FIELD TRIP #1 - SUNDAY, AUG. 14
LEADVILLE, COLORADO

Leaders: Rob Johansing (Leadville, Colo.), Pete Modreski (U.S.G.S.)

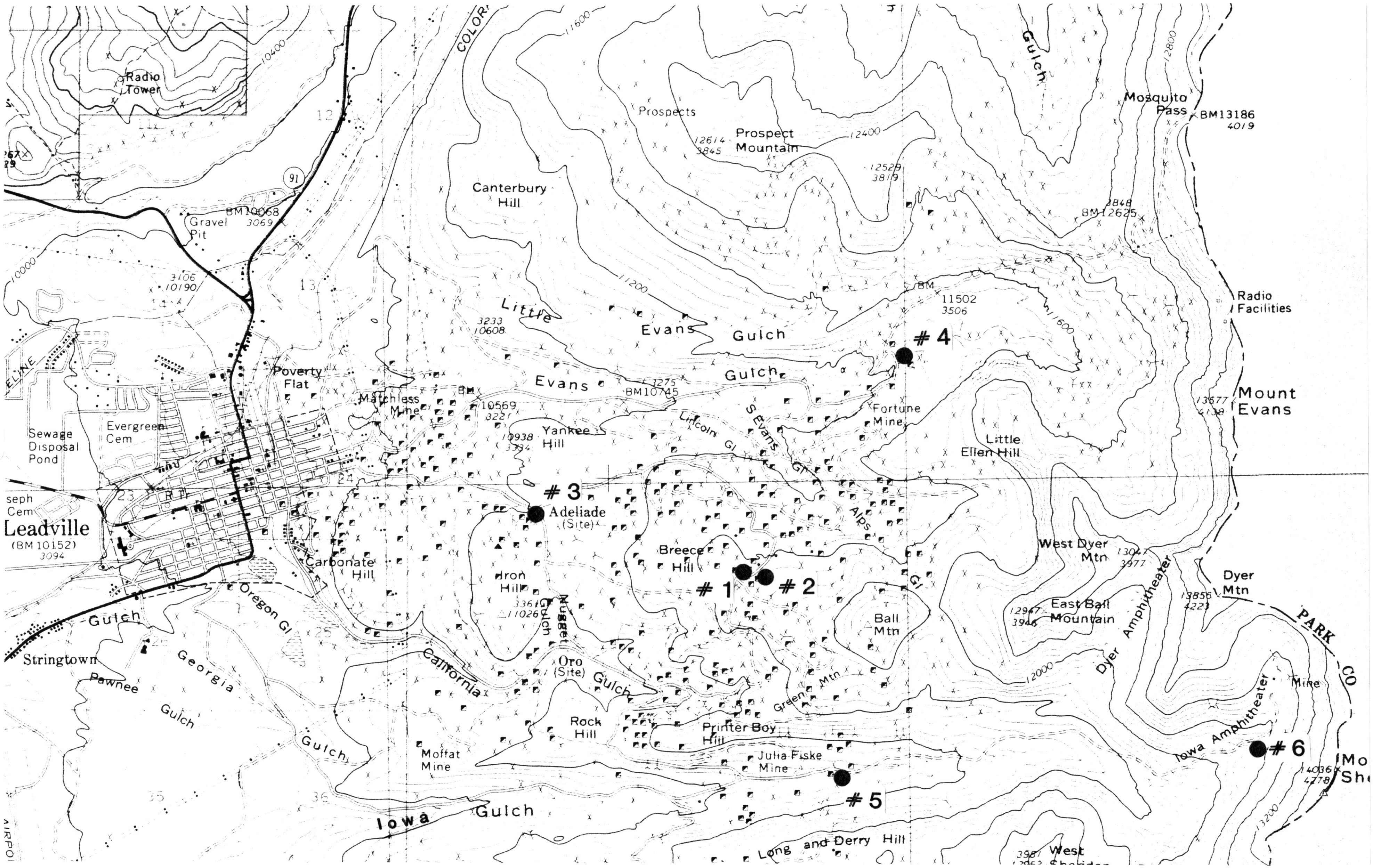
The first discoveries in what was to become the Leadville mining district were made in 1860 by placer miners working their way up the Arkansas River, searching for gold. The first find was in California Gulch, the only tributary draining the Mosquito Range that had not been scoured of gold and heavy minerals by Pleistocene mountain glaciation. Placer mining produced gold and silver-bearing cerussite, the latter of which was unrecognized until the late 1860's. Subsequent lode mining produced gold, silver, and base-metal ores. The estimated total production of the entire district is about 3.25 million ounces of gold and 256 million ounces of silver.

The district is near the center of the northeast-trending Colorado Mineral Belt. It lies on the east flank of the Sawatch uplift, and consists of east-dipping Paleozoic rocks, broken into fault blocks by extensional faults of Tertiary age associated with the Rio Grande rift.

Mineralization occurs as massive sulfide replacement bodies (mantos) in Paleozoic dolomite rocks intruded by Laramide-age to mid-Tertiary sills, dikes, and stocks of quartz monzonite porphyry. Host rocks include the Manitou (Ordovician), Chaffee (Devonian; including the Dyer Dolomite), and Leadville (Mississippian; formerly known as the "Blue Limestone") dolomites. The age of mineralization is about 34 m.y. An igneous stock at Breece Hill appears to be the center of the district. Mineralization is zoned around this stock; the zoning pattern includes quartz-pyrite-gold-tungsten veins within and adjacent to the stock, and Zn-Pb-Ag-Au-Cu replacement bodies outside it, with an increasing Pb:Zn ratio, increasing Ag, and decreasing Au and Cu going away from the stock. Mineral deposits at Leadville can be classified into seven types (see Beaty, p. 21-22 in Reed and others, 1987):

1. Placers in California Gulch.
2. Contact metamorphic magnetite-calc-silicate-carbonate bodies adjacent to the Breece Hill stock.
3. Vein quartz-pyrite-gold-silver (sometimes with tungsten) deposits within and adjacent to the Breece Hill stock.
4. Veinlet and disseminated quartz-pyrite-gold deposits in porphyry.
5. Base-metal veins.
6. Base and precious metal, dolomite-hosted replacement bodies ("Leadville-type" mineralization).
7. Silver-barite-minor base metal, dolomite-hosted replacement bodies ("Sherman-type" mineralization).

Minerals in the district include: abundant pyrite, sphalerite (variety marmatite, black sphalerite with about 20 mole percent FeS), galena, chalcopyrite, pyrrhotite, magnetite, marcasite, bismuthinite, tetrahedrite (silver-bearing), electrum (1:1 Au:Ag), quartz, dolomite, barite, and fluorite. Hydrothermal alteration is minor in the dolomite but more extensive in the igneous rocks; alteration types, from most to least intense, include phyllic (quartz-sericite-pyrite-siderite), argillic (kaolinite-montmorillonite-pyrite-quartz-sericite-carbonate), and propylitic (chlorite-dolomite-magnetite-pyrite). Classic "Leadville-type" mineralization of base-



Field Trip #1 Leadville

U.S.G.S. Lake County topographic map - 1:50,000 and precious-metal replacement mantos has been differentiated as distinct from the peripheral, and slightly lower-temperature, Sherman-type mineralization. The Leadville-type mineralization is inferred, from fluid inclusion studies, to have taken place at about 300-400° C and a pressure of about 1.2 kilobars; Sherman-type mineralization was at about 250-350° C, and an earliest phase of quartz-pyrite-gold veins occurred at about 400-450° C.

Please note: most or all of the active and inactive mines visited on these trips are on private property, and our field trip visits are made through courtesy of the owners. No visit to any of these sites should be made without permission of the property owners.

Trip Schedule:

7:30 am Leave Golden

9:30 am Arrive in Leadville. On Harrison Avenue in downtown Leadville, drive past E. 7th Street (which leads up Little Stray Horse Gulch past Fryer Hill and the Matchless mine and ultimately connects to the Mosquito Pass road). Turn left (east) up E. 5th Street, which follows Stray Horse Gulch past the tailings of the Hamm Mill and the site of the Maid of Erin mine on the right (0.8 miles) in the Downtown mining district of Leadville, with Carbonate Hill lying to the south; the Robert Emmett mine on the left and the Wolftone on the right (1.2 miles); the New Mikado Shaft on the right with Iron Hill to the south (1.4 miles); Adelaide Park (former site of Adelaide City) on the right (2.0 miles); the Black Prince mine on the right (3.3 miles); the Ibex mines and the former town of Ibex, on the north side of Breece Hill (3.5-3.7 miles); the Irene shaft on the left (3.8 miles); and the Garbutt shaft on the right (4.0 miles).

9:45 am **STOP #1 Venir mine overlook** (4.4 miles); geologic and scenic overview of the district. "The Venir Mining Co. of Boulder, Colo., developed the Venir Shaft at this location. From the 1920's until the 1940's it was leased by John Cortelleni for gold production. Cortelleni is fondly remembered as one of the last independent mine operators in the area and he also served as Mayor of Leadville for a number of years." [From "Travel the Routes of the Silver Kings, a self-guided tour of the famous Leadville Mining District", a pamphlet published in 1978 by the Leadville Chamber of Commerce.] The Venir mine was developed on quartz-pyrite-gold veins cutting Johnson Gulch Porphyry and the Belden Formation (Pennsylvanian). The veins strike northeast and are less than 0.5 m wide. Similar veins elsewhere in the district, where they extend down into the Leadville Dolomite, have developed base- and precious-metal manto deposits. From this point there is an excellent view, to the west, of Leadville, the Upper Arkansas Valley, and the Sawatch Range. The Continental Divide follows this range, though slightly to the west of most of the highest peaks. Visible to the southwest is Mount Elbert, highest mountain in Colorado (14,431'), and just north of it is Mount Massive, the third highest (14,418'). Turquoise Lake (elev. 9780') is to the right of Mount Massive. Beyond Turquoise Lake are the Sugarloaf (on the north) and St. Kevin (on the south) mining districts; the lake is named not for its sky-blue color, but for the gem-grade turquoise produced at the Turquiose Chief and several other mines north of the lake.

Stop #2 Antioch "Quarry" (optional stop) on Breece Hill, a few hundred yards from the Venir mine. At the open cut of this mine, several sets of northeast- and northwest-striking fissure veinlets intersect to form a broad stockwork zone of quartz-pyrite-gold mineralization, with very strong phyllic (quartz-sericite-pyrite) hydrothermal alteration.

10:30 am **STOP #3 North Moyer and/or Tucson mines.** Retrace the route back down Stray Horse Gulch; stop near Adelaide Park in the saddle between Iron Hill and Breece Hill. This area displays the massive sulfide replacement ore typical of deposits relatively near the Breece Hill intrusive center, the thermal center of the Leadville district. Massive, banded pyritic ore is common on the dumps.

11:30 am **STOP #3 Diamond Shaft [and lunch]** Return to Harrison Ave., drive north to 7th St., turn east up E. 7th St. This mine, currently operated by the Leadville Corporation, is located in the Resurrection fault block, in the northeast part of the Leadville district. The mine is in upper Evans Gulch (11,300'), just below Diamond Lake (11,390'). Beyond the mine, a four-wheel-drive road continues up over Mosquito Pass, and down to Mosquito Gulch (past the London gold mine) through Park City to Fairplay--part of the route of field trip #5. Mining took place in this area from the 1940's until the early 1960's; ore was base-metal, silver, and gold-rich manto deposits. Ore in this part of the district was relatively rich in native gold. Presently, the Diamond Shaft is mining a thoroughly oxidized, gold-rich manto deposit, which runs about 0.35 oz/ton Au.

Returning to downtown Leadville, continue south on Harrison Ave. Turn up E. 4th Street which follows California Gulch, winding along the south side of Carbonate and Fryer Hills and north of Rock Hill. California Gulch was the site of the first placer gold discovery in Leadville, by Abe Lee on April 26, 1860; one story has it that it was named because there was "all of California in this pan!". Pass the Resurrection Mill (1.3 miles, on right) and the Yak Tunnel (on left). The Yak Tunnel runs 4 miles to the northeast; it was begun in 1895 to drain numerous mines and to transport ore from mines in Evans Gulch. This tunnel is now a source of considerable water pollution from acid and heavy-metal-contaminated mine drainage into the Arkansas River via California Gulch, and has been the subject of numerous lawsuits; California Gulch is an EPA "superfund" cleanup site. Pass the site of Oro City (2.9 miles); the Printer Boy mine, which was the first hard rock mining operation in the district (3.3 miles, on right); the First National mine and mill on the right, and the Julia Fisk mine on the left (5.3 miles); continue east to the Black Cloud mine.

2:00 STOP #4 **Black Cloud mine.** The current mining operation at the Black Cloud mine is a joint venture between ASARCO and Newmont Mining Co. It has been in production since about 1971. Present production is about 800 tons/day, with a total production since 1971 of about 3.3 million tons. The ore averages approximately 0.073 oz/ton Au, 2.15 oz/ton Ag, 3.9% Pb, and 8.0% Zn. The mine currently has a total work force of about 143, with about 70 employed in underground mining. Ore is being produced from workings on the the 900, 1100, 1250, and 1500' levels. The ore is milled on the site; zinc-bearing concentrates are shipped for smelting to Bartlesville, OK, and lead-rich concentrates to East Helena, MT. Most of the pyritic fraction from the mill is used as underground backfill; a minor amount is sold as an Fe-rich smelter additive. The ore is produced from replacement deposits in the Leadville Dolomite and the Dyer Dolomite

3:30 **STOP #5** Sherman mine (Leadville Corp.), reached by continuing up Evans Gulch to the mine portal. The mine is at the base of Iowa Amphitheater, at an elevation of about 12,200'. The deposit was discovered in 1968 and the Sherman tunnel was begun in 1970; it went into production in 1975 and operated until about 1982. Ore averaged 18 oz/ton Ag, and was mined from small, irregular bodies in the Leadville Dolomite, typically hosted by karst solution-collapse breccia, although there is minor veining and replacement of dolomite. Total production was over 10,000,000 oz Ag. Unoxidized ore contains barite-dolomite-sphalerite-galena-argentian tetrahedrite; locally, strong oxidation and enrichment has produced a large variety of secondary minerals including malachite, azurite, wulfenite, rosasite, aurichalcite, cerussite, smithsonite, and native silver. The Sherman mine is one of many such "Sherman-type" deposits in the Mosquito Range, including those in the New York Cliffs area between Mosquito Peak and London Mountain (see Field Trip #5). Still above the Sherman mine, at an elevation of about 12,700 at the base of the headwall of the cirque, is the Continental Chief mine.

4:30 **Optional stops** and/or discussion at the Sunday/Ontario vein, Tucson mine dump, Robert E. Lee mine dump, Penn group of mines, Harrison Reduction Works.

5:30 **End of trip**; return to Golden.

<u>Selected References</u>

Arehart, G.B., 1978, Geology and geochemistry of the Black Cloud #3 Zn-Pb-Ag replacement orebody, Leadville district, Lake County, Colorado: Unpublished M.S. thesis, Colorado State University, 88 p.

Behre, C.H., Jr., 1953, Geology and ore deposits of the west slope of the Mosquito Range: U.S. Geological Survey Prof. Paper 235, 176 p.

DeVoto, R.H., 1983, Central Colorado karst-controlled lead-zinc-silver deposits (Leadville, Gilman, Aspen, and others), a late Paleozoic Mississippi Valley-type district: <u>in</u> The Genesis of Rocky Mountain Ore Deposits - Changes with Time and Tectonics, Proceedings of the Denver Region Exploration Geologists Society Symposium, Nov. 4-5, 1982, p. 51-70.

Emmons, S.F., 1886, Geology and mining industry of Leadville, Colorado: U.S. Geological Survey Monograph 12, 770 p. + 35 folio sheets.

Emmons, S.F., and Irving, J.D., 1907, The Downtown district of Leadville, Colorado: U.S. Geological Survey Bulletin 320, 75 p.

Emmons, S.F., Irving, J.D., and Loughlin, G.F., 1927, Geology and ore deposits of the Leadville mining district, Colorado: U.S. Geol. Survey Prof. Paper 148, 368 p.

Johansing, Robert J., 1982, Physical-chemical controls of dolomite hosted Sherman type mineralization, Lake and Park Counties, Colorado: Unpublished M.S. thesis, Colorado State University, 158 p.

Jonson, Dave, 1955, Geology of the Resurrection mine area, Lake County, Colorado: Unpublished M.S. thesis, Colorado School of Mines, 158 p.

Loughlin, G.F., 1918, The oxidized zinc ores of Leadville, Colorado: U.S. Geological Survey Bulletin 681, 91 p.

Loughlin, G.F., 1926, Guides to ore in the Leadville, district, Colorado: U.S. Geological Survey Bulletin 779, 37 p.

Loughlin, G.F., and Behre, C. H., Jr., 1934, Zoning of ore deposits in and adjoining the Leadville district, Colorado: Economic Geology, v. 29, p. 212-254.

Reed, J.C., and others, 1987, Geology and Mineral Resources of Central Colorado: Rocky Mountain Section, Geological Society of America [field trip guidebook], May 5-6, 1987, 33 p.

Shannon, John M., and Shannon, Geraldine C., 1985, Famous mineral localities: the mines and minerals of Leadville: Mineralogical Record, v. 16, p. 171-201.

Thompson, Tommy B., 1976, Geology of the down-dropped block, Leadville district, Colorado; p. 192-198 <u>in</u> Tectonics and Mineral Resources of Southwestern North America, New Mexico Geological Soc. Spec. Paper No. 6.

Thompson, Tommy B., 1986, Field Trip Guide Book to Colorado Ore Deposits: 14th General Meeting of the International Mineralogical Association, Stanford University, July 1986, 25 p.

Thompson, Tommy B., Arehart, G.B., Johansing, R.J., Osborne, L.W., Jr., and Landis, G.P., 1982, Geology and geochemistry of the Leadville district, Colorado: <u>in</u> The Genesis of Rocky Mountain Ore Deposits - Changes with Time and Tectonics, Proceeding of the Denver Region Exploration Geologists Society Symposium, Nov. 4-5, 1982, p. 101-115.

Tweto, Ogden, 1968, Leadville district, Colorado: p. 681-705 <u>in</u> J.D. Ridge, ed., Ore Deposits of the United States, 1933-1967, Graton-Sales Volume, vol. 1, A.I.M.E., New York.

Tweto, Ogden, Moench, R.H.,, and Reed, J.C., 1978, Geologic map of the Leadville 1° x 2° quadrangle, northwestern Colorado: U.S. Geological Survey Map I-999.

Voynick, Stephen M., 1984, Leadville: a Miner's Epic: Mountain Press, Missoula, Montana, 165 p.

FIELD TRIP #2 - SUNDAY, AUG. 14
CRIPPLE CREEK, COLORADO

Leaders: Earl Detra (Texasgulf), Chauncey Walden

More than 21 million troy ounces of gold have been recovered from the Cripple Creek district since its discovery by Robert Womack in 1891. The Cripple Creek district was a late-comer among Colorado gold districts. Because the gold occurred as inconspicuous telluride minerals rather than as free or placer gold, the gold potential of the area went unrecognized. The district is localized within and around the margins of a silica-undersaturated alkalic diatreme-intrusive complex. Magmas range in composition from phonolite to alkali basalt, and their age is about 27.9 to 29.3 (+/- 0.7) million years. The igneous flows, intrusives, pyroclastics, and breccias formed within three coalescing basins, which also accumulated sediments from lakes and rivers. This composite structural basin is surrounded by Precambrian crystalline rocks. The orebodies were typically narrow veins within both Precambrian and Tertiary rocks, or bulk tonnage deposits hosted by tectonic and hydrothermal breccias (see Thompson, 1986a, 1986b, and Thompson and others, 1985).

Please note: most or all of the active and inactive mines visited on these trips are on private property, and our field trip visits are made through courtesy of the owners. No visit to any of these sites should be made without permission of the property owners.

Trip Schedule:

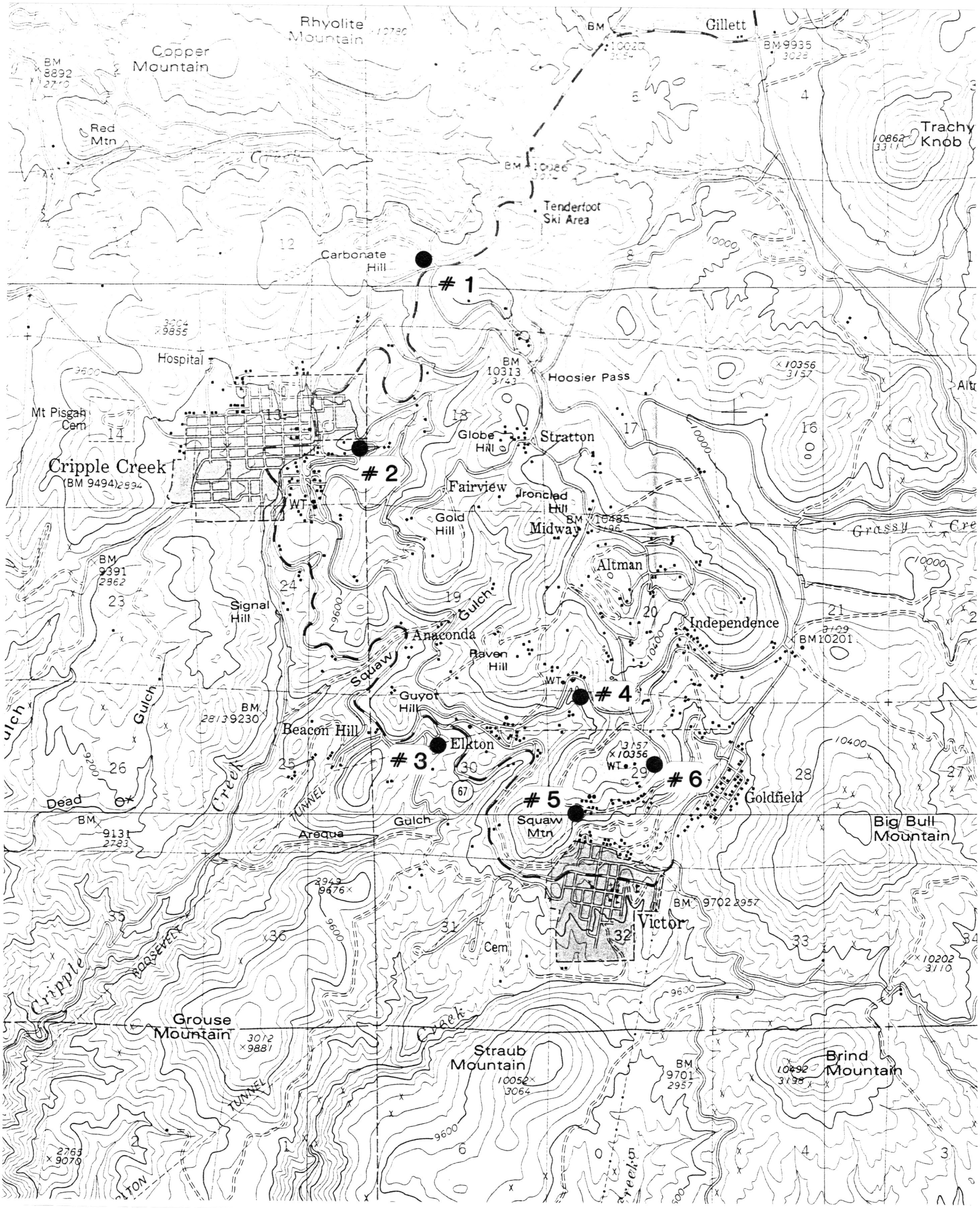
7:30 am Leave Golden

9:30 am **STOP #1** Levon Resources gold property on Carbonate Hill/Tenderfoot Hill (Dick Dwelley & Earl Detra). This gold deposit is located just northeast of the town of Cripple Creek, at a point before the highway drops down off of Carbonate Hill (past the Mollie Kathleen mine which provides commercial tours) into town. It is currently being developed by Levon Resources for possible mining, and it differs from most Cripple Creek ore deposits by containing free gold rather than tellurides. The gold is in fractures in an intrusive breccia; there are several stages of brecciation, of which the gold is associated with the latest. The gold forms subhedral, rounded octahedral crystals. Gold grains are up to about 1 mm in size. Associated minerals are characteristic of acid sulfate alteration: adularia, hematite, pyrite, huebnerite, jarosite (?), "clay", montmorillonite, and alunite. One small vein on the edge of the deposit contains gold which appears to have replaced telluride minerals. A gravity-separation pilot plant is now in operation, and there are plans for a 1000 ton/day gravity mill. The grade of the ore is around 0.05 oz Au/ton.

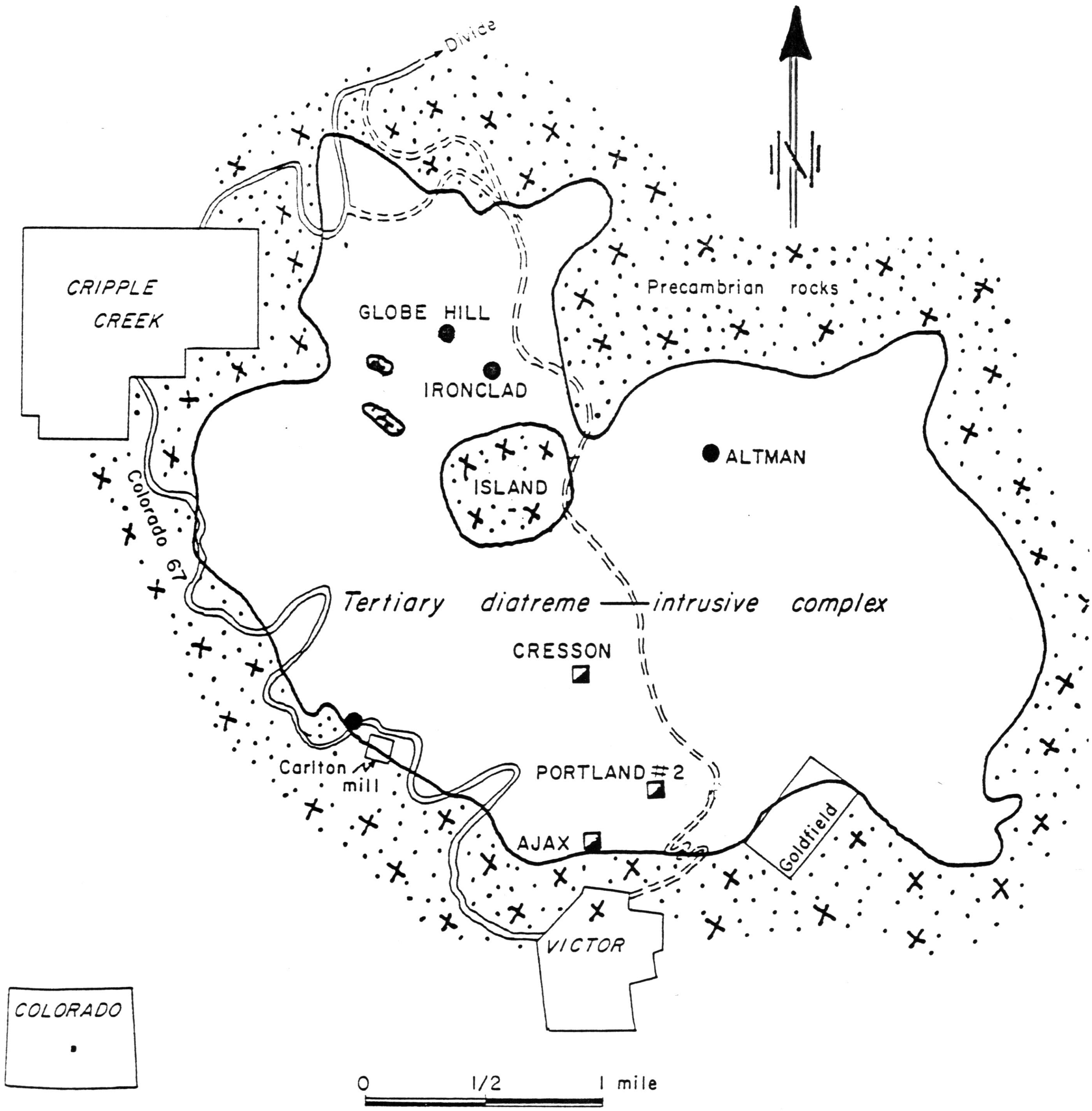
10:30 am **STOP #2** **Poverty Gulch** - overview of the district. Located just east of and above the town of Cripple Creek, this is the original part of the Cripple Creek mining district. In town, note the Cripple Creek and Victor narrow-gauge railroad, which runs along a few miles of old track part-way to Victor.

11:15 **STOP #3** **View of Texasgulf heap-leach pads.** Cyanide heap-leaching operations are conducted near the Carleton mill; others are located near the Portland pit.

Field Trip #2 Cripple Creek



U.S.G.S. Teller County topographic map - scale 1:50,000



Simplified map showing the geology of the Cripple Creek - Victor district; from Tommy B. Thompson, in DREGS Fall Field Guidebook, 1986.

11:45 **STOP #4 Cresson mine dump** The Cresson is probably the most famous of Cripple Creek's mines. The ore is a breccia, with a matrix rich in fluorite, and which carried gold tellurides. The Cresson "blowout" structure was a diatreme-like eruptive vent, in which the rock was brecciated and mineralized by carbon dioxide-rich fluids. The breccia contains fragments of basaltic igneous rock, and it is intruded by pre-mineral alkali basalt dikes. Ore was in open cavities; minerals include fluorite, quartz, adularia, carbonates, celestite, and various gold-silver tellurides. The "Cresson vug" is legendary among both miners and mineral collectors. Found in 1914, this 40 x 20 x 15-foot cavern contained about 1.2 million dollars worth of crystallized calaverite with minor native gold. Currently, the dump is being hauled away and cyanide-leached to recover gold; continual removal of dump material holds the possibility of uncovered new ore and mineral specimens being uncovered.

2:00 pm **STOP #5 Ajax mine** The Ajax, with a 3350'-deep shaft, was the second-largest gold producer in the Cripple Creek district--total production was about 1 million ounces of gold. It is located on the side of Squaw Mountain, above Victor. The ore was in northwesterly-striking veins, near the contact of a porphyritic granite gneiss (of Precambrian age) to the south, and a volcanic breccia (Tertiary age) on the north. Both fresh and highly-altered granite can be seen; the altered rock contains fluorite, dull green roscoelite (vanadium mica), pyrite, quartz, calaverite, and late-forming needles of celestite. According to Munn (1984), "This famous mine shipped granite honeycombed with gold tellurides as early as 1895." The present steel headframe was built in 1959; the most recent underground work at the mine was in 1976-1983, when it was worked by Texasgulf.

3:30 pm **STOP #6 Portland open pit** This deposit (near the site of the old Portland mine on Battle Mountain) contained a system of en-echelon, high-grade gold veins. It is now being worked by Texasgulf as an open pit for a relatively small deposit of low-grade ore. The original Portland mine was the most productive in the district, having produced about 2 million ounces of gold. The original claim was located in 1892 on 69/1000 acre of unclaimed ground. The ore and veins are hosted by a variety of lacustrine and fragmental volcanic rocks, including a heterolithic lapilli tuff and bedded ash-fall tuffs.

4:00 pm Possible other short geologic stops to examine diatremes, phonolites, and hydrothermal alteration.

5:00 pm End of trip.

Selected References

Denver Region Exploration Geologists Society, 1986, Fall Field Guidebook, 4-5 October 1986, Cripple Creek Mining District; 63 p.

Dwelley, P.C., 1984, Geology, mineralization, and fluid inclusion analysis of the Ajax vein system, Cripple Creek mining district, Colorado: unpubl. M.S. Thesis, Colorado State University, 167 p.

Engineering and Mining Journal, 1982, Hard work makes things go at a small Colorado mine: Eng. & Mining Journal, Feb. 1982, p. 74-76. [Cross mine]

Grimstad, Bill, and Drake, Raymond L., 1983, The Last Gold Rush, a Pictorial History of the Cripple Creek & Victor Gold Mining District: Pollux Press, Victor, Colorado, 159 p.

Koschmann, A.H., 1949, Structural control of the gold deposits of the Cripple Creek district, Colorado: U.S. Geological Survey Bulletin 955-B, p. 19-58.

Lindgren, W., and Ransome, F.L., 1906, Geology and gold deposits of the Cripple Creek district, Colorado: U.S. Geological Survey Prof. Paper 54, 516 p.

Loughlin, G.F., and Koschmann, A.H., 1935, Geology and ore deposits of the Cripple Creek district, Colorado: Colorado Scientific Society Proceedings, v. 13, no. 6, p. 217-435.

Munn, Bill, 1984, A guide to the mines of the Cripple Creek district: Century One Press, Colorado Springs, Colorado, 71 p.

Rickard, T.A., 1903, The lodes of Cripple Creek: Trans. A.I.M.E., v. 33, p. 578-618.

Smith, Arthur E., Jr., Raines, Ed, and Feitz, Leland, 1985, Great pockets - the Cresson Vug, Cripple Creek: Mineralogical Record, v. 16, p. 231-238.

Sprague, M., 1953, Money Mountain, the Story of Cripple Creek Gold: Little, Brown, and Company, Boston; reprinted (1979) by University of Nebraska Press, Lincoln.

Thompson, Tommy B., 1986a, Cripple Creek, p. 23-25 in Field Trip Guide to Colorado Ore Deposits, Internat. Mineralogical Assoc., 14th General Meeting, July, 1986, Stanford University.

Thompson, Tommy B., 1986b, Geology and mineral deposits, Cripple Creek district, Colorado; p. 16-63 in Denver Region Exploration Geologists Society, Fall Field Guidebook, 4-5 October 1986, Cripple Creek Mining District.

Thompson, Tommy B., Trippel, Alan D., and Dwelley, Peter C., 1985, Mineralized veins and breccias of the Cripple Creek district, Colorado: Economic Geology, v. 80, p. 1669-1688.

Wobus, R.A., Epis, R.C., and Scott, G.R., 1976, Reconnaissance geologic map of the Cripple Creek-Pikes Peak area, Teller, Fremont and El Paso Counties, Colorado: U.S. Geological Survey Map MF-805.

FIELD TRIP #3 - SUNDAY, AUG. 14
BOULDER COUNTY, COLORADO: NEDERLAND, CARIBOU, WARD, AND GOLD HILL DISTRICTS

Leaders: Bruce Geller, Jack Murphy

The Boulder telluride belt is an area of epithermal precious metal mineralization at the northeast end of the Colorado mineral belt. It includes the Boulder County districts of Gold Hill, Jamestown, Magnolia, and Sugarloaf. The Telluride belt extends roughly 23 km from north to south and about 8 km from east to west. The center of the belt lies in the Gold Hill mining district about 10 km northwest of Boulder.

Ore deposits in the northeastern part of the Colorado mineral belt, in Boulder County, include several types. Telluride deposits are typified by those at Gold Hill and are similar to deposits at Cripple Creek, Colorado; Vatukoula, Fiji; and Nagyag, Rumania. Pyritic-gold deposits, as at the Grand Republic and Slide mines, contain fine-grained auriferous pyrite plus chalcopyrite, galena, sphalerite, tetrahedrite, minor free gold, quartz, sericite, chlorite, roscoelite, and ankerite. Bonanza silver-base metal deposits (Yellow Pine, Victoria, and other mines) contain coarse-grained galena, sphalerite, pyrite, chalcopyrite, silver-bearing tetrahedrite-tennantite, silver sulfosalts, bornite, stromeyerite, electrum, arsenopyrite, covellite, quartz, adularia, and ankerite. The tungsten deposits contain wolframite with quartz and pyrite.

Trip Schedule:

7:30 am Leave Golden

8:30 am STOP #1 Sherwood Gulch (Hurricane Hill) tungsten mining area, north of Nederland (Bruce Geller and Al Rogers). This stop will afford one look at the Boulder County tungsten district, located around Nederland in southern Boulder County. The district consists of a belt of shallow veins, mainly within Precambrian quartz monzonite. The principal ore mineral is wolframite (ferberite); mineralization is believed to be related to early Tertiary biotite monzonite porphyry and biotite latite. Wolframite in the district shows a chemical zonation, with Mn-poor to nearly Mn-free ferberite in the deepest, central portion of the district, and progressively higher Mn/Fe toward the flanks (huebnerite with a maximum of Mn/Fe = 1.34 is found in the northern part). We will examine the dumps of the Clyde shaft and tunnel, a typical ferberite deposit; across the road, an unrelated(?) silver-lead orebody was mined out. The Clyde consisted of two main interconnecting veins; the vein filling included brecciated "horn" quartz, later fine-grained quartz, chalcedony, and ferberite, plus local barite, kaolinite, opal, and pyrite. Similar tungsten deposits occur at Tungsten Mountain, southeast of Nederland, and elsewhere in the district. Studies indicate that the tungsten deposits formed at relatively low temperatures (<200 C) from boiling, low- to moderate-salinity fluids at shallow depth (<200 m).

10:00 am STOP #2 Cross mine (Tom Hendricks - Hendricks Mining Co.), located below the Caribou mine and the former townsite of Caribou. The Cross mine was reopened by Tom Hendricks in 1977 and has produced ore

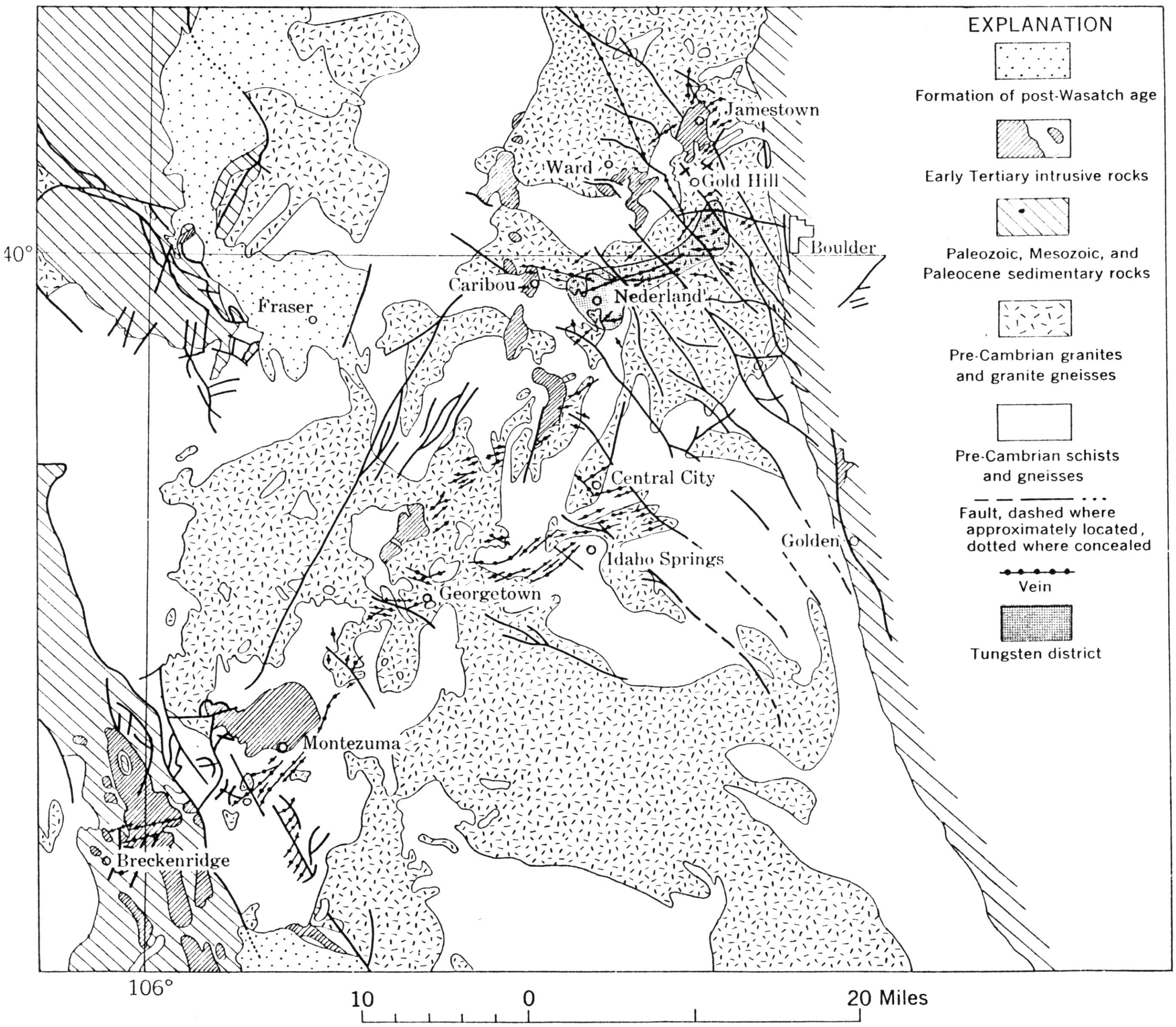
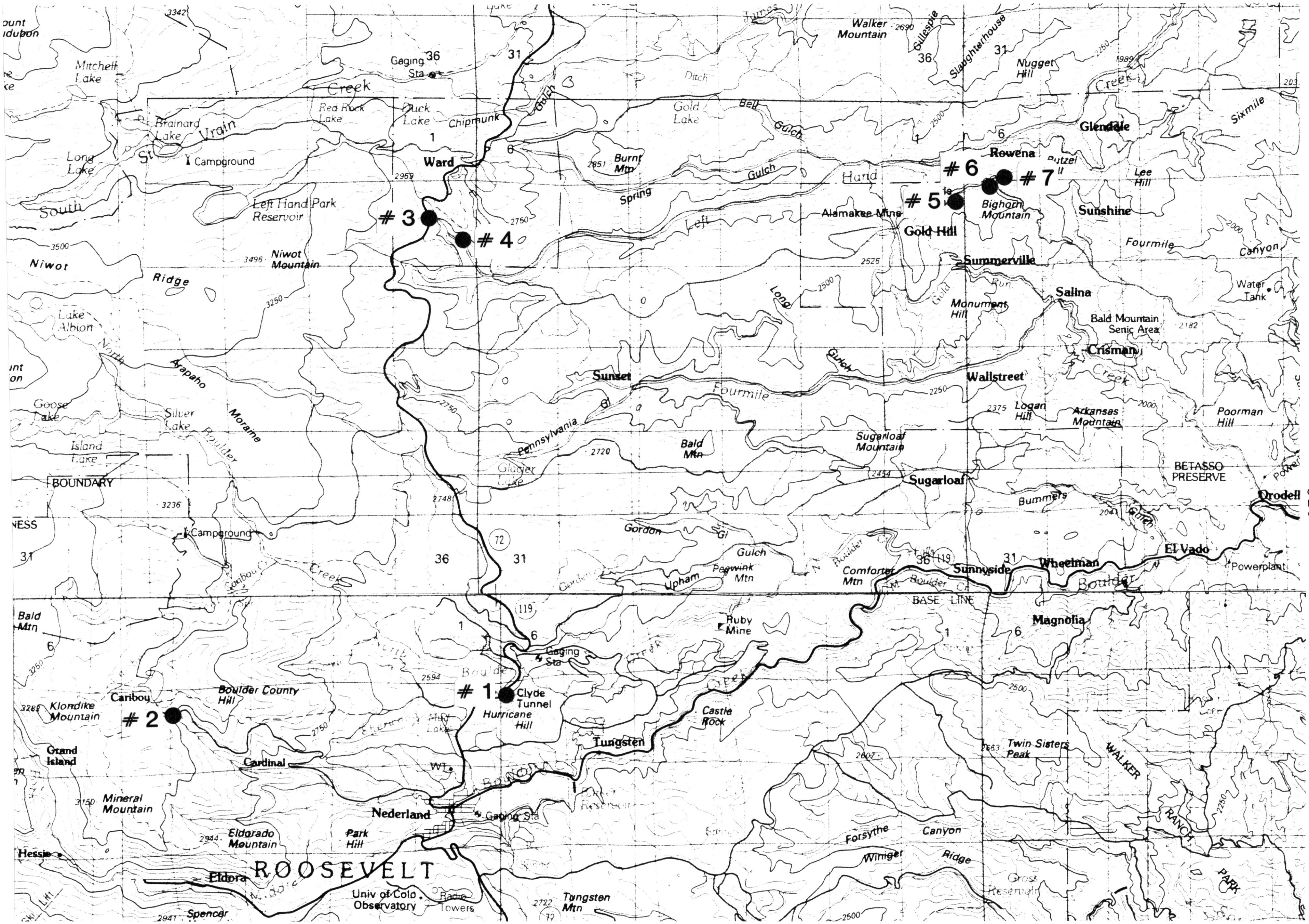


FIGURE 1.—Index map showing the location of the Boulder County tungsten district, Colo.

Fig. 1 (p. 3) from Lovering and Tweto, 1953, Geology and ore deposits of the Boulder County tungsten district, Colorado; U.S. Geological Survey Prof. Paper 245.



U.S.G.S. Estes Park and Denver West topographic maps - 1:100,000

Field Trip #3 Boulder County

sporadically. The ore is milled in Boulder and has produced concentrates from which gold, silver, lead, zinc, and copper have been recovered. The Cross and four other major vein systems are cut by the mine; they are associated with a Tertiary quartz monzonite intrusive. Minerals in the veins include pyrite, chalcopyrite, argentite, sphalerite, galena, quartz, and native silver. Gold is contained in pyrite; little free gold is seen.

1:00 **STOP #3 roadcut on highway 72, south of Ward**; overlook of Left Hand Canyon and discussion of Ward district (Valois Shea).

1:30 **STOP #4 White Raven mine, Ward district** (Valois Shea). The Ward district was one of the earliest and most productive mining areas in Boulder County. Gold was first found in the district in 1861 by Calvin Ward. The White Raven mine is about 3/4 mile south of Ward; it followed the White Raven vein, a prominent, east-west-striking vein. Most of the ore produced at the mine came from one chimney-like shoot, in which fragments of schist, granite, and porphyry were coated with layers of sulfide minerals, 1/8 to 3/4 inch thick. Ore and associated minerals included galena, calcite, barite, wire silver, chalcopyrite, minor sphalerite, and minor tetrahedrite. Ore shipped from the mine is reported to have assayed about 100 oz Ag/ton, and 10% lead.

"The White Raven mine exploits an ore deposit formed by two separate phases of mineralization. The first phase formed the Dew Drop vein which consists of a gold-bearing quartz-pyrite-chalcopyrite assemblage. The second formed the White Raven vein consisting of microcrystalline quartz plus a silver-bearing carbonate-sulfide-sulfosalt-sulfate-native metal assemblage. The two veins are traceable along California Gulch and beyond for approximately one mile. At the White Raven mine the two veins coincide. A breccia pipe bears the main ore shoot of the mine. Its formation accompanied the second mineralization phase. The breccia matrix consists of ore and gangue minerals from the silver mineralization phase, cementing fragments of the earlier gold-bearing vein, as well as fragments of the country rocks hosting the vein and breccia pipe. The ore deposit at the White Raven mine appears to span the evolution process of a hot spring system. Based on the vein textures and ore mineral assemblage, the earlier gold mineralization was precipitated while hydrostatic conditions still existed within the system, before the hydrothermal fluid vented to the surface. The later silver mineralization phase produced a mineral assemblage characteristic of that precipitated by boiling hydrothermal fluids at depth within a hot spring system." (courtesy of Valois Shea, M.S. candidate at the University of Colorado)

3:30 pm **STOP #5 Cash gold mill, Gold Hill** (Mark Steen) This is a new mill, constructed within the past few years to serve the Cash (located down the hillside below the mill) and the Who Do mines. The mill is designed to treat telluride ores, using a combined gravity and floatation process; the initial capacity is 50 tons/day. Gold was first discovered in this area on January 16, 1859, in Gold Run Creek. It is estimated (see Geller and others, 1988, in press) that the Gold

Hill district produced about 14.0 metric tons (450,000 troy ounces) of gold, worth just under $15,000,000 at the time of production, or $200,000,000 today.

4:30 pm **STOP #6 Roadcut east of Gold Hill** A bostonite dike is exposed along County Road 52, cutting sheared Boulder Creek (Precambrian) Granodiorite. Bostonite, an often purplish, altered rock with orthoclase phenocrysts, has been called a "suspicious associate to mineralization in the northeast end of the Colorado Mineral Belt from Idaho Springs northward" (Geller and others, 1986).

5:00 pm **STOP #7 Snowbound mine, east of Gold Hill** (Bruce Geller, Phil Hannum) The Snowbound mine was discovered by Henry N. Coffey in 1877. He found free gold at the surface and drove an adit along the vein for 400 feet into the mountainside, where he struck a "blowout" of rich ore. A shaft was sunk from the surface to intersect the vein, but it missed the adit. The shaft has a depth of 226 feet, with four levels. In 1917 equipment, including a 75-horsepower steam engine, was brought to the Snowbound from the Oronogo mine, north of Ward. The mine was idle after 1926, and reopened briefly after the Second World War. Before it closed permanently in 1947, it was the last mine in Boulder County to operate on steam power. The ore was predominantly silver (about 10-80 oz/ton) with minor gold (about 1-6 oz/ton); according to the owner, Phil Hannum, a present-day dump sample assayed 0.14 oz Au/ton. The shaft house and equipment are still in place at the mine; Phil hopes to preserve the mine as a museum.

6:00 pm **End of trip**; return via Boulder.

<u>Selected References</u>

Atkinson, William W., Jr., editor, 1987, Epithermal mineral deposits of Boulder County Colorado: the Gold Hill district: Geological Society of America, Rocky Mountain Section, 40th Annual Meeting, Field Trip No. 4 Guide-book, May 1, 1987, University of Colorado, Boulder, Colo., 19 p.

Cobb, Harrison S., 1988, Prospecting Our Past - Gold, Silver and Tungsten Mills of Boulder County: The Book Lode, Boulder, Colorado, 160 p.

Fenneman, N.M., 1905, Geology of the Boulder district, Colorado: U.S. Geological Survey Bull. 265, 101 p.

Gable, Dolores J., 1969, Geologic map of the Nederland quadrangle, Boulder and Gilpin Counties, Colorado: U.S. Geological Survey, Geologic Quadrangle Map GQ-835.

Gable, Dolores J., 1972, Geologic quadrangle map of the Tungsten quadrangle, Boulder, Gilpin, and Jefferson Counties, Colorado: U.S. Geological Survey, Geologic Quadrangle Map GQ-978.

Gable, Dolores J., 1980, Geologic map of the Gold Hill quadrangle, Boulder County, Colorado: U.S. Geological Survey, Geologic Quadrangle Map GQ-1525.

Gable, Dolores J., and Madole, Richard F., 1976, Geologic map of the Ward quadrangle, Boulder County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1277.

Geller, Bruce, Kurtz, Jeffrey, and Atkinson, W.W., Jr., 1988, Precious metal telluride mineral deposits of Boulder County, Colorado: the Gold Hill mining district: in Geological Soc. of America 100th Annual Meeting, Field Trip Guidebook (in press).

Geller, Bruce, Saunders, Jim, and Francis, Kevin, 1986, DREGS 1986 Spring Field Trip, Jamestown - Gold Hill - Caribou, Second Day, May 24, 1986; in DREGS 1986 Spring Guidebook: Denver Region Exploration Geologists Society, 86 p.

Hudson, Ann E., and Atkinson, W.W., 1988, A geochemical analysis of the tungsten vein deposits in Boulder County, Colorado [abst.]: Geological Society of America, Program with Abstracts, v. 20, no. 6, p. 421.

Kelly, William C., and Goddard, Edwin N., 1969, Telluride ores of Boulder County, Colorado: Geological Society of America Memoir 109, 237 p.

Lovering, T.S., and Goddard, E.N., 1950, Geology and ore deposits of the Front Range, Colorado: U.S. Geological Survey Prof. Paper 223, 319 p.

Lovering, T.S., and Tweto, Ogden, 1953, Geology and ore deposits of the Boulder County Tungsten district, Colorado: U.S. Geological Survey Prof. Paper 245, 199 p.

Moore, F.B., Cavender, W.S., and Kaiser, E.P., 1957, Geology and uranium deposits of the Caribou area, Boulder County, Colorado: U.S. Geological Survey Bulletin 1030-N, 36 p.

Pettem, Silvia, 1980, Red Rocks to Riches, Gold Mining in Boulder County, Then and Now: Stonehenge Books, 123 p.

Rickard, T.A., 1903, The veins of Boulder and Kalgoorlie: Transact. A.I.M.E., v. 33, p. 567-577.

Smith, D.A., 1974, Silver Saga, the Story of Caribou, Colorado: Pruett Publ. Co., Boulder, Colorado, 269 p.

Steen, Mark A., (undated, approx. 1986), Summary of the Cash Mine Project, Gold Hill mining district, Boulder County, Colorado: Gold Hill Ventures, Longmont, Colorado, 6 p.

Please note: most or all of the active and inactive mines visited on these trips are on private property, and our field trip visits are made through courtesy of the owners. No visit to any of these sites should be made without permission of the property owners.

Central City - Idaho Springs Mining Districts

Field Trip #4 - Monday, August 15
Leaders: Dan Kile, Paul Sims, Jim Hurlbut

Historical Background

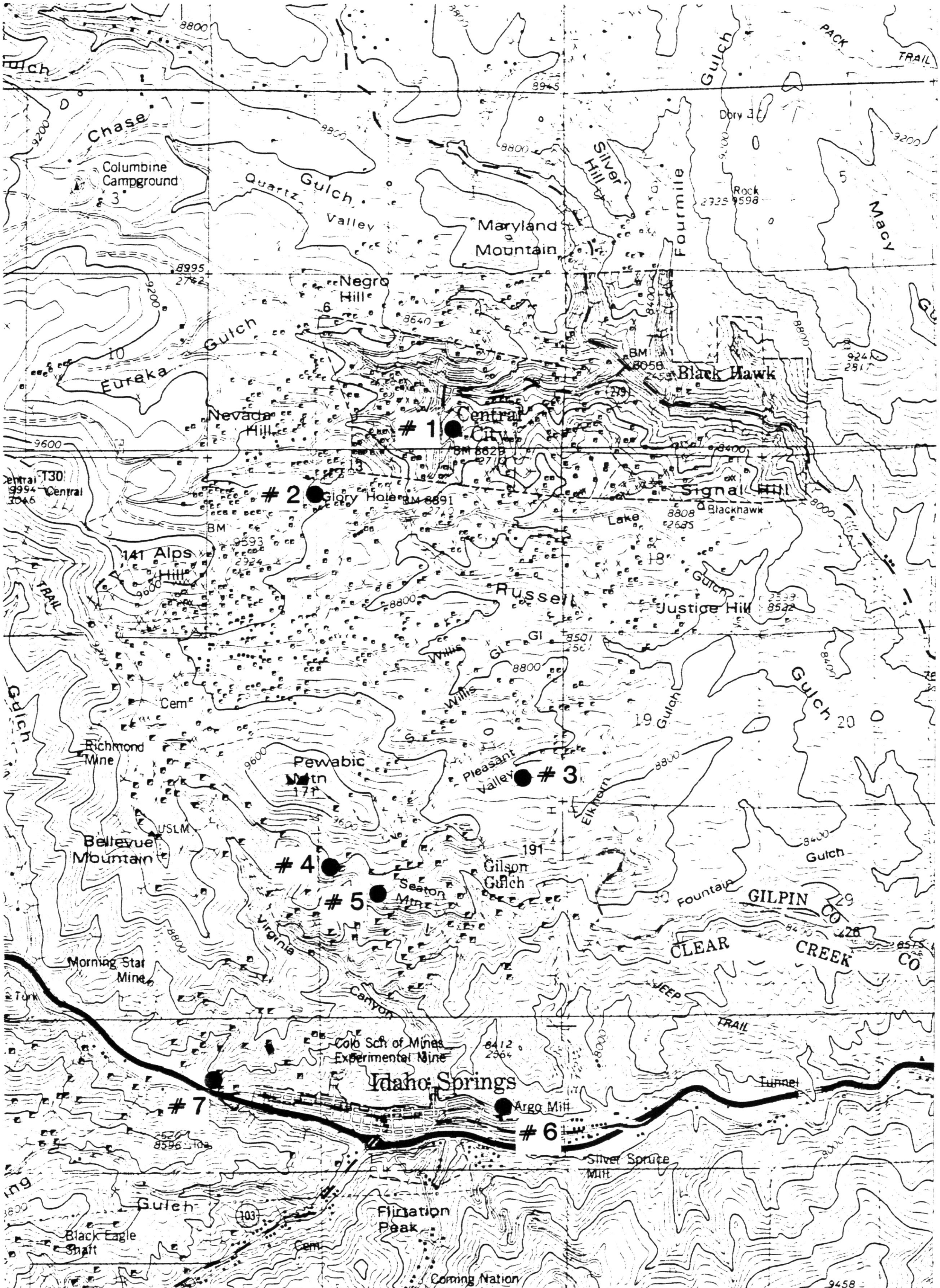
The Central City-Idaho Springs districts comprise an area of about 25 square miles in the southern part of Gilpin County and the northern part of Clear Creek County. These districts represent the earliest period of mining activity in the state of Colorado. Placer gold was discovered by George Jackson in January 1859 near the mouth of Chicago Creek, and shortly thereafter John Gregory located the first vein deposit at a site just east of Central City, near the town of Black Hawk. William Russell found gold in the gulch bearing his name, located between Central City and Idaho Springs; at the same time work commenced in Nevada Gulch, the site of the now deserted town of Nevadaville. Intense mine development continued in these areas for a relatively short period of time while the easily-milled oxidized ore zone was being worked (the supergene part of the ore deposits ranged from 50 to 175 feet in depth), but was considerably reduced thereafter when the primary unoxidized ores were reached. Activity remained at a near-standstill for a period of time until milling methods could be developed to satisfactorily treat the ores. In 1865 the first smelter was built at Black Hawk, and the district began a period of increasing production from the lode ores. The Argo tunnel was driven in 1904 from Idaho Springs to a point under Quartz Hill, near Central City; this tunnel was approximately 4-1/2 miles long and was intended to intersect many of the area's largest mines at a depth from 1,200 to 1,600 feet. Activity in the district slowly declined until 1918, when it came to a near standstill. The increased price of gold in 1933 led to a brief flurry of mining, which ceased with the beginning of World War II. The search for uranium ores (pitchblende) led to renewed activity between 1950 and 1955. There has been sporadic, small-scale mining activity in the past decade.

These two mining districts, together with smaller adjacent districts to the west and southwest, shipped ores valued at about $200 million; the Central City district alone shipped ores valued at more than $100 million, while the Idaho Springs district shipped ores valued at approximately $65 million. Gold has accounted for about 60 percent of the total value of ore.

Geology

The predominant rock in the region is schist and gneiss of Precambrian age, formerly referred to as the Idaho Springs Formation. Microcline bearing gneiss interlayered with biotite gneiss, and pegmatite, are the dominant rock units and generally form the walls of the ore deposits. Early Tertiary intrusive porphyries are abundant in the area, in some cases forming irregular stocks, the largest of which is about 1/2 mile in diameter. The ore deposits are predominately of the fissure-vein type, but stockwork deposits are also noted in the district. The Patch mine, and on a smaller scale, the Moose mine, are stockwork deposits, being characterized by a mineralized breccia that is cut by numerous intersecting small branching veins. The most persistent vein deposit in the area is the California-Mammoth, which has been traced for approximately 2 miles; the smaller veins do not typically extend to great depth, but some of the larger veins, such as the California, have been mined to a depth of 2,200 feet. Mineralization of the veins and stockworks was largely due to fissure-filling rather than replacement, although exceptions (such as in the Moose mine) are noted. The ores were probably derived from hydrothermal fluids related to early Tertiary magmatic activity.

Field Trip #4 Central City - Idaho Springs



U.S.G.S. Gilpin County and Clear Creek County topographic maps - 1:50,000

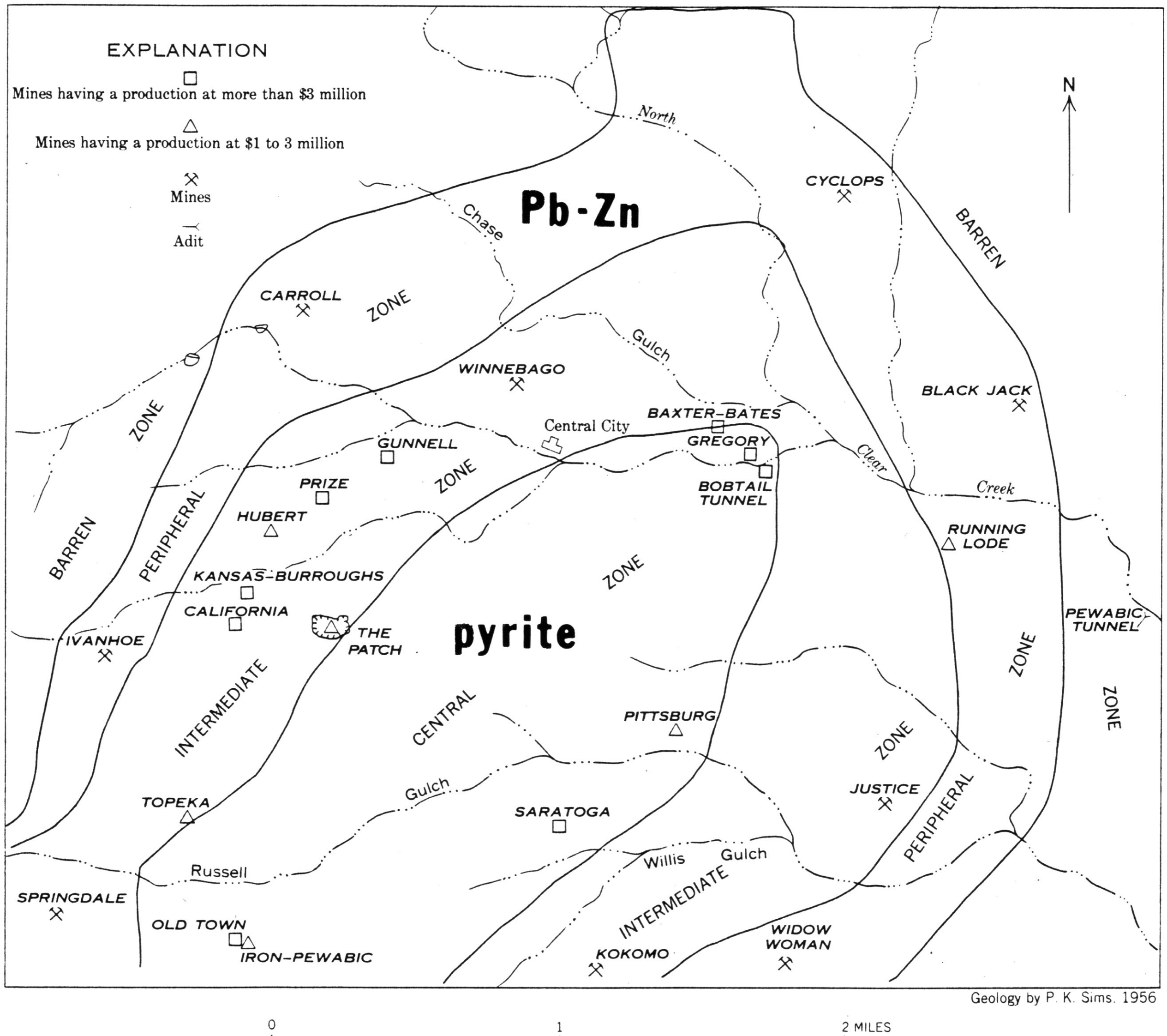


Figure 11.—Map of Central City district showing zoning of mineral deposits.

Fig. 11 (p. 39) from P.K. Sims and others, 1963, Economic geology of the Central City district, Gilpin County, Colorado; U.S. Geological Survey Prof. Paper 359.

The ore deposits are of four types: (1) pyritic gold; (2) galena-sphalerite; (3) composite ores - pyritic/galena/sphalerite; and (4) telluride ores. A concentric zonal arrangement of the ores was shown in the Central City district by Sims and others (1963), who noted a central core of pyritic-type ores surrounded by a peripheral zone of galena-sphalerite veins. The average gold content in district ores varies between 1 to 3 ounces gold, and 4 to 8 ounces silver per ton. Copper is generally less than 1.5 percent, but may range in some ores to 16 percent.

A brief itinerary and summary of the field trip stops follows (milage from Golden to Central City is approximately 26 miles; the round trip will be about 65 miles altogether):

Leave Golden ~ 8 A.M. (high-clearance vehicle required).

Stop No. 1 - Central City Overlook (~ 8:40 - 9:10):

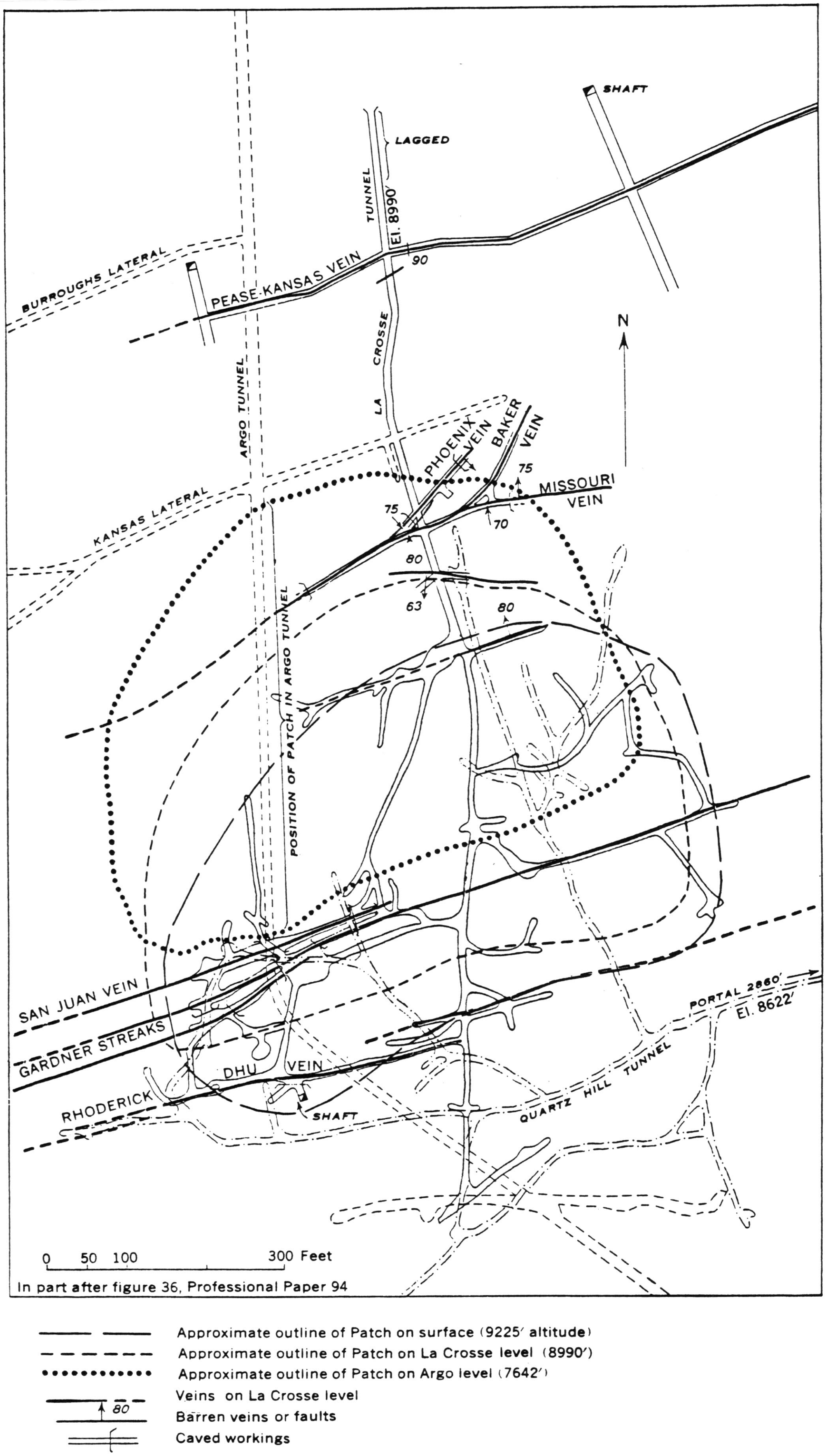
The overlook above Central City gives a panoramic view of one of the state's more important mining districts: John Gregory's discovery of lode gold in 1859 started a gold rush that vastly accelerated the development of the state of Colorado. In the 1860s Central City rivaled Denver in importance. The Opera House (with its famous "face on the bar room floor") was renowned worldwide for its cultural activities; Horace Tabor numbered among the fortune-seekers who came to this boom town. Visible from this overlook is not only the town of Central City, but also some of the important mines as well, such as the Couer d' Alene, National, and St. Louis, as well as the extensive mill tailings from the Patch mine mill (now used as a parking lot). The area surrounding Central City has been referred to as "the richest square mile on Earth"; while probably not totally accurate, the extensive mine dumps do attest to the fact that this was certainly one of the richer mining districts in the state of Colorado. West of this overlook is Quartz Hill - within it are some of the richer veins in the district, such as the California, Kansas, and Mammoth veins, as well as the Patch mine described below.

Stop No. 2 - Patch Mine (~ 9:20 - 12:00):

The Patch mine is located on Quartz Hill, approximately one mile southwest of Central City in Gilpin County. This mine was located by W.M. Muchow in 1929, who consolidated numerous older mines on Quartz Hill. Large-scale open pit ("glory hole") mining commenced, and progressed until 1937; activity has been sporadic since then. The open pit is presently about 750 feet long (east-west) and 400 feet wide (north-south).

The mine is situated within Precambrian rocks (granites, schists and gneisses) formerly known as the Idaho Springs Formation. It is a pipe or chimney-like body of fractured porphyry (containing rounded clasts of microcline-bearing gneiss, with bostonite porphyry evident at some places) cut by a network of branching and interconnecting small veinlets; mineralization has been mostly by fissure filling within the fractures. Major veins which intersect the breccia pipe are said to increase in width and value as they cross the pipe and infiltrate the breccia. This breccia pipe extends (dipping steeply to the north) to the Argo Tunnel level, 1,600 feet below the surface, but the assay values of the ore are substantially less at this level than they are in the upper workings.

Two types of ore mineralization are evident at this mine: (1) pyrite, chalcopyrite, and minor



Map of The Patch, Central City District; Fig. 61 (p. 172) from Lovering and Goddard, 1950, U.S.G.S. Prof. Paper 223.

tetrahedrite; and (2) sphalerite, with subordinate galena, chalcopyrite, and pyrite. Gangue minerals are mostly quartz and siderite, with minor barite.

Minerals commonly found at this mine are: barite, galena, greenockite, pyrrhotite (pseudomorph), pyrite, quartz, siderite, and sphalerite. Less common species are: chalcopyrite, gold, and tetrahedrite-tennantite.

Please be extremely careful around the open pit, and do not venture near any of the numerous shaft collars in the area.

The mill, built to treat ore from the Patch mine, is situated on the main road near the entrance; it contains a ball mill, flotation cells, Wilfley tables, and an electroplating unit. Last operated in the early 1980's, this facility is mostly in working condition.

Stop No. 3 - Moose Mine (~ 12:30 - 1:30):

The Moose mine is located in Pleasant Valley, between Idaho Springs and Central City, and was first operated before 1917; the last mining prior to recent development was done in 1936 by private contractors. Total production of ore at that time does not appear to have exceeded 5,000 tons. The mine was purchased in 1973 by members of the Bennett family, and was subsequently leased to Houston Mining Resources, which operated it from 1980 to 1982. It was at that time reopened to the 150 foot level. Recent assays gave values of up to 0.6 ounces per ton gold and 23 ounces per ton silver. The Moose mine is presently inactive, and the lower levels are flooded.

The mine is at the border of an area of monzonite porphyry; recent development has determined it to be a stockwork-type deposit, with the ore being a pyritic type. Mineralization appears to have been accomplished through replacement, rather than fissure-filling. Two types of ore are noted: (1) pyrite, chalcopyrite, minor tetrahedrite, and (2) galena, sphalerite, chalcopyrite, and subordinate pyrite. Gangue minerals are fluorite, quartz, and rhodochrosite. Rhodochrosite is the mineral of specimen interest; rhombohedral crystals have been found to 3 inches on edge.

Stop No. 4 (Optional Stop) - Lead Belt mine:

Visible from alongside Virginia Canyon Road, this inclined shaft gives a good perspective of a representative ore deposit of this area, with a dominant lead-zinc mineralogy that is characteristic of the peripheral zone of the district. A quartz-pyrite vein is visible near the entrance; this vein varies from two inches to over a foot in width. Sphalerite-galena veinlets are locally evident. Alteration extends 3 - 4 feet into the wallrock (a Precambrian microcline gneiss); a zone of quartz - sericite is adjacent to the vein, followed by an argillized (altered to clay minerals) zone that grades into unaltered wallrock.

Stop No. 5 - Virginia Canyon Overlook (~1:50 - 2:15):

This spectacular view down Virginia Canyon gives a glimpse not only of Idaho Springs, but also gives a perspective on the rugged terrain over which the early day prospectors had to travel in their search for ore deposits. Idaho Springs was named after the hot, alkaline springs located within the town. The original gold discoveries here in early 1859, known as "Jackson's diggings", were placer deposits; they were concentrated around the bars or flats near the confluence of Chicago Creek and Clear Creek. Lode gold was discovered shortly thereafter in the surrounding hills, and the rich oxidized ores were worked as early as 1860. Development of the district after 1866 was closely tied with implementation of efficient milling techniques and the fluctuations in precious metal prices. The financial panics of 1873 and 1894 caused the price of silver to decline, but the shift to gold-bearing ores during these periods kept the district's total production at nearly the same level as before. The continuing decline in the price of silver, however, caused a decrease in the level of activity beginning in 1894. Important mines in the area are the Stanley (formerly the Whale), Frontenac, Specie Payment, Sun and Moon, Gem, and French Flag-Silver Age-Franklin group.

Stop No. 6 - Argo Mill (~2:45 - 5:00):

The Argo tunnel (formerly known as the Newhouse tunnel, named after Samuel Newhouse, an international promoter) was started in 1893 and completed in 1910, and intended to intersect at depth many of the valuable veins in the Cental City and Idaho Springs districts. This tunnel , which is over 4 miles long, served to drain many of the mines from laterals that were driven to intersect it, and allow for easy transport of the ores to the Argo Mill situated near the portal. The tenor of the ore in the veins at depth was for the most part disappointing. The tunnel extends to a point 3/4 of a mile west of Central City; some of the important mines drained by this tunnel are the Saratoga, Old Town, Calhoun, and Mammoth. The tunnel also traverses the Patch mine breccia on Quartz Hill, between 18,867 and 19,412 feet from the portal. A drift from the Argo tunnel to the Kansas workings was intended to intersect the wide vein at the bottom, which had proved uneconomical due to high pumping costs. The Kansas shaft was flooded, and core holes were drilled from raises driven on ore shoots to determine the location of the water-filled stopes. On January 19, 1943, the flooded workings of the Kansas mine broke through into the Argo tunnel and four men drowned; at that point, for all practical purposes, work in the tunnel ceased. A tour of the Argo mill will give a good idea of milling and metallurgical processes in use during the 1920s; stamps, classifiers, amalgamation units, and flotation cells can be seen in the mill, as well as numerous other items of mining equipment used in the early 1900's.

Stop No. 7 (Optional Stop) - Interstate 70 Roadcut:

This stop (located approximately one mile west of the Argo tunnel, on Colorado Avenue) shows a bostonite dike that is exposed about 125 feet beyond the start of the outcrop. This rock is composed predominantly of alkali feldspars, and is characterized by a lavender aphanitic groundmass that is locally altered to a greenish-gray color. A number of pyrite veinlets cut the bostonite. This type of intrusive (Tertiary) rock has been postulated to be an offshoot of the magmatic chamber that provided mineralization for the area's ore deposits. The host rock is migmatitic Precambrian microcline gneiss, which exhibits prominent folding and injection dikes of granite and pegmatite. Several galena - sphalerite - pyrite - quartz veins can be seen in this outcrop, typical of much of the vein mineralization in the Idaho Springs - Central City districts.

Bibliography

Bastin, E.S., and Hill, J.M., 1917, Economic geology of Gilpin County and adjacent parts of Clear Creek and Boulder Counties, Colorado: U.S. Geological Survey Professional Paper 94, 379 p.

Henderson, C.W., 1926, Mining in Colorado, a history of discovery, development and production: U.S. Geological Survey Professional Paper 138, 263 p.

Lovering, T.S., and Goddard, E.N., 1950, Geology and ore deposits of the Front Range, Colorado: U.S. Geological Survey Professional Paper 223, 319 p.

Moench, R.H., and Drake, A.A., 1966, Mines and prospects, Idaho Springs district, Clear Creek and Gilpin Counties, Colorado: U.S. Geological Survey Open File Report, 213 p.

Moench, R.H., and Drake, A.A., 1966, Economic Geology of the Idaho Springs district, Clear Creek and Gilpin Counties, Colorado: U.S. Geological Survey Bulletin 1208, 91 p.

Rice, C.M., Harmon, R.S., and Shepherd, T.J., 1985, Central City, Colorado: The upper part of an alkaline porphyry molybdenum system: Economic Geology, v. 80, p. 1769 - 1796.

Sims, P.K., Drake, A.A., and Tooker, E.W., 1963, Economic geology of the Central City district, Gilpin County, Colorado: U.S. Geological Survey Professional Paper 359, 231 p.

Sims, P.K., 1964, Geology of the Central City quadrangle: U.S. Geological Survey Quadrangle Map GQ-267.

Sims, P.K., and James, L.P., 1986, DREGS 1986 Spring Field Trip Guidebook; Central City - Idaho Springs: Denver Region Exploration Geologists Society, Wheat Ridge, Colorado, 86 p.

Spry, P.G., 1987, A fluid inclusion and sulfur isotope study of precious and base metal mineralization spatially associated with the Patch and Gold Cup breccia pipes, Central City, Colorado: Economic Geology, v. 82, p. 1632 - 1639.

Vanderwilt, J.W., Burbank, W.S., and Traver, W.M. Jr., 1947, Mineral resources of Colorado: State of Colorado Mineral Resources Board, Denver, Colorado, 547 p.

Please note: most or all of the active and inactive mines visited on these trips are on private property, and our field trip visits are made through courtesy of the owners. No visit to any of these sites should be made without permission of the property owners.

FIELD TRIP #5 - MONDAY, AUG. 15
LONDON MINE - MOSQUITO GULCH - ALMA AREA

Leaders: Rob Johansing (Leadville), Pete Modreski (U.S.G.S.)

Please note: most or all of the active and inactive mines visited on these trips are on private property, and our field trip visits are made through courtesy of the owners. No visit to any of these sites should be made without permission of the property owners.

Trip Schedule:

7:30 am Leave Golden

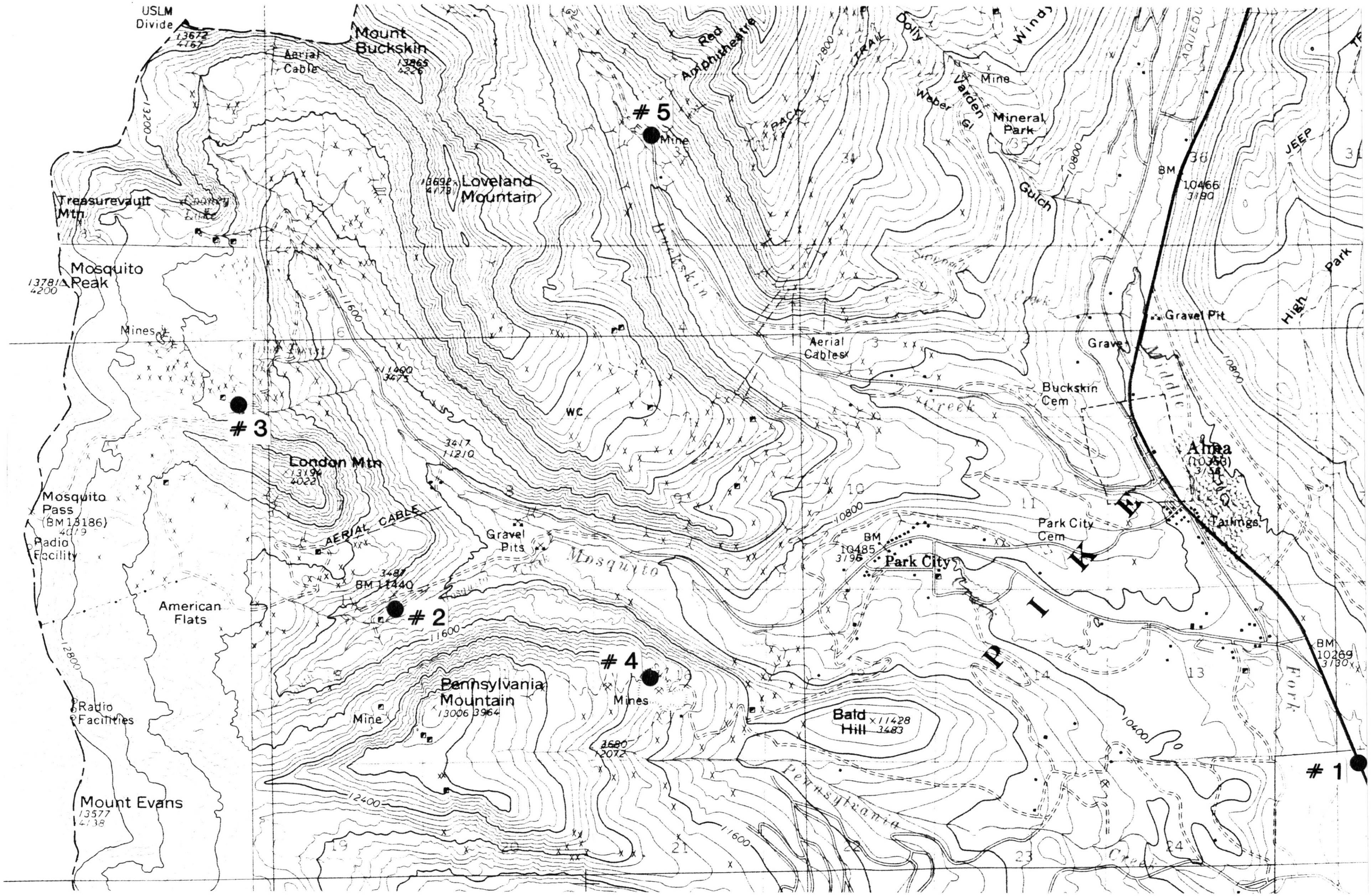
9:30 am Meet in Fairplay.

9:45 am STOP #1 Geologic overview; roadside stop between Fairplay and Alma. The Mosquito Range is capped by east-dipping Paleozoic sedimentary rocks; it lies on the eastern flank of the Sawatch uplift. Below the Paleozoic rocks is a basement of 1.7-billion-year-old Precambrian metamorphic rocks intruded by younger Precambrian granitic rocks. Porphyry sills, stocks, and dikes of Tertiary age cut the older rocks.

Driving north from Fairplay, turn left up the Mosquito Gulch road, passing through Park City. Other notable mines in the area just past Park City are, on the right, the Orphan Boy, which is a gold mine located on the south end of a fault zone cutting Loveland Mountain; and on the left, the Hock Hocking, which is a silver mine at the base of Pennsylvania Mountain. Mosquito Gulch forks at London Mountain; the right fork follows the old wagon road over Mosquito Pass, the highest driveable pass (13,186') in the United States.

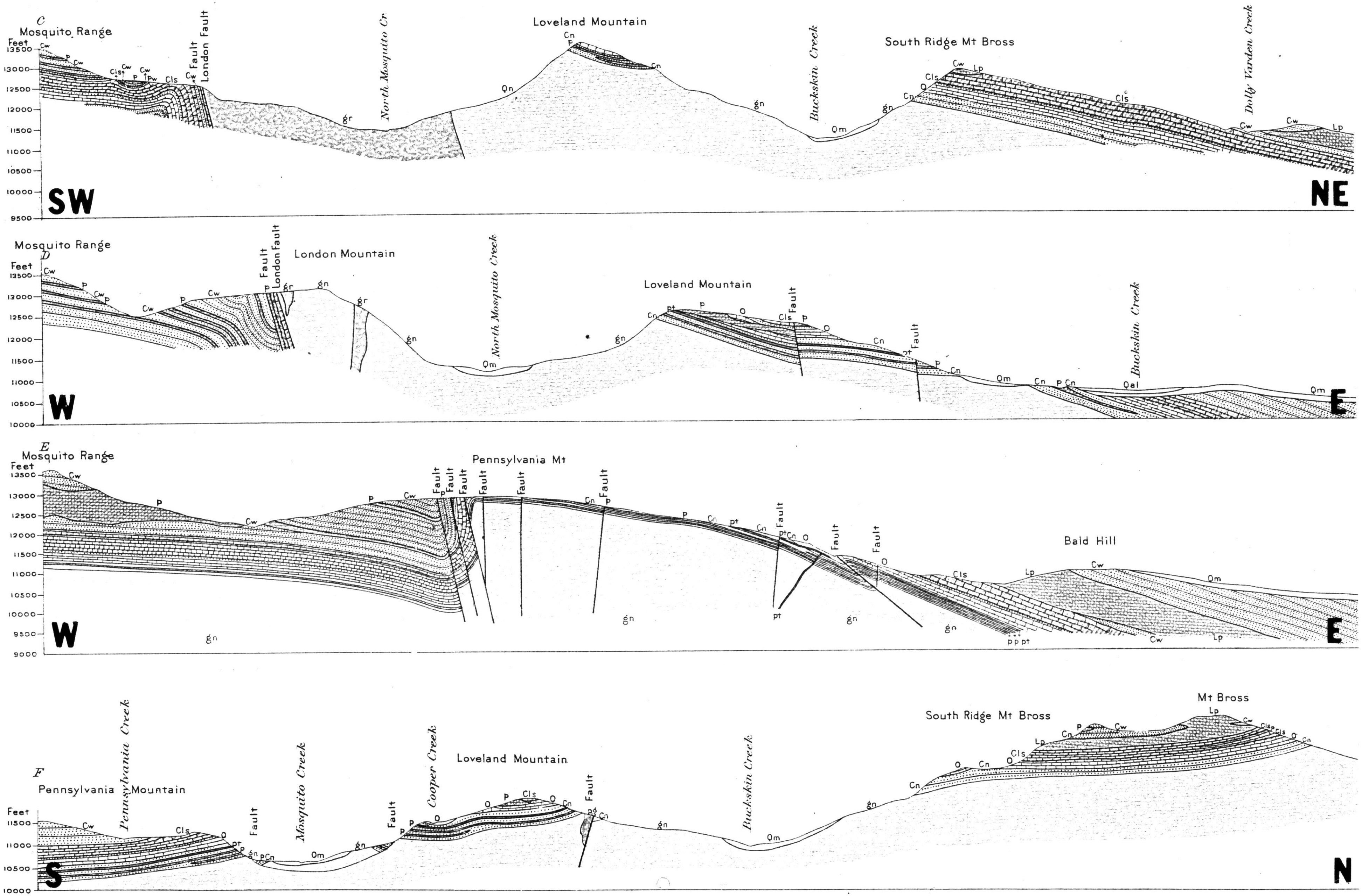
10:30 am STOP #2 London mine (Dean Misantoni, Cobb Resources Corp., and Rob Johansing). The London mine produced gold ore from about 1878 to 1942. The mine was reopened by Cobb Resources Corp. in about 1982, and it has recently begun to produce ore. The deposit consists of veins in the footwall of the London Fault, a Laramide-age, northwest-trending, high-angle reverse fault. The veins are of numerous orientations, vertical to flat-dipping, and they cut both Paleozoic sediments and Tertiary-age porphyries. Minerals in the ore include quartz, pyrite, chalcopyrite, galena, sphalerite, tetrahedrite, and hematite. Ores in the central part of this district are relatively gold-rich, with Au:Ag ratios typically >1.0. To the northwest and southeast along the London Fault, gold decreases and silver values increase.

12:00 STOP #3 North London mine [and lunch]. This was the original site of the "London mine" discovery and workings. The ore here is also gold-rich, and, as at the London, it consists of Au-Ag veins in the footwall of the London Fault. Further to the northwest, in the New York mine area, it grades into silver-rich and base-metal ore, hosted by the Leadville Dolomite, and is more typical of the "Sherman-type" mineralization (e.g., Sherman mine, Leadville) of the west slope of the Mosquito Range and Leadville. There is an excellent exposure of the London Fault near the North London mine. The New York mine/New



U.S.G.S. Park County topographic map - 1:50,000

Field Trip #5 Mosquito Range - Alma



"Sections to accompany geologic map of Alma district, Colorado"; from H.B. Patton and others, Geology and ore deposits of the Alma district, Park County, Colorado; Colorade Geological Survey Bulletin 3, 1912.

York Cliffs area produced approximately one-half million ounces of silver, at an average grade of about 35 oz/ton, prior to the 1893 silver crash.

2:30 pm STOP #4 Penn Placer We will drive to the Penn Placer (a 4WD road) atop the east flank of Pennsylvania Mountain. The placer is preserved because this ridge locally escaped glaciation during the Pleistocene. It is noted for production of some very coarse gold nuggets including the largest ever found in Colorado, a 12-ounce nugget now in the Denver Museum of Natural History. A lack of water has handicapped development of the placer. The gold tends to be about 850-900 fine, approximately the same as that at the London mine. The deposit is located down-dip from the London Fault; the gold in the placer is likely to have been derived from erosion and leaching of gold-bearing jasperoid bodies along the fault; most of the placer deposit is within a pre-Pleistocene gravel deposit, containing cobbles of Paleozoic carbonate rocks.

4:00 pm STOP #5 Sweet Home mine, Buckskin Gulch (Leonard Beach, Rob Johansing) The Sweet Home mine is noted as a source of beautiful rhodochrosite crystals; one specimen on display at the Denver Museum of Natural History is about 4" across. The deposit consists of silver/base-metal veins hosted by Precambrian rocks; the veins may represent a distal, peripheral part of the Climax porphyry molybdenum deposit located on the west side of the Mosquito Range. The mine (sometimes referred to as the Home Sweet Home mine) is located about 3-1/2 miles northwest of Alma. It was originally located as a silver mine in about 1895; it includes about 2 miles of underground workings, largely constructed in the 1930's. Good crystals of rhodochrosite were found during mining in the 1960's, and additional small-scale underground mining for specimens was done in the late 1970's. In addition to rhodochrosite, other minerals found at the mine include fluorite, quartz, pyrite, sphalerite, galena, chalcopyrite, tetrahedrite, tennantite, argentite, huebnerite, bornite, stromeyerite, native silver, apatite, calcite, siderite, and goyazite.

Other points of interest: An old arrastra (a primitive device for grinding ore) is located alongside the bed of Buckskin Creek, a few miles downstream of the Sweet Home mine; a sign along the road marks the spot. Kite Lake (properly "Kite-Shaped Lake"), at the head of Buckskin Gulch, is a beautiful spot for camping and picnicing, and a starting point for short hikes to the summits of Mount Bross (14,172'), Mount Democrat (14,148'), and Mount Lincoln (14,286').

5:30 pm end of trip.

Selected References

Johansing, Robert J., 1982, Physical-chemical controls of dolomite hosted Sherman type mineralization, Lake and Park Counties, Colorado: Unpublished M.S. thesis, Colorado State University, 158 p.

Kosnar, Richard A., 1979, Famous mineral localities: the Home Sweet Home mine: Mineralogical Record, v. 10, p. 333-338.

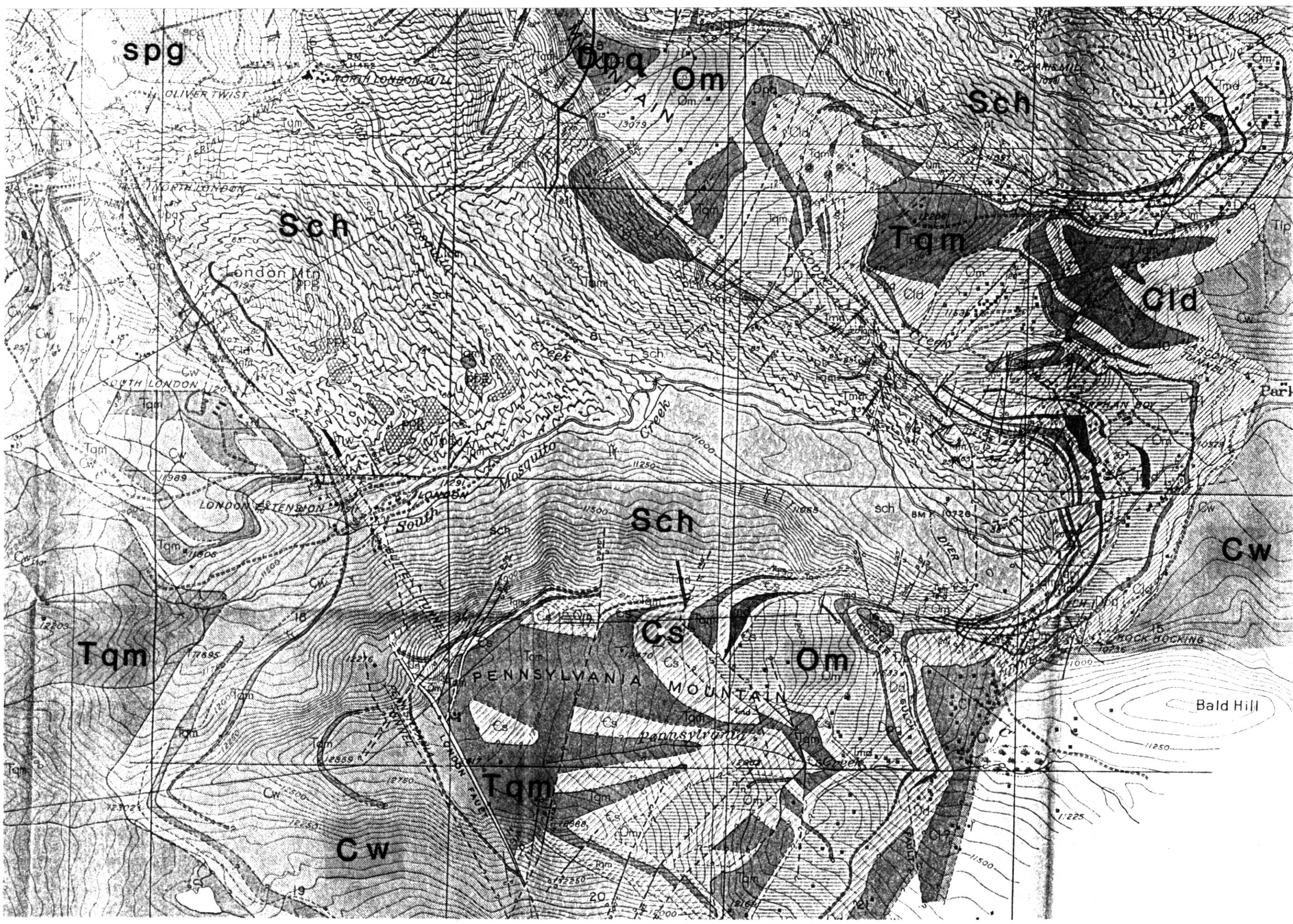
Loughlin, G.F., and Behre, C. H., Jr., 1934, Zoning of ore deposits in and adjoining the Leadville district, Colorado: Economic Geology, v. 29, p. 212-254.

Parker, Ben H., Jr., 1974, Gold placers of Colorado: Colorado School of Mines Quarterly, v. 69, no. 3, 268 p., and no. 4, 224 p.

Patton, H.B., Hoskin, A.J., and Butler, G. M., 1912, Geology and ore deposits of the Alma district, Park County, Colorado: Colorado Geological Survey, Bulletin 3, 284 p.

Singewald, Q.D., and Butler, B.S., 1941, Ore deposits in the vicinity of the London Fault of Colorado: U.S. Geological Survey Bulletin 911, 74 p.

Tweto, Ogden, Moench, R.H., and Reed, J.C., Jr., 1978, Geologic map of the Leadville 1° x 2° quadrangle, northwestern Colorado: U.S. Geological Survey Map I-999.



Geologic map of the Mosquito Gulch area; from Plate 1 of Singewald and Butler, 1941, U.S.G.S. Bull. 911. Tqm = quartz monzonite porphyry (Tertiary); Cw = Weber (?) Fm. (Pennsylvanian); Cld = Leadville Limestone (Mississippian) and Dyer dolomite (Devonian); Dpq = Parting Quartzite (Devonian); Om = Manitou Limestone (Ordovician); Cs = Sawatch Quartzite (Cambrian); spg = Silver Plume Granite (Precambrian); Sch = schist and gneiss (Precambrian). The London Fault trends NW-SE, from the upper left corner of the map through London Mountain and Pennsylvania Mountain.

GOLD MINERALS

native element
Gold Au

alloys and intermetallic compounds
Auricupride Cu_3Au
electrum (Au,Ag)
goldamalgam $(Au,Ag)Hg$
Tetra-auricupride $AuCu$
Weishanite $(Au,Ag)_3Hg_2$

antimonide
Aurostibite $AuSb_2$

bismuthinide
Maldonite Au_2Bi

selenide
Fischesserite Ag_3AuSe_2

sulfides
Penzhinite $(Ag,Cu)_4Au(S,Se)_4$
Petrovskaite $AuAg(S,Se)$
Uytenbogaardtite Ag_3AuS_2

tellurides
Bezsmertnovite $Au_4Cu(Te,Pb)$
Bilibinskite $Au_3Cu_2PbTe_2$
Bogdanovite $Au_5(Cu,Fe)_3(Te,Pb)_2$
Calaverite $AuTe_2$
Kostovite $CuAuTe_4$
Krennerite $AuTe_2$
Montbrayite $(Au,Sb)_2Te_3$
Petzite Ag_3AuTe_2
Sylvanite $(Au,Ag)_2Te_4$

telluride-sulfide
Nagyagite $Pb_5Au(Te,Sb)_4S_{5-8}$ (?)

minerals containing non-essential gold
küstelite (Ag,Au)
Muthmannite $(Ag,Au)Te$
Zvyagintsevite $(Pd,Pt,Au)_3(Pb,Sn)$

Based on Fleischer (1987), plus minerals subsequently described.
Uncapitalized names are varieties, or species of uncertain validity.

SILVER MINERALS

native element

Silver Ag

alloys and intermetallic compounds

amalgam (Ag,Hg)
electrum (Au,Ag)
kongsbergite (Ag,Hg)
küstelite (Ag,Au)
Luanheite Ag_3Hg
Moschellandsbergite Ag_2Hg_3
Paraschachnerite Ag_3Hg_2
Schachnerite $Ag_{1.1}Hg_{0.9}$

antimonides

Allargentum $Ag_{1-x}Sb_x$
Dyscrasite Ag_3Sb

selenides

Bohdanowiczite $AgBiSe_2$
Eucairite CuAgSe
Fischesserite Ag_3AuSe_2
Geffroyite $(Ag,Cu,Fe)_9(Se,S)_8$
Naumannite Ag_2Se
Selenostephanite $Ag_5Sb(Se,S)_4$

selenide-sulfide

Aguilarite Ag_4SeS

sulfides

Acanthite Ag_2S
Argentite Ag_2S
Argentopentlandite $Ag(Fe,Ni)_8S_8$
Argentopyrite $AgFe_2S_3$
Argyrodite Ag_8GeS_6
Balkanite $Cu_9Ag_5HgS_8$
Canfieldite Ag_8SnS_6-$Ag_8SnTe_2S_4$
Hocartite Ag_2FeSnS_4
Imiterite Ag_2HgS_2
Jalpaite Ag_3CuS_2
Mckinstryite $(Ag,Cu)_2S$
Penzhinite $(Ag,Cu)_4Au(S,Se)_4$
Petrovskaite AuAg(S,Se)
Pirquitasite Ag_2ZnSnS_4
Sternbergite $AgFe_2S_3$
Stromeyerite AgCuS
Uytenbogaardtite Ag_3AuS_2

sulfo-halide

Perroudite $Hg_5Ag_4S_5(Cl,I,Br)_4$

tellurides

Cameronite $AgCu_7Te_{10}$
Empressite $AgTe$
Henryite $Cu_4Ag_3Te_4$
Hessite Ag_2Te
Muthmannite $(Ag,Au)Te$
Petzite Ag_3AuTe_2
Sopcheite $Ag_5Pd_3Te_4$
Stützite $Ag_{5-x}Te_3$
Sylvanite $(Au,Ag)_2Te_4$
Volynskite $AgBiTe_2$

telluride-sulfide

Benleonardite $Ag_8(Sb,As)Te_2S_3$

sulfosalts

Andorite $PbAgSb_3S_6$
Antimonpearceite $(Ag,Cu)_{16}(Sb,As)_2S_{11}$
Aramayoite $Ag(Sb,Bi)S_2$
Arcubisite Ag_6CuBiS_4
Argentopentlandite $Ag(Fe,Ni)_8S_8$
Argentotennantite $(Ag,Cu)_{10}(Zn,Fe)_2(As,Sb)_4S_{13}$
Arsenpolybasite $(Ag,Cu)_{16}(As,Sb)_2S_{11}$
Benjaminite $(Ag,Cu)_3(Bi,Pb)_7S_{12}$
Berryite $Pb_3(Cu,Ag)_5Bi_7S_{16}$
Billingsleyite $Ag_7(Sb,As)S_6$
Cupropavonite $AgPbCu_2Bi_5S_{10}$
Dervillite Ag_2AsS_2
Diaphorite $Pb_2Ag_3Sb_3S_8$
Eskimoite $Ag_7Pb_{10}Bi_{15}S_{36}$
Fizelyite $Pb_{14}Ag_5Sb_{21}S_{48}$ (?)
Freibergite $(Ag,Cu,Fe)_{12}(Sb,As)_4S_{13}$
Freieslebenite $AgPbSbS_3$
Gustavite $PbAgBi_3S_6$ (?)
Hatchite $(Pb,Tl)_2AgAs_2S_5$
Heyrovskyite $Pb_{10}AgBi_5S_{18}$
Kitaibelite $Ag_{10}PbBi_{30}S_{51}$
Kutinaite $Cu_{14}Ag_6As_7$
Laffittite $AgHgAsS_3$
Lengenbachite $Pb_6(Ag,Cu)_2As_4S_{13}$
Marrite $PbAgAsS_3$
Matildite $AgBiS_2$
Miargyrite $AgSbS_2$
mummeite $(Ag,Cu)_9Pb_2Bi_{13}S_{26}$ (?)
Ourayite $Ag_{25}Pb_{30}Bi_{41}S_{104}$ (B-centered unit cell)
Owyheeite $Pb_{10-2x}Ag_{3+x}Sb_{11+x}S_{28}$ $(x = -0.13 - +0.20)$
P-ourayite $Pb_{14}Ag_{18}Bi_{28}S_{65}$ (Primitive unit cell)
Paderaite $AgPb_2Cu_6Bi_{11}S_{22}$
Pavonite $(Ag,Cu)(Bi,Pb)_3S_5$
Pearceite $Ag_{16}As_2S_{11}$
Polybasite $(Ag,Cu)_{16}Sb_2S_{11}$
Proustite Ag_3AsS_3
Pyrargyrite Ag_3SbS_3

Pyrostilpnite Ag_3SbS_3
Ramdohrite $Ag_3Pb_6Sb_{11}S_{24}$
Rayite $(Ag,Tl)_2Pb_8Sb_8S_{21}$
Samsonite $Ag_4MnSb_2S_6$
Schirmerite $Ag_3Pb_3Bi_9S_{18}$-$Ag_3Pb_6Bi_7S_{18}$
Smithite $AgAsS_2$
Stephanite Ag_5SbS_4
Sterryite $Ag_2Pb_{10}(Sb,As)_{12}S_{29}$
teremkovite $Ag_2Pb_7Sb_8S_{20}$ (?)
Treasurite $Ag_7Pb_6Bi_{15}S_{32}$
Trechmannite $AgAsS_2$
Uchucchacuaite $AgPb_3MnSb_5S_{12}$
Vikingite $Ag_5Pb_8Bi_{13}S_{30}$
Xanthoconite Ag_3AsS_3
Zoubekite $AgPb_4Sb_4S_{10}$

oxide
Stetefeldtite $Ag_2Sb_2(O,OH)_7$ (?)

halides
Bideauxite $Pb_2AgCl_3(F,OH)_2$
Bromargyrite $AgBr$
Chlorargyrite $AgCl$
Iodargyrite AgI
Miersite $(Ag,Cu)I$
Tocornalite $AgHgI_2$ (?)

hydroxy-halide
Boleite $Pb_{26}Ag_{10}Cu_{24}Cl_{62}(OH)_{48}\cdot 3H_2O$

sulfate
Argentojarosite $AgFe_3(SO_4)_2(OH)_6$

minerals with non-essential silver (others may also contain trace silver)
Aurorite $(Mn,Ag,Ca)Mn^{+4}{}_3O_7\cdot 3H_2O$
Crooksite $(Cu,Tl,Ag)_2Se$
Danielsite $(Cu,Ag)_{14}HgS_8$
Furutobeite $(Cu,Ag)_6PbS_4$
Giessenite $Pb_{13}(Cu,Ag)(Bi,Sb)_9S_{28}$ (?)
Giraudite $(Cu,Zn,Ag)_{12}(As,Sb)_4(Se,S)_{13}$
goldamalgam $(Au,Ag)Hg$
Hakite $(Cu,Hg,Ag)_{12}Sb_4(Se,S)_{13}$
Incaite $(Pb,Ag)_4Sn_4FeSb_2S_{13}$
Larosite $(Cu,Ag)_{21}(Pb,Bi)_2S_{13}$
Neyite $Pb_7(Cu,Ag)_2Bi_6S_{17}$
Novakite $(Cu,Ag)_{21}As_{10}$
Telargpalite $(Pd,Ag)_3Te$ (?)
Wallisite $PbTl(Cu,Ag)As_2S_5$
Weishanite $(Au,Ag)_3Hg_2$

Based on Fleischer (1987), plus minerals subsequently described.
Uncapitalized names are varieties, or species of uncertain validity.

COLORADO CHAPTER, FRIENDS OF MINERALOGY

Friends of Mineralogy (FM) is an organization of persons devoted to the advancement of interest in minerals and related activities. Its members include professional mineralogists, geologists, curators, and private collectors. The common bond uniting these people is a love of minerals and a desire to see the appreciation and knowledge of minerals spread.

FM is a nationwide and international organization with over 600 members. About two-thirds of the members belong to one of the seven present regional chapters, of which Colorado is one (plus Southern California, Great Basin, Indiana, Pacific Northwest, Pennsylvania, and Southeastern Michigan).

The Colorado Chapter has established the following goals:

1. Protect and preserve mineral specimens and localities.
2. Advance mineralogical education and research.
3. Support and disseminate mineralogical knowledge with seminars, publications, and educational projects.
4. Promote high ethical standards for collecting, exhibiting, and dealing with mineral specimens.
5. Build a spirit of cooperation and participation in the region for collecting, sharing, and using mineral specimens.

The Colorado Chapter is primarily a service organization, and much of its work is to support and act as a resource for other mineral clubs and organizations. Two major projects in recent years have been:

Revising and compiling information on minerals and localities for publication. A comprehensive volume on "Minerals of Colorado", updating U.S.G.S. Bulletin 1114 by Edwin B. Eckel, is presently being prepared for publication.

Holding seminars and meetings to discuss and present mineralogical research and information. Several mineral symposia have been held in September in conjunction with the Denver Gem and Mineral Show, and in 1986 the chapter sponsored the Colorado Pegmatite Symposium, held at the Denver Museum of Natural History.

To join the Colorado Chapter a person must have a desire to participate in and support the chapter, and must receive the sponsorship of a member of the chapter. Dues for the Colorado Chapter are ten dollars per year; this includes membership in Friends of Mineralogy, Inc. Both the local and the national organizations issue periodic newsletters to inform members of projects and activities. Unless otherwise stated, chapter meetings are held five times per year, in Jan., Mar., May, Sep., and Nov., on the second Thursday of the month, from 7:30 to 10:00 p.m. at the Denver Museum of Natural History. Visitors are welcome at the meetings. For more information contact:

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