914-------	[2] 215	--------	2.48	19,511	------	53,375	-------
1915-------	15	--------	.41	643	------	10,016	-------
1916-------	24	5	--------	459	------	4,641	-------
	121	--------	5.02	6,142	------	37,358	-------
1917-------	211	--------	10.01	9,165	------	64,281	-------
1918-------	49	15	.43	2,497	------	15,888	-------
	108	--------	18.80	6,069	350	25,026	-------
1919-------	54	18	116.90	1,503	2,966	8,051	-------

Table 6.--Production of the Bellevue-Hudson group,[1/] 1907-48--Continued

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1919-------	169	--------	5.10	15,505	------	46,318	42,419
1920-------	191	--------	4.62	11,518	------	47,787	41,997
1921-------	100	--------	2.09	4,333	------	20,232	17,793
1922-------	103	--------	3.24	6,120	------	18,392	19,754
1923-------	143	--------	3.17	8,255	------	36,414	24,572
1924-------	230	23	1.01	1,633	------	13,733	4,677
1925-------	1,000	28	.99	1,940	------	15,614	8,154
1926-------	200	20	.71	1,664	------	12,010	-------
1927-------	110	11	.22	166	------	2,810	1,013
	4	--------	.12	73	------	890	1,327
1934-------	47	2	1.88	152	172	165	574
1935-------	<1/2	--------	.05	41	8	370	125
1947-------	172	10	1.00	411	128	11,070	-------
	7	--------	--------	103	20	2,225	-------
1948-------	72	7	--------	98	------	4,412	4,546
Total----	<17,331 1/2	>139	1,217.12	138,703	3,976	815,249	220,408

1/ May include production from Crown Point, Crown Prince, and Prince Albert.
2/ Mainly from Annamosa level.

similar to that of other veins in the Lawson area. A sample from the Bellevue dump contained dark sphalerite, galena, quartz, pyrite, chalcopyrite, siderite, and a pink carbonate. The occurrence of pitchblende at a depth of about 800 feet (and of 1,000 feet in the Jo Reynolds and 600 feet in the Nabob) contrasts with the relatively shallow occurrence of pitchblende in the well-known Quartz Hill area of Central City.

Jo Reynolds mine

The Jo Reynolds mine, the most productive in the district, is on the northeast side of Columbian Mountain, near the abandoned mining camp of Silver Creek. The main workings consist of the Moore shaft (B-IV, 12), the Daily (B-IV, 14) and Elida (B-III, 60) tunnels, and the Main shaft (underground), which has 10 principal levels and connects the 2 tunnel levels. The workings chiefly develop four veins, known as the Jo Reynolds Nos. 1, 2, and 3, and the Cross veins. In addition, a crosscut driven from the Elida level cuts the American Sisters vein. The most extensive workings are on the Jo Reynolds No. 2 vein, but veins Nos. 1 and 3 were mined extensively in relatively shallow workings. All three veins were exposed on the Daily tunnel level; the outline of workings (fig. 21) on this level indicates that the No. 3 vein probably joins the No. 1 vein, which, in turn, is south of and subparallel to the main, or Jo Reynolds No. 2, vein. At the time of this survey (1954), the Elida level was being explored, but this was the only accessible part of the mine. Most of the upper workings are caved, and have been inaccessible for many years.

History and production

The Jo Reynolds claim was staked in 1865, but little mining was done before the completion of the railroad in 1877 (Bastin and Hill, 1917, p. 340). The earliest known production, as recorded by Burchard (1883, p. 429), was from the O'Conner[1/] level. Prior to 1883,

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1/ The O'Conner level is also referred to as the O'Connel (Burchard, 1884) and O'Connell (Burchard, 1885) level.

$200,000 worth of ore had been produced from a stope above the O'Conner level, and $140,000 worth from a stope below this level. In the following year, Burchard (1884, p. 262-263) identified the O'Conner level as being on the No. 3 vein, and 63 feet below the Daily level. Burchard also stated that the No. 3 vein was the best developed of the Nos. 1, 2, and 3 veins. The next recorded production is in mint reports for 1887-92 (Kimball, 1888-89; Leech, 1891-93), as follows:

Year	Gold (ounces)	Silver (ounces)	Lead (pounds)
1887-----	-----	135,490	-------
1888-----	91.7	128,312	190,533
1889-----	-----	-------	-------
1890-----	69.4	102,127	159,010
1891-----	44.8	82,900	133,402
1892-----	11.6	24,103	22,804
Total--	217.5	472,932	505,749

Callbreath (1899, p. 165) estimated the total production from the Jo Reynolds and allied claims at $1,500,000. Bastin and Hill (1917, p. 341) estimated total production to about 1908 at $1,462,500. From 1902 to 1949, Bureau of Mines production records (table 7) indicate that 36,330 tons of ore mined or taken from dumps contained 467.61 oz gold, 397,061 oz silver, 13,515 lb copper, 1,234,557 lb lead, and 921,273 lb zinc. Figures for copper and zinc are known to be low, as neither metal was reported for many years. The total value of production is estimated to be at least $2,000,000.

The Jo Reynolds mine has probably also produced some pitchblende ore. According to G. B. Guillotte (cited by Harrison and Leonard, 1952, p. 7), 8 tons of high-grade (72 percent U_3O_8) uranium ore was produced in 1919 and sold by R. B. Morton in France for $80,000. Although this production has not been thoroughly authenticated, it is considered probable; and it is also probable that the uranium ore came from the lower levels of the mine. According to E. B. Dingle (oral commun., 1954), the Jo Reynolds mine was examined for radioactivity by Mr. Morton with an electroscope. Some anomalous radioactivity occurs in the Jo Reynolds No. 2 vein on the Elida level, near the bottom of the Main shaft (Harrison and Leonard, 1952, pl. 2), and a thin stringer of pitchblende was penetrated in a subparallel vein that is about 125 feet northwest of the No. 2 vein in the American Sisters crosscut, on the Elida level. Pitchblende also was cut in a nearly horizontal hole drilled northwesterly from the Elida level during exploration in 1954 (A. R. Baldo, oral commun., 1954); this occurrence may have been in the American Sisters vein.

Geology of the Elida level

The wallrocks in the Elida tunnel, near the portal, are biotite gneiss and migmatite, but southwestward along the No. 2 vein, quartz diorite, biotite-muscovite granite, and an alaskitic type of the granite gneiss and pegmatite unit predominate. The ore bodies on this level are mostly in quartz diorite. A quartz bostonite dike is cut by the Elida tunnel 1,200 feet from the portal, and a biotite-quartz latite dike forms the wallrock for the Cross vein along part of its exposed length.

Table 7.--Production of the Jo Reynolds mine, 1902-49

[---, no production figures reported]

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1902-------	14	--------	0.80	786	------	1,680	-------
1903-------	467	--------	47.90	29,804	------	96,793	-------
1904-------	808	--------	72.45	44,439	------	99,672	-------
1905-------	5,264	297	33.19	34,361	------	66,500	162,079
1906-------	665	--------	37.54	31,258	------	72,118	127,574
1907-------	6,608	414	19.30	24,291	------	62,740	111,419
	267	--------	19.01	20,345	------	38,843	75,950
1908-------	5	--------	.21	565	------	827	-------
1910-------	1	--------	.03	108	------	232	-------
1913-------	3	--------	.08	270	------	330	332
1914-------	(?)	4	------	78	------	1,000	-------
	66	--------	1.71	3,348	------	10,194	9,120
1916-------	10	--------	.34	870	------	2,150	-------
1917-------	26	--------	1.46	2,674	------	6,256	-------

Table 7.--Production of the Jo Reynolds mine, 1902-49--Continued

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1918-------	126	21	8.04	15,305	51	30,105	-------
1919-------	67	--------	3.39	6,499	------	12,689	17,786
1920-------	48	--------	1.27	5,596	68	9,341	18,086
1921-------	1/ 4,055	206	14.49	13,529	------	66,143	-------
1922-------	103	--------	4.49	5,214	357	29,424	30,900
1923-------	276	55	6.41	9,336	35	16,962	-------
1924-------	1/ 288	28	2.90	1,373	------	8,769	10,733
1926-------	395	23	22.34	27,787	478	167,734	18,720
1927-------	151	30	3.25	3,194	------	13,380	12,620
1928-------	37	--------	.16	3,458	------	5,926	11,087
1929-------	34	--------	.53	4,605	------	6,930	16,964
1940-------	89	13	2.00	860	------	2,338	-------
1941-------	25	--------	1.62	965	111	3,048	-------
1942-------	26	--------	2.70	455	261	12,461	-------
	3,485	80	24.00	8,122	385	26,483	20,638
1943-------	2/ 2,747	173	33.00	18,779	1,517	60,427	3,580

Table 7.--Production of the Jo Reynolds mine, 1902-49--Continued

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1944-------	50	5	1.00	395	90	1,447	-------
1945-------	2/ 3,746	108	13.00	11,559	907	35,901	38,880
/	433	128	11.00	2,270	1,099	58,931	64,861
1946-------	1,200	87	9.00	11,757	1,356	48,877	33,966
1947-------	4,158	258	60.00	50,924	5,993	151,986	113,815
	8	--------	------	149	41	254	7,055
1948-------	450	18	3.00	1,520	255	4,836	14,906
1949-------	129	6	6.00	213	511	830	202
Total----	>36,330	1,954	467.61	397,061	13,515	1,234,557	921,273

1/ Some from American Sisters(?) vein.

2/ Daily(?) level dump.

Several veins are exposed on the Elida level (fig. 22). The tunnel crosscuts west-southwest for about 200 feet, where it intersects the DeCaprivi vein (see inset, fig. 26), which was worked in drifts, now caved, north of the tunnel. About 260 feet from the portal, the tunnel intersects the Merry May vein, and it follows this vein, which is generally tight and poorly mineralized, southwestward for about 1,750 feet, where the Merry May joins the Jo Reynolds No. 2 vein. The exact relations at this vein juncture are not clear, but the Jo Reynolds No. 2 vein probably displaces the Merry May vein; possibly the southwestern part of the Merry May vein is the so-called Elida vein. The main Elida level drift then follows the Jo Reynolds No. 2 west-southwestward for about 1,800 feet to a junction with the Cross vein. The Cross and Jo Reynolds No. 2 veins are also joined by connecting subsidiary veins that leave the Jo Reynolds vein near the bottom of the Main shaft. A long northwest-trending crosscut that starts about 150 feet northeast of the winze cuts several small veins, and at the face intersects the American Sisters vein.

The Jo Reynolds No. 2 vein has an average strike of about N. 65° E. and dips steeply to the northwest. Both on the surface and on the tunnel level, it is exposed for a strike length of nearly 1,800 feet. Northeast of the American Sisters crosscut, the vein is weakly mineralized, and generally consists of 1-6 inches of crushed rock, gouge, and quartz, and some sulfides. Southwest of the crosscut, the vein is from 6 inches to 2 1/2 feet wide, and contains veinlets of galena, sphalerite, chalcopyrite, quartz, and carbonate, and some tennantite. At the southwest side of the winze, the vein is 2 1/2 feet wide, and contains about 1 foot of intergrown sphalerite, galena, and some chalcopyrite. In the winze, the vein splits; one branch contains some galena and sphalerite, and the other is a poorly mineralized south-dipping vein. To the southwest, the No. 2 vein terminates against the Cross vein, which strikes about N. 50° W. and dips about 70° NE. No extension of the No. 2 vein beyond the Cross vein has been found, and the authors believe that the two vein fissures probably formed at about the same time. The Cross vein is also mineralized, and has been overhand stoped from the tunnel level; in a raise driven in 1954 (not shown on map, fig. 22), the Cross vein contained as much as 1 foot of intergrown sphalerite, galena, and chalcopyrite cut by thin veinlets of ruby silver. A polished section of the sulfide-rich vein material showed some pregalena argentite and polybasite-pearceite. One of the subsidiary fissures linking the Jo Reynolds No. 2 and Cross veins is also well mineralized, and as much as 1 foot of argentiferous resin sphalerite containing some galena and pyrite is left in places on the walls.

Ore shoots

The main ore shoot in the mine is on the No. 2 vein. According to a longitudinal section prepared by R. B. Morton in 1905 (inset, fig. 21), it extends from the surface to the Elida tunnel level--a vertical distance of 900 feet. Its northeast limit is roughly a line from the Moore

shaft at the surface to the winze on the Elida level, giving it an approximate plunge of 70° NE. The ore shoot has an average strike length of at least 400 feet. The control for this ore shoot has not been established. Strike-slip movement on the fault does not appear likely, as the apparent strike slip on the vein would tend to close the parts of the vein that are well mineralized, and the long vertical extent of the shoot does not seem to fit well with an origin by dip-slip movement. The vein is strongest in the parts where one or both walls are composed of quartz diorite, and since quartz diorite also crops out near the surface workings, the ore shoot possibly is related to the type of wallrock.

Another ore shoot, or shoots, may have been controlled by the junction of the Jo Reynolds No. 2 vein and the Cross vein, since ore bodies were found on both, near their intersection. Much of the ore mined in 1947 came from the vein linking the Jo Reynolds and Cross veins; it is not known whether this vein has been explored from the level below the Elida. Where it leaves the Jo Reynolds No. 2, near the shaft, the linking vein is small and poorly mineralized, and could easily be missed. If the American Sisters vein and the Cross vein intersect, there might be similar linking vein fissures near their juncture.

Some ore rich in zinc may have been passed by in the past and be of workable grade at the present time. Assays of sphalerite-rich samples collected by the authors and by Bastin and Hill (1917, p. 340) indicate that the sphalerite is locally an important carrier of silver. Bastin and Hill found that a sample of sphalerite that contained a little galena from the American Sisters vein carried 79.20 oz silver per ton. The authors separated concentrates of resin and dark sphalerite from the Jo Reynolds mine, and found that the sample of resin sphalerite carried 63.36 oz silver per ton, but that the dark sphalerite carried less than 1 oz per ton. This may be an exceptional sample, but if the resin sphalerite is a carrier of silver, then areas in the mine at depth that contain high amounts of resin sphalerite may have correspondingly high silver values.

Murry vein

The Murry vein and its probable extension, the East Murray vein, are on the south side of Clear Creek, opposite Lawson. The Murry is developed by two shafts, the Murry (B-III, 55) and the Yankee, by the Princess of India tunnel (B-III, 54), and probably by the Hamilton shaft (B-III, 57) and a short (East Murray) crosscut (B-III, 58), 1,300 and 1,800 feet east-northeast of the Murry shaft, respectively. At present (1960), the vein is accessible only in the Princess of India tunnel (fig. 24) and in the East Murray crosscut; it is believed to have been worked mainly through the Murry and Yankee shafts. Callbreath (1899, p. 184) stated that the mine had two shafts, one (the Murry(?)) 360 feet deep, and the other (the Yankee(?)) 150 feet deep, as well as 1,000 feet of drifts. Bastin and Hill (1917, p. 338) reported the main shaft to be 275 feet

deep, with levels at 80, 170, and 265 feet that were 580, 550, and 257 feet long, respectively.

The value of ore produced from the mine to 1899 was estimated by Callbreath (1899, p. 184) to be $140,000. Bureau of Mines production records (table 8) show that a total of 186 tons of ore produced since 1900 contained 102.09 oz gold, 11,190 oz silver, 1,727 lb copper, 14,661 lb lead, and 2,067 lb zinc. The value of all production is estimated to be about $160,000.

The Murry vein strikes about N. 85° E., and dips from 80° N. to vertical. Where exposed in the Princess of India tunnel, the vein consists of 6 inches to 2 feet of crushed rock and gouge containing quartz, fine-grained pyrite, chalcopyrite, chalcocite(?), limonite, and secondary copper minerals. In the East Murray crosscut, 2,000 feet to the east, the vein contains 3-5 inches of copper-stained crushed rock and gouge that includes fine-grained pyrite and galena. Bastin and Hill (1917, p. 338) stated that in the Murry shaft "ore from the upper workings was richest, and that from the 265-foot level is reported to be low grade." They further indicated that the oxidized surface ore contained limonite, copper carbonates, cerussite, and, exceptionally, polybasite, and that the value of the ore was due largely to silver content, although lead ran as much as 45 percent and copper as much as 7 percent.

The Murry vein cuts bodies of biotite gneiss and biotite-muscovite granite; the East Murray is largely in sillimanitic biotite-quartz gneiss. A quartz monzonite porphyry dike forms the south wall of the vein throughout much of its length.

Nabob mine

The Nabob vein (B-IV, 18) is exposed west of the valley of Silver Creek, about 1 mile south of Lawson. It is developed by three drift adits at elevations of 9,480, 9,635, and 9,905 feet (fig. 23). The three adits, referred to as the lower, middle, and upper in this report, are 1,300, about 1,200, and an estimated 600 feet long, respectively. In 1954 the lower adit was accessible to the face, the middle adit to within about 200 feet of the face, and the upper adit was caved at the portal. A stoped area, 80-150 feet in horizontal length, connects the lower and middle adits (fig. 23) and probably continues upward, to or above the upper adit level.

Data on the history and production of the Nabob mine are sparse. The mine was worked in the 1880's, and a report by the Director of the Mint (Kimball, 1889) states that in 1888 production from the Nabob mine was 1,500 oz silver and 1,375 lb lead. The mine was reopened in 1949, and ore was shipped during the years 1949-54. Bureau of Mines records show that 3,545 tons of ore shipped from 1949 through 1952 contained 147 oz gold, 79,974 oz silver, 18,573 lb copper, and 286,314 lb lead.

Table 8.--Production of the Murry mine, 1901-36

[---, no production figures reported]

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1901--------	30	--------	90	9,300	------	------	-----
1910--------	1	--------	.05	11	------	110	-----
1916--------	3	--------	.24	92	86	743	-----
1917--------	42	--------	4.65	621	1,019	6,590	-----
1918--------	17	--------	2.24	562	256	3,105	-----
1919--------	1	--------	.23	24	36	153	39
1930--------	5	--------	1.63	244	291	868	1,151
1934--------	2	--------	.84	44	------	217	375
1935--------	2	--------	.22	59	------	537	121
1936--------	83	5	1.99	233	39	2,338	381
Total-----	186	5	102.09	11,190	1,727	14,661	2,067

The Nabob vein strikes about N. 80° E., and is nearly vertical. It generally consists of 6-8 inches of crushed rock and gouge that contains gray quartz and pink carbonate. The principal ore mineral is argentiferous galena, which occurs mostly in the main ore shoot. In many places the vein splits into two parallel branches that rejoin within a short distance. On the middle adit level, these splits have been followed in three places for short distances by side drifts, but generally both splits are within the boundaries of the drift. Where splits occur, the vein generally consists of 2-6 inches of crushed rock and gouge in both splits, the area between containing highly altered and fractured country rock that in places is weakly mineralized with sulfides. Except for the stoped areas, the sulfide content of the Nabob vein is low. In the lower adit, 1,200 feet from the portal, the vein widens to 3-4 feet, and consists of crushed rock and gouge interlaced with sulfide veinlets. In places, the sulfide veinlets covered the full width of the drift, and the vein was mined over a drift width.

Minerals identified are galena, dark sphalerite, pyrargyrite, tennantite, freibergite(?), and argentite(?). Gangue consists mostly of quartz, containing some pink carbonates (dolomite(?) and ankerite(?)). Galena is by far the most abundant ore mineral, and occurs both in fine-grained aggregates with the silver minerals and as medium-grained crystals.

Pitchblende occurs in a thin vein (strike N. 50° W., dip 75° NE.) 1,040 feet from the portal of the lower adit.

The ore shipped in 1949-52 averaged 0.04 oz gold, 22.5 oz silver, 0.26 percent copper, and 4.0 percent lead. Zinc was not reported, but in the Nabob vein it is probably somewhat less than half as abundant as lead. As this ore came from a depth of 600-700 feet, it probably had not undergone appreciable supergene enrichment.

The control of the ore along the Nabob vein is not known. The vein varies but little in both strike and dip throughout the exposed part, and no unusual variation in either is noted in the main ore zone. The wallrock in the ore zone is biotite-muscovite granite, which is probably more favorable than biotite gneiss for localization of ore. However, because at least half the exposed part of the vein is in biotite-muscovite granite and the ore occurs in less than 10 percent of the exposed vein, the type of wallrock is a rather vague control at best. Vein junctions may have had some influence on ore localization, but the vein branches and rejoins throughout its length, and most of the junctions have no effect on ore.

Princess of India group

The Princess of India group of mines consists of the Aubrey, Columbian Chief (B-III, 61), Franklin County, and Platts mines (or veins), and is developed by the Princess of India tunnel (B-III, 54) (fig. 24), the Platts adit (B-III, 62) (fig. 25), and other workings that are now inaccessible. One of these, the Franklin County shaft, is reported to be 185 feet deep and to have 350 feet of drift levels (Callbreath, 1899, p. 151). All the veins except the Franklin County are on old patented claims, and all except the Aubrey, which was worked from the Murry shaft, were originally mined from separate shallow mine workings. Production records for the group are incomplete, but the total value of production probably exceeded $100,000. Records of the Bureau of Mines for a period between 1910 and 1935 show that 2,094.5 tons of ore, largely from the Princess of India tunnel and the Platts adit, contained about 153 oz gold, 40,888 oz silver, 7,088 lb copper, 236,163 lb lead, and 107,820 lb zinc (table 9). The mines were idle from 1935 to 1955, when the Princess of India was reopened and further crosscutting started. Callbreath (1899, p. 151) estimated that the Franklin County produced $6,000 worth of ore prior to 1899.

Wallrocks exposed in the Princess of India tunnel and in the Platts adit are biotite gneiss, quartz diorite, and biotite-muscovite granite, all of Precambrian age, and quartz monzonite porphyry and quartz bostonite of Tertiary age. Biotite gneiss, the predominant wallrock, strikes northwest and dips northeast. The biotite-muscovite granite is exposed only in the Platts adit, and is part of a generally discordant body. The quartz bostonite, exposed in both the tunnel and the adit, forms a dike as much as 50 feet wide that strikes northwest and dips steeply northeast. The dike is well exposed on surface, and can be traced southeastward for about 1,500 feet from the tunnel. The quartz monzonite porphyry forms a steeply dipping dike that strikes generally east, parallel to the Murry vein. The dikes appear to join in the Princess of India tunnel, and possibly continue northwestward as a composite dike.

The Princess of India tunnel (fig. 24), at an altitude of 8,160 feet, trends about S. 22° E. for 730 feet, and within this distance intersects all the veins of the group as well as the Murry vein which is discussed elsewhere. Laterals are driven on the Murry vein, intersected 130 feet from the portal, and on the Franklin County, Columbian Chief, and Platts veins--a complex series of veins intersected at about 200 feet. Six other veins are intersected between the Platts vein and the face of the tunnel. Any or all of the last three of these six veins could be the Aubrey.

The Franklin County vein, which strikes about N. 72° E., the Columbian Chief vein, which strikes N. 65° W., and the Platts vein, which strikes about N. 55° W., join immediately east of the tunnel (fig. 24). The main vein, northwest of the junction, where exposed along the tunnel contains as much as 4 inches of sphalerite in 1 foot of crushed rock and

Table 9.--Production of the Princess of India group, 1910-35

[---, no production recorded. Data from U.S. Bureau Mines, 1910-35]

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1910--------	28.0	4	3.48	127	------	1,494	-------
	13.0	--------	1.82	442	------	6,845	-------
1911--------	48.0	--------	3.34	2,607	180	9,573	5,503
1912--------	164.0	--------	9.80	10,310	377	37,592	21,940
1913--------	43.0	--------	3.83	3,317	95	11,504	8,573
1914--------	32.0	--------	3.03	2,069	------	9,614	6,768
1915--------	10.0	--------	.65	281	------	3,389	2,100
1916--------	1/ 67.0	14	9.87	3	------	-------	-------
	6.0	--------	1.13	110	170	2,771	-------
1917--------	2/ 59.0	--------	12.69	1,938	------	11,824	591
1918--------	90.0	--------	8.57	1,848	488	21,068	-------
1920--------	3/ 5.0	--------	.36	129	------	1,030	375
	4/ 2.0	--------	.37	179	50	252	-------
1921--------	17.0	--------	4.12	680	43	3,793	-------

Table 9.--Production of the Princess of India group, 1910-35--Continued

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1922--------	23.0	--------	1.94	985	156	5,793	2,441
1923--------	200.0	28	2.87	1,048	179	4,870	4,112
	10.0	--------	.80	525	56	1,598	-------
1924--------	4.0	--------	.22	184	------	2,147	344
1925--------	24.0	4	2.19	223	187	963	653
	6.0	--------	1.29	656	247	759	664
1926--------	25.0	5	1.10	300	220	1,060	-------
	3.0	--------	.36	149	------	-------	-------
1928--------	45.0	5	.65	277	159	1,470	620
	5.0	--------	.36	135	135	1,702	379
1929--------	50.0	10	1.84	433	------	4,431	1,452
1930--------	50.0	5	1.58	260	274	1,842	1,489
	21.0	--------	7.52	216	------	1,789	310
1932--------	14.0	--------	2.16	270	------	5,422	-------
1933--------	8.0	--------	.73	236	------	-------	-------

Table 9.--Production of the Princess of India group, 1910-35--Continued

Year	Crude ore	Concentrates	Gold	Silver	Copper	Lead	Zinc
	(tons)		(ounces)		(pounds)		
1934--------	929.0	138	55.19	9,051	3,680	62,169	41,801
	48.0	--------	5.29	1,185	384	16,360	6,602
1935--------	45.5	--------	3.89	715	8	3,039	1,103
Total-----	2,094.5	213	153.04	40,888	7,088	236,163	107,820

1/ Columbian Chief.

2/ Part from Columbian Chief.

3/ Platts.

4/ Princess of India.

gouge; a footwall vein contains from 1/2 to 4 inches of quartz, pyrite, chalcopyrite, galena, sphalerite, tennantite, and polybasite(?) in a foot of crushed rock.

As exposed in a drift accessible for 230 feet, the Franklin County vein is weakly mineralized and has not been stoped. It typically consists of about 6 inches of crushed rock that contains small amounts of quartz, fine-grained pyrite, chalcopyrite, chalcocite(?), and a pink carbonate. The Columbian Chief vein, visible for about 70 feet from the vein juncture, is stronger and contains more sulfides. It is 12-15 inches wide and contains about 6-8 inches of sulfides, principally dark sphalerite, and carbonates.

The drift on the main vein of the group, the Platts vein, is caved just southeast of its intersection with the Columbian Chief, but the vein has been described by Bastin and Hill (1917, p. 337): "The Platts vein strikes N. 60° W. and dips on an average 70° NE. It varies from a tight fracture to 14 inches in width * * * [and] consists of crushed altered country rock, in places barren but elsewhere carrying disseminated sulphides and cut by veinlets of dark-gray quartz and barite in which there are elongate masses of sulphides up to two inches in width. Galena and sphalerite are the most abundant primary sulphides, though pyrite is present in all the ore and occasionally a little chalcopyrite is seen."

Six veins are cut in the inner part of the tunnel; any or all of the last three could be the Aubrey vein. A vein intersected 40 feet from the change in course of the tunnel strikes N. 80° W., dips 70° NE., and contains 4-6 inches of quartz and pyrite and traces of dark sulfides. At 58 feet, a 4-inch to 1-foot vein striking N. 85° E. and dipping 54° N. is but weakly mineralized. The vein at 315 feet strikes N. 60° W. and dips 70°-80° NE.; the only evidence of mineralization was some copper stain in the 1 inch of gouge that comprises the vein. The last three veins range in strike from N. 65° W. to N. 80° W. and in dip from 53° to 80° NE. They probably represent the north, middle, and south splits from a single vein, as they appear to come together toward the east. Two of the splits have been followed for short distances by drifts. The north split consists of 1 foot of crushed rock, gouge, quartz, pyrite, and gray copper having recent(?) calcium sulfate and copper stain. The middle and south splits contain pockets of sulfides 3-4 inches wide that are formed in the steep parts of the vein. The sulfides are mostly galena and sphalerite, and occur either in small aggregate bodies or in gash veins that cut across the vein with a nearly vertical or steep reverse dip. Elsewhere the middle and south splits contain 2-3 inches of crushed rock and gouge including veinlets of late carbonate.

Workings of the Platts adit (fig. 25), at an altitude of 8,408 feet, are on the Platts vein, the John D. Long(?) vein, and two unnamed veins. The adit crosscuts about south for 50 feet to the

Platts vein, which it follows southeastward for at least 250 feet. The Platts vein is nearly straight (N. 55° W.), and dips on an average 65° NE. (fig. 25). It varies in width from 4 to 18 inches, and is composed of crushed rock, quartz, and sulfides. The sulfides--pyrite, galena, and, particularly, dark sphalerite--are more abundant near the stoped area in the southeastern part of the drift, and in this area are, with quartz, chiefly in the hanging-wall part of the vein.

The other three veins in the Platts adit are practically unmineralized. The John D. Long(?) vein (strike N. 58° E., dip about 60° NW.) crosses the Platts vein with no displacement. It consists of 1-2 inches of quartz and gouge. The unnamed cross vein, similar in attitude, offsets the Platts vein by about 1 foot--the northwest side moving northeastward; it is nearly barren.

Other mines

Climax tunnel

The portal of the Climax tunnel (B-III, 59) is at the mouth of Silver Creek, at an altitude of 8,183 feet. The tunnel trends irregularly about S. 35° W. for 1,200 feet to the DeCaprivi and Merry May veins (fig. 26). Both veins have been drifted on for 350-400 feet at the Climax tunnel level, and both veins also are exposed in the Elida tunnel of the Jo Reynolds mine. These veins were worked but little at the surface, although a caved adit estimated to be 200 feet long has about the correct position and trend to be on the Merry May vein.

Total production from the Climax tunnel from 1913 to 1955 was 352 tons of ore, containing 14.48 oz gold, 3,598 oz silver, 73 lb copper, 14,393 lb lead, and 8,229 lb zinc. These figures are believed to represent nearly the complete production. The DeCaprivi vein was not cut by the Climax tunnel until 1924, and all but 1 ton of the ore was produced subsequent to that date. The DeCaprivi vein also was worked from the Elida tunnel, about 260 feet vertically above the Climax tunnel, but any ore produced is included in figures for the Jo Reynolds mine.

The Climax tunnel follows for 1,000 feet an almost unmineralized shear that contains 1-12 inches of gouge, crushed rock, and some carbonate. Apparent displacement of a small body of biotite-muscovite granite that cuts the dominant biotite gneiss wallrock, and of a northwest-trending vein, indicates a right-lateral strike slip of about 10 feet along the shear.

At 530 feet from the portal, a vein (strike N. 50° W., dip 53° NE.) that contains 6 inches of gouge, crushed rock, and a trace of sphalerite and galena is cut and displaced by the shear. This vein has been followed 290 feet southeastward to the Merry May vein.

At 1,200 feet the tunnel intersects the DeCaprivi vein (average strike N. 75° E., dip 56° NW.). The vein, which has been followed by a drift for 400 feet, consists of 2-6 inches of gouge, crushed rock, quartz, and pink carbonate, and some sphalerite and galena in places. A manway and ore chute near its junction with the Merry May vein apparently marks the place from which small production came between 1927 and 1936 (see below). Two hundred thirty feet east of the crosscut the DeCaprivi vein joins, or is cut off by, the nearly straight Merry May vein (strike N. 40° E., dip 75° NW.) (fig. 38). The Merry May vein is but weakly mineralized throughout its 360 feet of exposed length. The vein generally contains from 1 to 6 inches of crushed rock and gouge, including small amounts of quartz, carbonate, and, in places, sphalerite. A 15- to 18-foot raise on the Merry May vein and two similar raises on the DeCaprivi vein are believed to have served the purpose of exploring wide places in the veins, and are not believed to have produced any ore. The sparsity of pyrite is a rather unusual feature of both veins.

Cymric tunnel

The Cymric tunnel (B-IV, 3) is on the east bank of Silver Creek, at an altitude of about 8,600 feet. The tunnel was inaccessible in 1954, and the data below are taken from Bastin and Hill (1917, p. 338).

The Cymric tunnel is a crosscut driven S. 11° E. for about 1,265 feet; it intersects the Cymric vein about 1,155 feet from the portal, and a lateral has been driven westward on the vein for 495 feet. The wallrock is "granite gneiss and schist" (probably microcline gneiss and biotite gneiss) except near the face of the crosscut, where a "45-foot dike of porphyry, probably bostonite, nearly free from dark-colored minerals, strikes a few degrees north of east and dips 55° N."

The Cymric vein strikes east-west and dips 35°-60° N. The vein generally is weakly mineralized except in two small stoped areas, where irregular stringers and bunches of fine-grained galena and some sphalerite occur in crushed rock and in gray-brown cherty silica.

The Big Horn fracture, which strikes N. 53° W. and dips 40° NE., joins the Cymric vein 395 feet west of the main tunnel and has been followed by a drift for 130 feet; ore minerals are limited to the last 5 feet of the drift, where 3 inches of fine-grained galena occurs in a 7-inch vein of cherty silica.

The production of the mine has been small. Bureau of Mines records show that 2 tons of ore produced in 1912 contained 705 oz silver and 1,000 lb lead.

Drummond mine

The Drummond mine (B-III, 65) is on the south side of Clear Creek about 800 feet west of Lawson, at an altitude of 8,785 feet. Workings consist of an adit that crosscuts for 130 feet, then follows the Drummond vein S. 50° E. for 310 feet, where it is caved (fig. 27). There is a water-filled winze 320 feet from the portal. The vein has been stoped, but extensive timbering prevents accurate determination of the amount of stoping. No production is recorded.

The Drummond vein strikes N. 50° E. and dips 55°-60° NW. The vein is strong, consisting generally of distinct footwall and hanging-wall fractures separated by 1-2 1/2 feet of crushed rock which locally contains sulfides. The footwall fracture generally consists of 2-3 inches of gouge, but the hanging-wall fracture generally consists of 3-6 inches of quartz, carbonate, dark to resin sphalerite, galena, and sparse pyrite, all frozen to the wall. The vein is stronger and better mineralized in the southwestern part of the mine. Wallrock is dominantly quartz diorite to 220 feet, then, after an amphibolite layer, granite gneiss and pegmatite including sparse biotite gneiss layers to the caved portion of the mine.

Kohinoor mine

The Kohinoor mine is on the northwest side of Columbian Mountain. The exact location is not known, but it is believed to be near the western edge of the mapped area, a few hundred feet south of the Bellevue vein, at an altitude of about 9,200 feet. The mine was worked during the late 1870's and early 1880's, and apparently some rich ore was produced in this period. It has been idle for so long that no data were available from local sources. The data came from the sources indicated.

[Sources: *Calbreath, 1899, p. 166; **Corregan and Lingane, 1883, p. 147-148; ***Eng. and Mining Jour., Feb. 28, 1880, p. 153; ****Eng. and Mining Jour., Apr. 24, 1880, p. 289. Mine is also mentioned in Burchard (1884, p. 262; 1885, p. 194)]

Workings:
*Adit 300 feet long, 500 feet of levels; **adit 300 feet long, 250-foot shaft; ***adit 300 feet long, nearly vertical shaft 200 feet deep.

Mineralogy and metal content:
*Silver; **gray copper, native and brittle silver, ore worth $500 to $3,000 per ton; ***sulphurets and copper carbonates; ****four inches of fine galena and sulphurets, first-class ore mills 1,300 ounces silver per ton.

Production:
$100,000; *$50,000.

Millington mine

The Millington mine is on the north slope of Columbian Mountain, about three quarters of a mile southwest of Lawson. Four main adits, at altitudes of 9,187, 9,425, 9,510, and 9,625 feet, develop the vein, and will be referred to as No. 1 to No. 4, in order of increasing altitude (B-IV, 4, 5; A-IV, 6, 7). At the time of this survey (1954), only adit No. 3 was accessible, but, owing to its location, was not examined. The following information is taken from the report by Bastin and Hill (1917, p. 339), who examined adits Nos. 1 and 2.

The Millington vein strikes about N. 45° E., and is nearly vertical. In places, the vein consists of a single fissure 5 inches-4 feet wide, but where the vein splits into several branches the width may be greater. Most of the vein contains crushed rock and gouge, and is only weakly mineralized. The ore is reported to occur in pockets, and, although erratically distributed, is of high grade. One small lot shipped in 1899 contained more than 1,000 oz silver per ton. Galena, sphalerite, pyrite, limonite, and azurite have been identified in samples from the dump and ore bin. Much of the ore is oxidized.

A cross vein, known as the Silver Treasure (A-IV, 5), is cut in adit No. 2 about 190 feet from the portal. The Silver Treasure vein strikes N. 70° W. and dips 60°-70° NE. The ore in this vein is also oxidized, and consists of quartz, fine-grained galena, native silver, and cerargyrite.

Most of the values in the ore were from the silver content, although some ore contained as much as 17 percent lead. The gold content is generally less than 0.1 oz per ton.

Gross production of the mine to about 1912 was reported to be $50,000 (Bastin and Hill, 1917, p. 339). Bureau of Mines production records (table 10) show that since 1907, 500 tons of ore has been shipped, and that it contained 62.16 oz gold, 14,742 oz silver, 97 lb copper, 11,161 lb lead, and 3,265 lb zinc. About 500 tons of ore was produced in the period 1907-34 (table 10).

Peabody (Robineau) prospect

The Peabody, or Robineau, prospect shaft (A-IV, 8) is on the ridge at the southwest edge of the mapped area (fig. 2), at an altitude of 10,570 feet. The shaft, reportedly about 40 feet deep (King and Granger, 1952), was accessible to a depth of about 20 feet in 1954. Exposure of the vein was poor. According to reports from the district (Ragner Johnson, oral commun., 1955), more recent work includes the cleaning out of the shaft and the driving of an adit to cut the vein at depth.

The Peabody(?) vein strikes about N. 75° E. and dips 65° NW., and is about 1 foot wide. It consists of sheared rock with cherty silica,

Table 10.--Production of the Millington mine, 1907-34

[---, no production recorded]

Year	Crude ore	Concentrates	Gold	Silver	Copper	Lead	Zinc
	(tons)		(ounces)			(pounds)	
1907-----	8	--------	4.01	541	------	434	------
1908-----	7	--------	.77	473	------	435	------
1910-----	9	--------	.77	109	------	------	------
1911-----	29	--------	3.73	1,790	14	636	------
1912-----	21	--------	34.80	1,077	------	1,940	------
1913-----	10	--------	.86	2,446	------	1,046	------
1914-----	4	--------	-------	75	------	344	------
1920-----	5	--------	.21	77	------	692	------
1921-----	1	--------	.10	48	------	200	------
1922-----	37	--------	2.41	1,308	45	2,842	1,102
1923-----	8	--------	.82	281	------	627	207
1924-----	2	--------	.25	132	------	189	41
1926-----	1/ 10	1	.33	93	------	388	------
1927-----	1	--------	.05	34	------	98	21
1934-----	348	--------	13.05	6,258	38	1,290	1,894
Total--	500	1	62.16	14,742	97	11,161	3,265

1/ Estimate.

limonite, torbernite, and dumontite, and in less oxidized samples, pitchblende. The torbernite forms thin coatings along fracture surfaces; the dumontite occurs in 1/4- to 1/2-inch layers along the vein.

The country rock in the vicinity of the shaft is biotite-muscovite granite.

There is no known production from the property.

Tom Moore mine

The Tom Moore mine is on Columbian Mountain half a mile south of Lawson, at an altitude of about 9,000 feet. The workings (fig. 28) consist of a shaft on the Tom Moore vein and a crosscut and drift adit (B-IV, 1) which develop two main veins. The No. 1 vein, intersected 120 feet south-southeast of the portal, is followed eastward for a distance of 300 feet by a drift; it is entirely in quartz diorite. About midway along the drift a crosscut trends nearly north for 110 feet to the No. 2 vein. The No. 2 vein is followed eastward for an estimated 300 feet by a drift in biotite-muscovite granite, but an open winze prevented examination of more than 150 feet of this vein. A winze on the No. 1 vein near the crosscut that connects the drifts is reported to be 125-150 feet deep (Charles Johnson, oral commun., 1954). East of the shaft, the vein has been stoped for about 70 feet, and Mr. Johnson reported that there had been some mining from the shaft. Callbreath (1899, p. 210) gave total production for the Tom Moore mine as $30,000. Bureau of Mines records show that since 1902 a total of 172 tons of ore has been produced, and that it contained 6.2 oz gold, 1,552 oz silver, 112 lb copper, 29,000 lb lead, and 13,441 lb zinc. Much of the recent production probably came from the winze or underground shaft on the No. 1 vein.

Watt Stemble mine

The portal of the Watt Stemble adit (B-IV, 17) is on the east bank of Silver Creek, at an elevation of about 9,250 feet. The adit crosscuts S. 78° E. for 490 feet, and thence about S. 25° E. for an additional 75 feet to the main vein (fig. 29). Minor veins are cut at 70, 210, 225, 260, and 318 feet from the portal. The veins at 70, 210, and 318 feet have been followed short distances by drifts, but no stoping has been done except on the main vein, the Watt Stemble. The wallrock is largely biotite gneiss and biotite-muscovite granite.

The mine was operated for a short time in 1952 when 6 tons of ore that contained 13 oz silver, 251 lb lead, and 739 lb zinc was shipped. No ore was produced from 1939 to 1951; production prior to 1939 is not known, but is believed to have been small.

The main vein is a lode zone at least 10 feet wide that strikes about N. 46° E. It is nearly vertical, as indicated by the attitude of small stopes; the precise determination of dip is prevented by lack of

well-defined walls, and limited exposures. The zone has been followed for more than 100 feet in two subparallel drifts. It consists of a wide weakly mineralized breccia and gouge zone and small subparallel veins. Sulfides, mostly galena and sphalerite, occur as broken irregular masses as much as 1 foot across in the central portion of the brecciated part of the vein.

Projected upward at a dip of 84° NE., the vein coincides with a vein of similar strike exposed in a shallow shaft about 250 feet above.

Other mines or prospects--tabular summary

Data on other mines or prospects south of Clear Creek in the Lawson area are summarized in table 11. Workings of several of these mines are extensive, but they are now completely inaccessible; locations of other mines are uncertain or unknown.

Dumont area, north of Clear Creek

Larger mines

Albro mine

The Albro mine, half a mile northeast of Dumont, has been the leading producer of gold and copper ores in the district. It is on the Albro vein and is opened by a series of shafts and adits on five claims that are, from west to east, the Veta Madre de Zacatecas, the Albro (patent 155), the Albro (patent 119), the Veta Grande, and the Monitor. From west to east, the workings are (1) caved shafts (D-III, 11, 12) and stopes on the Veta Madre de Zacatecas claim; (2) upper west Albro adit (D-III, 13) (Albro 119 claim); (3) lower west Albro adit (D-III, 14) (Veta Grande claim) which follows the vein northwesterly and is accessible for about 600 feet; (4) the caved Albro crosscut (D-III, 16) to the first level of the Albro shaft; (5) the Albro or Veta Grande shaft (D-III, 15), at an altitude of about 8,270 feet and having about 1,600 feet of accessible workings on three levels (fig. 30); (6) the East Albro shaft (E-III, 14) and short connecting drift adit (Veta Grande claim); (7) the Monitor shaft (E-III, 15) and short connecting drift adit (Monitor claim), and (8) a shallow shaft about 250 feet east of the Monitor shaft. The Hiawatha and Specht tunnels (fig. 31) intersect the Albro vein at depth, and a raise from a drift on the Hiawatha tunnel level connects with the Albro shaft.

The Albro vein was discovered in 1859. The oxidized ores of the Albro and other nearby mines were carried downhill in sacks and milled in five arrastras on Clear Creek, between Dumont and the Specht tunnel. Most of the early production probably came from surface stopes on what is now the Veta Madre de Zacatecas claim. The mine was closed, probably when unoxidized ore was reached, and was reopened in 1881 (Burchard, 1882, p. 373). In 1882, Burchard (1883, p. 429) reported that 45 men were employed at the mine and that approximately one carload of ore was shipped per week; one carload is reported to have sold for $2,282. According to mint reports for 1887-92 (Kimball, 1888-89; Leech, 1891-93), the Albro mine within this period produced 3,109 oz gold, 18,206 oz silver, and 43,000 lb copper. In addition, the Monitor produced 547 oz gold and 7,417 oz silver in 1890. From 1907 to 1937 (table 12) the mine produced 3,473.62 oz gold, 26,419 oz silver, 201,863 lb copper, 17,538 lb lead, and 4,174 lb zinc. Much of this ore was produced from 1916 to 1918 from a stope on the 1st level of the Albro shaft, in a part of the mine that is now inaccessible (E. B. Dingle, oral commun., 1954). The total value of recorded production from the Albro mine is about $372,000; the total value of all production is estimated to be about $500,000.

Rocks exposed in the Albro shaft (fig. 30) belong mainly to the biotite gneiss unit. The foliation generally strikes north-northeast and dips to the southeast. An apparently concordant body of biotite-muscovite granite is exposed for more than 200 feet on the first level

Table 12.--Production of the Albro mine, 1907-37

[---, no production recorded]

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1907-----	2	--------	1.50	24	100	------	-----
1908-----	203	--------	111.23	1,151	8,485	------	-----
1909-----	306	--------	169.00	6,432	27,393	------	-----
1910-----	83	--------	55.60	1,070	11,000	------	-----
1911-----	36	6	10.87	47	260	------	479
	139	--------	164.04	1,512	15,119	------	-----
	Unknown	--------	2.53	20	-------	------	-----
1914-----	110	--------	159.03	1,932	11,398	6,274	-----
1915-----	102	--------	157.63	820	11,876	------	-----
1916-----	281	--------	796.19	3,691	33,410	99	-----
1917-----	729	76	187.11	549	4,026	1,782	-----
	481	--------	724.87	2,796	28,475	442	-----
1918-----	462	83	128.24	737	6,311	1,850	-----
	95	--------	162.00	878	10,403	------	-----
1919-----	1/ 100	20	34.93	130	1,098	------	-----

Table 12.--Production of the Albro mine, 1907-37--Continued

Year	Crude ore	Concentrates	Gold	Silver	Copper	Lead	Zinc
	(tons)		(ounces)		(pounds)		
1919-----	52	--------	80.41	696	6,564	------	-----
1920-----	130	20	41.56	214	1,859	273	-----
	111	--------	88.47	1,214	8,586	1,468	-----
1921-----	4	--------	4.47	71	145	------	232
1923-----	65	13	38.32	172	3,111	2,722	-----
	39	--------	78.00	696	2,994	------	-----
1926-----	20	--------	112.37	482	3,056	242	-----
1929-----	375	36	60.88	587	4,934	2,269	3,276
1932-----	67	--------	36.27	304	-------	------	-----
1934-----	42	--------	63.70	172	1,134	------	-----
1937-----	63	4	4.40	22	117	117	187
Total--	4,097	258	3,473.62	26,419	201,854	17,538	4,174

1/ Estimate.

east, and smaller concordant bodies of amphibolite, migmatite, and granite gneiss and pegmatite are interbedded with the biotite gneiss. A quartz monzonite porphyry is cut by the Albro vein about 500 feet west of the shaft, on the 2d level; this porphyry evidently pinches out or flattens appreciably, because it was not found on the 3d level of the mine.

The only vein worked from the shaft is the Albro, which strikes west-northwest to west and dips to the north at 40° or less. It ranges in width from about 1 inch to 2 feet, and is mineralized in most places. Displacement of contacts and rock units shows that the vein had a normal dip-slip or a left-lateral strike-slip movement, or, more probably, displacement that included both dip-slip and strike-slip components. A vein that joins the Albro from the footwall on the 1st level, about 200 feet east of the shaft, may be the Golden Calf.

The mineralogy of the vein is variable; much of the vein material consists of quartz and pyrite, and small amounts of other sulfide minerals, but in several places chalcopyrite, tennantite, galena, and sphalerite are abundant. Other than quartz, the gangue is mainly crushed and altered wallrock. Galena and dark sphalerite occur as thin lenses in quartz-pyrite vein material in the east drift of the 1st level and on the 2d level 500 feet west of the shaft. Copper-rich ores, probably similar to much of the ore mined, were observed in three places: (1) on the 1st level 130 feet west of the shaft, where supergene(?) copper sulfides occur in copper-stained quartz-pyrite ore; (2) just east of the shaft on the 3d level, where a 4- to 6-inch pyrite-tennantite-sphalerite seam has been left on the footwall; and (3) 250 feet west of the shaft on the 2d level, where the vein consists of 1-2 inches of pyrite, chalcopyrite, and tennantite on the footwall of a quartz-pyrite vein. The vein is also well mineralized 260 feet west of the shaft, on the 3d level, where a 2-foot quartz-pyrite vein contains a 3-inch veinlet of intergrown pyrite, chalcopyrite, tennantite, galena, and sphalerite.

Three main occurrences of anomalous radioactivity or uranium minerals have been found in the Albro shaft workings. A 30-foot zone on the 1st level, east of the shaft, shows radioactivity of as much as 2 mr per hr, and a 50-foot zone on the 3d level and a somewhat longer zone exposed above it on the 2d level show radioactivity of greater than 0.2 mr per hr and 0.1-0.2 mr per hr, respectively. On the 1st level, both the Albro and an intersecting vein (Golden Calf(?)) are radioactive and contain sooty pitchblende. A 10-inch sample of the Albro vein contained 0.069 percent equivalent uranium, 0.091 percent uranium, 0.02 oz gold per ton, 0.80 oz silver per ton, 0.07 percent copper, 1.77 percent lead, and 3.39 percent zinc. Two samples (8 and 9, fig. 30) taken on the 3d level, near the western boundary of anomalous radioactivity, were far out of equilibrium and deficient in uranium.

Some of the ore shoots in the mine were probably due to a normal dip-slip component on the vein. According to E. B. Dingle (oral commun., 1954), former mine operator, miners considered the steeper

parts of the vein more favorable for ore. Possible examples of ore controlled by dip-slip movement may be seen on the 2d level in two stoped areas whose centers are at 290 and 420 feet west of the shaft. The stoped areas have dips ranging from 37° to 43° N., and are separated by a section of the vein that dips 33° N. and consists of only 1 inch of quartz and pyrite in 5-6 inches of altered rock. On the 1st level of the mine, the first stope west of the shaft is on a west-striking part of the vein, which suggests left-lateral movement. However, as this stope is also centered on a high-angle intersecting fracture, and as the shoot apparently plunges straight downdip of the vein to the 2d level, the localization of this shoot may be more complex. A stoped area 290 feet west of the shaft, on the 3d level, is in a wide part of the vein formed at the intersection of two branching fractures.

The ore mined from the Albro has been of good grade. Its gold content averaged more than 1 oz per ton, the silver content generally was from 10 to 30 oz per ton, and most of the smelting ore contained several percent copper and some lead. The chances for further discoveries of ore in the shaft workings, however, probably are poor. The vein exposed at depth in the Hiawatha tunnel is small, and, according to E. B. Dingle (oral commun., 1954), the vein in the westernmost part of the shaft workings was poorly defined, apparently grading into barren fractures in the gneiss. Little is known of the character of the vein in the east, or Monitor, workings, but rich gold ore was produced there before 1900, so the eastern extension of the vein may merit further prospecting. The main shoots on the Albro vein are west of the raise from the Hiawatha tunnel and east of the Specht tunnel (fig. 31), so the part of the Albro vein between the two tunnels should be considered favorable for exploration at depth.

Hiawatha, Lincoln, and Specht tunnels

The Hiawatha (E-III, 25), Lincoln (D-III, 21), and Specht (D-III, 22) tunnels are north-trending crosscut adits that were driven for the purpose of intersecting veins of the Albro area at depth. The Lincoln, the westernmost, at an altitude of 7,961 feet, trends N. 20° E. for 535 feet; the Specht (or Gilpin and Clear Creek), the middle tunnel, at an altitude of about 7,920 feet, trends N. 12° W. for more than 2,150 feet; and the Hiawatha, the east tunnel, at an altitude of about 7,845 feet, trends almost due north for 1,970 feet. Geologic maps of the Lincoln and Hiawatha tunnels, and a plan of part of the Specht tunnel, are shown in approximately correct relative positions on figure 31, together with approximately located workings on the Albro vein.

Ore was mined in appreciable amounts from only the Specht and Lincoln tunnels. The California vein was mined in the Lincoln tunnel, but this production is not recorded; the vein was also stoped in the Specht tunnel, and probably furnished most of the production recorded for that mine. According to Bureau of Mines records, the Specht

tunnel was operated from 1925 to 1940, and within this period produced 14,888 tons of ore that contained about 2,576 oz gold, 25,744 oz silver, 165,725 lb copper, 155,693 lb lead, and 8,850 lb zinc, valued at about $187,000.

Rocks exposed in the tunnels are biotite gneiss--locally migmatitic, granite gneiss and pegmatite, and biotite-muscovite granite, all of Precambrian age, and quartz monzonite porphyry, of Tertiary age. The biotite gneiss and thin and thick concordant layers of the granite gneiss and pegmatite are the predominant rock types. The tunnels are on the east flank of the Dumont anticline, and so in general the foliation strikes northeast and dips southeast. In the Hiawatha tunnel, biotite-muscovite granite forms a thin approximately concordant body, and quartz monzonite porphyry forms a discordant dike that strikes north-northwest; the dike is cut and displaced by the west-northwest-trending Albro vein fissure.

Several veins and barren faults are cut in the Hiawatha tunnel (fig. 31). At 1,250 feet from the portal, the tunnel cuts a 1-inch to 1-foot iron-stained gouge zone that contains minor quantities of pyrite and chalcopyrite. The gouge zone, possibly the Sound vein, strikes N. 75° W., dips 40°-60° NE., and has been drifted on for 250 feet to the west. A vein that strikes N. 80° E. and dips northwest is exposed at 1,350 feet in the main tunnel, and possibly in the western part of the Sound(?) drift, where it apparently cuts off the Sound(?) vein. The tunnel cuts the Albro vein at about 1,950 feet from the portal, and turns and follows the vein on a general west-northwesterly course for about 700 feet to the face. The Albro vein is small on the Hiawatha level, and generally consists of a 1- to 3-inch vein that contains small amounts of pyrite, chalcopyrite, and galena.

Most of the veins intersected by the Lincoln tunnel strike west-northwest and dip either 30°-50° NE. or almost vertically. Except for the California vein, which is as much as 2.5 feet wide, all are only a few inches wide and have not been explored, although the low-angle veins contain some galena, sphalerite, and chalcopyrite. A vein that strikes northeast and dips about 50° NW. is cut at about 450 feet from the portal. The California vein averages about 2 feet in width, and consists mainly of quartz, pyrite, chalcopyrite, and gouge. Copper, in the form of secondary chalcanthite, is plentiful, and several specimens of ore found on the dump, presumably from the California vein, contain sphalerite, galena, and tennantite in addition to pyrite and chalcopyrite.

Several veins are also known to have been cut in the Specht tunnel, which was, however, inaccessible in 1954. According to Bastin and Hill (1917, p. 353), the tunnel was 870 feet long; since their survey it has been driven forward and is now more than 2,150 feet long (E. B. Dingle, oral commun., 1957). At the time of Bastin and Hill's (1917, p. 353-354) survey, veins had been intersected at 260 and 605 feet from the portal. Three veins come together at 260 feet. One of these strikes N. 75° W. and dips 85° N., and consists of 4-8 inches of altered

wallrock containing disseminated pyrite and traversed by a 1-inch stringer of quartz and pyrite. This vein is cut off by a low-angle vein that strikes N. 55° W. and dips 30° N. The third vein consists of about 1 inch of quartz and pyrite, strikes N. 75° W., and dips 80° N. The California vein was intersected about 605 feet from the portal, where it strikes N. 70° W. and dips 40° N. The vein is about 2 feet wide, and consists of crushed somewhat-silicified biotite gneiss and pegmatite. East of the tunnel a 2-inch quartz vein contains galena, sphalerite, pyrite, and chalcopyrite, and some barite as a gangue mineral; west of the tunnel there is some coarse pyrite. The west drift probably connects with the stope in the California vein in the Lincoln tunnel. The tunnel also intersects the Equinox, Albro, and several other veins; it was reported (E. B. Dingle, oral commun., 1957) as cutting the Albro vein about 2,100 feet from the portal.

Pioneer tunnel

The portal of the Pioneer tunnel (D-II, 7) is near the head of Pioneer or Ulster County Gulch (1 mile north of Dumont), at an elevation of about 8,800 feet. The tunnel trends N. 45° W. for 850 feet, and then turns to an average bearing of N. 27° E. for 800 feet toward a vein believed to be the Chloride Belle. At the time of this survey (1954), the tunnel was caved 150 feet beyond the turn (fig. 32). Information beyond that point was taken from a map of the Pioneer workings furnished by P. P. Barbour, of Georgetown, Colo.

The tunnel is entirely in gneissic rocks; a thick layer of amphibolite that strikes N. 15° E. and dips northwest is exposed at the portal, and the rest of the tunnel is in migmatite or biotite gneiss. The rocks dip northwestward from the portal for about 500 feet, where the tunnel cuts a synclinal axis. Dip of the foliation changes to southeast at this axis, and at about 600 feet changes again at a less well defined fold axis.

Some production is shown by mint reports for 1887 (Kimball, 1888, 1890; Leech, 1891) and Bureau of Mines records for 1908-11, as follows:

Year	Ore	Concentrates	Gold	Silver	Copper	Lead	Zinc
	(tons)		(ounces)		(pounds)		
1887-----	---	-----	399.9	------	----	------	------
1890-----	---	-----	180	721	----	------	------
1908-----	2	-----	3.19	13	----	------	------
1909-----	700	84	147.01	273	----	------	------
	10	-----	1.79	90	----	------	------
1910-----	21	-----	8.84	194	41	11,500	10,111
1911-----	20	3	7.29	15	----	------	------
Total--	753	87	748.02	1,306	41	11,500	10,111

Some of the more recent production may be from other small mines in the area. The minimum value of all production from the mine is estimated to be $50,000; rather extensive open stopes are above the tunnel level, and if the grade of ore were similar to that of the recorded production then the value of the mine's production would be considerably greater than the estimated minimum.

The tunnel is a drift on the Pioneer vein for almost 800 feet from the portal, although the vein is poorly defined for about 660 feet. Probably the vein is slightly displaced by a small vein intersected at 730 feet, but it apparently continues to 776 feet, where it either joins or is cut off by vein A (fig. 32). The Pioneer vein strikes on an average about N. 46° W., and dips steeply, generally to the northeast. In most places it is 3-10 inches wide, and contains 1-5 inches of quartz, pyrite, chalcopyrite, galena, and sphalerite. Locally, as near as 150, 250, and 475 feet from the portal, the vein splits; the vein zone formed is at least 6 feet wide and has been stoped over this width. Five stopes on the vein have an aggregate length of about 350 feet, and a winze or underground shaft 260 feet from the portal was reported to be 170 feet deep (Bastin and Hill, 1917, p. 343).

Vein A strikes about N. 40° E. and dips 50° NW., and consists of 1-5 inches of gouge that is cut by carbonate veinlets. Its relationships to the Pioneer vein are not clear because of stoping at the intersection; however, it seems likely that either the northeast-trending vein A cuts the Pioneer vein or the Pioneer vein changes strike and joins with vein A, since the Pioneer vein was not found beyond the intersection.

Vein B, which was intersected 850 feet from the portal, strikes N. 30° E. and dips 55° NW.; it consists of 1-12 inches of gouge and crushed rock locally containing 1-2 inches of pyrite, chalcopyrite, and carbonate. No stoping has been done on either vein A or vein B in the exposed parts.

Silver King group

The Silver King group of claims is in Spring Gulch, about half a mile above its junction with Clear Creek. The group consists of seven claims, which have been explored by eight adits. The main Silver King vein is probably developed by three adits: a drift adit (E-III, 8), at an altitude of 8,142 feet, and two crosscut adits (E-III, 9, 10). Only the drift adit and the upper crosscut adit (E-III, 10), at an altitude of 8,282 feet, were accessible in 1952. They are connected by an underground shaft that has an intermediate level at about 8,210 feet (fig. 33). An extension or branch of the Silver King vein on the east side of Spring Gulch is developed by a short crosscut (E-III, 7) and by drift adits. Three short adits were driven for exploration of other branch or parallel veins in the area.

The only production recorded for the Silver King group is for the period 1944-47. During this time 1,353 tons of ore was shipped; it contained 25 oz gold, 1,900 oz silver, 3,630 lb copper, 52,692 lb lead, and 5,280 lb zinc. According to Bastin and Hill (1917, p. 343), galena- and chalcopyrite-rich ore seen at the mine was reported to contain 35-100 oz silver per ton, 12-35 percent lead, and 5-10 percent copper.

The main Silver King vein strikes about N. 70° E. and dips 40°-50° NW. Throughout most of its exposed length--about 1,200 feet--the vein cuts biotite gneiss and migmatite, but small bodies of alaskitic granite gneiss and pegmatite are exposed in the area near the manway between levels. On the main or drift adit level the vein consists of a 4-inch to 3-foot shear that is strongly mineralized only near the intersections of N. 15° E. cross shears, which contain but few sulfides themselves. Although formed later than the main Silver King vein, the cross shears produce a definite displacement at only one place.

The vein minerals include white quartz and coarse-grained pyrite, gray quartz and fine-grained pyrite, chalcopyrite, sphalerite, galena, chalcocite(?), and chalcanthite. White quartz and coarse pyrite is not abundant, and is found at only a few places. Gray quartz and fine pyrite are found throughout the mine, and are difficult to distinguish from the associated crushed silicified wallrock that carries disseminated pyrite. Galena and sphalerite are concentrated mostly in the main ore shoot about 500 feet from the portal, on the main level. Chalcopyrite and a soft dark material believed to be sooty chalcocite occur in small amounts on the lower levels. Chalcanthite is limited to the upper levels and, with the exception of some quartz and pyrite, is the only vein mineral visible on the 140-foot or upper level.

The Silver King Extension mine consists of a northeast-trending crosscut adit that intersects a 1-foot-wide vein at 440 feet from the portal (fig. 34). This vein, which strikes N. 70° W. and dips about 40° NE., probably is a branch of the main Silver King vein. It contains quartz, pyrite, chalcopyrite, galena, sphalerite, and carbonate. At 240 feet from the portal the adit cuts a 1- to 1 1/2-foot northwest-trending shear zone that contains only small quantities of quartz and pyrite. This zone is believed to be the extension of the Idaho Springs fault which is exposed to the east in the Dubuque mine, in Fall River.

A small southwest-trending adit 350 feet south of the main Silver King portal contained small amounts of rich ore. Samples from the dump consisted of quartz, pyrite, galena, tetrahedrite, and covellite. One dump sample contained gold that assayed at 0.64 oz per ton and silver that assayed at 127.38 oz per ton.

Mines along Mill Creek

Alexander mine

The Alexander vein crops out on the north side of Mill Creek about 1 mile northwest of Dumont, at an altitude of about 8,500 feet. The vein is developed by two adits (C-II, 6) and a shallow prospect shaft; none of the workings were accessible at the time of this survey (1954). Production from 1907 to 1930, recorded in the files of the U.S. Bureau of Mines and the Idaho Springs Sampling Works, totaled 28 oz gold, 1,117 oz silver, 53 lb copper, 3,704 lb lead, and 6,972 lb zinc, valued at about $3,300.

As exposed in the shaft, the Alexander vein strikes about N. 45° E. and dips 53° NW. As determined from dump specimens, it is composed of pyrite, chalcopyrite, galena, and sphalerite in a quartz-carbonate gangue. According to E. B. Dingle (oral commun., 1956), some galena-rich ore assaying about 5 oz gold per ton was shipped from the mine. Sampling-works assays of small-lot shipments are as follows:

Tons	Gold	Silver	Lead	Zinc
	(ounces per ton)		(percent)	
0.58	0.26	182.80	2.40	1.55
.75	.30	111.30	2.52	1.56
1.22	3.41	107.35	12.60	27.55
1.57	2.60	97.30	10.30	22.42
2.09	.89	65.00	4.20	14.65
1.09	1.48	59.40	5.60	21.00
1.81	.45	58.60	6.50	19.80
1.79	.54	23.40	1.58	9.95
.94	.42	31.50	-----	3.12

Copenhagen (Cincinnati) mine

A mine known as the Copenhagen (C-II, 5) is about 250 feet west-southwest of the lower Alexander adit; it is probably the same mine that Bastin and Hill (1917, p. 355) described as being on the Cincinnati vein.

Some production is reported from the Cincinnati mine in mint reports for the years 1890-92 (Leech, 1891-93):

Year	Gold	Silver	Lead
	(ounces)	(ounces)	(pounds)
1890-----	240.0	10,824	4,826
1891-----	83.3	2,536	7,000
1892-----	57.0	5,268	------
Total--	380.3	18,628	11,826

The vein material noted on the dump is similar to that found on the Alexander and Golden Hope dumps, although carbonate apparently is somewhat more abundant; veinlets of siderite as much as 1 inch thick cut the vein material. According to Bastin and Hill (1917, p. 355), some ore assayed as much as 2 1/2 percent copper.

Elm City mine

The Elm City mine (C-II, 2) is about 900 feet north-northwest of the junction of the north and south forks of Mill Creek. Apparently it is the same mine that Bastin and Hill (1917) described as being on the Great Northern vein. The mine was opened by two adits. A lower adit, completely caved (not shown on fig. 2), apparently crosscuts to the vein. The upper adit is accessible for several hundred feet, and, according to Bastin and Hill (1917, p. 356), is 1,200 feet long. At 100 feet a raise or stope is open to the surface.

Wallrocks noted in a reconnaissance of the first several hundred feet of the upper adit are microcline gneiss and Tertiary quartz monzonite porphyry. The Elm City vein closely follows the northern contact of the porphyry; the strike of the vein and porphyry for 100 feet from the portal is N. 81° E., and they both dip steeply to the south. The vein is as much as 1 foot wide, but consists mostly of quartz fragments in post-mineral gouge. Some ruby silver was noticed as a joint coating.

According to Bastin and Hill (1917, p. 356), part of the vein near the face shows galena and sphalerite; and material found in the dump, presumably from the inaccessible part of the mine, consists of as much as 2 inches of galena and dark sphalerite in a quartz gangue. A polished section of this type of material shows minor covellite coatings around galena and sphalerite grains.

Golden Hope mine

The Golden Hope mine (C-II, 7) is on the north side of Mill Creek, about 150 feet southeast of the Alexander mine, at an altitude of about 8,300 feet. The mine workings consist of an adit and a winze (fig. 35); no production has been recorded.

The wallrock in the adit is biotite gneiss, which strikes generally N. 35°-40° E. and dips to the northwest. The adit crosscuts about 40 feet to the vein, and then follows the vein on a general N. 65° E. course for about 260 feet. The vein is actually made up of several small nearly parallel veinlets separated by barren wallrock. From 40 to 120 feet, it consists of two subparallel branches 3-6 feet apart; the hanging-wall branch, which leaves the drift at 120 feet, contains pyrite, galena, and sphalerite, but at most is only 2 inches wide. Slickensides on this branch plunge slightly west of north, and suggest a reverse movement. The drift follows the footwall branch, which

splits at about 155 feet from the portal into two branches that contain sulfides. The footwall branch near the face is as much as 1 1/2 feet wide. Two chip samples from the hanging-wall branch (fig. 35) show some gold and small amounts of silver, copper, lead, and zinc:

Sample No.	Length	Uranium	Equivalent uranium	Gold	Silver	Copper	Lead	Zinc
	(in.)	(percent)		(oz per ton)		(ppm)	(percent)	
1	8	-------	0.001	0.78	0.40	250	0.49	1.12
2	3	-------	.002	.78	.90	950	.82	.26

Happy Thought mine

The Happy Thought mine (D-III, 2) is about half a mile above the mouth of Mill Creek, on the northeast side of the valley. Workings consist of an adit at an altitude of about 8,160 feet, and an 80-foot shaft that intersects the adit 80 feet from the portal. At the time of the authors' visit (1954), deep water prevented examination of more than the first 200 feet of the adit.

The Happy Thought vein strikes N. 24° E. and dips about 70°-80° NW. It is a composite structure whose footwall and hanging-wall seams are 2-3 feet apart. The footwall seam consists of a 6- to 15-inch gouge zone containing as much as 1 foot of quartz and pyrite that is locally stained by copper sulfate. The hanging-wall seam contains a few inches of gouge; in the area just northeast of the shaft it appears to be part of a breccia zone that extends into the hanging wall.

The wallrock along the drift is mainly granite gneiss and pegmatite, but a quartz monzonite porphyry dike is cut about 60 feet from the portal by the adit.

Keith mine

The Keith mine, west of the Golden Hope and Alexander mines, consists of an inclined shaft (C-II, 3), a crosscut tunnel (Keith tunnel) (C-II, 4), and probably an adit about 200 feet northwest of the tunnel. All workings except the upper part of the shaft are inaccessible. The shaft is in microcline gneiss and amphibolite.

As seen in the shaft, the Keith vein strikes N. 80° E., and dips 30° NW. It is partly oxidized, but contains scattered remnants of galena; a grab sample showed slight anomalous radioactivity and small amounts of silver and lead, as follows:

Equivalent uranium	Uranium	Gold	Silver	Lead
(percent)		(oz per ton)		(percent)
0.008	0.001	Trace	4.56	3.38

The tunnel was visited by Bastin and Hill (1917), and the following description was taken from their report (p. 355-356):

"The Keith tunnel * * * is a northward-trending crosscut 690 feet long, that intersects five fractures. The country rock is largely schist with lenses of pegmatite but near the face of the crosscut is granite gneiss.

"At 90 feet the tunnel cuts a 2-inch barren fracture that strikes N. 74° E. and dips 54° N. Between 300 and 430 feet it follows a westward-dipping barren fracture, and at 440 feet it cuts an 8-inch fracture containing unmineralized crushed rock that strikes N. 45° E. and dips 37° NW. A drift follows the fracture northeast for 80 feet; at 610 feet a 2-foot zone of crushed schist and pegmatite is cut and has been drifted on for 50 feet west of the tunnel. It strikes N. 80° W., is vertical, and is unmineralized. The Keith vein cut 650 feet from the tunnel mouth, strikes about east and west, and dips on an average 50° N. It consists of about 1 foot of crushed wall rock somewhat silicified and altered and carrying scattered crystals of pyrite."

Mineralized rock seen on the dump consisted of highly altered wallrock that contained disseminated crystals of pyrite and galena and was cut by carbonate veinlets.

Wolverine mine

The Wolverine mine (B-I, 1) is on the north side of Mill Creek about 2,250 feet northwest of the Elm City mine, at an altitude of about 9,050 feet. It is opened by a drift adit (fig. 36) about 650 feet long and by a shaft on the vein.

Wallrocks are entirely microcline gneiss interbedded with amphibolite layers. Generally the foliation strikes slightly east of north and dips at low angles to the southeast.

The Wolverine vein trends N. 84° E. and dips steeply, generally to the south. It is wide and fills the drift in many places, and consists mainly of white quartz and dark-brown carbonate, but contains sparse pyrite and very sparse galena. The vein has been sheared, and in many places is an open breccia.

Unknown No. C6-45

Mine C6-45 (B-II, 2) is in the south fork of Mill Creek, about 1 mile northwest of the Alexander and Golden Hope mines. The workings consist of a short adit and a water-filled winze (fig. 36). A small amount of ore has been shipped from the mine, but production has not been recorded.

The vein strikes generally N. 63° W. and dips 53°-65° NE.; it is on the contact of microcline gneiss and Tertiary quartz monzonite porphyry which is on the hanging wall. At the winze the vein is about 2 feet wide; east of the winze it breaks up into three small fractures, and to the west it is at least 1 1/2 feet wide for about 25 feet. Sulfides are confined principally to a hanging-wall seam that locally contains as much as 3 1/2 inches of fine-grained galena and dark sphalerite. A grab sample assayed:

Equivalent uranium (percent)	Gold (ounces per ton)	Silver	Lead (percent)	Zinc
0.001	Trace	1.84	5.23	4.20

Unknown No. G643

Unknown mine G643 (D-II, 17) is on the northeast side of Mill Creek, about 600 feet above the Dundee tunnel. The portal is near the road, at an altitude of 8,230 feet, and accessible workings are shown on figure 37.

Two quartz- and pyrite-bearing veins, both striking nearly east-west and dipping 32°-50° N., are exposed in the mine. The northern vein is as much as 1 foot thick in places, and has been stoped in its eastern part, where it cuts granite gneiss and pegmatite. The southern vein contains 2-4 inches of quartz and pyrite which is cut by a veinlet of galena. In both veins, the quartz is white and the pyrite is coarse grained, constituting a type of ore that is believed to be unfavorable for high gold values in the district. Dump material is locally radioactive.

The production of ore from the mine is not known.

Mines between Mill Creek and Spring Gulch

Angeline mine

The Angeline mine (D-I, 1) is near the head of Spring Gulch, about 1 1/2 miles north of Dumont. Workings consist of a nearly straight adit that follows the vein N. 50° E. for at least 440 feet (fig. 38).

The Angeline vein is a nearly vertical fracture zone 1-2 inches wide that contains iron- and copper-stained gouge, quartz, some carbonates, and sparse fine-grained pyrite. The adit is caved 440 feet from the portal, but near the caved part the vein widens slightly, and timber and parts of a ladder in the caved material indicate a raise or stope beyond.

The wallrock throughout the entire length of the adit is migmatitic

biotite gneiss.

Production from the mine is unknown, but is believed to have been small.

Columbine mine

The Columbine adit (D-II, 12) trends N. 25° E. for 610 feet, and follows the Columbine vein from a point 140 feet from the portal to the face. The vein dips about 70° NW., or about parallel to the foliation of the biotite gneiss which comprises most of the wallrock (fig. 39).

The Columbine vein ranges in width from a few inches to 2 feet, and contains sheared rock, quartz, pyrite, and a small quantity of chalcopyrite. No stoping has been done on the vein, but some ore may have been taken from a shallow winze 460 feet from the portal.

Cuba tunnel

The portal of the Cuba tunnel (E-III, 5) is near the stream in Spring Gulch, at an altitude of 8,260 feet. The mine is a crosscut largely in biotite gneiss and granite gneiss and pegmatite. It was driven to cut the Milton vein at a depth of about 450 feet. It is nearly straight on a bearing of S. 58° W. for 660 feet, where it cuts an east-west vein that dips steeply north. It follows this vein westward for 130 feet, and, continuing westward for another 120 feet in barren rock, again turns southwestward, but is caved about 50 feet beyond the turn (fig. 40). The adit probably did not reach the Milton vein.

The veins cut in the accessible part of the adit are all weakly mineralized and none have been stoped. A vein (strike N. 55° W., dip 54° NE.) 110 feet from the portal contains 1-2 inches of quartz and pyrite, and has been drifted on for 40 feet to the northwest. Three steeply dipping shears that strike about N. 20° W. are cut between 550 and 600 feet from the portal. All contain some pyrite, but although one is from 1-1 1/2 feet wide none has been followed by a drift. The east-west vein, which is cut at 660 feet, contains 6 inches-1 foot of gouge and disseminated pyrite; although the strike is similar to that of the Milton vein, its dip is much steeper. By projection, the Milton vein should lie about 300 feet to the north at this level. The Mammoth vein, however, projects to about the position of the east-west vein.

Eagle-Tim Tarsney vein

The Eagle vein (D-III, 8) and its probable eastern continuation, the Tim Tarsney, are developed by four inclined shafts and probably more than a thousand feet of drifts. The main, or Eagle, shaft is about 900 feet north-northwest of the Albro shaft, at an altitude of 8,550 feet. The vein strikes about N. 70° W. and dips about 40° NE.,

and thus belongs to the same vein system as the Albro, Kaverne, and California veins. The shaft workings on the vein were not examined, but most of the mineralized rock on the dumps consists of gray and white quartz and pyrite. The Eagle vein where exposed in the Kaverne crosscut (fig. 45) is as much as 2 feet wide, and consists of pyritic wallrock cut by quartz-pyrite veinlets.

In 1881, the Rocky Mountain News (June 12) reported that a carload lot from the Eagle mine assayed 31 percent copper, and 3 1/2 oz gold and 19 oz silver per ton. The mine operated at least through 1890, but after 1902 was idle until 1938-39, when again some ore was shipped. It was mentioned as operating by Burchard (1882, p. 373; 1883, p. 429), and, according to the mint report for 1890 (Leech, 1891), produced 240 oz gold and 1,082 oz silver in that year. Bureau of Mines records for 1938-39 show the following data:

Year	Ore	Gold	Silver	Copper	Lead
	(tons)	(ounces)		(pounds)	
1938-----	4	2.60	13	------	70
1939-----	130	12.71	65	81	73

The high copper and gold content of the ore mined in 1881, together with the low grade of the ore mined recently, suggests that the near-surface ores mined in the 1880's had been enriched by supergene processes.

Golden Calf mine

The Golden Calf mine (D-III, 17) is about 250 feet southeast of the Albro shaft, at an altitude of 8,205 feet. The mine is developed by an adit that follows the vein for nearly 300 feet, by a winze to a lower level 73 feet downdip of the vein, and by a 100-foot drift along the vein on the lower level (fig. 41). A stope extends from the lower level to about 50 feet above the adit level, and five other small stopes are on the adit level. A sublevel 33 feet down the winze has been opened for about 50 feet to the east.

Records of the U.S. Bureau of Mines show that 146 tons of ore shipped in 1937 contained a total of 16 1/2 oz gold, 52 oz silver, 89 lb copper, 68 lb lead, and 312 lb zinc. No other production records are available, but total production is believed to have been small.

The wallrock in the mine is dominantly migmatitic biotite gneiss. The quantity of pegmatitic material in the migmatite increases from the face to the stoped area 240 feet from the portal. Foliation of the migmatite strikes northeast, and dips southeast at an average of about 60°.

The Golden Calf vein strikes N. 68° E. for about 180 feet from the portal, and then N. 78° E. for the next 120 feet; dips range from 46° to 55° NW., and average about 50° N. The vein probably joins the west-northwest-striking Albro vein about 200 feet east of the Albro shaft, on the 1st level of the Albro workings (fig. 30). The vein ranges in thickness from 3 inches to 3 feet, and as exposed contains only one sizable ore body. Vein minerals, in apparent order of deposition, are quartz, white quartz and pyrite, gray quartz and fine-grained pyrite, chalcopyrite, sphalerite, galena, sooty pitchblende, and carbonate--although chalcopyrite seems to be contemporaneous with gray quartz and pyrite in one sample and with sphalerite in another.

Sooty pitchblende occurs along the hanging wall of the vein, in and to the east of the main ore shoot. The radioactive zone averages almost a foot in thickness, and extends for nearly 50 feet along the drift on the lower level. A total of 18 samples, representing an average vein width of 0.8 foot, contained an average of 0.012 percent uranium. These samples were taken from the lower level, from the 33-foot sublevel, and from the underhand stope below the adit level. A sample collected from the ore bin and which Mr. Stanhope, the owner, said came from the stope on the lower level contained 0.15 percent uranium. The main stope was inaccessible in 1952.

Gold Chloride mine

The Gold Chloride mine (E-III, 2) is about 300 feet east-northeast of the Milton crosscut, at an altitude of 8,750 feet. The mine consists of an adit (fig. 42) and a shallow prospect shaft. No record of production exists, and interest in the mine is due to slight anomalous radioactivity shown both by the Gold Chloride vein and by pegmatite wallrock along that vein.

The Gold Chloride adit crosscuts northeast 50 feet through garnetiferous biotite gneiss to the Gold Chloride vein, which it follows southeastward 75 feet through pegmatite. The pegmatite is an equigranular biotite-rich variety which is not noticeably zoned but which everywhere is slightly radioactive. The vein itself is as much as 2 feet wide, and consists of limonitic crushed rock and gouge; no unoxidized ore minerals were noted. A 0.6-foot sample of the vein (fig. 42) showed 0.006 percent equivalent uranium and 0.02 oz gold per ton.

Golden Eagle mine

The Golden Eagle mine is on the southwest side of Spring Gulch, at an altitude of about 8,400 feet. The mine is developed by a drift adit (E-III, 4) that trends S. 63° W. for 210 feet, and by a shaft 60 feet northeast of the portal, along the trend of the vein (fig. 43). As the shaft and adit have a common dump, the depth of the shaft can be estimated only roughly, but it is believed to be shallow. A second adit (E-II, 18), nearer Spring Gulch and 110 feet vertically below the upper

workings, appears to be on a parallel vein, but is now caved at the portal.

The Golden Eagle vein as exposed in the upper adit strikes N. 63° E. and dips from 50° to 75° NW. The dip and width of the vein decrease from northeast to southwest along the tunnel. The vein is 1-2 feet wide near the portal and 4-5 inches wide at the face. It consists of a hanging-wall zone of gouge, crushed rock, and pyrite, and a hard footwall zone, of about equal width, of quartz, pyrite, chalcopyrite, and gray copper.

Although the lower Golden Eagle adit is inaccessible, several samples found on the dump indicate that considerably more lead-zinc was found in the lower adit than in the upper. The samples show black, resin, and white sphalerite. Several contain pyrite and chalcopyrite in one part, and galena and sphalerite in another, and fine carbonate veinlets cut all the sulfides.

The wallrock in the upper adit is biotite-muscovite granite for the first 65 feet, beyond which it is biotite gneiss that locally contains enough granitic material to be classed as migmatite.

Heliotrope mine

The Heliotrope vein, which strikes about N. 80° E. and dips about 55° NE., crops out about 100 feet south of the eastern part of the Albro vein. It is explored by means of three adits and two shafts. From east to west, the workings are the Major C. and Little Colonel adit (E-III, 18), the Orvetta and Little Ruby adit (E-III, 17), the Heliotrope tunnel (E-III, 16), and the Heliotrope shaft (fig. 44). Parts of the vein have been stoped, and Bureau of Mines records show a small production: 53 tons of ore shipped from 1909 to 1935 contained 20.63 oz gold, 498 oz silver, 1,621 lb copper, 840 lb lead, and 381 lb zinc. Sampling-works returns in the possession of E. B. Dingle show that 7,600 lb ore shipped in July 1906 assayed 1.35 oz gold and 30 oz silver per ton, and 11 percent copper, and that 6,800 lb shipped in September 1906 assayed 0.44 oz gold and 15.5 oz silver per ton, and 3.5 percent copper. The part of the vein represented by these returns is not known.

The Heliotrope tunnel is driven S. 65° W. for 150 feet, within which distance it is partly crosscut and partly drift. At 150 feet, the adit cuts the main vein, which is followed N. 80° W. for 85 feet. In the part of the drift 150-185 feet from the portal, several branches join, and here the vein is 1-1 1/2 feet wide, and contains 5-6 inches of massive sulfides (mostly chalcopyrite) on the hanging-wall side. A winze 15-20 feet deep and a small underhand stope, 160 and 180 feet from the portal, respectively, mark the area from which ore has been produced. A 5-inch sample cut just east of the winze gave the following assay returns: gold, 0.76 oz per ton; silver, 16.38 oz per ton; and

copper, 23.20 percent.

Wallrocks in both workings mapped in detail--the Major C. and Little Colonel, and the Orvetta and Little Ruby--are predominantly garnetiferous biotite gneiss that contains thin layers of garnetiferous gneiss. The garnetiferous gneiss is folded into a minor syncline whose axis cuts through the Orvetta and Little Ruby mine.

The Major C. and Little Colonel mine consists of a drift adit and an inaccessible inclined shaft sunk from the portal of the adit. The adit follows the vein for 220 feet to the east; within most of this distance the vein consists of footwall and hanging-wall veins that are 1-2 feet apart. The footwall vein is generally tight, but, particularly near the portal and again near the face, the hanging-wall vein is 6 inches-1 foot wide, and contains quartz, pyrite, and chalcopyrite.

The Orvetta and Little Ruby tunnel crosscuts about 60 feet west to the vein, and then follows the vein for 270 feet, generally west-southwest. The vein is as much as 1 foot wide, and contains pyrite, trace amounts of other sulfides, and secondary copper minerals.

Kaverne crosscut mine

The Kaverne crosscut adit (D-III, 9) is about two-thirds of a mile northeast of Dumont, at an altitude of 8,461 feet. The adit, which trends N. 9° W., was driven to cut the Kaverne vein at depth near the Kaverne shaft (D-III, 6). It is caved 415 feet from the portal (fig. 45), short of the Kaverne vein.

Three veins and numerous small stringers cut by the adit are all of the pyrite type. A 6-inch to 1-foot vein that was cut 145 feet from the portal strikes about east and dips 35°-40° N., and has been explored for a short distance to the west. A low-angle vein, probably the Eagle (D-III, 8), is cut 250 feet from the portal, and has been drifted on for short distances east and west from an overhand stope. The third vein, 265 feet from the portal, dips 66°-70° N. This vein has been explored by an 85-foot drift.

Milton-Kaverne vein

The Milton vein is opened by an inclined shaft and intersecting crosscut (E-III, 1) (fig. 42), by the Milton shaft (E-III, 3), and by a third shaft about 400 feet east-southeast of the Milton. Its western extension, known as the Kaverne, is opened by a shaft (D-III, 6) at an altitude of 8,736 feet and a crosscut tunnel (D-III, 9) at about 8,461 feet. According to Callbreath (1899, p. 166), prior to 1899 the Kaverne produced ore valued at $25,000; Bureau of Mines records show that 500 tons of ore produced in 1902 contained 125 oz gold and 500 oz silver.

The vein belongs to the same fissure set as the Eagle and Albro veins. It was examined only in the Milton crosscut (fig. 42), which was driven entirely in biotite gneiss. The vein was intersected about 200 feet N. 8° E. of the portal, and consists of a pyritized zone as much as 2 feet thick that is cut by numerous pyrite veinlets. The zone has an average strike of about N. 60° W., and a dip of 40° NE.

Sunshine mine

The Sunshine mine (D-III, 18) is about 1,000 feet northeast of Dumont, at an altitude of 8,104 feet. It consists of a drift adit that follows a vein for 305 feet in a N. 70° E. direction and an 80-foot cross drift on a second vein, the Equinox (D-III, 19), which is intersected by the adit 295 feet from the portal (fig. 46). A shaft on the Equinox vein (D-III, 19), called the Sunshine shaft by Bastin and Hill (1917, p. 354), is 150 feet southeast of the face of the Equinox drift. The wallrock in the adit consists mainly of biotite gneiss, migmatite, and biotite-muscovite granite, and some granite gneiss and pegmatite, pegmatite, and amphibolite.

The N. 70° E. vein dips about 75° NW.; it is 2-3 inches wide, and contains quartz, pyrite, chalcopyrite, and carbonates. At 295 feet, this vein is cut and displaced 3 feet (the northeast side moved northwest) by the Equinox vein. The Equinox vein is 2-4 inches wide, and is composed of quartz, pyrite, and small amounts of galena, sphalerite, chalcopyrite, and tennantite in a highly siliceous gangue. No stoping has been done on either vein, and no production from the mine is recorded.

West End(?) mine

The West End(?) mine is about a quarter of a mile north of Dumont; main workings consist of two adits (D-III, 3, 4), at altitudes of about 8,300 and 8,550 feet. Both adits trend a little north of east, and are believed to have been driven for the purpose of cutting the Kaverne vein at depth. The upper adit is caved, but the lower one is accessible for about 430 feet (fig. 47).

The tunnel cuts through two nearly concordant bodies of biotite-muscovite granite in biotite gneiss, and cuts at a small angle across a Tertiary quartz monzonite porphyry that strikes about N. 80° W. and dips 20° NE. At both places where the tunnel swings southeasterly, the apparent purpose was to follow small low-angle pyritic veins, which, according to E. B. Dingle (oral commun., 1954), the operators believed to be splits of the Albro vein.

The size of the dumps of the West End(?) mine indicates a length of 600-800 feet for each of the adits. As the upper, and nearer, adit is 1,200 feet from the Kaverne shaft, it is doubtful that either adit reached the Kaverne workings. Moderate amounts of quartz and pyrite

vein material on both dumps show that some veins were cut, but it is believed that not much ore was produced from either of the West End(?) adits.

Wild Wagoner mine

The Wild Wagoner mine (D-II, 9) is at the head of Pioneer Gulch, to the east of the Pioneer tunnel. The mine is opened by a shaft and small adits that are now inaccessible. The Wild Wagoner vein, as exposed in a roadcut and in the shaft, is a lode zone composed of silicified and otherwise altered rock. Its outcrop may be traced to the crest of the ridge, and a series of northeast-trending veins that crop out north of the south fork of Spring Gulch probably is a continuation of the Wild Wagoner lode system.

Nothing is known of the history of the mine. However, on the basis of the strength of the vein and its location in relation to the regional zoning, it merits further prospecting.

Mines between Spring Gulch and Fall River

Ella(?) mine

The Ella(?) mine (F-III, 10) (fig. 48) is in a small gulch about 1,500 feet east-southeast of the mouth of Spring Gulch. The mine was opened by two adits; the upper adit, possibly a drift, is caved; the lower adit, at an altitude of 7,890 feet, crosscuts N. 39° E. for 60 feet to a vein, and follows the vein N. 85° E. for about 160 feet. Wallrocks are biotite gneiss and granite gneiss and pegmatite, and the drift is mainly in the granite gneiss and pegmatite.

The vein generally strikes N. 85° E. and dips 50° N.; it is tight for about 33 feet from the crosscut, but farther east it is as much as 2 1/2 feet thick. It is composed principally of quartz and pyrite, but small amounts of galena and sphalerite were noticed in dump specimens. A polished section of galena- and sphalerite-bearing pyritic ore shows that, atypically, galena precedes sphalerite in the paragenetic sequence.

Two chip samples (fig. 48) showed only small amounts of valuable metals:

Length	Equivalent uranium	Gold	Silver	Copper	Zinc
	(percent)	(oz per ton)		(ppm)	(percent)
8 in.	0.001	0.02	1.14	300	0.08
1.3 ft	.003	Trace	Trace	300	.02

Firemen and Conductors tunnel

The Firemen and Conductors tunnel (E-II, 15) is on the north side of Spring Gulch, 1 1/4 miles above its junction with Clear Creek; the portal is at an altitude of 8,450 feet. The tunnel is a crosscut driven 840 feet N. 20° E. (fig. 49); within this distance it intersects a series of west-northwest-trending shears, only two of which were considered by the miners as being well-enough mineralized to warrant exploration. At 300 feet from the portal, a 2- to 3-foot shear, which strikes N. 83° W. and dips 55° NE., has been followed east and west by drifts that are now caved near the crosscut. At 790 feet, a vein that strikes N. 80° W. and dips 85° SW. contains 2-3 inches of gouge and 2 inches of gray quartz and fine-grained pyrite. This vein has been followed for 130 feet to the east and at least 25 feet to the west, where deep water prevented further examination.

The country rock is biotite gneiss, migmatite, granite gneiss and pegmatite, and amphibolite.

Torrey tunnel

The Torrey tunnel (F-III, 11) (fig. 50) is on the north side of Clear Creek, 4,200 feet west-northwest of the Fall River-Clear Creek junction, at an altitude of about 7,800 feet. The workings consist of 750 feet of crosscut and drift, and a water-filled winze. The tunnel trends northeast for about 620 feet, and then north for 130 feet to the face.

The wallrock is entirely biotite gneiss, which is locally somewhat migmatitic. A change in the general foliation at about 620 feet and again near the face suggests that the axis of a north-northeast-trending minor syncline cuts across the tunnel.

A vein that strikes N. 41° W. and dips 17° NE. is cut 110 feet from the portal. It consists of pyritized biotite gneiss cut by pyritic quartz veinlets, and is about 3 feet thick. It apparently displaces a steeply dipping vein that strikes about N. 45° E. and is followed by the tunnel for from 110 to 270 feet. The steep vein contains white quartz and rather coarse pyrite, and is as much as 1 1/2 feet wide. The winze probably was sunk to follow the junction of the steep and flat veins.

Unknown No. G454

The G454 mine (D-II, 5) is in Spring Gulch, 1,800 feet upstream from the Firemen and Conductors tunnel. The portal is beside the road, at an altitude of 8,590 feet.

The workings consist of an adit about 300 feet long which follows a 1/4- to 2-inch veinlet that locally contains quartz and pyrite (fig. 51).

The veinlet strikes N. 45° E. and dips 65°-80° NW. Two hundred fifteen feet from the portal, a vertical northwest-striking vein cuts and displaces the veinlet; the northeast side moved southeast 3 feet. Although the northwest-striking vein contains 6-8 inches of quartz and pyrite and 1 foot of gouge, values must have been low, because almost no attempt was made to follow the vein. There has been no production from the mine.

Other mines and prospects--tabular summary

Data on small mines and prospects north of Clear Creek, near Dumont, are presented in table 13. Several of the mines, including the Chicago Belle, Kaverne, and Lee, have produced some gold and silver ores.

Dumont area, south of Clear Creek

Blue Ridge and Senator mine

The Blue Ridge and Senator mine is about 1 mile southwest of Dumont, and straddles the ridge separating Ohio Gulch and Silver Creek. The main workings of the mine consist of the Capitol shaft (C-IV, 4) and several adits or tunnels (fig. 52) that explore two veins, the Blue Ridge and the Senator. All the workings are now largely inaccessible, and the data on geology are taken from Bastin and Hill (1917, p. 344-347).

Production is recorded for the years 1887-88 and 1890 in mint reports, and for 1909-27 by the U.S. Bureau of Mines (table 14).

Most of the production came from the Senator vein, although the Blue Ridge vein was stoped to as much as 4 1/2 feet in width for 200 feet in the upper tunnel. The ore mined before Bastin and Hill's survey generally contained more than 50 oz silver per ton, and locally contained more than 100 oz. Typical grades of smelting ores shipped from the Senator from 1912 to 1921 are suggested by the assays shown below:

Smelting ore shipped from the Senator mine

Year	Tons	Gold	Silver	Copper	Lead	Zinc
		(oz per ton)		(percent)		
1912---	86	0.134	58.73	Trace	23.4	10.7
1913---	155	.153	46.52	------	27.5	9.0
1919---	25	.030	15.80	------	4.8	2.8
1921---	165	.122	42.84	0.5	32.1	3.1

Some oxidized ores near the surface are reported to have contained as much as 2.55 oz gold per ton, probably as a result of residual enrichment.

The Senator vein strikes about N. 42° E., and dips 45°-75° NW. In the southern part of the mine it is in "granite gneiss" walls, but in the northern part it parallels or is in dikes of bostonite and trachytic granite porphyry. North of its intersection with the Blue Ridge vein, the vein was a barren slip in porphyry, but south of the intersection it was a fractured zone as much as 8 feet wide that was cut by veinlets containing galena, sphalerite, chalcopyrite, pyrite, quartz, calcite, and barite. Silver sulfosalts also occurred locally, both as fracture coatings and as metasomatic replacements of solid sulfides.

The Blue Ridge vein strikes about N. 50° W., dips 60°-65° NE., and either ends at or is cut off by the Senator vein. It is similar mineralogically to the Senator vein, but is not so strong, nor, in most places, so well metalized.

Table 14.--Production of the Blue Ridge and Senator mine,[1] 1909-27

[(?), unknown]

Year	Crude ore	Concentrates	Gold	Silver	Copper	Lead	Zinc	Remarks
	(tons)		(ounces)		(pounds)			
1909---------	4		0.73	4				
1910---------	54	9	.98	417		4,491		
	13		.64	328	23	2,814		
1911---------	23		1.81	1,073		12,168		
1912---------	86		11.53	5,051		40,185	18,320	
1913---------	724	181	30.66	8,193		89,461	38,893	
	155		23.72	7,210		85,334	27,932	
1915---------	4		.45	229		2,173		
1916---------	2		.65	121		1,432		
1917---------	(?)	2	.39	342		2,031		Senator, White Extension.
1918---------	[2] 105	15	4.50	1,275	113	13,243		
	164		1.20	2,916		36,188		
	46		2.00	945		5,501		Senator, White Extension.
1919---------	500	51	24.60	809	74	7,947		

Table 14.--Production of the Blue Ridge and Senator mine,[1/] 1909-27--Continued

Year	Crude ore (tons)	Concentrates (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)	Remarks
1919---------	103		1.85	1,809		12,689	1,400	
1920---------	219		33.10	5,560	48	62,607		
1921---------	836	43	58.63	3,548	388	36,481	10,182	
	165		20.13	7,068	1,501	105,908	10,329	
1922---------	30	6	1.91	391	21	4,985	1,778	
	10		1.39	863		6,250	974	
1925---------	6		.69	418		3,564	702	Senator, White Extension.
1926---------	20	2	.52	169		1,670		Do.
	20		1.18	947		4,698		Do.
1927---------	28		1.14	1,305		7,871	1,702	Do.
Total------	>3,317	309	224.40	50,991	2,168	549,691	112,212	

1/ Also may include some production from Golden Slipper and Capitol mines and the Hiawatha tunnel.

2/ Estimate.

Commonwealth mine

The Commonwealth mine (C-IV, 9) is on the east side of Ohio Gulch, at an altitude of 9,140 feet; it is opened by an inclined shaft about 160 feet long that has three levels. From the trend of the workings (fig. 53), it probably explored two veins. According to E. B. Dingle (oral commun., 1960), the Commonwealth vein probably was worked below the shaft workings through the Legal Tender adit (C-IV, 8) (fig. 53). No production is recorded, but the longitudinal section shows small stopes on all three levels of the mine. The vein probably strikes about N. 80° W. and dips 60° NE., and, like the Startle and Legal Tender veins, contains galena-rich pockets or shoots.

Earl of Kent group

The Earl of Kent group of claims is on the south side of Clear Creek, opposite Dumont. Workings consist of four crosscut adits and a shaft, at altitudes of 7,960-8,200 feet. The adits, from west to east, are: the Alkire, or Puzzler, tunnel (D-III, 25), 245 feet long; the New (D-III, 27), 470 feet long; the Lower Kent (D-III, 28), 260 feet long; and the Upper Kent (D-III, 29), 490 feet long. The Puzzler shaft (D-III, 26), near the Puzzler adit, is 275 feet deep (Bastin and Hill, 1917, p. 349-350). In 1953, only the Lower Kent workings were accessible. All the workings are believed to have explored the Puzzler vein, although the Upper and Lower Kent adits were probably started to explore the Earl, Kent, and allied claims farther south. The Puzzler vein is apparently the same vein as the one called the Earl of Kent by Bastin and Hill.

In the Lower Kent adit the Puzzler vein strikes N. 70° W. and dips 30°-40° NE. (fig. 54). The vein, which is 1-3 feet wide, consists of crushed and altered rock that contains 2-6 inches of quartz and pyrite, and minor amounts of chalcopyrite. Bastin and Hill (1917) reported traces of galena in the vein. The wallrocks in the Lower Kent adit are migmatite and a pegmatitic phase of the granite gneiss and pegmatite unit.

Bastin and Hill (1917, p. 350) reported that ore from the vein generally averaged $10 a ton in value, and that the total value of ore produced, mostly from the Lower Kent adit and the Puzzler shaft, was $12,000.

Elky(?) mine

The Elky(?) mine (D-III, 24) is on the south side of Clear Creek, at Dumont, at an altitude of about 8,075 feet. The property has been idle for many years, so that at present (1955) even the name is somewhat in doubt. The amount of ore produced from the mine is not known.

The workings consist of a drift adit that follows a vein (herein

called the Elky(?) vein) for 800 feet (Joseph Allaria, oral commun., 1953). Bad air 520 feet from the portal prevented examination of the adit beyond that point (fig. 55). An ore chute, raise, and winze at 520 feet indicate a stoped area ahead.

The Elky(?) vein strikes about N. 55° E., and dips an average of 45° NW. The vein averages 2-3 inches in width, and consists generally of quartz, disseminated pyrite, and gouge, although at places it also contains chalcopyrite, sphalerite, and carbonate. At 120 feet from the portal the vein cuts a steeply dipping north-south pyrite veinlet that has been followed for 80 feet to the south by a drift.

With the exception of a narrow layer of amphibolite and one of granite gneiss, the wallrock throughout the exposed part of the adit is biotite gneiss, which in many places contains enough granitic material (50-60 percent) to be classed as migmatite.

Legal Tender mine

The Legal Tender mine (C-IV, 8) is about 500 feet west of the Commonwealth shaft, at an altitude of 8,944 feet. Workings consist of an adit that has about 800 feet of workings (fig. 56). The mine was mentioned by Corregan and Lingane (1883, p. 148), and production was recorded for 1891 by Leech (1892) and for 1924-29 by the Bureau of Mines:

Year	Ore	Gold	Silver	Copper	Lead	Zinc
	(tons)	(ounces)		(p o u n d s)		
1891-----	------	21.70	313	-----	------	------
1924-----	13	2.64	318	-----	9,782	1,168
1925-----	57	3.55	3,024	1,196	46,819	9,324
1926-----	48	1.67	191	-----	8,798	------
1929-----	16	.42	113	316	10,789	1,510
Total--	134+	29.98	3,959	1,512	76,188	12,002

Mattie Jack tunnel

The Mattie Jack tunnel (C-III, 9) is near the mouth of Ohio Gulch, at an altitude of about 8,167 feet. In part, the tunnel follows the Range Line vein, but it was driven to intersect the Senator vein, which was, however, either not reached or not recognized. According to Callbreath (1899, p. 183), the Mattie Jack mine consisted of a 600-foot tunnel, an 800-foot drift, and 1,200 feet of drifts. Production prior to 1899 was reported at $6,000; some production has been recorded since 1902, but it has been lumped with that of 16 other claims or mines.

Judged from dump specimens containing dark sphalerite, galena, pyrite, and sparse chalcopyrite, the veins in the Mattie Jack tunnel are a galena-sphalerite or possibly composite type.

Morning Star mine

The Morning Star mine (C-III, 8) is south of Clear Creek and about 1,000 feet west of Ohio Gulch, at an altitude of about 8,165 feet. The mine workings consist of a crosscut adit that trends south and southwest for about 550 feet (fig. 57). A vein is intersected about 300 feet from the portal, and is followed for about 300 feet west of the crosscut. The wallrock is mainly interlayered biotite gneisses, which strike northeast and dip northwest. Granite gneiss and pegmatite and biotite-muscovite granite are interlayered with biotite gneiss along the crosscut, and biotite-muscovite granite is also cut near the face in the drift. Bostonite porphyry dikes are exposed both in the drift and in the crosscut.

The vein strikes about N. 80° W. and dips about 50° N. It has been stoped for 45 feet just west of the crosscut, but elsewhere it is generally tight, and consists of gouge and altered rocks, and some quartz and pyrite. The vein offsets a bostonite dike that strikes N. 45° W. and dips 60° N., and a second small bostonite dike apparently ends at about the vein. The production of the mine has undoubtedly been small.

Ohio Belle(?) mine

The Ohio Belle(?) mine (C-IV, 2) is about 1,400 feet north-northeast of the Capitol shaft, on the Senator vein. The workings consist of an upper adit, at an altitude of 8,990 feet, which generally follows the Ohio Belle(?) vein, and a lower westward-trending crosscut adit driven to intersect the vein 120 feet lower. The lower adit trends N. 81° W. for 200 feet, mostly through biotite gneiss, to the Ohio Belle(?) vein, and then turns southward to follow the vein. The drift is caved 20 feet south of the turn, but a caved stope on the surface about 45 feet farther south shows that the drift continues and that some ore was mined (fig. 58).

The Ohio Belle(?) vein is probably the northern extension of the Senator vein; it strikes N. 35° E. and dips 50°-70° NW., and, like the Senator, is subparallel to a trachytic granite porphyry dike. In the lower adit the vein contains 1/2-1 inch of quartz and carbonate, and 3-4 inches of crushed rock and gouge. In the upper adit, at the head of the underhand stope, the vein is 10 inches wide, and consists of 2 inches of gouge and 8 inches of crushed rock containing fragments of galena. Production from the mine is not known.

Silent Friend mine

The Silent Friend mine, about half a mile southeast of Dumont, consists of two adits. The lower adit (D-III, 31), at an altitude of 8,260 feet, exposes the Hecla, Silent Friend, Fault, and Arrowhead(?) veins; the upper adit (D-IV, 1), at about 8,440 feet, probably exposes only the latter three veins. The only production recorded by the

Bureau of Mines was for 1914, when 2 tons of ore that contained 2.52 oz gold, 40 oz silver, 212 lb copper, and 398 lb lead was mined. Production as reported by Bastin and Hill (1917) was valued at $22,000. The mine was inaccessible in 1954, and its description and sketch map (fig. 59) are taken from Bastin and Hill (1917, p. 348-349).

The Silent Friend vein is the major vein exposed in the mine; it strikes about N. 35°-50° W. and dips 35°-60° NE. It is partly in gneiss walls, but it generally is in or on the hanging wall of a quartz monzonite porphyry dike. In most places, the vein consists of 2 inches-3 feet of fractured wallrock that contains disseminated pyrite; locally, it contains distinct veinlets or lenses of pyrite, or other sulfides, and veinlets of pyrite and gray quartz. To the southeast, the vein splits, or joins, the more east striking Arrowhead(?) vein. In the lower adit, the vein also joins the nearly barren Hecla vein, and in both adits the vein is cut and displaced by the Fault vein, a low-angle vein that strikes about due north. Apparently, most of the ore has been found near the intersection of the Silent Friend and Fault veins. The ore mined contained chalcopyrite, tennantite, sphalerite, and galena in addition to pyrite and quartz, and one pocket in the lower tunnel contained native gold in white quartz.

Syndicate-Monarch vein

The Syndicate vein (D-IV, 2) and its eastern continuation, the Monarch (E-IV, 2), can be projected along strike with reasonable certainty for more than 2,500 feet. The veins are opened by a series of workings in three main groups. The westernmost group, called the Western Syndicate (D-III, 33), is about 2,500 feet southeast of Dumont, and consists of two adits at altitudes of about 8,086 and 8,160 feet. The Eastern Syndicate workings (E-IV, 1), about 1,800 feet farther east, consist of an old inclined shaft that connects two adits, which are at altitudes of about 8,776 and 8,675 feet. The workings on the Monarch vein, two adits at 8,520 and 8,560 feet, are 700 feet farther east. The general distribution of workings is shown on the vein map (fig. 2); more detailed maps are shown on figures 60, 61, and 62. In 1954, only the upper Monarch adit (fig. 62) was open, but the workings on the Syndicate vein were described by Bastin and Hill (1917, p. 350-352), Collins (1909), and Bancroft (1914), and the description of the Syndicate vein is based upon these reports.

The Syndicate vein is of the pyrite type, and most of the ore has been low in grade, valued chiefly for gold. Locally, silver was reported to run as high as 40 oz per ton (Bastin and Hill, 1917, p. 352), and near the surface some of the ore also contained minable concentrations of lead as cerussite (E. B. Dingle, oral commun., 1955). A total production of 362 oz gold, 14,386 oz silver, 17,101 lb lead, 1,967 lb copper, and 631 lb zinc was recorded by Leech (1891) for 1890 and by the Bureau of Mines for 1902-37 (table 15).

Table 15.--Production of the Syndicate group, 1902-37

[(?), unknown; ---, no production recorded]

Year	Crude ore	Concentrates	Gold	Silver	Copper	Lead	Zinc
	(t o n s)		(o u n c e s)		(p o u n d s)		
1902-----	1,000	--------	38.63	220	------	------	-----
1907-----	(?)	8	91.04	262	20	38	0
1909-----	28	--------	4.64	381	------	------	-----
1910-----	5	2	1.50	15	------	------	-----
1911-----	9	10	10.97	58	200	------	-----
1912-----	28	20	19.56	457	------	------	-----
1914-----	80	--------	17.20	1,167	------	449	-----
1915-----	89	--------	11.85	583	------	------	-----
1916-----	142	--------	27.30	1,417	------	10,093	-----
1917-----	(?)	11	30.20	260	------	------	-----
1918-----	(?)	13	6.40	59	226	451	-----
1919-----	(?)	18	10.31	300	1,521	3,055	412
1924-----	(?)	--------	8.81	6	------	------	-----
1925-----	3,000	--------	31.00	3	------	------	-----
1926-----	100	--------	10.50	19	------	------	-----

Table 15.--Production of the Syndicate group, 1902-37--Continued

Year	Crude ore	Concentrates	Gold	Silver	Copper	Lead	Zinc
	(t o n s)		(o u n c e s)		(p o u n d s)		
1932-----	12	--------	11.25	------	------	------	-----
1934-----	2	18	16.53	149	------	------	219
1936-----	2	--------	3.16	6	------	35	-----
1937-----	1	--------	1.20	4	------	------	-----
Total--	>4,498	100	352.05	5,366	1,967	14,121	631

The Syndicate-Monarch vein is a strong vein that strikes west-northwest and dips generally about 40° NE. Because the vein has not been traced between all the workings, it possibly is a series of en echelon subparallel veins rather than one single vein. In many places it appears to be of replacement rather than fissure-filling origin.

In the lower Western Syndicate adit, 650 feet from the portal, the vein is about 4 feet wide, and consists mainly of pyritized pegmatite wallrock cut by veinlets of quartz and pyrite. The vein in the upper Western Syndicate adit (fig. 60) ranges in width from less than 6 inches to 5 1/2 feet, and is well mineralized to a point about 250 feet from the breast. At 300 feet from the portal, the vein, from hanging wall to footwall, consists of:

		Feet	Inches
1.	Pegmatite cut by stringers of quartz and pyrite, disseminated pyrite.		3
2.	Pegmatite, sparse pyrite along small fractures.	1	3
3.	Cherty quartz----------		1
4.	Pegmatite, sparse disseminated pyrite.		5
5.	Pegmatite, abundant disseminated pyrite.	2	0
6.	Crushed and altered rock, sparse pyrite.	1	0
		5	0

The veins exposed in the Eastern Syndicate and Monarch workings are similar in width, mineralogy, and dominant replacement character. Locally, the Monarch vein contains sparse dark sphalerite and galena in addition to the dominant quartz and pyrite. Biotite gneiss is believed to be the dominant wallrock in all the workings.

Other mines and prospects--tabular summary

Data on other mines and prospects in the Dumont area, south of Clear Creek, are shown in table 16.

Table 16.--Small mines and prospects, Dumont area, south of Clear Creek

Production

Big Dipper, some stoping (Bastin and Hill, 1917, p. 350)
Ohio, ore produced in 1880's (E. B. Dingle, oral commun., 1954)
Range Line, 21 tons contained 1.6 oz gold, 483 oz silver, 865 lb copper, 7,840 lb lead (U.S. Bur. Mines, 1908-14)

[--- indicates no information available]

Name	Locality No. (fig. 2) and general location	Mine workings	Vein			Wallrock
			Strike	Dip	Mineralogy	
American Eagle--	C-IV, 3; 330 ft E. of lower Ohio Belle(?); alt. approx. 8,785 ft.	Shaft, est. 300-400 ft of workings.	N. 65° E.	67° NW.	Quartz, pyrite, sphalerite; secondary copper and manganese(?) minerals.	
Andrew Lowe-----	C-IV, 6; 1,000 ft ENE. of Senator; alt. 8,860 ft.	500- to 600-ft adit----------	N. 85° W. (near portal)	50° NE.	Galena and sphalerite---------	
Big Dipper[1]----	D-III, 32; SE. of Dumont, alt. about 8,350 ft.	150-ft crosscut adit to vein, 110-ft drift adit; 50-ft shaft.[2]	N. 76° W.	40° NE.	Gray quartz and pyrite--------	Biotite gneiss.
Estrella(?)-----	C-III, 11; Ohio Gulch; alt. 8,280 ft.	Adit: Crosscuts N. 77° W. 55 ft, follows vein S. 25° W. 350 ft; winze at 325 ft along vein.	NNE.	NW.	Trace of pyrite; vein 25 ft from portal contains 1 in. pyrite, galena, and sphalerite.	Biotite gneiss; 2 1/2-ft bostonite porphyry dike 40 ft from portal.
Franklin D------	D-III, 23; south of west part of Dumont; alt. 8,080 and 8,190 ft.	2 short adits----------	---------	-------	No ore minerals noted---------	
Ohio-----------	C-IV, 7; east side of Ohio Gulch; alt. about 8,795 ft.	Shaft, est. 200-300 ft of workings.	N. 42° E.	82° SE.	Galena and sphalerite---------	
Range Line. (See Mattie Jack.)	C-III, 10; west side of Ohio Gulch; alt. about 8,630 ft.	Shaft and adit----------	N. 60° E.	67° NW.	Galena, gray copper, pyrite, chalcopyrite; secondary copper minerals.	
Startle---------	C-IV, 10; east side of Ohio Gulch; alt. 9,140 ft.	2 adits and 2 shafts. (See map of Commonwealth, fig. 53.)	About N. 80° W.	NE.	Galena----------	

1/ Vein is probable continuation of Puzzler. It is cut off by N. 32° E.-striking shear (Bastin and Hill, 1917, p. 350).

2/ Information from Bastin and Hill (1917, p. 350).

Fall River area

The mines in the Fall River area have worked veins of pyritic, composite, and galena-sphalerite types. The Golconda and Virginia veins, both of composite type, have reportedly produced small quantities of good-grade ores, valued chiefly for their gold and silver content. The Blazing Star vein and probably other galena-sphalerite-type veins in upper Fall River have produced some silver ores of good grade; locally, small pockets of very high grade ore have been found.

Uranium minerals are found in the Almaden, Golconda, and Mary mines; three other mines--the Pennsylvania, Standard, and Gold Quartz--show some anomalous radioactivity, but the source of the radioactivity is not known.

Uranium-bearing mines

Almaden mine

The Almaden mine is on the southwest side of Fall River, 2 1/2 miles above its junction with Clear Creek. The workings consist of two drift adits and a shaft, all on the Blazing Star vein. The portal of the lower adit, called the Blazing Star tunnel (E-II, 3), is near the stream bed, at an altitude of 8,250 feet. The adit is caved 1,150 feet from the portal, but was reported by Bastin and Hill (1917, p. 316) to be about 1,300 feet long. The upper adit (E-II, 2) is 620 feet long, at an altitude of 8,520 feet. The shaft (E-II, 1), whose collar is at an altitude of 8,760 feet, intersects the upper and lower adits at distances of 310 and 700 feet, respectively, from their portals (fig. 63).

From 1904 to 1934 (table 17), the Almaden produced 1,064 tons of ore that contained 201.98 oz gold, 45,041 oz silver, and small amounts of copper, lead, and zinc. This relatively small production from a mine having about 2,000 feet of drifts reflects the small size of ore bodies.

The Blazing Star vein strikes about N. 80° W., and dips 60° NE. Throughout most of the workings it is a single fissure, from 2 inches in width to about 2 1/2 feet. It shows little variation in strike, and shows left-lateral movement. The country rock is mostly biotite gneiss, but layers of granite gneiss and pegmatite, amphibolite, and garnetiferous gneiss as much as 50 feet thick are interlayered with the biotite gneiss. The garnetiferous gneiss localized uranium deposition.

The Blazing Star vein is composed in most places of gray flinty quartz, barite, sphalerite, and galena, in about that order of abundance. Thin chalcopyrite-rich veinlets occur on the footwalls or hanging walls of the quartz-rich veins. The mine is also known to have yielded some rich silver ores, which probably came from small pockets that were found in drifting. Bastin and Hill (1917, p. 317) reported native silver, proustite, pyrargyrite, pearceite, and cerargyrite from the mine. Native silver was supposedly abundant in the upper workings; masses rich in ruby silver assaying as much as 5,000 oz silver per ton were mined, possibly

Table 17.--Production of the Almaden mine, 1904-34

[---, no production recorded]

Year	Crude ore	Gold	Silver	Copper	Lead	Zinc
	(t o n s)	(o u n c e s)		(p o u n d s)		
1904-----	11	1.50	1,320	------	------	-----
1906-----	46	6.63	5,509	104	6,947	-----
1907-----	167	11.61	4,071	------	------	-----
1908-----	150	18.48	10,247	------	15,238	-----
1909-----	31	5.90	4,255	721	5,862	3,437
1910-----	46	7.14	4,508	------	------	-----
1912-----	31	4.67	1,320	226	2,519	-----
1913-----	35	3.58	1,015	------	3,397	1,939
1914-----	31	12.49	1,552	------	------	-----
1915-----	52	4.97	3,102	------	6,264	-----
1917-----	163	9.87	3,201	------	3,112	-----
1919-----	51	2.76	1,353	------	------	825
1920-----	28	11.64	788	264	635	522
1921-----	7	1.16	263	------	------	-----
1922-----	3	1.31	113	------	------	-----
1923-----	10	1.33	33	44	111	178
1924-----	9	1.64	295	------	1,427	-----
1926-----	5	1.61	323	------	620	-----
1927-----	20	4.49	675	------	290	54
1928-----	32	20.11	1,076	------	1,916	552
1934-----	136	69.09	22	------	------	-----
Total--	1,064	201.98	45,041	1,359	48,338	7,507

from a winze about 525 feet from the portal of the lower tunnel.

Pitchblende is found in four places in the mine, and a fifth area shows considerable radioactivity. In the lower adit, 520 feet from the portal, thin branch fractures in the hanging wall of the vein contain hard botryoidal pitchblende veinlets as much as a quarter of an inch in thickness. The pitchblende is intimately associated with niccolite, pararammelsbergite(?), tennantite, and fine-grained freibergite; a pitchblende separate showed about 7 percent silver by semiquantitative spectrographic analysis, the high content presumably due mostly to the fine-grained intergrown freibergite. At 1,070 feet from the portal of the lower adit, sooty pitchblende occurs in a veinlet on the footwall side of the vein; a grab sample contained 0.099 percent uranium. In the upper adit, pitchblende occurs at 380-410 and 500-520 feet from the portal, and, in addition, at 290 feet the vein shows radioactivity of more than 2 mr per hr. As in the lower adit, the occurrences of pitchblende (or anomalous radioactivity) coincide with similar occurrences in areas where the wallrock is composed of garnetiferous gneiss. In the occurrences at 380-410 feet, the Blazing Star vein consists of hanging-wall and footwall splits; the hanging-wall split is as much as 1 foot wide, and contains disseminated sooty pitchblende through as much as 0.9 foot; a 0.9-foot sample (fig. 63) contained 0.12 percent uranium. The footwall split is as much as 6 inches wide, and contains a thin veinlet of hard pitchblende near a raise. As seen in polished section, the hard pitchblende is associated with and is older than pearceite, argentite(?), and sphalerite; these minerals, in turn, are older than chalcopyrite, tennantite, and galena. A 0.4-foot chip sample of this vein contained 0.2 percent uranium, 0.95 percent copper, 0.74 percent lead, 1.48 percent zinc, 0.04 oz gold per ton, and 105.82 oz silver per ton. A 50-foot raise driven upward from the hard pitchblende occurrence was in garnetiferous gneiss for 23 feet on the hanging wall and 37 feet on the footwall. Most of the uranium in the area between 500 and 520 feet from the portal is in the form of sooty pitchblende; grab samples contained as much as 0.39 percent uranium. This uranium occurrence is also exposed in a 45-foot raise that shows thin veins of hard pitchblende and veins of sooty pitchblende as much as 10 inches thick. A dark-gray highly radioactive quartz vein is exposed on the west side of the raise, on the footwall of the vein, from about 10 to 30 feet from the floor of the drift; two grab samples of this quartz-rich vein, which is generally only 1-2 inches thick, contained 1.91 and 4.69 percent uranium.

Golconda tunnel

The Golconda tunnel (E-II, 6), about 500 feet southeast of the Almaden mine, at an altitude of about 8,265 feet, was driven to develop the Golconda, Virginia (E-II, 8), and other veins that crop out on the

ridge between Fall River and Spring Gulch. The tunnel workings consist of a southwest-trending crosscut, and drifts on at least four northwest-striking veins. The tunnel trends S. 64° W. for 880 feet, then S. 29° W. for 100 feet, and S. 50° W. for 365 feet to a point where the tunnel is caved (fig. 64). It intersects the Virginia(?) vein 985 feet from the portal, the No. 4 vein at about 1,165 feet, the Golconda vein near the caved workings at 1,345 feet, and, reportedly (Bastin and Hill, 1917, p. 316), the Logan vein, 240 feet farther southwest. The Virginia(?) vein is followed by a short drift north of the crosscut; the No. 4 and Golconda veins, by drifts extending both north and south. The south drift on the No. 4 vein is about 400 feet long; the north drift is caved about 40 feet north of the crosscut. At the time of Bastin and Hill's (1917, p. 316) survey, the south drift on the Golconda vein was caved 50 feet from the tunnel, but the north drift was 475 feet long, and a 40-foot winze was 180 feet northwest of the tunnel.

A small amount of gold, silver, and copper ore of good grade has been produced from the tunnel. Probably most of the production came from the now inaccessible part of the Golconda vein, although some may have come from a stope on the No. 4 vein. Two hundred seventy-one tons of ore mined from 1902 to 1912 contained 433.6 oz gold, 3,604 oz silver, and 6,201 lb copper. The value of this production was about $20,300.

The wallrock exposed in the Golconda tunnel is mainly biotite gneiss, which at places is migmatitic. Lesser quantities of pegmatite, biotite-muscovite granite, amphibolite, and garnetiferous gneiss are also present. Layers as much as 90 feet thick of the garnetiferous gneiss occur in the part of the mine near the Virginia, No. 4, and Golconda veins.

Changes in the strike and dip of the foliation in the wallrocks suggest that a north-northeast-trending syncline crosses the tunnel about 500 feet from the portal.

Vein descriptions.--The Virginia(?) vein strikes N. 42°-52° W., averaging about N. 48° W., and dips 70°-75° NE. A vein that strikes about N. 48° W. and dips 85° NE. is cut 10 feet closer to the tunnel portal, and is a split off the hanging wall of the Virginia vein. The movement on the Virginia vein fissure apparently is small.

The Virginia vein is composed mainly of quartz and pyrite, but small amounts of galena, sphalerite, and chalcopyrite are commonly present. Uraniferous material is found in the parts of the vein closely associated with a layer of garnetiferous gneiss or adjacent to blocks of garnetiferous gneiss included in pegmatite. Chalcopyrite is particularly abundant in the branch vein cut 10 feet northeast of the Virginia, and a grab sample of about 3 inches assayed 0.12 oz gold and 3.74 oz silver per ton, and 7.13 percent copper.

The No. 4 vein strikes generally N. 57° W., and dips 50°-77° NE. It is along a fault on which apparent horizontal displacement ranges from 20 to 32 feet. The vein is as much as 2 feet wide, and in most places

consists of crushed rocks veined by late carbonates containing sparse broken crystals of galena and light-colored sphalerite. Locally, sulfides are abundant; tennantite, chalcopyrite, and pyrite occur in a quartz vein immediately southeast of a stoped part of the vein 60 feet from the crosscut, and massive galena-sphalerite-chalcopyrite veins, as much as 0.8 foot thick, occur in raise A-A' (fig. 64). Sooty pitchblende is locally abundant, and proustite occurs in thin films in winze A-A', and also with argentite(?) and chalcopyrite in raise A-A'. The paragenetic sequence of the common vein minerals, as observed in both hand specimens and polished sections, is: pyrite, sphalerite, chalcopyrite, tennantite, galena, a second generation of sphalerite, and carbonates.

Sooty pitchblende occurs in the No. 4 vein almost continuously over a strike length of about 200 feet, starting 80 feet southeast of the crosscut. The distribution coincides almost exactly with that of the garnetiferous gneiss in the walls of the vein. The maximum uranium content is near section A-A', and here a 1-foot section of the vein contains 0.3 percent uranium. Chip and grab samples of veins containing visible sooty pitchblende, principally the No. 4 vein (table 18), contain from 0.003 percent to 0.45 percent uranium, and commonly more than 0.02 percent.

The Golconda vein is now exposed along a drift length of only about 140 feet. The main Golconda ore shoot, according to Bastin and Hill (1917, p. 316), was farther to the west of the crosscut tunnel, and extended about 250 feet along the drift. The ore consisted of pyrite, chalcopyrite, some tennantite, galena, and sphalerite, and the vein along the shoot was as much as 18 inches wide. No uranium was noted in the accessible part of the Golconda drift, but uranium minerals were noted in the shallow surface workings on the vein. Thin layers of garnetiferous gneiss are exposed in one of the shafts, and at this shaft the vein shows some anomalous radioactivity and contains thin coatings of a torbernitelike mineral. One thin veinlet of hard lustrous pitchblende was noted in the dump material at the Golconda shaft (E-II, 7). The main layer of garnetiferous gneiss exposed along the No. 4 vein in the tunnel projects toward the caved south drift of the Golconda vein; it seems likely that, if the layer reaches the vein, uranium minerals will also be found in this part of the Golconda vein.

Mary mine

The Mary mine (E-II, 14) is on the west side of Fall River, 2,000 feet southeast of the Golconda tunnel. The mine is a crosscut adit having approximately 1,400 feet of crosscuts or drifts, at an altitude of 8,191 feet. The adit, at one time called the Philips tunnel (Bastin and Hill, 1917, p. 313), was driven to develop the Lucky group of six claims. The tunnel exposes four main veins, which, because of uncertain correlation with the surface claims, will be numbered consecutively according to distance from the portal. The course of the tunnel is irregular, but it trends generally westward (fig. 65). At the time

Table 18.--Results of sampling in the Golconda tunnel

[Tr, trace; n.d., not determined. Analysts: H. E. Bivens, R. F. Dufour, S. P. Furman, W. L. Goss, E. C. Mallory, R. McClure, J. P. Schuch, D. L. Skinner, and J. E. Wilson]

Sample No.	Sample locality	Length of sample (ft)	Length of sample (in.)	Type of sample (C, chip; G, grab)	eU (percent)	U (percent)	Au (oz per ton)	Ag (oz per ton)	Cu (percent)	Pb (percent)	Zn (percent)	Remarks
3	No. 4 drift near foot of raise A-A', NW. wall just above timber.	1		C	0.050	0.037	0.08	5.50	0.27	0.43	n.d.	
4	No. 4 drift, to W. of raise A-A'------	1		C	.24	.30	.02	6.33	.12	.28	n.d.	
26	No. 4 drift, 85 ft from crosscut------		11	C	.066	.050	.04	11.72	.22	.31	1.00	
29	No. 4 drift, 140 ft from crosscut-----	1		C	.033	.044	Tr	3.80	.24	.17	.61	4 in. of pyritic garnet rock on footwall, 6-7 in. of carbonate gangue containing sulfide fragments, and 1 in. of sooty pitchblende on hanging wall.
30	----do----------		1	G	.29	.45	n.d.	n.d.	n.d.	n.d.	n.d.	Sooty pitchblende on hanging wall.
31	No. 4 drift, 105 ft from crosscut-----	1		C	.065	.083	.06	5.44	.27	.91	1.57	Includes sooty pitchblende and some wallrock.
32	----do----------		2	G	.19	.29	n.d.	n.d.	n.d.	n.d.	n.d.	Do.
43	No. 4 drift, cross vein----------	1		C	.002	n.d.	.08	.32	.20	.06	.20	6 in.; mostly pyrite; some chalcopyrite, galena, and sphalerite.
45	No. 4 vein, 195 ft from crosscut------	1.2		C	.072	.075	.06	.66	.03	.25	1.06	
46	No. 4 vein, 250 ft from crosscut------	2		C	.050	.067	.06	.66	.04	.35	1.85	
6	Winze A-A'----------		9	G	.019	.012	.03	1.89	.22	.79	n.d.	
10	----do----------	.7		C	.028	.037	Tr	2.54	.09	.22	n.d.	
11	----do----------	.3		C	.20	.29	Tr	2.36	.06	.36	.97	
13	----do----------		6	C	.002	n.d.	2.46	32.24	.12	1.34	2.30	0.5 ft of silicified wallrock containing chalcopyrite, galena, and tennantite.
14	----do----------		1	G	.007	.007	n.d.	n.d.	n.d.	n.d.	n.d.	Gray gouge seam on footwall of vein.
15	----do----------		6	C	.007	.003	Tr	.54	<.01	.22	1.13	
16	----do----------	.8		C	.051	.046	Tr	.26	<.01	.15	.87	
17	----do----------	.4		C	.014	.009	n.d.	n.d.	n.d.	n.d.	n.d.	Mainly sooty pitchblende near junction of 2 fractures.
18	----do----------		.5	G	.019	.022	n.d.	n.d.	n.d.	n.d.	n.d.	Sooty pitchblende-gouge stringer.
47	Raise A-A'----------	1		C	.088	.12	n.d.	n.d.	n.d.	n.d.	n.d.	Sooty pitchblende stringers on both vein walls; pitchblende coats carbonate vein fragments.
48	----do----------	.8		C	.044	.042	Tr	7.68	.69	2.10	1.32	0.8-ft sulfide-bearing vein in footwall.
49	----do----------	1		C	.005	.004	.04	9.96	.19	.22	1.12	Some sulfides in footwall.
37	Raise B-B'----------	1		C	.001	n.d.	.04	.60	.05	n.d.	n.d.	
38	----do----------	.6		C	.002	n.d.	Tr	.52	.08	n.d.	n.d.	
39	----do----------	.55		C	.002	n.d.	.40	4.40	.05	n.d.	n.d.	
41	----do----------	.6		C	.001	n.d.	.06	.74	.06	n.d.	n.d.	
42	----do----------	.8		C	.002	n.d.	2.66	32.72	.61	1.21	.45	0.25-ft galena-sphalerite vein on hanging wall.
22	Virginia drift----------			G	.16	.19	n.d.	n.d.	n.d.	n.d.	n.d.	
24	----do----------	.4		G	.18	.23	n.d.	n.d.	n.d.	n.d.	n.d.	
25	Steep vein in Golconda crosscut, 10 ft NE. of Virginia vein.		3	G	<.001	n.d.	.12	3.74	7.13	n.d.	n.d.	
33	Virginia vein----------	1		G	.006	.006	n.d.	n.d.	n.d.	n.d.	n.d.	Sooty pitchblende streak.

of the authors' visit, bad air prevented a complete examination of the mine, and this description and the map of the mine are based in part on data furnished by the U.S. Atomic Energy Comm.

The history of the Mary mine is imperfectly known. In 1911-12 the adit was 435 feet long, and the pyritic ore, reported by Bastin and Hill (1917, p. 313) to average about $5.00 a ton in gold, was treated in a stamp mill nearby. In about 1950 a prospector found pitchblende on the Mary dump, and a limited amount of rehabilitation was undertaken by the U.S. Atomic Energy Comm. in order to evaluate the deposit.

The wallrock exposed in the first 890 feet of the Mary adit is Tertiary hornblende granodiorite porphyry, which is part of the large stock exposed along Fall River about 1 1/2 miles from the mouth of Clear Creek. From about 890 to 1,010 feet the adit is in biotite gneiss, and from 1,010 feet to the face it is in garnetiferous gneiss containing some interlayered biotite gneiss.

The No. 1 vein is exposed for 150-300 feet. It is not a discrete vein, but rather a series of veinlets along west-northwest-striking joints characteristic of the porphyritic wallrock. The joints contain veinlets of pyrite, and pyrite also is disseminated in soft altered porphyry in the vein zone. Similar veinlets containing pyrite and molybdenite were noted in the dump rock, and may have come from the No. 1 vein. The No. 2 vein, cut 405 feet from the portal, is along a better defined structure. The vein strikes about N. 77° W., and dips about 65° NE. As exposed in a 180-foot drift north of the crosscut, it consists of 6 inches-1 foot of quartz, pyrite, and gouge. It has not been stoped from the adit level, but a raise has been excavated from a point about 95 feet to the west, along the drift. The No. 3 vein was cut about 530 feet from the portal, and is followed by the adit for 510 feet. It strikes about N. 65° W., dips 80° N. to almost vertical, and is similar in width and mineralogy to the No. 2 vein. Raises have been driven at about 285 and 500 feet along the drift. Most of the No. 3 vein is in porphyry walls, but the last 150 feet of drift is in the Precambrian rocks. At the end of the drift on the No. 3 vein, the adit swings southwestward and follows the No. 4 vein, which strikes about N. 63° E. and dips steeply to the northwest. The No. 4 vein is predominantly in garnetiferous gneiss wallrock and is abnormally radioactive or contains visible uranium minerals throughout much of its exposed length. The vein consists of a generally tight fracture on the hanging wall of a 1- to 2-foot breccia zone. The pitchblende occurs in different ways along the vein. A hard botryoidal variety occurs in closely spaced branching fractures, particularly at 130 feet along the drift. A sooty variety occurs with carbonates, particularly in a cross vein exposed at the face, and a partly soft or sooty variety occurs in the footwall along the No. 4 vein. Besides pitchblende, the No. 4 vein contains sparse pyrite; marcasite, sphalerite, chalcopyrite, and galena occur in a fine-grained form visible in polished sections.

Other mines

Berry mine

The Berry mine (F-III, 7) is on the west side of Fall River, about 1,600 feet northwest of the Dubuque mine. Workings consist of two adits. The lower adit, now caved at the portal, was approximately 620 feet long when visited by Bastin and Hill (1917, p. 309). The upper adit, at an altitude of 7,860 feet (fig. 66), is about 190 feet long. A small part of the vein was underhand stoped in the upper adit, but no stoping was reported for the lower adit, and production must have been very small.

The vein exposed in the upper adit strikes N. 40°-60° E., dips generally 40° NW., and cuts obliquely through the foliation of microcline gneiss containing sparse conformable amphibolite layers. The vein is a pyritic type. It generally consists of disseminated pyrite along a sheared and altered zone 6 inches-2 feet wide, but in a short drift on a branch vein 75 feet from the portal it consists of quartz and quartz-pyrite veinlets in pyritic wallrock, and is as much as 3 feet wide. Some of the pyrite is rather coarse and is typically subhedral. Other sulfides were not noted, but copper sulfate stains the vein at several places, so copper sulfides are probably present in trace amounts. Judged from Bastin and Hill's (1917, p. 309) description, the vein in the lower tunnel is similar in width and in mineralogy to that in the upper adit.

Dubuque mine

The Dubuque mine (F-III, 9) is on the west side of Fall River, approximately 1,800 feet north of the junction of Fall River and Clear Creek. The workings consist of a short adit at an altitude of about 7,865 feet, and a 650-foot adit (fig. 67) at an altitude of 7,840 feet. Although there is no recorded production from the mine, approximately 40 feet of the vein exposed in the lower adit has been stoped.

The country rock is principally microcline gneiss that contains some granite gneiss and pegmatite and is cut by a short Tertiary quartz monzonite porphyry dike. Adjacent to the vein, both the microcline gneiss and the Tertiary porphyry generally contain abundant disseminated pyrite and locally are silicified. The quartz monzonite porphyry follows the branch vein exposed at the portal and forms the right-hand wall of the adit for 100 feet, where the vein leaves the drift; what is inferred to be the same dike is picked up again at 225 feet from the portal, but here it follows the main fault; the porphyry apparently pinches out about 265 feet from the portal.

Vein and fracture system.--The vein and fracture system in both adits is complex. The main structure is a fault that strikes generally N. 70° W. and dips 65°-70° NE. This fault is intersected in the lower adit at 235 feet from the portal, and is metalized from 270 feet to the

face. Subsidiary branching fractures that trend about N. 50° W. and dip about 60° NE. project southeastward from the main fracture. The portal of the lower adit and the entire length of the upper adit are on these branch fractures, as may also be a shaft on a strong pyritic vein on the east side of Fall River, approximately 900 feet southeast of the Dubuque mine. The main fault is either the direct continuation or a main branch of the Idaho Springs fault, which can be traced eastward for several miles. The barren to weakly mineralized northwest fracture exposed just east of Fall River, in the Dover and Philadelphia tunnels (Bastin and Hill, 1917, p. 306-308 and fig. 60), is probably a closely related structure. To the west, the fault is generally concealed, but it is marked at least locally by quartz monzonite porphyry dikes, and is exposed as the Great West(?) vein on the ridge above Clear Creek and as the first crosscutting vein in the Silver King Extension mine near Spring Gulch.

Ore deposits.--The veins exposed in the lower Dubuque adit range in width from a few inches to 5 feet, and consist principally of sheared pyritic wallrock or fine-grained gray pyritic quartz. The vein exposed at the portal strikes about N. 46° W. and dips 53° NE.; it is as much as 1 1/2 feet wide, but is apparently of low grade and has been stoped for only a few feet near the portal. The vein leaves the north wall of the drift about 100 feet from the portal, but a subparallel vein comes in on the south wall at 110 feet and is followed for about 130 feet to its junction with the main Dubuque fault or vein. The Dubuque fault, which strikes about N. 70° W., seems to be barren east of the junction, but is mineralized continuously to the west. It reaches a maximum width of 5 feet about 390 feet from the portal; apparently the widening of the vein is due to the intersection of a steep (70°-80°) fracture and a flatter (50°-60°) nearly parallel fracture forming a virtually flat shoot that continues to within about 485 feet of the portal, where the vein splits into two branches.

Locally, the veins exposed in the Dubuque mine contain metallic minerals other than pyrite. At about 325 feet from the portal the vein is dominantly gray quartz and pyrite, but contains, in addition, scattered crystals of galena, and is cut by almost microscopic veinlets of tennantite. Polished sections indicate that sphalerite and chalcopyrite are also present, and show a paragenetic sequence of pyrite, [fracturing], sphalerite, chalcopyrite, tennantite, and galena.

Gold Quartz mine

The Gold Quartz mine (E-I, 2), also known as the Ivan Gold, is on the west side of Fall River, about 1,000 feet north-northwest of the Almaden mine, at an altitude of about 8,345 feet. The workings consist of a drift adit that trends N. 70° W. for 380 feet, from which point a brecciated shear zone is followed S. 65° W. for 220 feet, where the adit is caved (fig. 68). According to the late Ivan Johnson, former owner of the mine, a parallel vein (the Ingham) (E-I, 3) is intersected by the

Gold Quartz adit a short distance beyond the caved drift.

The Gold Quartz vein strikes N. 70° W., and dips 85° NE. The vein varies but little in strike, but the dip flattens to 59° in one place. The vein generally consists of 1/2-6 inches of gouge and bunches of quartz, pyrite, and sphalerite. Stoping is confined almost entirely to an area between 60 and 110 feet from the portal, where, according to Johnson, a small amount of free-gold ore was found. A cross veinlet 120 feet from the portal is radioactive, but although a count of more than 0.2 mr per hr was registered with a Geiger-Müller counter no uranium minerals could be identified.

The wallrock in the Gold Quartz adit is predominantly biotite gneiss that locally is migmatitic. The adit intersects a 3 1/2-foot-wide bostonite dike at 490 feet from the portal. The dike strikes N. 65° W., and is noticeably radioactive--a reading of nearly 0.02 mr per hr being registered on a Geiger-Müller counter.

The total production from the mine is not known, but it is believed to have been small, and was probably confined to the small stoped area near the portal.

Jumbo mine

The Jumbo mine (F-I, 4) is near the head of the middle fork of York Gulch, at an altitude of 9,147 feet. The mine is opened by a near-vertical shaft that is about 188 feet deep; short levels are at 52 and 76 feet, and a longer level is at 175 feet. A small production was recorded by the Idaho Springs Sampling Works: 5.75 tons of ore shipped in 1921 and 1939 contained 11.3 oz gold, 262.8 oz silver, 732 lb lead, and 48 lb zinc.

The ore minerals observed on the dump were galena, sphalerite, and pyrite. Paragenetic relations are shown well by some of the dump specimens. Quartz, locally showing comb structure, was the first mineral deposited, and was succeeded by pyrite, which in turn was followed by galena and sphalerite. Small veinlets of carbonate cut the galena-sphalerite ore. In some specimens the galena-sphalerite ore is deposited in open spaces in quartz-pyrite veins, but one specimen shows a 1/2-inch galena-sphalerite vein cutting across a 1-inch quartz-pyrite vein that contains sparse galena.

Magdalena mine

The Magdalena mine, in the upper east fork of York Gulch, consists of a caved inclined shaft that connects with the Magdalena tunnel (F-II, 2) (fig. 69). The tunnel, which is at an altitude of about 8,900 feet, is about 1,610 feet long. It is partly a crosscut and partly a drift tunnel on the Magdalena, or L. D. B., vein. It is entirely in interlayered biotite gneiss and migmatite that generally

strikes northeast and dips northwest. Local changes in dip and strike are caused by drag folds that plunge west to west-southwest and are well exposed in the first 150 feet of the tunnel, and by small northeast-trending folds. There is no recorded production from the mine, but about 100 feet of the vein on the tunnel level has low overhand stopes.

The Magdalena vein is intersected 260 feet north of the portal, and the tunnel then follows the vein northeastward for about 600 feet. A short lateral driven westward from about 210 feet also intersects the vein, and connects the tunnel with the shaft workings. From 260 to about 580 feet, the strike of the vein varies from about N. 20° to 65° E., and the dip is 35°-58° NW. From 580 to about 840 feet, the vein strikes about N. 52° E. and dips 60° or more NW. The sinuous and somewhat flatter part of the vein varies in width from 3 inches to 1 foot, and contains pyrite and, locally, other sulfides; the straight and steeper part is tight, and consists mostly of gouge. Typical vein material along the mineralized parts of the vein consists of highly sericitized pyritic biotite gneiss cut by veinlets of pyrite, some chalcopyrite, and carbonates. Specimens of similar material seen on the dump show that, in addition, thin stringers of steel galena and dark sphalerite cut the sericitic vein material. About 460 feet from the portal, a barren vein or fault consisting of talclike gouge splits from the Magdalena vein and has been followed eastward by a drift that is accessible for about 170 feet. A barren vein or fault is cut about 1,380 feet from the portal. The vein strikes N. 51° E., is 1 foot wide, and consists mainly of gouge and sheared migmatite cut by numerous carbonate veinlets.

Martha-Mandolina vein

The Martha vein, which strikes about N. 85° E. and dips 50° NW., is exposed in a 120-foot drift adit (F-III, 1) on the west side of Fall River, opposite the mouth of York Gulch. It is probably the westward continuation of the Mandolina vein, exposed east of Fall River, about 500 feet from the Martha mine. The Mandolina vein is developed by an adit (F-III, 2) about 645 feet long, at an altitude of about 7,990 feet; the adit crosscuts S. 40° E. for 45 feet to the vein, and then follows the vein eastward for about 600 feet (fig. 70). There is no recorded production nor evident stoping on the vein.

The wallrock in the Mandolina mine is almost entirely microcline gneiss, although some sheared pegmatitic rock is exposed on the footwall of the vein, near the portal. The foliation of the gneiss generally strikes north to northwest, and dips to the west.

The Mandolina vein strikes N. 85° E. for 180 feet, turns to about N. 80° E. for 320 feet, and then splits into two branches; the south branch strikes almost due east, the north branch about N. 70° E. In general, the vein dips about 50° N., and contains ore minerals. In

places it is composed of coarse and medium-coarse pyrite in a quartz gangue, but the characteristic filling is fine-grained quartz that contains fine-grained pyrite and local galena, and is cut by veinlets of dark sphalerite. Samples of the two types of filling show that neither contains more than trace amounts of gold and silver, but that the more typical contains as much as several percent lead and zinc:

Sample No. and description	Length	Equivalent uranium	Gold	Silver	Copper	Lead	Zinc
	(feet)	(percent)	(oz per ton)		(ppm)	(percent)	
1. Quartz-pyrite--	0.3	0.002	Trace	Trace	50	0.04	0.15
2. Fine-grained sphalerite-bearing vein.	.15	.001	0	0.10	500	1.24	6.15
3. ----do---------	.2	.003	Trace	Trace	450	.36	3.25

Pennsylvania tunnel

The Pennsylvania tunnel (F-II, 12) is on the east side of Fall River, about 1,600 feet northwest of the mouth of York Gulch, at an altitude of about 8,000 feet. It trends N. 38° E. for 285 feet, and then swings almost due north for more than 1,600 feet (fig. 71). The tunnel was designed to intersect the Pennsylvania, Saginaw (F-II, 8), Eagle (F-II, 4), Jumbo (F-I, 4), and other veins at depth, but these objectives were only partly attained. The face of the tunnel is about 3,000 feet short of the Eagle vein (of the Fall River area), and an even greater distance short of the Jumbo. The tunnel did cut the Pennsylvania, Saginaw(?), and other veins; there is a total of about 1,000 feet of drifts, 570 feet of which is on the Pennsylvania vein.

The wallrock is mainly biotite gneiss. Concordant bodies of granite gneiss and pegmatite are exposed along the north-trending part of the tunnel, and the upper part of the microcline gneiss is exposed in the east end of the Pennsylvania drift. The strike of the foliation ranges from about N. 30° W. to N. 58° E.; much of it strikes north to N. 10° E. All dips, except small-scale reversals on drag folds, are to the west.

The Pennsylvania vein, the most important in the tunnel, consists of a series of fractures that strike slightly north of west and dip 50°-64° to the north. Near the crosscut, the vein is composed of two distinct branches about 40 feet apart; these branches are cut and displaced about 30 feet by a nearly barren north-striking fault. Eastward, the two main branches are inferred to come together about 185 feet from

the crosscut, but the vein remains a composite type or lode throughout the drift. Individual veins in the composite structure are as much as 1 foot wide, but generally less than half of an individual vein is composed of sulfide-rich material. Although pyrite is the most common sulfide, galena and sphalerite are present locally. Part of these latter minerals is in veinlets cutting quartz-pyrite vein material, but some veins are composed of intergrown pyrite, sphalerite, and galena, in a quartz gangue, and the sulfides appear about contemporaneous. The drift contains radon, and a grab sample of a 3-inch vein 200 feet east of the crosscut contained 0.007 percent equivalent uranium, as well as 0.06 oz gold per ton.

In all, 15 other veins or faults are cut by the tunnel; most are small, and contain only a small amount of pyrite. A very small north-striking vein exposed 110 feet from the portal contains quartz and molybdenite, and two of three veins cut between 1,600 and 1,700 feet show small amounts of sulfides other than pyrite. One of these, the vein cut at about 1,700 feet, is possibly the Saginaw vein, and it has been drifted on for about 250 feet east of the tunnel. About 140 feet east of the tunnel, a 1 1/2-inch galena-sphalerite-gray quartz vein is frozen to the footwall, and at the face the more north striking split contains a 2-inch vein composed of quartz, pyrite, chalcopyrite, and some galena.

Polar Star mine

The Polar Star mine (E-I, 5) is on the northeast side of Fall River, about 2 3/4 miles above its junction with Clear Creek. The mine is opened by an adit that trends northeast for more than 300 feet (fig. 72). The adit follows a northwest-dipping barren fracture for 240 feet, where the fracture feathers out into the foliation. A weakly mineralized fracture that strikes N. 13° W. and dips 60°-63° NE. is cut 190 feet from the portal. This northwest-striking fracture contains minor amounts of pyrite, galena, and sphalerite, in a quartz-carbonate gangue.

The wallrock in the adit is mostly biotite gneiss, whose foliation is nearly parallel to the trend of the adit. A small mass of quartz monzonite porphyry is cut near the portal, and the last 20 feet of the adit is in granite gneiss and pegmatite.

No production from the property is recorded.

Saginaw mine

The Saginaw mine is in York Gulch, about 1,700 feet north of the American-Standard vein (fig. 2). Workings consist of an adit (F-II, 8) at an altitude of 8,340 feet and accessible for about 180 feet (fig. 73), a caved shaft at road level, and a shallow shaft 100 feet southwest of the adit. No production is recorded for the mine, but the vein has been stoped and so probably produced ore before 1902.

As exposed in the adit, the Saginaw vein strikes about N. 70° E. and dips 40°-45° NW., cutting obliquely across the foliation of biotite gneiss and interlayered granite gneiss and pegmatite bodies. For the first 115 feet, the vein is composed mainly of quartz and pyrite; at 105 feet it is composed of 8 inches of quartz and medium-grained pyrite bounded by a 1/2-inch gougy slip on the hanging wall. Beyond 115 feet, the vein contains galena and sphalerite, and at 160 feet it contains 3 inches of gray quartz, and galena, sphalerite, and some pyrite. A barren siliceous vein that strikes north and dips 37° W. is cut at 165 feet from the portal. The Saginaw vein has been stoped from 160 feet and is inaccessible beyond 180 feet. As previously noted, the vein that is cut at about 1,700 feet in the Pennsylvania tunnel is possibly the Saginaw.

Standard tunnel

The portal of the Standard tunnel (E-II, 5) is near the bed of Fall River, at an altitude of 8,240 feet. The tunnel is a north-trending crosscut more than 1,300 feet long (fig. 74); bad air prevented examination of more than the first 860 feet in 1953, and this description is based partly on Bastin and Hill's (1917) survey. The wallrocks for the first 550 feet are mainly biotite gneiss, including a hornblende-bearing type, granite gneiss and pegmatite, and migmatitic gneiss; from 550 to 1,050 feet the tunnel is mostly in hornblende granodiorite porphyry, and from 1,050 feet to the face, probably mostly in granite gneiss and pegmatite (mapped as mainly pegmatite by Bastin and Hill (1917, fig. 62)).

A series of west- to northwest-trending veins is cut in the part of the tunnel accessible in 1953, but only three were well-enough mineralized to warrant stoping. Most of the veins observed were a pyritic type, although Bastin and Hill (1917, p. 313-314) stated that a vein (No. 11) near the face is a galena-sphalerite type. Bastin and Hill (p. 315) also reported that chalcopyrite and tennantite were present in some of the veins.

Ore shipped from the mine prior to 1912 was of value chiefly for gold, and most is believed to have been taken from the No. 2, or Standard, vein (fig. 74). Several small lots of ore, probably from the No. 11 vein, had high silver values. Five tons of silver ore shipped in 1916 contained 0.17 oz gold and 1,005 oz silver, and three tons shipped in 1919 contained 0.05 oz gold and 811 oz silver. According to Bureau of Mines records, more than 926 tons of ore produced from 1903 to 1939 contained 294.19 oz gold and 3,545 oz silver, and small amounts of copper, lead, and zinc (table 19).

A small amount of anomalous radioactivity was noted on the Standard dump, but the source of the radioactive material was not located in the mine.

Table 19.--Production of the Standard tunnel, 1903-39

[---, no production recorded]

Year	Crude ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
1903--------	600	101.00	225	------	------	------
1910--------	6	5.78	90	------	------	------
1916--------	>52	64.96	1,551	53	1,062	------
1917--------	22	12.96	286	------	158	------
1919--------	3	.05	811	13	647	79
1922--------	1	------	121	4	123	------
1926--------	1	2.18	32	------	------	------
1934--------	27	20.10	65	------	------	------
1935--------	160	71.98	292	------	------	------
1936--------	20	11.81	41	------	------	------
1939--------	34	3.37	31	------	------	------
Total-----	>926	294.19	3,545	70	1,990	79

Washington tunnel

The Washington tunnel (E-II, 13), at an altitude of 8,150 feet, is on the east side of Fall River, about 3,700 feet northwest of the Pennsylvania tunnel. The tunnel (fig. 75) trends N. 38° E. for its entire length, reportedly (Bastin and Hill, 1917, p. 313) 1,080 feet; in 1953, only 910 feet was accessible.

The wallrock is partly migmatitic biotite gneiss, some of which contains amphibolite. The foliation generally strikes northeast and dips to the southeast, toward the Bald Mountain synclinal axis which crosses Fall River a short distance southeast of the tunnel. The first 410 feet of the tunnel is driven along a steeply dipping almost barren fracture zone; at about 390 feet, the fracture leaves the tunnel, and is followed into the east wall by a 60-foot drift. In this drift the fracture is somewhat mineralized and contains as much as 6 inches of gray quartz, and pyrite and sparse chalcopyrite. Horizontal movement along the fracture is indicated by the displacement of a 2-inch white quartz-pyrite vein, first cut at 55 feet from the portal. The fault, however, does not displace a northeast-trending galena-sphalerite vein that apparently crosses the fault at 240 feet. The tunnel intersects a 1-inch quartz-pyrite vein at 560 feet. At about 890 feet, a northeast-striking vein that contains coarse pyrite is apparently cut off by a pyritic vein that strikes N. 40° W. and dips 48° NE. According to Bastin and Hill (1917, p. 313), two small veins are exposed at 950 feet. One, which strikes N. 13° W., is about 6 inches wide, and contains disseminated pyrite; the other, which strikes N. 68° W., is unmineralized.

Other mines and prospects--tabular summary

Data on some other mines in the Fall River area are shown in table 20. The Clifford mine probably has about 1,000 feet of workings, and it and the Ingham mine have had some production; however, it is not recorded.

Table 20.--Small mines and prospects, Fall River area

[* indicates source listed in Remarks and references column;
--- indicates no information available]

Name	Locality No. (fig. 2) and general location	Mine workings	Vein			Remarks and references
			Strike	Dip	Mineralogy	
Aztec(?)----------	F-II, 9; Fall River, between Washington and Pennsylvania tunnels.	Adit----------	---------	------	Gray quartz, green sphalerite, galena.	
Bald Mountain(?)-------	F-I, 3; 1,400 ft NNW. of Jumbo mine; alt. approx. 9,580 ft.	Shaft----------	---------	------	----------	
Clifford----------	E-I, 9; upper York Gulch; alt. 9,320 ft.	Vertical shaft, about 900 ft of drifts.	N. 60° E.	About 90°.	Gray quartz, barite, sphalerite, galena. *Molybdenite.	Undoubtedly some production before 1900. *K. Baker (oral commun., 1963).
Ingham----------	E-I, 3; upper Fall River-------	Drift adit and shaft. Adit is 630 ft long; shaft, 120 ft deep.	E.-W-----	45° N.	----------	High-grade gold, silver, base metals (sampling works assays reported by Broadman (1904)).
Maple Leaf----------	F-I, 1; 700 ft N. 55° E. of Clifford.	Shaft----------	1/ E.-W---	------	Similar to that of Clifford mine.	
Western(?)----------	E-I, 8; 850 ft S. 17° E. of Clifford.	----do----------	1/ E.-W---	------	----do----------	

1/ Approximate.