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THE GEOLOGICAL SURVEY OF WYOMING
Gary B. Glass, State Geologist

MINERAL DEPOSITS OF THE ENCAMPMENT MINING DISTRICT, SIERRA MADRE, WYOMING - COLORADO

by
W. Dan Hausel

Report of Investigations No. 37
1986

Laramie, Wyoming

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Cover photograph - Station number 2 on the Ferris-Haggarty tramline, about 1902. The construction of this tramline was considered to be one of the greatest engineering feats of the early 1900s. The line began at the Ferris-Haggarty copper mine on the western flank of the Sierra Madre, crossed the 10,690-foot-high Continental Divide and ran down the eastern slope to the Boston-Wyoming smelter at Riverside. Eight hundred and forty ore buckets were suspended from the line to transport copper from the Ferris-Haggarty mine. Today, much of the tramline is gone, but a remnant of the tramline and its history is preserved at the Grand Encampment Museum in Encampment, Wyoming. (Photograph courtesy of The University of Wyoming American Heritage Center, Orlando Peterson collection.)

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Abstract

The Encampment mining district includes the entire Sierra Madre of southern Wyoming and extends a short distance south into Colorado. Production from the district is not known, but it probably approached 20 million pounds of copper, with some zinc, lead, silver and gold.

Based on geology, the district is divisible into two subdistricts, simply termed the northern and southern regions. The northern region is underlain by thick successions of Late Proterozoic miogeoclinal metasediments that unconformably overlie Archean (greater than 2.5 billion year [>2.5 b.y.] old) basement. The northern region is separated from the southern region by a major disconformity known as the Mullen Creek-Nash Fork shear zone. In places, the shear zone is greater than one-half mile wide. The southern region is underlain by Middle Proterozoic calc-alkaline metavolcanics (1.9 to 1.6 b.y. old). The Sierra Madre was intruded by granitic plutons 1.6 to 1.8 b.y. ago.

Mineral deposits and historic mines are numerous, totaling in the thousands. The recognized deposits can be classified as: (1) stratabound, (2) vein and pegmatite, (3) contact metamorphic and (4) undetermined.

Introduction

The discovery of copper in the Encampment district in 1874 led to the development of the Doane-Rambler mine several years later. The most important historic discovery in the district was made in 1897, when Ed Haggarty located limonitic gossan in quartzite. His discovery was later developed into the Ferris-Haggarty mine. This mine and essentially the entire district became dormant following declines in copper prices and the destruction of the Boston-Wyoming smelter in 1908.

According to Beeler (1903a, 1905a), the boundaries of the Encampment district completely enclosed the Sierra Madre of southern Wyoming, and extended south into the North Park Range to south of Pearl, Colorado. To the east, the historic district continued as far as the eastern slope of the Medicine Bow Mountains, enclosing nearly 2,500 square miles (sq mi) of mountainous terrane. But since the Medicine Bow Mountains have been subdivided into several smaller districts (for example, see Harris and others, 1985), only the Sierra Madre of Wyoming and the North Park Range of Colorado, comprising about 600 sq mi of Precambrian terrane, are presently included in the Encampment district (**Figure 1**).

Structurally, the Sierra Madre is a block of Precambrian rock that was uplifted during Laramide time. This Precambrian core consists of rock from two provinces that are separated by a major east-west-trending suture called the Cheyenne belt and known locally as the Mullen Creek-Nash Fork shear zone (Houston and others, 1968, 1983). North of the shear zone, Archean (>2.5 b.y. old) granites, gneisses and infolded metasedimentary and metavolcanic rocks are unconformably overlain by a thick clastic wedge of Early Proterozoic (<2.5-1.8 b.y. old) miogeoclinal and epicontinental metasediments. These Early Proterozoic metasediments include quartzite, metaconglomerate, metalimestone, metadolomite and phyllite, with lesser metavolcanics (**Figure 1**). The Early Proterozoic metasediments and the underlying Archean basement abruptly

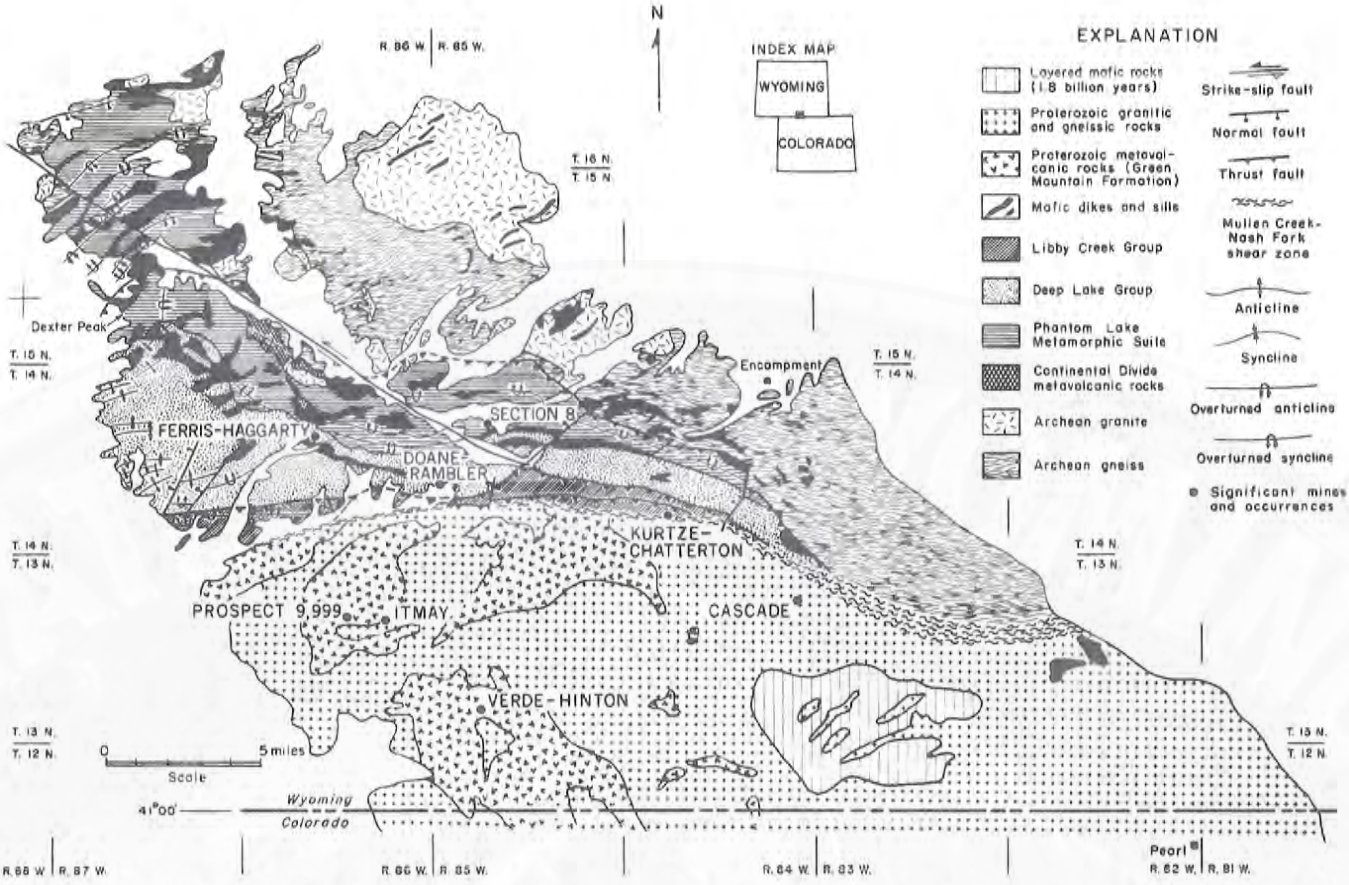

Figure 1. Generalized geologic map of the Sierra Madre, Wyoming (modified from Karlstrom and others, 1981).

terminate to the south at the shear zone. South of the shear zone, late Early Proterozoic eugeoclinal schists and gneisses form a thick suite of metavolcanics and volcaniclastics. These rocks are of calc-alkaline affinity and include metabasalts, meta-andesites and metarhyolites. At several localities these units retain relic volcanic textures (Divis, 1976).

Tectonic models for the Sierra Madre indicate a collision boundary between a continental margin and an island arc (Graff, 1978; Hills and Houston, 1979; Houston and Karlstrom, 1979). The Mullen Creek-Nash Fork shear zone marks that boundary. Although the Encampment district historically was relatively unproductive compared to many other base-metal districts in the western United States, similar Archean - Early Proterozoic boundaries and similar collision terranes have been prolific producers of metals worldwide (Hills and Houston, 1979).

Mineral deposits in the Encampment district are dominated by copper. North of the shear zone, the miogeoclinal sequence contains copper-bearing quartzite, pegmatites, quartz veins and uraniferous metaconglomerate; south of the shear zone, the eugeoclinal rocks host stratiform volcanogenic sulfides and related mineralization. The shear zone itself contains scattered, fracture-controlled base-metal deposits dominated by copper.

Mining history

The Encampment district (also known as the Grand Encampment district) was explored as early as 1868, when the first recorded mining claims were staked in the region. In 1874, pieces of copper float were found in the central Sierra Madre one-half mile north of Battle Lake, but the metal was not traced to its source until seven years later. In 1881, the float was traced to quartzite on the north bank of Battle Creek (Messerschmidt, 1972). A shaft sunk on the gossan cap intersected a rich pod of copper oxides and sulfides down dip. This deposit was developed into the Doane-Rambler mine.

The greatest copper producer in the district was discovered 16 years later, in 1897, when a similar gossan-stained quartzite was located 3.5 miles northwest of the Doane-Rambler mine. This gossan was developed into the Ferris-Haggarty mine. The mine was driven into an unusually rich copper ore body that contained traces of gold and silver (Beeler, 1905a).

To support mining at the Ferris-Haggarty, a 16-mile-long aerial tramway was constructed in 1902 (**cover photograph**) that ran from the Ferris-Haggarty mine on the western slope of the Sierra Madre, crossed the continental divide at an elevation of 10,690 feet and continued down the eastern slope to the Boston-Wyoming smelter at the town of Riverside in the Encampment-Saratoga valley (**Figure 2**). The tramway was constructed with 370 towers and 840 ore buckets; each of the ore buckets had a 2.5-ton capacity. The tramway had a 984-ton daily haulage capacity and the smelter had a maximum capacity of 500 tons of ore per day (Beeler, 1905a, p. 10; Armstrong, 1970). Tramway spurs proposed to connect the Doane-Rambler mine, in the Sierra Madre, and the New Rambler mine, in the Medicine Bow Mountains to the east, were never built because the Ferris-Haggarty closed permanently in 1908 following substantial drops in copper prices and the destruction of the Boston-Wyoming smelter by fire (Messerschmidt, 1972). The amount of copper mined from the Encampment district is unknown; however, from 1899 to 1908, 24 million pounds of copper were produced in Wyoming, nearly all from the Encampment district.

Regional geology and stratigraphy

Divis (1976, 1977), Hills and Houston (1979), Houston and Karlstrom (1979) and Karlstrom and others (1981) summarized the regional geology and tectonic setting of the Precambrian terrane of the Sierra Madre, and regional maps were prepared by Houston and Ebbett (1977) and Graff (1978). The Sierra Madre is split into a northern and a southern region by the Mullen Creek - Nash Fork shear zone. This zone of cataclastics is greater than one-half mile wide on the eastern slope of the mountains (Houston and Ebbett, 1977; Graff, 1978). The shear represents a major suture, and no rock units other than post-kinematic intrusives can be correlated across the zone. Based on the faulting out of a four-mile-thick section of the Libby Creek Group, and on the presence of large sheared blocks of Libby Creek Group rocks found 6.5 miles northeast of the present outcroppings, the vertical and left-lateral displacements are substantial (Hills and Houston, 1979). Pre- and post-tectonic granites in the shear indicate that tectonic displacement along this shear occurred between

Figure 2. The Boston-Wyoming smelter, pictured here in 1902, was constructed to support mining in the Encampment district. In 1908, the smelter was destroyed by fire and never rebuilt. (Photograph courtesy of University of Wyoming American Heritage Center (AHC), Laramie, Orlando Peterson collection.)

1,640 and 1,730 million years (m.y.) ago. The shear zone is interpreted to represent a collision boundary between the Archean craton to the north and the Proterozoic island arc to the south (Hills and Houston, 1979). Copper mineralization in the shear zone is chiefly fracture controlled and associated with faults (McCallum and Menzer, 1982).

North of the shear zone, Archean basement felsic gneisses contain infolded and interlayered metasediments and metavolcanics. These have been intruded by Late Archean granite and are older than 2.7 b.y., based on the ages of the intrusives (Graff, 1979). This Archean terrane is exposed along the northern flank of the Sierra Madre and continues to the south under Late Archean to Early Proterozoic miogeoclinal and epicontinental metasediments. The metasediments form a clastic wedge that is as much as eight miles thick. The metasediments are metaconglomerates, quartzites, phyllites, metalimestones and metadolomites, with minor metavolcanics, which were deposited in both marine and nonmarine environments. At least four sedimentation cycles have been recognized, each consisting of a lower quartz-pebble conglomerate with a fining-upward sequence (Graff, 1979). In the miogeoclinal terrane, mineral deposits of greatest interest are the uraniferous metaconglomerates and the cupriferous quartzites.

Rocks south of the Mullen Creek - Nash Fork shear zone include a 12,000-foot section of volcanogenic schists and gneisses mapped as the Green Mountain Formation (Divis, 1976, 1977; Swift,

1982; Schmidt, 1986). Many of these amphibolite-grade metavolcanics retain relict porphyritic, agglomeratic and vesicular textures (Divis, 1976). These Early Proterozoic metavolcanics are intruded by granite and granodiorite. The eugeoclinal metavolcanics are calc-alkaline and consist of metabasalt, meta-andesite and metarhyolite, with associated volcaniclastics (Schmidt, 1986). Volcanogenic massive sulfide deposits may offer the greatest economic potential in this region.

Houston and others (1975) and Graff (1978) subdivided the Sierra Madre into three geologic terranes: (1) a northern Archean gneissic and granitic terrane; (2) a northcentral terrane of miogeoclinal metasediments and associated metavolcanics; and (3) a southern terrane of Early Proterozoic eugeoclinal metavolcanics, synorogenic granites and layered gabbroic complexes located south of the Mullen Creek - Nash Fork shear zone **(Figure 1)**.

Lithologic units of the northern terrane have not been separated in **Figure 1** and are identified as Archean gneiss. The northcentral miogeoclinal terrane has been subdivided into formations by Graff (1978) and Flurkey and others (1981) **(Table 1)**. The southern eugeoclinal terrane includes metavolcanics and volcaniclastics grouped into the Green Mountain Formation **(Table 1)** and undifferentiated Proterozoic granitic and gneissic rocks **(Figure 1)**.

Mineral deposits

The principal mines of the Encampment district were described by Beeler (1903a, 1905a) and Spencer (1903a, 1903b, 1904). The early descriptive reports on the mineral deposits in the Encampment district attempted to classify the known deposits into types and emphasized the economic importance of the quartzite-hosted ore deposits. Based on the early descriptions and on general reconnaissance field work, the known deposits can be grouped into one of the following: (1) stratabound, (2) vein and pegmatite, (3) contact metamorphic and (4) undetermined.

Stratabound deposits

Stratabound deposits include volcanogenic sulfide mineralization, cupriferous quartzites, and paleoplacers. Among these occurrences, the cupriferous quartzites have been the most important.

Volcanogenic sulfide deposits

All but one of the known volcanogenic sulfide deposits in the Encampment district lie south of the shear zone in metavolcanics of the Green Mountain Formation and in undifferentiated Proterozoic gneisses. Volcanogenic sulfide deposits are found in the Fletcher Park and Hog Park areas of Wyoming, and many of the Pearl, Colorado, deposits are described by Spencer (1903b) as stratiform in gneisses and amphibolites.

In Fletcher Park, sulfides are associated with two volcanic cycles, each consisting of metarhyolite and meta-andesite overlain by exhalite (deposits interpreted to have been precipitated on the sea floor from volcanically derived fluids; exhalites described in this report have all experienced metamorphism in conjunction with their host rocks). One of these cycles, the Fletcher Park cycle, contains a zinc-copper-silver-garnet-epidote exhalite at a prospect located at 9,999 feet above sea level. Adjacent to the exhalite, the metavolcanics are intensely altered to epidote,

Table 1. Proterozoic-Archean stratigraphy of the Sierra Madre (after Flurkey and others, 1981, p. 416).

Rock unit	Formations	Thickness (in feet)	Description
Layered mafic rock	-----	-----	-----
Volcanogenic gneisses	Green Mountain Formation	12,000	Amphibolite-grade, calc-alkaline volcanics and volcaniclastics. Some relict vesicular agglomerate and porphyritic textures are preserved. Host to volcanogenic massive sulfides.
Cataclastics of the Mullen Creek-Nash Fork shear zone (1,730 to 1,640 million years old)			
Libby Creek Group	Slaughterhouse Formation	$\geq$ 3,700	Metadolomite, metachert, quartzite and metalimestone.
	Copperton Formation	$\geq$ 3,400	Quartzite and phyllite.
Deep Lake Group	Vagner Formation	1,280	Paraconglomerate, phyllite, quartzite and metacarbonate.
	Cascade Quartzite	1,800-4,800	Quartzite and quartz-pebble conglomerate. Host for copper at Doane-Rambler mine.
	Singer Peak Formation	0-2,650	Phyllite, quartzite, paraconglomerate and quartz-pebble conglomerate.
	Magnolia Formation	0-1,470	Quartzite, quartz-pebble conglomerate and phyllite. Quartzite is host to Ferris-Haggarty copper deposit. Basal conglomerate is uraniferous.
Phantom Lake Metamorphic Suite	Bridger Peak Quartzite	2,590	Quartzite, phyllite, metavolcanics, metacarbonate and pyritic quartz-pebble conglomerate locally.
	Silver Lake Metavolcanics	960	Mafic and ultramafic metavolcanics, paraconglomerate, mica schist, metagreywacke, metatuff, quartzite and metacarbonate. Host to Section 8 massive sulfide.
	Jack Creek Quartzite	960-2,560	Hosts some copper mineralization. Quartzite, phyllite, marble, paraconglomerate, quartz-pebble conglomerate and metagreywacke. The Deep Gulch conglomerate at base is pyritic and uraniferous.
Continental Divide Metavolcanics	-----	1,150	Amphibolite, metabasalt, hornblende gneiss; minor quartzite, schist and marble.
Older metamorphic rock	-----	-----	Metasediments, metavolcanics and biotite-plagioclase gneiss.

chlorite, calcite, garnet and actinolite (Nelsen, 1981).

The Itmay cycle in Fletcher Park has weak to moderate stratabound and fracture-related copper-silver mineralization associated with actinolite-epidote-magnetite exhalite (Lawrence, 1981). Near the collar of the Itmay shaft, sericitic alteration is intense adjacent to the magnetite-rich exhalite. The exhalite hosts localized massive sulfides consisting of colloform pyrite mantled by chalcopyrite in a matrix of magnetite with minor chlorite. Nearby, a distinct metavolcanic breccia with rock fragments up to eight inches across crops out (Figure 3) (Hausel, 1982).

These stratabound deposits are characteristically associated with some form of exhalite and may be spatially associated with volcaniclastics. The deposits near Pearl are poorly documented, but based on Spencer's (1903b) descriptions, these are stratiform deposits hosted by gneiss (volcanogenic?) and may be similar to the Fletcher Park and Hog Park volcanogenic sulfide mineralization.

Quartzite-hosted copper deposits

Quartzite-hosted copper deposits have been important economic deposits in the district. They all occur within the northcentral miogeoclinal terrane north of the shear zone. These include the Beulah, Doane-Rambler, Echo, Ferris-Haggarty, Finley, Gertrude, Leighton-Gentry and Investors (Umslopagus) group (see the following section on mines and occurrences). Some strike veins may also be genetically related to the quartzites, although these are poorly documented.

Probably the best documented of these stratabound cupriferous quartzites is the Ferris-Haggarty deposit. Mineralization at the Ferris-Haggarty mine consists of disseminated pyrite and chalcopyrite grains that occur along bedding planes of the host quartzite. However, the massive ore body mined at the Ferris-Haggarty was described by Spencer (1904) to lie along a quartzite-schist contact and to cross cut foliation. Based on the historic description, the ore may have been remobilized from the host quartzite during regional metamor-

Figure 3. This fragmental unit near the Itmay shaft is interpreted as a vent breccia.

phism and emplaced along the quartzite-schist contact by way of permeable fractures. The impermeable hanging wall schist formed a natural barrier to the ore solutions and produced an unusually rich ore body (**Figure 4**).

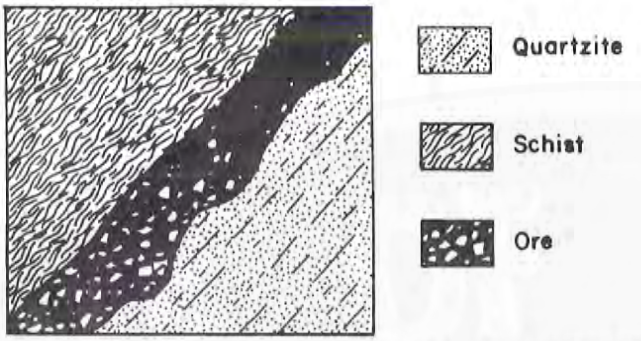

Figure 4. Schematic section of a Ferris-Haggarty ore shoot. Copper is localized within Magnolia Formation quartzite at the contact with hanging wall schist. (From Spencer, 1904.)

Nearly all of the known quartzite-hosted copper deposits in the Sierra Madre are in quartzites of the Deep Lake Group, but at least two occur in the Jack Creek Quartzite of the Phantom Lake Group. These deposits appear to be fairly widespread.

Paleoplacers

Quartz-pebble metaconglomerates north of the shear zone contain local paleoplacer pyrite, uranium and thorium. These paleoplacer occurrences have similarities to paleoplacers in the Blind River area of western Ontario and Witwatersrand, South Africa (Graff, 1978; Houston, 1978; Houston and Karlstrom, 1979). During the late 1970s and early 1980s, several uranium companies and some precious-metal companies prospected the district. Much of the exploration activity occurred after the downturn of the uranium mining industry, and the paleoplacers were only partially explored, with few drill holes completed.

The Sierra Madre quartz-pebble conglomerates were deposited in continental-margin basins by southward-flowing braided streams and other river systems (Graff, 1979). The basal conglomerate member of the Magnolia Formation (**Table 1**) is fluviatile, pyrite-bearing and radioactive over large areas. In places, the radioactive zones are as much as ten feet thick (Houston and Karlstrom, 1979). A conglomerate in the Phantom Lake Suite also is radioactive, but it is apparently not as mineralized as the basal conglomerate of the Magnolia Formation.

Substantial resources of uranium and thorium have been identified in the quartz-pebble conglomerates in the northern Sierra Madre and Medicine Bow Mountains. Resources estimated from scattered drilling and outcrop sampling are 3,860 tons of U_3O_8 at a cutoff grade of 100 parts per million (ppm) U_3O_8, and 8,350 tons of ThO_2 at a cut-off grade of 100 ppm ThO_2 (Karlstrom and others, 1981, p. 179-180).

The conglomerates have not been sampled in detail for gold, but similarities with the Witwatersrand, South African conglomerates indicate that they may have some potential for the precious metal. Incomplete sampling in the Sierra Madre and Medicine Bow Mountains show approximately 25 percent of the analyzed samples contain detectable gold, ranging from 0.01 ppm to 10 ppm with an average content of 0.37 ppm. The sample that assayed 10 ppm gold was collected in the Dexter Peak area of the northwestern Sierra Madre (**Figure 1**) (Karlstrom and others, 1981, p. 180).

Vein and pegmatite deposits

Most of the vein deposits in the Sierra Madre are reported in Archean rocks in the northern part of the range. These veins are reported to range from a few inches up to 100 feet wide. Quartz gangue may be accompanied by

calcite, limonite, hematite and(or) siderite. Sulfides include chalcopyrite and pyrite with lesser chalcocite and bornite. A few veins are dominated by argentiferous galena and a few were mined exclusively for gold and silver. Sphalerite is only rarely reported. For the most part, these are high-temperature veins formed during the Precambrian. Wallrock alteration has not been studied although thin selvages of chlorite and biotite have been reported along some vein contacts.

The great majority of these veins were mined for copper, but in the Purgatory Gulch area south of Encampment, a few narrow veins were mined for gold (Wied, 1960). Some cupriferous pegmatites were also mined in the district. Uranium-bearing pegmatites associated with vermiculite and rare earths were prospected for vermiculite on the east side of the district and south of the Mullen Creek-Nash Fork shear zone (Ray E. Harris, personal communication, 1985).

Contact metamorphic deposits

Contact metamorphic deposits consist of mineralized bodies formed along intrusive contacts. The intrusives are commonly gabbroic although some are granitic. Most of these deposits are small mineralized bodies localized along narrow contacts. At the Creede property (see page 13), Spencer (1904, p. 54) reported magnetite, pyrrhotite and chalcopyrite localized along a contact between hornblende schist and intrusive norite.

An irregular mineralized zone occurs along a northeast-trending contact between granite and a series of amphibolites and gneisses at the Broadway mine. Sulfides (sphalerite, galena, chalcopyrite and covellite) replace the amphibolite along a 1,000-foot zone.

Mines and occurrences

In 1901, more than 2,500 mines and prospects were reported in the district (Armstrong, 1970). Table 2 classifies the deposits. Only a few of the numerous mines and occurrences are briefly summarized in this section, where they are listed in alphabetical order. Many of the descriptions are abstracted from the original historical reports and may contain archaic rock terms. Legal descriptions are given where they are known.

Alma property

Located on the divide between Spring Creek and South Spring Creek, southwest of the Meta mine. An 18-inch-wide mineralized quartz vein trends east-northeast and dips 40°N to 60°N. The country rock consists of black schist, diorite, quartzite and alaskite dikes. (Several early authors use "diorite" for diabase, gabbro, amphibolite and other related rocks. The word is used in the following descriptions without quotation marks, but the reader should be aware of its possibly ambiguous meaning.) The vein contains galena, chalcopyrite and siderite (Spencer, 1904, p. 99).

Batchelder mine

Located in sec. 18, T.14N., R.86W., near the historic Dillon townsite. A series of quartzite, schist and gabbro layers strike east-west. According to Beeler (1905b), the rocks are replaced by lime and silica near a gabbro-schist contact. Beeler reported that the cupriferous rocks in a drift at the bottom of the 100-foot shaft dip north while at the surface the rocks dip south. The sulfides are in a quartz vein that is up to ten feet wide. Approximately 1,000 feet of workings were developed on the property (Beeler, 1905b).

Table 2. Classification of mineral deposits of the Encampment district.

Stratabound deposits

1. Volcanogenic sulfide deposits

Big Creek shaft*
Big Horn shaft*
Grand Republic mine*
Itmay mine
Prospect 9,999
Section 8 mine
Sierra Madre shaft*
Sun Anchor and Sweet claims
Swede group*
Verde-Hinton mine
SW1/4NE1/4 sec. 11, T.12N., R.85W.
SW1/4NE1/4 sec. 15, T.12N., R.85W.

2. Quartzite-hosted deposits

Beulah prospect
Doane-Rambler mine
Echo property
Ferris-Haggarty mine
Finley mine
Gertrude mine
Investors (Umsiopagus) property
Leighton-Gentry mine

3. Paleoplacers

Deep Gulch area
Dexter Peak area
Joes Park area
North Fork Savory Creek area

Vein and pegmatite deposits

Alma property
Batchelder mine
Big Chief group
Bonita prospect
Bridger mine
Cascade mine
Charter Oak mine
Continental group
Copper Gem prospect
Dreamland King group
Elkhorn mine
Eureka mine
Gold Coin prospect
Great Lakes claims
Hidden Treasure mine
Hub prospect
Independence group
Iron King prospect
Island City group
King of the Camp prospect
Kurtze-Chatterton mine
Lena Shields group
Meta mine
Mt. Zirkel shaft
Newton group
Newsboy claim
North Fork group
North Spring Creek prospect
Octivia prospect
Portland-Hercules mines
Purgatory Gulch mines
Standard mine
Syndicate mine
Tennant property
Three Forks group
SW1/4 sec. 9, T.12N., R.84W.
SW1/4 sec. 24, T.14N., R.84W
NE1/4 sec. 20, T.14N., R.83W.
SW1/4 sec. 25, T.14N., R.85W.
SW1/4NW1/4 sec. 2, T.12N., R.85W.

Contact metamorphic deposits

Broadway mine
Creede property
Wolverine shaft

Deposits of unknown origin

Blue Bell mine
Century mine
Colorado Belle group
D & L group
Copper Rock group
Cox Mine
Mohawk prospect
Monarch group
North Fork mine
SW1/4 sec. 24, T.14N., R.84W.
SE1/4 sec. 28, T.14N., R.83W.

* *Stratiform deposits in amphibolites and gneisses of undetermined origin.*

Beulah prospect

Located one mile north of Battle. Altered schists strike east-west, dip 45°N to 50°N and contain bands and stringers of quartz. A tunnel cut 15 feet of malachite-stained quartzite, which also contained spots and streaks of copper and iron sulfides (Beeler, 1901a).

Big Chief group

Located in sec. 18, T.14N., R.85W., and secs. 13 and 24, T.14N., R.86W., on the flank of Bridger Peak. Copper-carbonate-stained quartz veins cut schist and diorite. One large vein is about 15 feet wide and has a four- to five-inch gouge zone in the south wall. The heaviest mineralization occurs in a one-foot-wide zone next to the gouge. The schist strikes east-west and dips 45°S to vertical (Beeler, 1902a).

Big Creek shaft

Located two and one-half miles northwest of Pearl. A 145-foot shaft was sunk on a N60°W-trending, nearly vertical calcite-bearing vein in granite-gneiss country rock. The vein carries some chalcopyrite and sphalerite and apparently is associated with a hornblende-rich unit (Spencer, 1903b).

Big Horn mine

Located about three miles south of Pearl (Figure 5). The Big Horn shaft intersected a chalcopyrite-bearing amphibolite unit that is conformable to regional foliation. The amphibolite varies from 18 to 36 inches wide and encloses fragments of the country rock schist that is also mineralized up to three feet from the amphibolite (Spencer, 1903b).

Blue Bell mine

The location of the mine is not known. Some ore mined from the Blue Bell property was reported to contain five percent cobalt (Armstrong, 1970, p. 2).

Bonita prospect

Located in secs. 25 and 36, T.15N., R.85W. Quartz veins on the Bonita property cut mica schist and red granite. A two- to eight-inch-thick vein carries limonite, hematite, malachite and a small amount of gold (Beeler, 1901d).

Figure 5. Early photograph of the Big Horn mine near Pearl, Colorado. (Photograph courtesy of AHC, Clinton Van Vleck collection.)

Bridger mine

Located in N1/2NW1/4 sec. 2, T.15N., R.87W. This mine may be mislocated on the Divide Peak topographic map (Paul J. Graff, personal communication, 1984). The Bridger vein is conformable to regional foliation and trends northwest with a dip of 25°SW to 55°SW. The vein is hosted by quartzite and lies near a contact with overlying metagabbro. The vein consists of a one-half- to four-foot-wide sulfide- and calcite-bearing quartz vein in quartzite. The sulfides are galena and chalcocite.

The vein has altered zones in both the hanging wall and footwall. The hanging wall consists of altered quartzite averaging ten inches wide that is highly mineralized and reported to assay from a trace to 69 ounces/ton gold. The footwall zone is four to ten inches wide and contains both gold and silver. The altered zones enclose a six-inch- to three-foot-wide silicified quartzite.

A 100-pound sample taken from the middle silicified quartzite streak of the Bridger vein assayed 90 ounces/ton silver and 0.26 ounce/ton gold. With depth, the gold values decrease and the silver values increase (Spencer, 1904, p. 100).

Broadway mine

Located in S1/2SW1/4 sec. 32, T.13N., R.83W. The Broadway mine consists of an irregular mineralized body lying along a northeast-trending contact between granite and a series of gneisses and amphibolites. According to Osterwald (1947), the metals probably replaced amphibolite along a 50- by 1,000-foot zone. The zone dips 50°SE to 50°NW.

Mineralization includes sphalerite, galena, chalcopyrite, chalcocite and covellite, with some malachite and chrysocolla near the surface. One channel sample assayed 12.5 percent zinc, 1.9 percent lead and 0.02 percent copper with a trace of platinum group metals (Osterwald, 1947).

Cascade mine

Located in the W1/2NE1/4 sec. 12, T.13N., R.84W., on the east bank of the Encampment River. A N20°W-trending, south-dipping copper-bearing pegmatite was developed by a 425-foot tunnel and a 100-foot shaft during 1902. Spencer (1904, p. 96) reported that it was the intention to drive the tunnel 800 feet in order to intersect the shaft. The shaft cut the pegmatite at a depth of 80 feet and a crosscut exposed 24 feet of mineralized pegmatite. On the northeast the country rock is diorite, while on the southwest it is pink granite (Spencer, 1904, p. 96). Spencer reported a similar outcrop of cupriferous pegmatite 6,000 feet to the northwest that may have been a northern extention of the Cascade deposit. Some specimens of diorite collected from the mine dump contain pink lenses and disseminations, suggesting possible potassium-silicate alteration may have accompanied the emplacement pegmatite or granite.

Century mine

Located in secs. 32 and 33, T.13N., R.85W., on Harrison Creek seven miles south of Battle. A 50-foot shaft sunk in altered hornblende schist and diorite contains hematite, bornite and chalcopyrite. The schist trends northeasterly and dips vertically (Beeler, 1907).

Charter Oak mine

Located in sec. 24, T.14N., R.85W., 6.5 miles northwest of Encampment. A quartz vein lies on the east side of a broad syncline formed in granite-gniess, schist and diorite country rock. The vein contains iron and copper sulfides, which also impregnate fractured country rock. Chalcopyrite, chalcocite, bornite and azurite were identified (Spencer,

1904, p. 82-85). The vein strikes northerly and dips to the east. Mineralized rock can be traced for two miles on the surface and varies in width from 14 feet at the Charter Oak shaft to a maximum of 100 feet elsewhere. An open cut near the top of Puzzler Hill shows a "huge ledge of mineralized diorite" stained with copper-carbonate (Beeler, 1906a). As much as four to five percent cobalt has been reported (Armstrong, 1970, p. 2) with some nickel (Paul J. Graff, personal communication, 1985). The Charter Oak shaft was sunk to a depth of 488 feet with more than 300 feet of drifts (Beeler, 1905a, p. 21).

Colorado Belle group

Located on Miner Creek four miles south of Encampment. Small amounts of copper were found in a fault in the Miner Creek drainage (Beeler, 1906b).

Continental group

Located in sec. 18, T.14N., R.85W. on Cow Creek, 12 miles west of Encampment. Diorite dikes cut a series of northeast-trending schists and conglomerates that dip at a low angle. Copper-carbonate- and limonite-stained quartz veins conform to the foliation of the country rock "conglomerate-schist" (Beeler, 1908). Samples taken at a 30-foot depth assayed as high as $50 per ton (1899 prices) (Armstrong, 1970, p. 5).

Copper Gem prospect

Located on Dunkard Creek in Purgatory Gulch, eight miles south of Encampment. An incline was driven into a one-inch- to one-foot-wide gouge zone in granite and mica schist. The gouge zone contains some malachite and a little gold (Beeler, 1901b). Nearby, a one- to two-foot-wide quartz vein was developed by a 358-foot shaft. The vein contained specks and streaks of chalcocite and chalcopyrite. Schistose rocks south of the vein also contain scattered sulfides (Beeler, 1903b).

Copper Rock group

Located in secs. 27 and 28, T.14N., R.85W., about eight miles west of Encampment. A mafic dike cuts schist, slate and quartzite. The country rock trends east-west and dips 45° south. Three shafts were sunk on limonite- and copper-stained outcrops. The middle shaft intersected copper sulfides (Beeler, 1905c).

Cox mine

Located near Encampment. Assays of ore from the mine ranged from 2.3 percent to 74.5 percent copper plus some gold and silver (Osterwald and others, 1966, p. 46).

Creede property

Located in the N1/2 sec. 10, T.14N., R.86W. Magnetite, pyrrhotite and chalcopyrite are localized along a contact between hornblende schist and a norite intrusive. The schist strikes east-west and dips to the south. The prospect contains some detectable nickel and cobalt (Spencer, 1904, p. 54, 86).

D&L group

Located in secs. 27 and 28, T.14N., R.85W., about two miles east of Battle. Small amounts of chalcocite and considerable amounts of hematite were discovered at the base of a gossan (Beeler, 1905d).

Deep Gulch area

Located in sec. 36, T.16N., R.88W., and secs. 30 and 31, T.16N., R.87W. Approximately one mile northwest of the old Hub copper-silver mine are excellent

exposures of radioactive quartz-pebble conglomerate. These are some of the best exposures in the entire region (Paul J. Graff, personal communication, 1982). Radioactivity is also reportedly above background at the nearby Hub mine (Paul J. Graff, personal communication, 1985).

Dexter Peak area

Located in sec. 21, T.15N., R.87W. The basal quartz-pebble conglomerate of the Magnolia Formation contains three to 131 ppm uranium and 16 to 664 ppm thorium. One sample assayed ten ppm gold (Houston and others, 1979; Karlstrom and others, 1981).

Doane-Rambler mine

Located in NE1/4 sec. 25, T.14N., R.86W. (Figure 1). The host rock is a steeply dipping unit of the Cascade Quartzite. The quartzite trends east-west and dips 65°N to 75°N and is as much as 500 feet thick at the mine site.

Mineralization at the Doane-Rambler mine is localized where fracture planes intersect bedding planes within three distinct horizons. The ore follows stratification within the quartzite (Figure 6) (Spencer, 1904; Houston and others, 1975). Ore minerals include chalcopyrite, bornite, chalcocite, covellite, malachite, azurite and chrysocolla. It is not known if the Doane-Rambler ore carried any gold or silver, but according to early newspaper accounts some cobalt was present (Armstrong, 1970, p. 2).

Dreamland King group

Located in secs. 1 and 2, T.14N., R.86W., on South Spring Creek. Interlayered quartzite and schist with occasional gabbro dikes strike east-west and dip south. Limonite, malachite and azurite stain a 20-foot-wide quartz vein

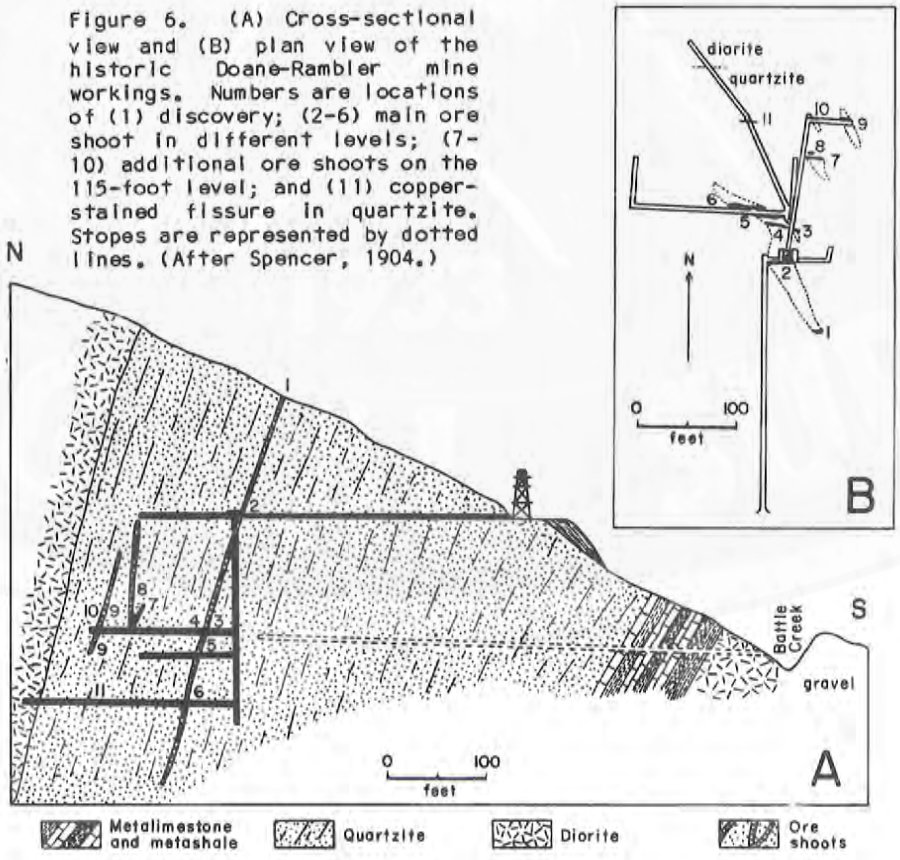

Figure 6. (A) Cross-sectional view and (B) plan view of the historic Doane-Rambler mine workings. Numbers are locations of (1) discovery; (2-6) main ore shoot in different levels; (7-10) additional ore shoots on the 115-foot level; and (11) copper-stained fissure in quartzite. Stopes are represented by dotted lines. (After Spencer, 1904.)

in schist and gabbro. The vein also contains some pyrite and a little gold (Beeler, 1905e).

Echo property

Located on the northern edge of the same band of quartzite that hosts mineralization at the Ferris-Haggarty mine. A shaft was sunk 114 feet on a three-foot-wide, copper-stained gossan. The mineralization occurs in a hanging wall quartzite underlain by footwall schist (Beeler, 1905a, p. 18-19). These relationships are opposite to the conditions at the Ferris-Haggarty mine where schist forms the hanging wall.

Elkhorn mine

Located in SW1/4 sec. 20, T.12N., R.85W., about one and one-half miles south of the State Line in Colorado. The shaft was collared on a N6°W-trending fissure vein with a slight westerly dip. The country rock is amphibolite schist.

Galena, cerussite and sphalerite, with some pyrite and chalcopyrite were mined. The ore had a very high silver/gold ratio. Spencer (1904) reported that around 1897 several carloads of ore were shipped that yielded $97/ton (1897 prices?). This ore averaged 0.5 ounce/ton gold with the remaining value (greater than 50 ounces/ton) in silver.

Eureka mine

Located in SW1/4 sec. 22, T.14N., R.84W. The host rock is diorite. A shallow shaft was sunk on a hematite-limonite-malachite-stained milky quartz vein that contained disseminated and fracture-filling chalcopyrite. The wall-rock adjacent to the vein shows narrow biotite selvages. Reported assays are 11 to 46 percent copper and 0.15 to 0.38 ounce/ton gold (Armstrong 1970, p. 3).

Ferris-Haggarty mine

Located in center sec. 16, T.14N., R.86W. (Figure 1). Copper was discovered at this site in 1897, which was initially called the Rudefeha mine, but later became known as the Ferris-Haggarty (Figure 7). The mine was developed in a very rich copper deposit localized in quartzite along a contact with hanging wall schist (Figure 4). The 20-foot-thick ore body (Figure 8) averaged six to eight percent copper (Messerschmidt, 1972, p. 29). High-grade ore mined from the ore body supplied the Boston-Wyoming smelter with an average of 200 to 500 tons per day. The high grade ore varied from 30 to 40 percent copper, carried some silver and 0.1 to 0.37 ounce/ton gold (Beeler, 1905a, p. 17).

Assays of grab samples from the dump gave 3.95 percent copper with a trace of silver, and 4.6 percent copper with 0.06 ounce/ton silver. Another sample of cupriferous quartzite contained 3.23 percent copper and 0.61 ounce/ton silver.

The host quartzite dips 30° to 35°S. The ore body was reportedly 250 to 300 feet long and was opened to a depth of 300 feet in 1903 (Spencer, 1904, p. 72-82).

Finley mine

Located in NE1/4 sec. 22, T.14N., R.84W. The Finley mine was developed in quartzite. Mineralization was intersected in a crosscut at a depth of 170 feet (Armstrong, 1970, p. 7).

Gertrude mine

Located in E1/2 sec. 28, T.14N., R.85W. The Gertrude mine was developed on a stratiform, massive, earthy hematite body containing some specularite and

Figure 7. (A) The Ferris-Haggarty mine in 1902. The tramway is located in the right half of the photograph and runs from the mine dump to Encampment 16 miles to the east (photograph courtesy of AHC). (B) The Ferris-Haggarty mine as it appeared in 1983. The same mine dump is located in the photograph with Haggarty Creek seen in the lower right corner. Not much remains of the historic buildings.

minor copper stains. The host quartzite trends east-west and dips 40°S. The hematite varied from two and one-half feet thick near the surface, to nine feet thick at an 80-foot depth. The extent of the hematite along strike was not investigated.

Assays of hematite samples reportedly showed 0.37 ounce/ton gold (Spencer, 1904, p. 92-93). Spencer suggested that the Gertrude deposit was probably a gossan cap over a copper deposit. Beeler (1901e) noted that lime (probably calcite) occasionally substituted for quartz in the hematite.

Gold Coin prospect

Located in E1/2SW1/4 sec. 11, T.15N., R.87W., south of the Bridger mine on the

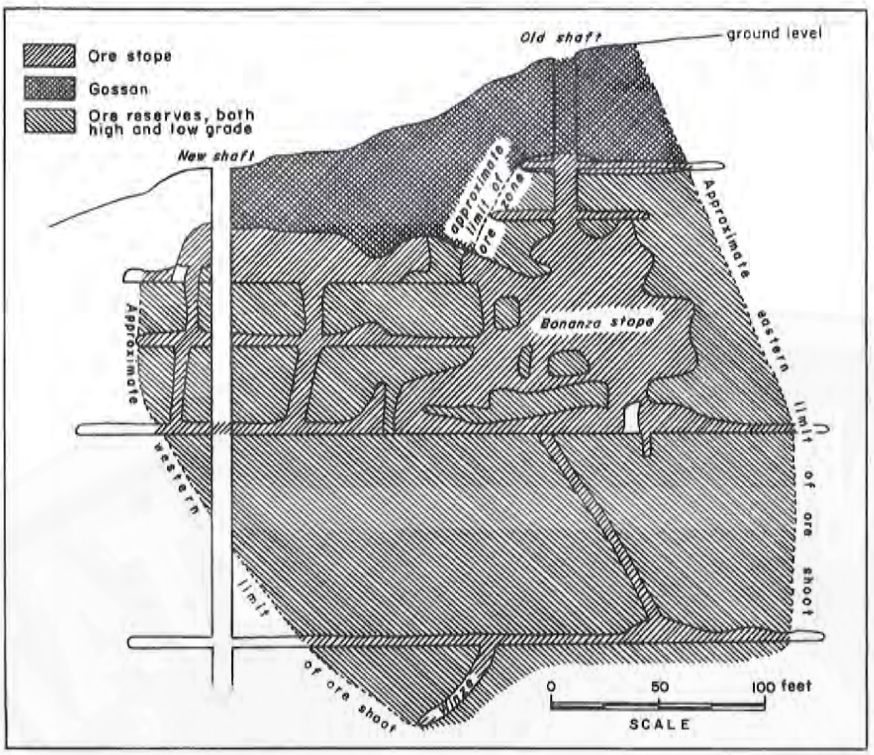

Figure 8. Cross section of the Ferris-Haggarty ore body. The sketch is of a vertical plane parallel to the strike of the ore body (from Spencer, 1904).

Continental Divide. A one-foot-wide calcite-quartz vein contained galena, pyrite and chalcopyrite, with some gold and silver. The minerals filled a N75°E-trending fissure that dipped steeply south. The vein cuts regional schistosity in the host diorite (Spencer, 1904, p. 100-101). Southwest of the Gold Coin are some historic gold placers on Jim Creek and Strawberry Creek (Paul J. Graff, personal communication, 1982).

Grand Republic mine

Located three miles southeast of the Big Horn shaft near Pearl, Colorado. Chalcopyrite in a three-foot-wide quartz vein parallels regional foliation. A massive zone of epidote in amphibolite lies adjacent to the vein. Chalcopyrite and sphalerite were reported in mineralized samples (Spencer, 1903b). Spencer noted some similarities of the Grand Republic to mineralization at the Verde-Hinton mine to the northwest.

Great Lakes claims

Located in S1/2 sec. 30, T.14N., R.84W., east of Willow Creek and immediately west of the Kurtze-Chatterton mine. A four- to five-foot-wide vein in gabbro(?) contained as much as 30 percent copper and 0.13 ounce/ton gold (Armstrong, 1970, p. 7).

Hidden Treasure mine

Located in sec. 28, T.14N., R.85W., one mile east of the historic town of Battle and one-half mile from the Gertrude claim. A N70°E-trending vein dips steeply to the south. The country rock also strikes northeasterly and dips to the south and is formed of brecciated and mylonitized schist, quartzite and altered diorite. The vein occurs near the center of the intrusive diorite and contains chalcopyrite, chalcocite, malachite and some gold. The average of nine assays from samples in the Hidden Treasure workings was 0.3 ounce/ton gold. One sample reportedly produced 11 ounces/ton gold. Gangue minerals include a small amount of specular hematite with quartz, calcite, siderite and lesser feldspar (Spencer, 1904, p. 93-94).

Hub mine

Located in E1/2NE1/4 sec. 6, T.15N., R.87W. The prospect was developed on a 1.5-foot-wide, steeply dipping quartz vein in sheared amphibolite. A selected vein sample assayed 0.41 percent copper, no gold and 4.4 ounces/ton silver. Paul J. Graff (personal communication, 1985) observed visible gold in a quartz vein sample from the mine.

Independence group

This is a group of lode and placer claims originally staked in secs. 11, 12, 13 and 14, T.12N., R.86W., near the Colorado-Wyoming State Line. A quartz vein at the contact between diorite and schist strikes N60°W. The vein is stained with limonite and contains a little gold and silver. The diorite footwall contains pyrite and chalcopyrite (Beeler, 1905f).

Investors (Umslopagus) property

Located in secs. 19 and 30, T.14N., R.85W., near the historic town of Rambler. A series of schists and quartzites are cut by northwest-trending "diorite or gabbro," dikes. A nine- to 22-feet-thick cupriferous limonite zone (gossan) lies between hanging wall schist and the footwall quartzite. Copper sulfides occur below the gossan (Beeler, 1905i; Osterwald and others, 1966).

Iron King prospect

Located in sec. 15, T.14N., R.85W., three miles north of the old town of Battle on Cow Creek. A quartz vein contains copper and iron oxides at the surface and sulfides at depth. The vein trends northeast, dips 30°S and cuts altered schist and mafic dikes. The vein is 15 feet wide at the surface (Beeler, 1901f).

Island City group

Located in secs. 3 and 10, T.14N., R.86W., on the north side of Bridger Mountain near the head of North Spring Creek. A vein containing pyrrhotite was located along the contact between norite and schist. Limonite and copper carbonates stain the vein. The vein also contains small quantities of copper sulfides (Beeler, 1904a).

Itmay mine

Located in E1/2NE1/4 sec. 14, T.13N., R.86W. **(Figure 1)**. Spencer (1904, p. 51) reported one sample from the Itmay mine assayed 17.92 percent copper and 0.05 ounce/ton gold. From 1979 to 1980, Conoco Minerals, Incorporated explored the Itmay mine area for massive sulfides.

In the Itmay area, there are differentiated metarhyolites overlain by pyritiferous actinolite-epidote-magnetite exhalite. North of the main shaft, metavolcanic breccia lies near the exhalite **(Figure 3)**. The exhalite is coincident with higher copper soil values, anomalous ground magnetics and pyrite-sericite alteration in the footwall rhyolite crystal tuffs (Nelsen, 1981).

Conoco Minerals, Incorporated drilled three holes. Drill hole IM-1 cut strongly chloritized and epidotized rock. The drill hole (total depth 383 feet), intersected a zone with fracture veining and locally high concentrations of remobilized chalcopyrite in the lower part of the core. This suggested that the hole may have been drilled in close proximity to a massive sulfide. A mineralized interval from 210 to 211 feet assayed 1.6 percent copper and 0.06 ounce/ton silver.

Drill holes IM-2 and IM-3 encountered a southeast-dipping section of siliceous metasediments and interbedded metatuffs, a 15-foot-thick exhalite and a lower

Table 3. Mineralized zones at the Itmay mine property in Fletcher Park, Sierra Madre (from Lawrence, 1981).

Drill hole	Total depth (in feet)	Mineralized intervals	Values
IM-2	316	34.7 to 41 feet	1.9 % copper, 0.2 ounce/ton silver
		124.5 to 128 feet	0.12 % copper, 0.03 ounce/ton silver
		293.0 to 302 feet	0.35 % copper, 0.01 ounce/ton silver
IM-3	501	35.7 to 59 feet	0.09 % copper, 0.03 ounce/ton silver
		368.0 to 398 feet	0.17 % copper, 0.04 ounce/ton silver

metarhyolite crystal tuff. Pyrite and chalcopyrite were recognized in the metasedimentary-tuffaceous rocks as fine disseminations, in discrete seamlets parallel to bedding and locally in abundant epidote-actinolite veinlets. Weak mineralization occurs as veinlets in an intensely altered actinolite-epidote-magnetite exhalite. Rhyolite crystal tuff is weakly mineralized with veinlets and along foliation. Locally strong chlorite-magnetite alteration occurs near the contact with the exhalite. Mineralization was encountered in both drill holes (Table 3) (Lawrence, 1981).

Joes Park area

Located in secs, 25, 26, 35 and 36, T.16N., R.87W. Anomalous radioactivity is present in soil over Precambrian metamorphic rocks. Numerous small pits and trenches expose weathered rock and subsoil that emit more radioactivity than present at the surface (Ray E. Harris, personal communication, 1985).

King of the Camp prospect

Located in sec. 36, T.14N., R.83W., about five miles south of Encampment on the South Fork of Encampment River. At the surface, a five-foot-thick quartz vein in mica schist trends northeast and dips 45°NW. However, in the shaft, the dip of the quartz vein is 20°NW. The quartz is stained with iron oxides and contains pyrite and chalcopyrite with gold below an oxidized zone. Traces of azurite and malachite are scattered throughout the vein (Beeler, 1903c). A tunnel developed to intersect the vein cut numerous faults and six veins from two to four feet wide. In addition to these veins, a fifteen-foot vein was cut by the shaft at a depth of 100 feet. This vein assayed 0.2 to 0.3 ounce/ton in gold (Beeler, 1904b).

Kurtze-Chatterton mine

Located in S1/2S1/2 sec. 29, T.14N., R.84W. (Figure 1), along Copper Creek, five miles southwest of Encampment. More than 1,700 feet of tunnel and several hundred feet of drifts had been driven at this mine by 1901 (Armstrong, 1970, p. 9). In 1984, several fresh open cuts and one old shaft were found on the property. These cuts were developed on several veins ranging from three to 20 feet wide that strike N55°W and dip to the north. The old shaft was sunk on a narrow N72°E-trending shear in the altered diabase.

Quartz veins in the open cuts are hosted by pink granite. Some malachite, chrysocolla, chalcopyrite and tenorite were found in the quartz. The property was one of the three most productive copper mines in the district during the early 1900s.

Leighton-Gentry (Jack Creek) mine

Located in SW1/4 sec. 5, T.14N., R.86W., near the Continental Divide at the head of Jack Creek. A three-inch-wide gossan is structurally overlain by

four feet of black, crumbly mica schist. The schist is overlain by a thick norite sill. The footwall of the gossan is formed by an eleven-foot-thick limy quartzite. Pyrite, pyrrhotite and chalcopyrite occur along bedding planes and are disseminated throughout the limy quartzite. Metalimestone below the quartzite contains no sulfides. The rocks strike N80°W and dip 30°S. One assay showed 3.07 percent copper, 0.67 percent nickel and cobalt and a trace of zinc (Spencer, 1904, p. 87-88). Spencer noted similarities to the Ferris-Haggarty deposit.

Lena Shields group

Located in sec. 12, T.14N., R.86W., near the head of the main fork of Cow Creek. The Lena Shields group encloses a series of fine-grained mica schists, abundant schistose conglomerate, and fractured diorite dikes that are altered in many places. At one locality, a N70°W-trending quartz vein with interlaminated schist has an aggregate thickness of five to 15 feet. The vein contains limonite, azurite, malachite and pyrite at the surface (Beeler, 1902b; Osterwald and others, 1966).

Meta mine

Located in sec. 24 or 25, T.15N., R.86W. The Meta mine was developed by a 100-foot shaft on a six-inch to six-foot wide vein. The vein strikes roughly east-west and dips nearly vertical at the surface, but at depth dips about 60° southward. Although the quartz-biotite gneiss country rock foliation strikes parallel to the Meta vein, the foliation dips only 20-25°N.

Samples of vein material contain a variety of minerals. The ore consists of massive galena that is probably argentiferous (Spencer, 1904, p. 99, reported that silver was produced from the mine), anglesite(?), cerussite(?), some sphalerite, chalcopyrite, pyrite, azurite, malachite, chrysocolla(?), hematite, limonite, hemimorphite(?) and smithsonite(?), in a gangue of mostly quartz and lesser barite (Haff, 1944).

Spencer (1904, p. 99) reported that one carload of silver ore was shipped from the property. Haff (1944) estimated six or seven carloads of ore were shipped to Salt Lake City sometime after 1930. From these accounts, at least 200 to 300 tons of ore have been shipped from this mine. Ore mined after 1930 was reported to run 27 to 54 percent lead, about eight percent zinc and $20 to $22 combined gold and silver per ton (prices prior to 1944) (Haff, 1944).

Mohawk prospect

Located in NW1/4 sec. 20, NW1/4 sec. 35, T.14N., R.85W. Some brown iron-stained and copper-stained siliceous material occurs along the contact between granite and altered schist (Osterwald and others, 1966). The schist contains much "lime" and is associated with a quartz conglomerate. In 1902, a 70-foot shaft was sunk on the property (Beeler, 1902c).

Monarch group

Located in secs. 32 and 33, T.14N., R.85W., about 1.5 miles southeast of the historic Battle townsite. Interlayered schists and quartz diorites trend east-west and dip vertically. The rocks, where altered and silicified, contain some "white iron pyrites" (Beeler, 1902d).

Mount Zirkel shaft

Located in sec. 2, T.11N., R.82W., 2,500 feet northeast of the Wolverine shaft. A shaft was sunk to a depth of 185 feet on granite pegmatite and levels were established at 71 and 155 feet. Chalcopyrite occurs as fracture-fillings in the pegmatite, and some mineraliza-

tion also occurs in fractures in the gneissic country rock (Spencer, 1903b).

Newsboy claim

Located four miles east of Encampment. A vein was traced for 4,500 feet on the surface, and at one point contained a four-foot-wide ore zone that averaged 28.8 percent copper (Armstrong, 1970, p. 6).

Newton group

Located in secs. 13 and 24, T.14N., R.85W. and secs. 18 and 19, T.14N., R.84W. The Newton claims are located on an east-west-trending layer of mafic rock sandwiched between a metaconglomerate to the south and quartzite schist to the north. On the Copper Queen claims, a 140-foot shaft was sunk on a vein in the mafic rock. The vein contains abundant limonite, hematite, cuprite, malachite, azurite and chrysocolla near the surface. At depth, chalcopyrite, bornite and chalcocite were found (Beeler, 1905g).

North Fork group

Located in sec. 13, T.12N., R.86W., fourteen miles south of Battle. Granite and diorite dikes strike northwesterly and dip northeasterly and are cut by a N45°W-trending, 70°NE-dipping quartz vein. The vein is six to 26 inches wide at a depth of 160 feet. Near the surface, limonite, malachite and azurite were found in the vein, and at depth the vein carried pyrite and chalcopyrite, with some lead and zinc. A second vein trending N88°E cuts the first vein. This vein is 23 feet wide and is mineralized throughout much of its width with pyrite and chalcopyrite. According to Beeler (1905h), some galena ore from the property assayed as high as 600 ounces/ton silver. Assays of the oxidized ore produced as much as 33 to 73 ounces/ton gold! The average workable ore ran $36.39/ton gold, silver and lead (1905 prices).

North Fork mine

Located in NW1/4SE1/4 sec. 33, T.13N., R.85W. This is a different property than the North Fork group reported by Beeler (1905h).

Swift (1982) visited the North Fork mine in 1981 and described a variety of rock types including biotite-rich amphibolite, metagreywacke, mica schist and quartz pegmatite. No signs of mineralization were reported by Swift.

North Fork Savery Creek area

Located in sec. 27, T.16N., R.87W. A quartz-pebble conglomerate in the Magnolia(?) Formation is radioactive. Samples from NW1/4SW1/4NE1/4 sec. 27 contained 0.05 to 0.07 percent U_3O_8 (Ray E. Harris, personal communication, 1985).

North Spring Creek prospect

Located in E1/2SE1/4 sec.10, T.15N., R.86W along a tributary of North Spring Creek. Four short adits were driven into a near-horizontal milky quartz vein. The vein is six to ten inches wide and strikes N40°W. The country rock is diorite.

The deepest penetration of any of the tunnels was only 100 feet. A one- to two-inch-wide zone of fine-grained chlorite occurs in the wallrock adjacent to the vein exposed in the northernmost portal.

A second vein, which crops out about 150 feet above the adits, is milky quartz with greater amounts of sulfides and spotty malachite.

Octavia prospect

Located on the West Fork of Savery Creek about five miles west of the old town of Battle. A northwest-trending, 30°SW-dipping quartz vein follows the trend of limy altered schist host rock. The quartz contains occasional calcite and disseminations and small streaks of pyrite and chalcopyrite (Beeler, 1901c).

Portland and Hercules mines

The Portland shaft is in the E1/2SE1/4 sec. 30 and the Hercules shaft is located in W1/2SW1/4 sec. 29, T.14N., R.85W., south of Battle along the Huston-Standard Park jeep trail. The Hercules shaft was sunk to a 70- to 80-foot depth and collared near the jeep trail east of the Portland mine. The Portland was developed by 370 feet of tunnel and 120 feet of crosscuts (Beeler, 1905a, p. 13). The Portland mine is west of the Hercules, a short distance downslope.

These two mines lie along a sheared contact between metadolomite and phyllite with intrusive red granite to the south (**Figure 9**). North of the portals a chloritic schist is interpreted to be metamorphosed mafic igneous rock. Regional foliation is roughly east-west and dips steeply to the north.

Spencer (1904, p. 91-92) reported that the mineralized veins cut the metadolomite and chlorite schist. The veins, which trend N65°E, are narrow at the surface (a few inches wide) and can be traced for several hundred feet. In places, the metadolomite and schist are brecciated and impregnated with chalcopyrite.

Mineralization consists of chalcopyrite, chalcocite and bornite, in hematite, quartz, calcite and siderite gangue. A selected sample of silicified mafic rock with chalcopyrite and chalcocite collected from the Portland mine dump assayed 2.75 percent copper.

Prospect 9999

Located in W1/2 sec. 15, E1/2 sec. 16, T.13N., R.86W. (**Figure 1**). The geology at this prospect is similar to the Itmay and Verde-Hinton massive sulfide deposits that lie to the east and southeast. This property is located in the Fletcher Park area of the Sierra Madre and occurs within a series of metavolcanics and volcanogenic metasediments collectively grouped into the Green Mountain Formation.

In the Fletcher Park area, there are two recognized volcanic cycles, termed the Fletcher Park cycle and the Itmay cycle (see Itmay mine, p. 18). These cycles consist of metarhyolites overlain by exhalites.

Two types of alteration occur in the Fletcher Park area: sericite-pyrite at the Itmay mine, and an area-wide sausseritization. This second type of alteration occurs as epidote ± chlorite ± calcite ± garnet ± actinolite replace-

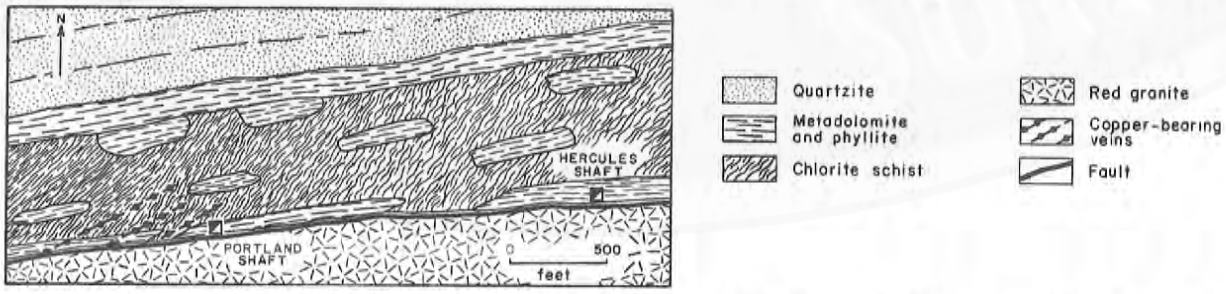

Figure 9. Schematic map of the Portland and Hercules mines (from Spencer, 1904, p. 91). The two mines are located in metadolomite and phyllite at a sheared contact with granite. The metadolomite and phyllite appear to have been intruded by chloritic schist, producing several pendants of metadolomite and phyllite (Spencer, 1904).

ments, and is very intense locally near the Fletcher Park exhalite in the vicinity of Prospect 9999.

In 1979 and 1980, Conoco Minerals drilled the Fletcher Park exhalite at Prospect 9999. Drill hole FWDH-2 (Figure 10) was collared near the top of the Fletcher Park exhalite and intersected alternating tuffaceous sediments and tuffs, all of which showed strong garnet-epidote alteration. Significant zinc-copper mineralization was present in the garnet-epidote rock, which averaged 0.9 percent zinc, 0.16 percent copper and 0.32 ounce/ton silver over a true thickness of 67 feet.

In drill hole FP-2, a 479-foot section of Fletcher Park cycle was tested. The hole, collared in andesite lapilli tuff, graded downward into rhyodacite tuff, intersected the exhalite and terminated in the rhyolite tuff with interbedded porphyritic andesite. The exhalite was altered to silica, garnet, epidote and chlorite.

Two mineralized zones were encountered. In the lower part of the andesite lapilli tuffs, between 214.5 and 320 feet, mineralization ranges up to 2.1 percent zinc and 0.19 percent copper. Within the exhalite (510 to 564 feet), copper, zinc and lead sulfides average one to four percent of volume and locally reach up to 15 percent volume.

Drill hole FP-3 was collared 500 feet southeast of FP-2. This hole encountered andesite tuffs, interbedded cherts, siliceous sediments and calc-silicates and terminated in rhyolite tuff with interbedded porphyritic andesite. Mineralization was anomalous over a 200-foot interval, the strongest located in the lower andesite-upper exhalite zone, between 197 feet and 263 feet. In the basal(?) andesite, assays were as high as 0.55 percent copper, 0.11 percent zinc and 0.04 ounce/ton silver (Nelsen, 1981).

Purgatory Gulch mines

Located in NE1/4 sec. 1, T.13N., R.84W., includes the Golden Eagle claim. A group of short adits were driven into limonite-stained shears in gneiss (see also Copper Gem prospect). On the west side of the gulch, two mines were examined in 1984. The southernmost adit

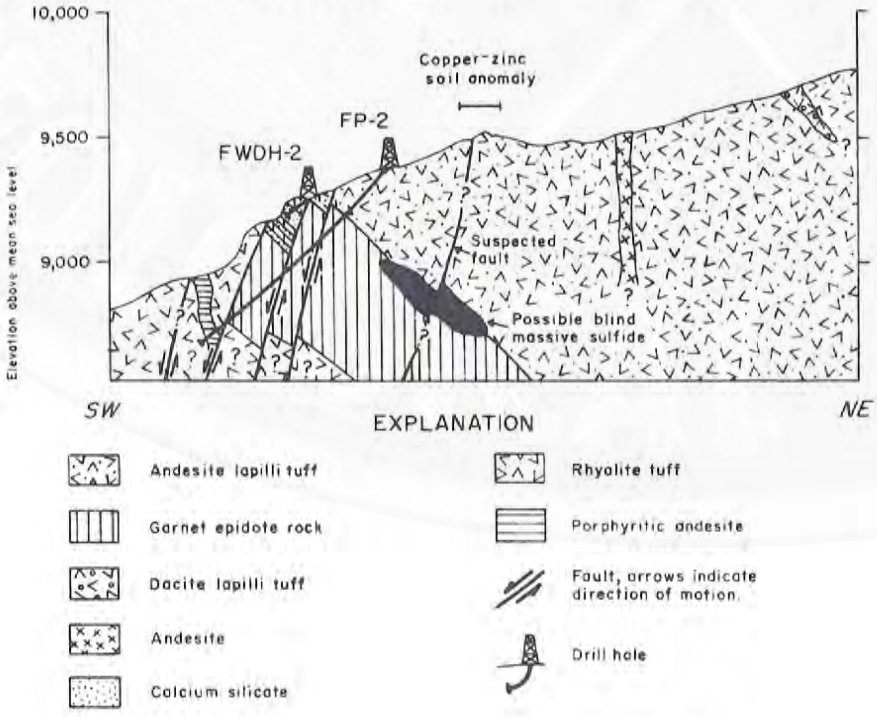

Figure 10. Diagrammatic cross-sectional sketch showing suspected fault and copper-zinc soil anomaly, and positions of drill holes FP-2 and FWDH-2 in Fletcher Park (from Nelsen, 1981).

was driven into granodiorite-gneiss along a narrow shear. Four narrow copper- and limonite-stained veins were intersected in the mine workings (Figure 11). A short distance north, a short adit extended less than 100 feet into the country rock. Across the gulch are more extensive workings, but when visited by the author in 1984, the adit was caved.

Some remarkably rich gold specimens were found here (Beeler, 1905a, p. 20). According to Armstrong (1970, p. 2), a ten-foot-wide, free-milling gold vein was struck on Purgatory Gulch. Samples assayed as high as six ounces/ton gold.

Section 8 mine

Located in S1/2SE1/4 sec. 8, T.14N., R.85W., adjacent to the historic Ferris-Haggarty tramway (Figure 1). Stratiform copper mineralization occurs in a banded pyritized chert. The chert is hosted by an amphibolite of the Silver Lake Volcanics, which trends N81°E and dip 52°S.

A sample of the mineralized banded chert contained limonite, chalcopyrite and bornite. The sample assayed 2.61 percent copper with no detectable gold.

Sierra Madre shaft

Located near the State Line about 1.5 miles north of Pearl. The shaft was sunk on a stratiform deposit in gneiss. The gneiss contains a N60°E-trending mineralized zone that is about seven feet wide. This zone parallels regional foliation and consists of massive amphibolite carrying pyrite, chalcopyrite and sphalerite with minor galena. Sphal-

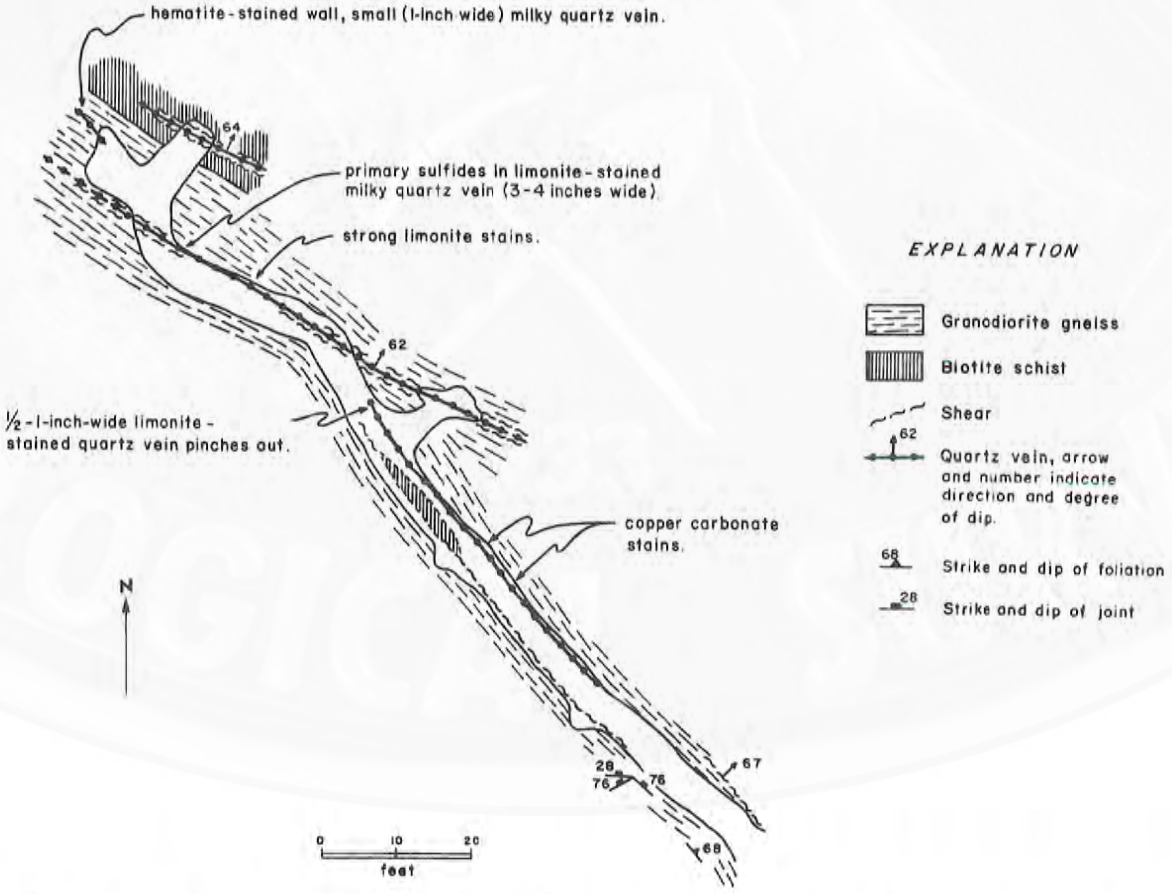

Figure 11. Geologic map of the southern Purgatory Gulch adit (mapped by the author and J.T. Roberts, 1984).

erite also replaces mafic minerals in the gneiss (Spencer, 1903b).

Standard mine

Located in NE1/4NE1/4 sec. 13, T.13N., R.86W. According to Lackey (1965, p. 74), the Standard mine is mislocated on the Fletcher Peak 7 1/2-minute quadrangle. Rock samples from a large dump near a water-filled shaft are dark and fine grained, with pyrite, chalcopyrite and traces of bornite. The original rock type is unknown, but large mafic inclusions and dikes crop out in the area (Lackey, 1965; Osterwald and others, 1966).

Sun-Anchor and Sweet claims

Spencer (1904) reported these claims to be located on a zone of metamorphism in a series of east-west-trending hornblende schists. These schists occur along the north face of Green Mountain. The zone contains an appreciable amount of epidote, small bright red garnets and a little magnetite and chalcopyrite (Spencer, 1904, p. 94-95). Spencer's description suggests that this may be a volcanogenic sulfide deposit associated with an epidote-garnet-magnetite-sulfide exhalite.

Swede (Hawkeye) group

Located in SW1/4SW1/4 sec. 6, T.11N., R.81W. A N10°W-trending mineralized zone occurs in granite country rock. The mineralization consists of pyrite, chalcopyrite and sphalerite with calcite and serpentine gangue. Spencer (1903b) indicates this deposit may be similar to mineralization at the Sierra Madre shaft.

Syndicate mine

Located in sec. 26, T.15N., R.87W. Precambrian quartzite that is overlain by a 150-foot-thick diorite sill, strikes east-west and dips south. A shaft was sunk on a fissure vein in the quartzite to a depth of 135 feet. The vein cross cuts bedding in the quartzite, trends N70°W and dips 65°S. The vein, which is three to eleven feet thick, consists of calcite filling a breccia zone in quartzite. Mineralization occurs as disseminated chalcocite in the calcite and in some fragments of quartz (Spencer, 1904, p. 88-89).

Tennant property

Located in sec. 21 and 22, T.14N., R.84W. A six-foot-wide fissure vein in section 22 contains copper and a small quantity of gold. Six tons of ore mined from the claim netted $400.00 in copper (at $0.20 per pound) (Osterwald and others, 1966, p. 49). In section 21, three strike veins containing gold, silver and lead assayed from $15 to $112/ton (1927 prices). Some of the country rock schist is also mineralized and assayed 0.12 to 0.18 ounce/ton gold (Osterwald and others, 1966, p. 84).

Three Forks group

Located in secs. 11, 12, 13 and 14, T.12N., R.86W. Smoky quartz veins along a contact between granite and schist contain a small amount of copper with some lead and zinc. The veins are stained by hematite near the surface and carry some gold. The galena is argentiferous. Some cerargyrite is present (Osterwald and others, 1966, p. 49).

Verde-Hinton mine

Located in NE1/4NW1/4 sec. 32, T.13N., R.85W. (Figure 1). An average ore sample collected from the mine dump by Spencer (1904) assayed 8.18 percent copper and 0.02 ounce/ton gold. Spencer described the ore as stratabound. Samples collected by Swift (1982) contained flecks of chalcopyrite, pyrite

and magnetite in a fine-grained hedenbergite matrix.

The Verde-Hinton mine was prospected by Conoco Minerals, Incorporated in 1981. Weak to moderate copper-zinc sulfide mineralization (two percent copper, 0.04 percent zinc, 0.15 ounce/ton gold and 0.35 ounce/ton silver) was found in a ferruginous chert and in a felsic tuff breccia on the mine dump. Outcrops of chert, actinolite-epidote-garnet exhalite, pods of marble (possibly metamorphosed travertine) and a tuff breccia containing rhyolite clasts up to 18 inches long are in the immediate vicinity. The breccia is interpreted to be a vent breccia (mill rock) **(Figure 12).**

The entire felsic volcanic exhalite horizon varies from 100 to 400 feet thick and can be traced 5,000 to 7,000 feet along strike. A group of prospects dug in the NW1/4SW1/4 sec. 33 exposed epidote-magnetite exhalite. The rock contained disseminated sphalerite and chalcopyrite with some bornite (Lawrence, 1982).

Wolverine shaft

Located in sec. 2, T.11N., R.82W. A wedge-shaped mineralized body hosted in foliated granite(?) contains chalcopyrite, which replaces biotite in the host rock. Some chalcocite and sphalerite are also present as disseminated grains (Spencer, 1903b).

Unnamed localities

SW1/4 sec. 9, T.12N., R.84W. Malachite is found at the contact of amphibolite and pegmatite. Two shafts were sunk on the copper-stained contact (Merry, 1963).

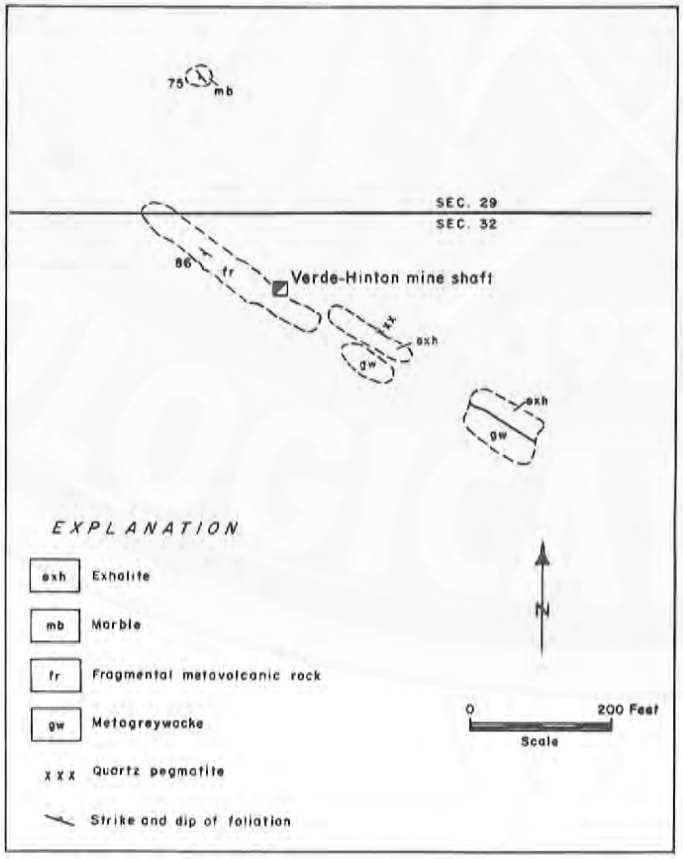

Figure 12. Geologic sketch map of the Verde-Hinton mine and vicinity. According to Swift (1982) the shaft was sunk in a sulfide-rich exhalite adjacent to a fragmental metavolcanic rock. (After Swift, 1982.)

Sec. 24, T.14N., R.84W. A caved shaft that was sunk on the contact of a quartz vein and amphibolite wallrock exposed bornite and chalcopyrite (Ferris, 1964).

NE1/4 sec. 20, T.14N., R.83W. A 40-foot shaft was sunk on an amphibolite dike. The dike is cut by an eight- to 18-inch-wide quartz-feldspar vein that carries chalcopyrite and bornite. The mineralization is localized in fractures (Ferris, 1964).

SW1/4 sec. 24, T.14N., R.84W. Chalcanthite encrustations were found on the ribs and back of an adit driven in gneiss (Ferris, 1964).

SE1/4 sec. 28, T.14N., R.83W. Crusts and stains of malachite occur on quartz and amphibolite fragments found in a prospect pit (Ferris, 1964).

SW1/4NE1/4 sec. 11, T.12N., R.85W. A prospect was developed in an exhalite associated with dacitic metavolcanics (Swift, 1982, p. 53).

SW1/4NE1/4 sec. 15, T.12N., R.85W. A small mine was dug in fragmental felsic and mafic rocks and exhalite in a thick metabasalt sequence (Swift, 1982).

SW1/4 sec. 25, T.14N., R.85W. A 100-foot-deep shaft and two short portals were developed at a hill top. The two portals (15 to 20 feet long) apparently stopped short of intersecting the shaft. The country rock is felsite and felsite breccia with lesser mafic rock. The shaft was sunk to intersect an east-west-trending milky quartz vein that is well exposed along the west flank of the hill.

The vein is one to two feet wide and is located along the contact between footwall mafic schist and hanging wall felsite. The vein contains minor chalcopyrite and malachite in a quartz and calcite gangue.

SW1/4NW1/4 sec. 2, T.12N., R.85W. A barite vein associated with quartz and feldspar pegmatite intrudes metavolcanic rocks along the Continental Divide (Swift, 1982).

Conclusions

During the early 1900s, the Encampment district was an important base-metal district. Nearly all of the historic production was mined from strata-bound cupriferous quartzite deposits north of the Mullen Creek - Nash Fork shear zone; in particular, the Ferris-Haggarty and the Doane-Rambler mines were notable producers. These quartzite deposits may still represent attractive exploration targets depending on their precious metal contents.

Additionally, uraniferous quartz-pebble conglomerates north of the shear zone have been incompletely explored for gold. These are similar to the uranium-rich Blind River, Canada, conglomerates and the gold-rich Witwatersrand, South Africa, conglomerates. These conglomerates may represent one of the better exploration targets.

Volcanogenic sulfide deposits south of the shear zone, such as the Itmay, Verde-Hinton and Pearl deposits, are stratiform in volcanogenic schists and gneisses. Principally, these are copper-zinc-silver deposits that could contain large base-metal resources.

In summary, the Encampment district was an important base-metal mining district from 1900 to 1908 but has never been fully explored for precious metals. With current precious metal prices ranging from $300 to $400/ounce (compared to $19/ounce in the early 1900s) some of the copper deposits may be developed for precious metals. With a more favorable domestic economic climate, the Encampment district could provide attractive base-metal, precious-metal and uranium targets for exploration.

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