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THE GEOLOGY AND ORE DEPOSITS OF THE TINCUP MINING DISTRICT, GUNNISON COUNTY, COLORADO[1]

by

E. N. GODDARD[2]

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ILLUSTRATIONS

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[1]Published by permission of the Director, United States Geological Survey, the Colorado State Geological Survey Board, and the Colorado Metal Mining Fund.

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Introduction and Acknowledgements

The Tincup mining district is in the east-central part of Gunnison County, Colorado, 35 miles northeast of Gunnison and 3 miles west of the crest of the Continetal Divide. It ranges in altitude from 10,150 to 12,150 feet. Tincup, the only town in the district, is on Willow Creek in sec. 7, T. 15 S., R. 81 W., and in 1934 had a variable population of 20 or less. It is connected with Gunnison by 45 miles of good automobile road with gentle grade and with Pitkin by 12 miles of Forest Service road. The principal mines of the district are on Gold Hill and West Gold Hill, 2 to 5 miles south of Tincup, but there are a few mines on Cross Mountain, 5½ miles S. 70° W. of Tincup.

In July 1932 the writer, assisted by C. D. Hier, spent 10 days in the Tincup district studying ore deposits and structural features. In this work he was greatly aided by a geologic reconnaissance map prepared by B. S. Butler and C. H. Behre the previous summer and by unpublished reports on the Gold Cup and Alhambra mines by George H. Garrey.[3] The data gathered in this work were to be incorporated in a report on the ore deposits of Colorado, but as that report has been delayed and as there is considerable interest in the Tincup district, it seems advisable to publish the material in a separate paper.

History[4]

Gold was discovered in the Tincup district in the summer or fall of 1861. James Taylor, after whom Taylor Park was named, Ben Grey, Charles Grey, and Gus Lamb came into the district from the south and prospected for gold along Willow Creek. Taylor, in searching for strayed horses, wan-

[3] Garrey, G. H., Unpublished report on the Gold Cup mine in the Tincup mining district, Gunnison County, Colorado, 1928; unpublished report on the Alhambra and adjacent claims, Tincup district, Gunnison County, Colorado.

[4] Compiled from the following sources:
Henderson, C. W. Mining in Colorado; U. S. Geol. Survey Prof. Paper 138, pp. 124-126, 1926. Poet, S. E., The Story of Tincup: Colorado Mag., vol. 9, No. 1, pp. 30-38, State Hist. Soc., January 1932. Oral information by Eric Norloff and Frank Korn, of Tincup.

dered into a small gulch in which the gravel looked favorable for placering. Having only a tin cup with him, he panned with that and found good colors. The next day Taylor and his companions staked out claims in the gulch and named it "Tincup Gulch." More or less placer mining went on in Tincup Gulch for the next 18 years. In the spring of 1878 "Cap" Hall and a man named Hurd picked up a rich piece of float, while constructing a placer ditch in Tincup Gulch. They immediately searched for the source and discovered the Gold Cup ore body. The ore body of the Tincup mine was discovered the next year, but its high-grade ore was not opened up until 1880, when it was bought by J. J. Mastin.

These discoveries of rich lodes caused a rush into the district, and the towns of Hillerton, Virginia City, Garfield, Abbeyville, and Tincup sprang up. Virginia City and Hillerton each had a population of over 1,500. A new rush to Gothic left the Tincup region almost deserted for a time. The town of Tincup grew more slowly than the others but was more enduring. At the end of the year 1880 its population was nearly 4,000, and it was the leading mining town in the county.

During 1879 and 1880, the ore was carried by burros to St. Elmo, on the east side of the divide, 8½ miles southeast of Tincup. Later a toll road was constructed to St. Elmo, and ore was hauled by 6-horse teams. In 1882 a railroad was constructed to Quartz, 9½ miles south of Tincup, and the ore was hauled there by wagon.

In 1881 two smelters were constructed in the district, one by the Virginia City Mining & Smelting Co., and the other by the Willow Creek Reduction Co. The two had a capacity of 50 tons a day. In 1882 the Virginia City smelter turned out a carload of base bullion every 4 days. Burchard[5] states that 600 miners were at work in the camp in 1882.

In 1893 a decline in the price of silver caused the cessation of activity in the district. In 1904 a second "boom"

[5]Burchard, H. C., Report of the Director of the Mint for 1882, p. 465, 1883.

brought in about 2,000 people, but by 1912 the camp was again nearly deserted. Since 1912 the mining activity has been very intermittent.

Production

The total production of the Tincup district to 1928 is variously estimated at $2,000,000 to $3,000,000, according to Garrey.[6] He states: "Mr. A. M. Welles, a mining engineer, put the production of the Gold Cup mine at about $1,500,000 gross production, and the Tincup mine at about $250,-000.00." Burchard[7] in his report for 1883 gives the production of the Gold Cup mine for the years 1878 to 1880 as over $450,000. The Jimmy Mack mine has produced about $700,-000, according to J. W. Belcoe, the owner. These three mines have been the outstanding producers of the district.

The reports of the Director of the Mint[8] give the following production statistics for the Tincup district:

[6]Garrey, G. H., Unpublished report on the Gold Cup mine in the Tincup mining district, Gunnison County, Colorado, 1928.

[7]Burchard, H. C., Report of the Director of the Mint for 1883, pp. 312-313.

[8]Burchard, H. C., op. cit., p. 328.
Munson, G. C., Report of the Director of the Mint for 1887, pp. 169-171; idem for 1888, pp. 109-111.
Smith, M. E., Report of the Director of the Mint for 1889, pp. 148-149; idem for 1890, p. 134.

1883 (*Taken from the "Tincup Miner"*)

Mine	Tons	Value
Gold Cup	800	$ 88,000
Tin Cup	400	60,000
Jimmy Mack	500	55,000
Tellurium	175	26,250
Miantonoma	80	20,000
H. D. Pearsall	200	16,000
Cumberland	530	13,250
El Capitan	100	10,000
Douglas	10	10,000
Others (11 mines, less than $10,000 each)	----	68,895
Placers:		
Union	----	40,000
Texas	----	22,000
Gray	----	1,800
Others	----	3,000
Total		$434,195

	Gold	Silver	Lead	Total
1887				
Jimmy Mack	--------	$1,900	--------	$ 1,900
Robert E. Lee (est.)	--------	9,000	--------	9,000
				$10,900
1888				
Robert E. Lee	--------	$3,878	$3,960	$ 7,838
Jimmy Mack (est.)	$1,000	5,000	--------	6,000
				$13,838
1889				
Ida May	$ 500	$ 272	$ 228	$ 1,000
1890				
Gold Cup	$3,900	$50,424	$4,071	$58,395
Jimmy Mack	--------	2,327	913	3,240
Robert E. Lee	----	4,202	1,696	5,898
Tin Cup	1,100	14,222	1,131	16,453
				$83,986

The above figures give a total production of $543,919 for the 5 years, but it seems likely that the figures for 1887-1890 are incomplete. Hill[9] described the district in 1908.

[9]Hill, J. M., Notes on the economic geology of southeastern Gunnison County, Colorado; U. S. Geol. Survey Bull. 380, p. 29, 1908.

Production of Gold, Silver, Copper, Lead, and Zinc in the Tincup District, Gunnison County, Colorado, 1901-1935, Inclusive, in Terms of Recovered Metals

[Compiled by Chas. W. Henderson, U. S. Bureau of Mines, Denver]

Name of Mine	Ore (tons)	Gold (ounces)	Silver (ounces)	Copper (pounds)	Lead (pounds)	Zinc (pounds)
Blistered Horn Tunnel	788	78.48	9,583	119	62,166	-----
El Capitan	68	12.53	2,263	12	6,687	-----
Gold Cup-Omiopa	264	110.83	6,812	19	21,003	-----
Jimmy Mack	152	55.24	977	-----	14,396	-----
Robert E. Lee	38	1.00	2,535	-----	15,600	-----
Tin Cup	125	3.07	4,270	27	33,968	-----
Tin Cup Placer	-----	33.95	6	-----	-------	-----
Wahl	3	2.67	------	-----	-------	-----
Total, 1901-35	1,438	297.77	26,446	177	153,820	-----

General Geology

The formations exposed in the Tincup district include pre-Cambrian metamorphic, Paleozoic sedimentary, and Eocene igneous intrusive rocks. A broad belt of the Paleozoic strata trending northwest and dipping to the east extends across the central part of the district (fig. 1). This is bordered on the west and unconformably underlain by pre-Cambrian granite gneiss; on the east it is separated from pre-Cambrian schist by a strong northwestward-trending thrust fault.

Pre-Cambrian rocks.—The pre-Cambrian schist, which is the oldest rock in the region, does not occur within the mineralized area, except as a few small lenses within the granite gneiss. These lenses consist of biotite and quartz-biotite schist which resembles that of the Idaho Springs formation of the Front Range.

The granite gneiss of the Tincup district forms part of a large batholith that intrudes the schist and occupies more than 100 square miles in the east-central part of Gunnison County. The gneissic structure has a general north-south trend and stands nearly vertical or dips steeply to the east. This structure conforms roughly with the foliation of the schist areas northwest and northeast of the Tincup district. It is the result of rather strong metamorphism of the original granite, for it is well developed, and the quartz lenses show some crushing, but the rock is not banded. The rock is medium-grained and has a gray mottled appearance when fresh but is brownish when weathered. It is made up of long, slender lenses of quartz 5 to 10 millimeters long and 1 to 2 millimeters wide, irregular lenses of feldspar 5 to 10 millimeters long and 3 to 5 millimeters wide, and lenses of biotite 2 to 4 millimeters long and 0.5 to 1 millimeter wide. The granite gneiss crops out along both sides of the valley of West Fork and occupies a large area on the crest of the divide between Willow Creek and Quartz Creek. Its pre-Cambrian age is established by the fact that it is unconformably overlain by Cambrian quartzite.

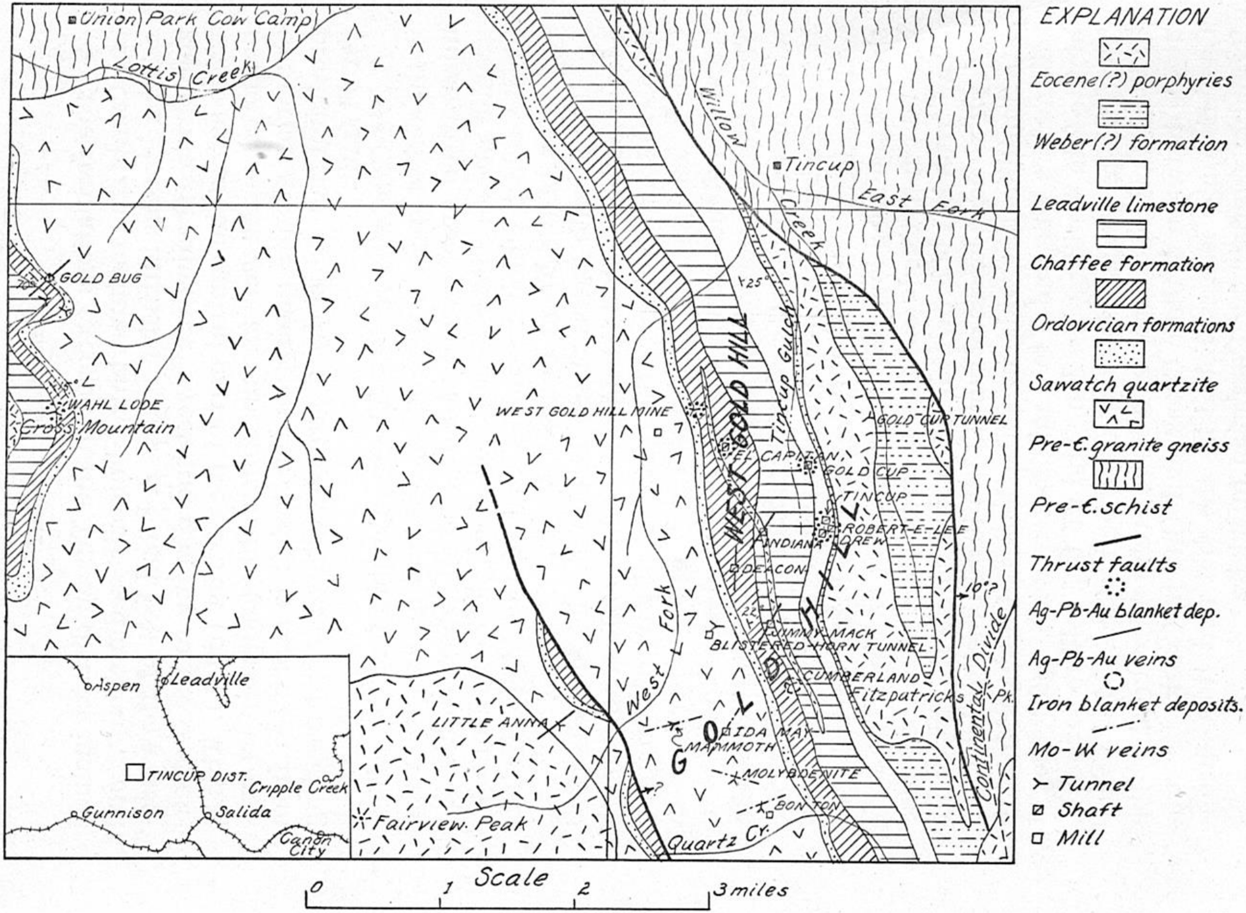

Figure 1. Sketch map of the Tincup mining district, showing the general geology and the distribution of the principal mines. (The geology is taken in large part from a reconnaissance map by B. S. Butler and C. H. Behre).

Paleozoic rocks.—The Palezoic sedimentary rocks of the Tincup district range in age from Cambrian to Pennsylvanian and consist chiefly of limestone, but contain some quartzite and shale. They are similar to the Paleozoic rocks exposed in the Leadville and Aspen mining districts, but include the Harding quartzite and Fremont limestone, both of which are absent in those districts. A generalized section of the Paleozoic sedimentary formations as exposed in the Tincup district is given in the following table.

GENERALIZED SECTION OF PALEOZOIC SEDIMENTARY ROCKS IN THE TINCUP DISTRICT[a]

Age	Formation	Member	Local name	Description	Thickness (feet)
Pennsylvanian	Weber (?) formation			Black shale and shaly limestone. Quartzite with shaly and sandy limestone.	150 10-15
Mississippian	Leadville limestone		"Dolomitic limestone"	Light- to dark-gray dense limestone with 5 to 12 feet of yellow-stained chert beds near top.	150-165
Devonian	Chaffee formation	Dyer member	"Blue limestone"	Bluish-gray massively bedded finely crystalline dark limestone; gray or black cherts locally mark top.	90-120
		Dyer member	"Granular limestone"	Dark-gray coarsely crystalline limestone with some depositional breccia near base.	25-50
		Dyer member	"Siliceous limestone"	Light-gray dense thin-bedded limestone and dolomite.	50-70
		Parting member	"Leadville basal quartzite"	White, pink, and brown quartzite with cross-bedding. Locally represented by yellow calcareous mudstone and greenish limy shale.	12-20
		Parting member	"Buckskin limestone"	Light-gray finely crystalline thin-bedded limestone and dolomite, weathering to buff.	30-60
		Parting member	"Fairview shale"	Yellow, reddish, and greenish shales alternating with thin-bedded limestones.	10-15
Ordovician	Fremont limestone		"Ordovician crystalline limestone"	Gray to mottled gray and yellow dolomitic limestone.	40-65
	Harding quartzite		"Ordovician parting quartzite"	White quartzite.	5-10
	Manitou limestone		"Ordovician lower limestone"	Light- to medium-gray dolomitic limestone with white and gray chert nodules near base.	200±
Cambrian	Sawatch quartzite			White, gray, and pink quartzite with a foot or two of conglomerate at the base in places.	120-130

[a]Compiled from a section given by G. H. Garrey in his report on the Gold Cup mine; descriptions by Garrey in his report on the Alhambra; a section measured on the east side of Cross Mountain by the writer's assistant, C. D. Hier; and a section measured by J. Harlan Johnson 2¼ miles south of Tincup.

The main band of Paleozoic formations, which is from 1½ to 2 miles wide, extends N. 30° W. from Napoleon Pass and Gold Hill to Willow ranger station, in Taylor Park, and passes just west of Tincup. The Cambrian quartzite lies on the west side of this band, and the "Weber grits" on the east. On the top and upper slopes of Cross Mountain the Paleozoic rocks occupy an oval area of north-south trend about 4 miles long and 1½ miles wide.

Tertiary igneous rocks.—Both the pre-Cambrian and Paleozoic rocks have been intruded by a group of "porphyries" which are apparently closely related and are thought to be of Eocene age. These rocks were not studied in thin section, but on the basis of field identification are classified into three groups—hornblende diorite porphyry occurring as dikes, quartz monzonite porphyry occurring as sills, and quartz monzonite porphyry occurring as a stock.

The hornblende diorite porphyry consists of a very fine-grained gray groundmass enclosing numerous small phenocrysts of feldspar and hornblende. A strong dike of this porphyry about 200 feet wide cuts through the upper of the Ordovician formations and the lower part of the Devonian Chaffee formation. It strikes N. 25°-30° W., nearly parallel to the strike of the beds, and dips about 50° E. The outcrop extends along the west slope near the crest of Gold Hill and West Gold Hill. A few small northeastward-trending dikes of this porphyry, 10 to 15 feet wide, cut the sediments near the large dike and may connect with it.

The quartz monzonite porphyry that occurs in sills consists of a very fine-grained light-gray groundmass enclosing numerous rounded quartz phenocrysts about one-eighth of an inch in diameter and rather scarce rectangular feldspar phenocrysts averaging one-fourth inch wide and three-eighths of an inch long. There are three large sills of this porphyry in the Weber grits: one, about 135 feet thick, lies 40 feet above the base of the Weber; the second, about 480 feet thick, about 40 feet above the first; the third, which contains fewer phenocrysts than the others, is about 120 feet thick and lies about 70 feet above the second. These sills crop out along the east side of Gold Hill and are well exposed in the Gold Cup tunnel.

The third type of porphyry is a quartz monzonite containing smaller but more abundant phenocrysts than the second. It consists of a very fine-grained light-gray groundmass enclosing abundant rounded phenocrysts of quartz about one-eighth to one-quarter inch in diameter and numerous phenocrysts of hornblende and feldspar one-sixteenth to one-eighth inch in diameter. This porphyry occurs as a large stock of about 2 to 4 square miles, cutting the granite gneiss, on the southwestern edge of the Tincup district. It lies on the east side of Fairview Peak and forms part of the divide between the drainage of Willow Creek and that of Quartz Creek.

The porphyries of the Tincup district are probably of Eocene age. They are very similar to porphyries throughout the mineral belt of Colorado that have been regarded as Eocene, and some of them at least are younger than the thrust faulting that took place in early Eocene time.

Structure

The structure of the Tincup district is fairly simple. The sedimentary formations are all nearly conformable to one another and the main area forms an eastward-dipping monocline or east limb of an anticline that trends about N. 25° W. The beds strike N. 10°-35° W. and dip 23°-45° NE. In the Cross Mountain area the beds have a general strike of N. 55° W. and a dip of 15°-25° NE. These two monoclines are too far apart to be parts of the same fold (see fig. 1) unless there is a strong fault between them, and it seems likely that they are parts of a series of gentle northwestward-trending folds, which have been partly eroded.

On the east side of the Tincup district the sediments are cut off by a strong thrust fault called the Tincup fault, which strikes about N. 25° W. and dips about 10° E. This fault extends from a point south of Fitzpatricks Peak northwestward into Taylor Park, passing just west of Tincup and just east of Willow ranger station. The pre-Cambrian schist has been thrust westward over the Pennsylvanian "Weber grits," and the throw probably amounts to several miles.

At the southwestern edge of the main Tincup district there is another strong fault of northwest trend, which appears to be a steep thrust. It strikes about N. 22° W. and extends from the divide just west of Gold Hill northwestward across Anna Mountain. The dip could not be determined but appears to be steep to the east. Pre-Cambrian granite gneiss on the east side lies against a narrow strip of Cambrian and Ordovician sediments on the west, which strike about N. 30° W. and dip about 25° NE.

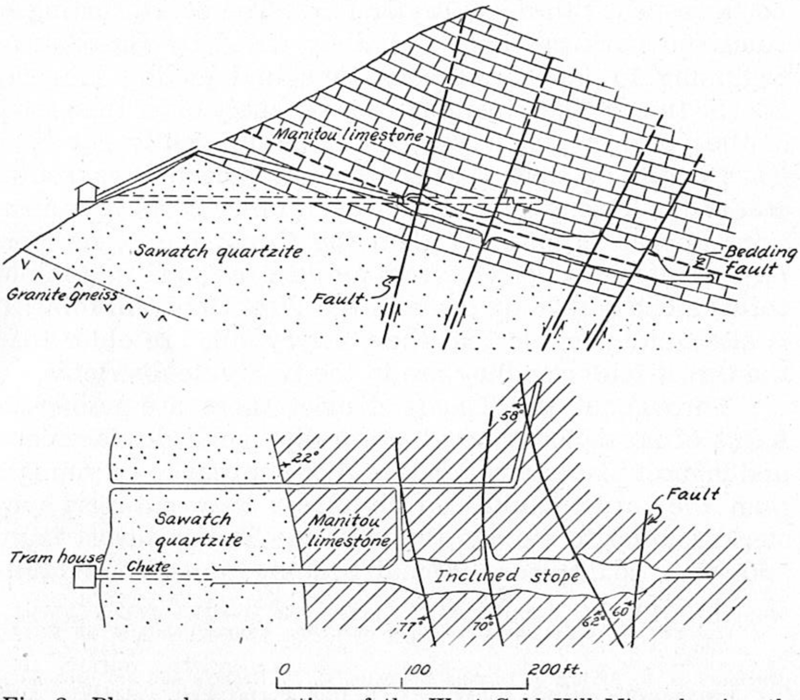

Fig. 2—Plan and cross section of the West Gold Hill Mine showing the relation of the ore body to the north-south fault fissures.

In some of the mines there has been considerable displacement along certain bedding planes in the sediments, as indicated by thin zones of breccia and gouge. In the West Gold Hill mine (see fig. 2) such a fault occurs along a bedding plane in the Manitou limestone and is associated with an ore body. In the limestone breccia there are fragments of diorite porphyry which must have been dragged in from the large dike 100 to 200 feet to the east, and as the beds dip 20° E., the movement must have been a thrust. In several of the mines these bedding faults are cut and displaced by steep normal faults, and therefore they are tentatively correlated with the Tincup thrust fault.

The thrust faults in the Tincup area form a part of an extensive zone of overthrusting that extends from Huerfano Park, on the east side of the Sangre de Cristo Range, northwestward through Taylor Park. The overthrusting in Huerfano Park has been definitely dated by Burbank as beginning in late Cretaceous time and ending in early Eocene time.[10] The Tincup fault is probably older than some of the porphyry intrusions, for it is apparently cut by a large porphyry stock just south of Napoleon Pass, southeast of the Tincup district. However, other porphyry intrusions appear to be older than the thrust faults, for porphyry fragments derived from a dike are found in a minor thrust along a bedding plane in the West Gold Hill mine. It is also quite possible that the porhyry sills are older than the thrust faults, as they are in the Leadville district.[11]

Throughout the Tincup district there are numerous faults of north-south trend, steep dip, small displacement, and in most places, small extent. They appear to be younger than the thrust faults, for in places they cut porphyry stocks similar to the one that cuts the Tincup thrust fault, and they also displace the small bedding faults. These faults

[10]Burbank, W. S., and Goddard, E. N., Thrusting in Huerfano Park and related problems of orogeny in the Sangre de Cristo Range, Colorado (in preparation).

[11]Emmons, S. F., Irving, J. D., and Loughlin, G. F., Geology and ore deposits of the Leadville district, Colorado; U. S. Geol. Survey Prof. Paper 148, p. 96, 1927.

range in strike from N. 25° W. to N. 35° E., and in dip from 85° E. to 60° W. Most of those on Gold Hill strike northeast; those on West Gold Hill strike northwest. Most of the faults dip 60°-75° W. and appear to be normal faults with the downthrow on the west side. However, according to Garrey,[12] some faults in the Gold Cup mine have the downthrow on the east side. In most places the displacement is not more than 30 or 40 feet.

Most of this group of faults were formed before ore deposition, but there are several rather strong faults that were formed afterward. Garrey describes a "big fault" in the workings of the Gold Cup shaft, which strikes N. 30° E., dips 60°-70° NW., and cuts off the ore bodies on the southeast side. He also mentions a N. 75° W. fault that cuts the ore bodies off on the north and apparently cuts off the "big fault."

The pre-ore faults apparently served as channels for the upward movement of the ore-forming solutions. In some places these faults contain ore-bearing veins—for example, the Jimmy Mack and the Indiana—but in most places, the ore-forming solutions welled up through the faults and spread out along the bedding planes, depositing the ore as replacement bodies in limestones.

Ore Deposits

The ore deposits of economic importance in the Tincup district are of three distinct classes—silver-lead-gold "blanket" deposits, silver-lead-gold veins, and molybdenum-tungsten veins. A fourth class, unimportant commercially but none the less interesting, is represented by iron "blanket" deposits. The chief silver-lead-gold blanket deposits are confined to certain horizons in the sediments on Gold Hill and West Gold Hill, 2 to 3 miles south of Tincup. (See fig. 1.) The silver-lead-gold veins occur in both sediments and granite gneiss on Gold Hill 3 to 4 miles south of

[12]Garrey, G. H., Unpublished report on the Gold Cup Mine in the Tincup mining district, Gunnison County, Colo., 1928.

Tincup, and also on Anna Mountain 4½ miles south of Tincup. The molybdenum-tungsten veins are confined to the crest and south slope of the divide between Willow Creek and Quartz Creek 4½ to 5½ miles south of Tincup. The iron blanket deposits occur in a small area on the south end of Gold Hill 4 miles south of Tincup. As indicated in figure 1, there is a suggestion of a zonal arrangement of these deposits with respect to the porphyry stock of Fairview Peak, with molybdenum-tungsten deposits close to the stock, iron deposits farther away, and silver-lead-gold deposits still farther removed. This appears to be somewhat similar to the zonal arrangement of ores found by Loughlin and Behre in the Leadville district.[13] However, the solving of this problem would necessitate a careful examination of the ore deposits southwest and southeast of the Fairview Peak stock, as well as those of the Tincup district, and time was not available for such detailed study.

Silver-lead-gold blanket deposits.—The silver-lead-gold blanket deposits are the most valuable in the Tincup district and appear to be very similar to those of the Leadville and Aspen districts. They occur as flat-lying tabular replacement ore bodies, which have a rather lenticular outline, and lie along certain limestone beds at their intersections with the steeply dipping faults or fractures. The upper surfaces of the ore bodies in most places conform with the bedding planes, but the lower surfaces are more or less irregular and extend downward for short distances along the fractures. The ore bodies are commonly not more than 8 or 10 feet thick but range from 30 feet to several hundred feet in length and from 20 to 50 feet in width.

The ore horizons in the sediments are given by Garrey[14] as (1) the limestone beds immediately underlying the Harding quartzite; (2) the limestone beds immediately un-

[13]Loughlin, G. F., and Behre, C. H., Zoning of ore deposits in and adjoining the Leadville district, Colo.; Econ. Geology, vol. 29, No. 3, pp. 215-254, May, 1934.

[14]Garrey, G. H., The Alhambra and adjacent claims, Tincup district, Gunnison County, Colo. (unpublished report).

derlying the "Fairview shale"; (3) the limestone beds immediately above and below the quartzite bed of the Parting member; (4) the granular limestone just above the "Siliceous limestone"; (5) the granular limestone immediately below the "Blue limestone"; and (6) the "Blue limestone" directly below the "Dolomitic limestone." Most of the production of the Tincup district has come from horizons 4 to 6. Horizon 1 afforded at least one valuable ore body, that of the West Gold Hill mine. The beds at horizons 2 and 3 have been only slightly productive in the Tincup district but have contained good ore bodies in the Pitkin district, 10 miles south of Tincup, and may be of potential importance in the Tincup district.

The confinement of the ore bodies to these particular horizons seems to be due to a variety of factors. At the lower horizons the deposition of ore is undoubtedly due to the damming effect of quartzite or shale layers. At the upper horizons the localization of the ore seems to be due to the greater permeability and susceptibility to alteration of certain beds than of others. In this respect the brecciation along certain bedding planes probably had considerable effect. The porphyry sheets probably served to some etxent as dams or baffles, but apparently this was not as effective a factor as the permeability and composition of the limestones.

The valuable metals in the ores of the blanket deposits are silver, lead, gold, and small amounts of copper, listed in the order of their value. The chief primary ore minerals are argentiferous galena and pyrite, which are accompanied by small amounts of chalcopyrite and sphalerite. The gold is apparently associated with the pyrite. Garrey[15] mentions small amounts of gray copper associated with high-grade silver ore. The chief oxidized ore minerals are cerussite, anglesite, cerargyrite, and limonite. They are accompanied by small amounts of free gold, malachite, azurite, chrysocolla, and calamine. The chief gangue minerals are quartz and calcite.

[15]Garrey, G. H., Unpublished report on the Gold Cup mine, 1928.

All the ore of the blanket deposits so far exploited is at least partly oxidized, and much of it is completely oxidized. The ore consists of irregular masses of cerussite and anglesite, commonly enclosing small masses of galena, in a limonitic and siliceous gangue, which in some places is a dense yellow jaspery material and in other places is a honeycomb quartz containing abundant limonite. Some of the ore is stained with manganese oxide, forming a black cindery-looking material. Oxidation of the ore bodies extends to a depth of more than 500 feet. Ore at the bottom of the Gold Cup shaft, at a depth of more than 500 feet, is partly oxidized, and in the Gold Cup tunnel mineralized fissures are oxidized at a depth of nearly 600 feet.

Silver-lead-gold vein deposits.—The silver-lead-gold vein deposits occur in northeastward-trending, steeply dipping fissures that cut both the sediments and the granite gneiss. The appearance of the ore on the Jimmy Mack and Indiana dumps suggest that there has been considerable replacement of the wall rock where the veins cut limestones. The veins range from 1 to 6 feet in width and probably do not exceed 600 to 1,000 feet in length. The ore minerals and the character of the ore are the same as in the blanket deposits, except in the Blistered Horn tunnel, where the ore is unoxidized and consists of solid quartz, pyrite, and galena. The depth of oxidation in these veins appears to be about 500 feet.

Molybdenum-tungsten veins.—The molybdenum-tungsten deposits were exploited chiefly in 1917-18, during the World War, but have been worked very little since, as the market for molybdenum and tungsten has been readily supplied at low cost from larger domestic and foreign deposits. They occur in strong northeastward-trending, southeastward-dipping veins with clear-cut walls, which range from 2 to 7 feet in width and are more than 1,000 feet in length. The wall rock is granite gneiss. The chief ore minerals are molybdenite and hübnerite, but the veins also contain small amounts of pyrite, chalcopyrite, sphalerite, galena, and gray copper. In most of the veins molybdenite is the only ore mineral, but in some molybdenite and hübnerite occur together. Secondary ore minerals are molybdite, occuring along late fractures, and covellite, coating sphalerite and chalcopyrite. Quartz is the chief gangue mineral. The ore minerals are irregularly distributed through massive glassy or milky quartz—the molybdenite in flakes and finely disseminated grains, the hübnerite in tabular crystals, and the sulphides in irregular aggregates. The molybdenum and tungsten contents of this ore are on the average low, ranging from less than 1 to about 15 percent.

Iron blanket deposits.—The iron blanket deposits are apparently of little economic importance, and they were not examined by the writer. They are briefly described in the Mint report for 1883[16] and in the Colorado Mining Directory.[17] According to these reports the iron deposits occur in either limestone or porphyry and consist of large blanket bodies of rather pure hematite ore, which contains 64 to 78 percent of iron and in places 6 to 12 ounces of silver to the ton and some gold. Some of these deposits have been worked for gold and silver.

Ore Deposits at Cross Mountain

At Cross Mountain, 6 miles S. 70° W. of Tincup, there are several small mines, which are so far removed from the main Tincup district that they practically constitute a separate district. However, the geologic setting and the character of the deposits are much the same as at Tincup. The mines of Cross Mountain were not easily accessible in 1932. An automobile could be driven to Union Park Cow Camp, 3 miles north of Cross Mountain, but from that place only trails led to the mines. The chief mines are on the east slope of Cross Mountain.

[17]Corregan, R. A., and Lingane, D. F., Colorado Mining Directory, p. 327, 1883.

[16]Burchard, H. C., Report of the Director of the Mint for 1883, p. 313.

The same pre-Cambrian granite gneiss and the lower Paleozoic sediments are exposed here as at Tincup, but the upper part of the Dyer member and the entire Mississippian and Pennsylvanian formations are missing. (See fig. 1.) There are several small lenticular sills of monzonite and quartz monzonite porphyry at different horizons throughout the section. A sill more than 50 feet thick caps the top of Cross Mountain. The sediments form an oval area on the upper slopes of Cross Mountain, and granite gneiss covers the lower slopes.

On the east side of Cross Mountain the beds have a general strike of N. 55° W. and dip 15° NE. Three-quarters of a mile north of the peak the beds dip into a sharp syncline, of which the limbs dip 70° and the axis trends about east. A mile north of the peak the dip decreases to 22° SW.

The ore deposits have been worked chiefly for gold, although they contain some silver and lead. They include both blanket deposits and vein deposits.

Placers

Placer mining within the Tincup district began in 1861 in Tincup Gulch and was carried on more or less continuously until 1879, when the lodes were discovered. Tincup Gulch was dry for much of each year, so considerable ditching was done. Several other placer grounds were discovered during the period from 1861 to 1879. Smith[18] stated in 1883 that "The placers of Union Park, Taylor Park, Bertha Gulch, West Willow, and Tincup have added much to the general output." Foster[19] the same year reported that the placer mines were actively worked and the results were very profitable. Burchard[20] gives the production of the placers for 1883 as follows:

[18]Smith, J. A., Report on the development of the mineral resources of Colorado, p. 56, Denver, Tribune Publishing Co., 1883.

[19]Foster, E. L., Report of the State geologist, 1883-84, p. 46, Denver, Tribune Publishing Co., 1884.

[20]Burchard, H. C., op. cit., p. 317.

Union	$40,000
Texas	22,000
Gray	1,800
Others	3,000
	$66,800

Burchard also gives a brief description of the Texas placer, in Union Park. It was started in July, 1883, and was worked by hydraulic methods. "In laying the flume a large body of iron cement was encountered, which washes gold as high as from 50 to 80 colors to the pan. This body is quite extensive; a large quantity can be mined as easily as gravel, some of which was assayed in Leadville and gave 16⅖ ounces gold and 7 ounces silver."

The last placer project, according to an article in the Colorado Magazine,[21] was undertaken by the Columbine Gold Dredging Co. near the old site of Hillerton and was a financial loss. Poet in this article estimates that the placers of the Tincup district have produced a total of 20,000 ounces in free gold.

DESCRIPTION OF THE MINES

Silver-Lead-Gold Blanket Deposits

Gold Cup

The Gold Cup mine, which has been by far the largest producer in the district, lies on the east side of Tincup Gulch, 2½ miles south of Tincup, at an altitude of about 11,250 feet. It is developed by an inclined shaft, which extends N. 56° E. for 900 feet directly down the dip of the beds and has an average slope of 30°. Figure 3 shows the extent of the levels and stopes.

As the Gold Cup workings were inaccessible to the writer, much of the following material has been taken from

[21]Poet, S. E., op. cit., pp. 30-38.

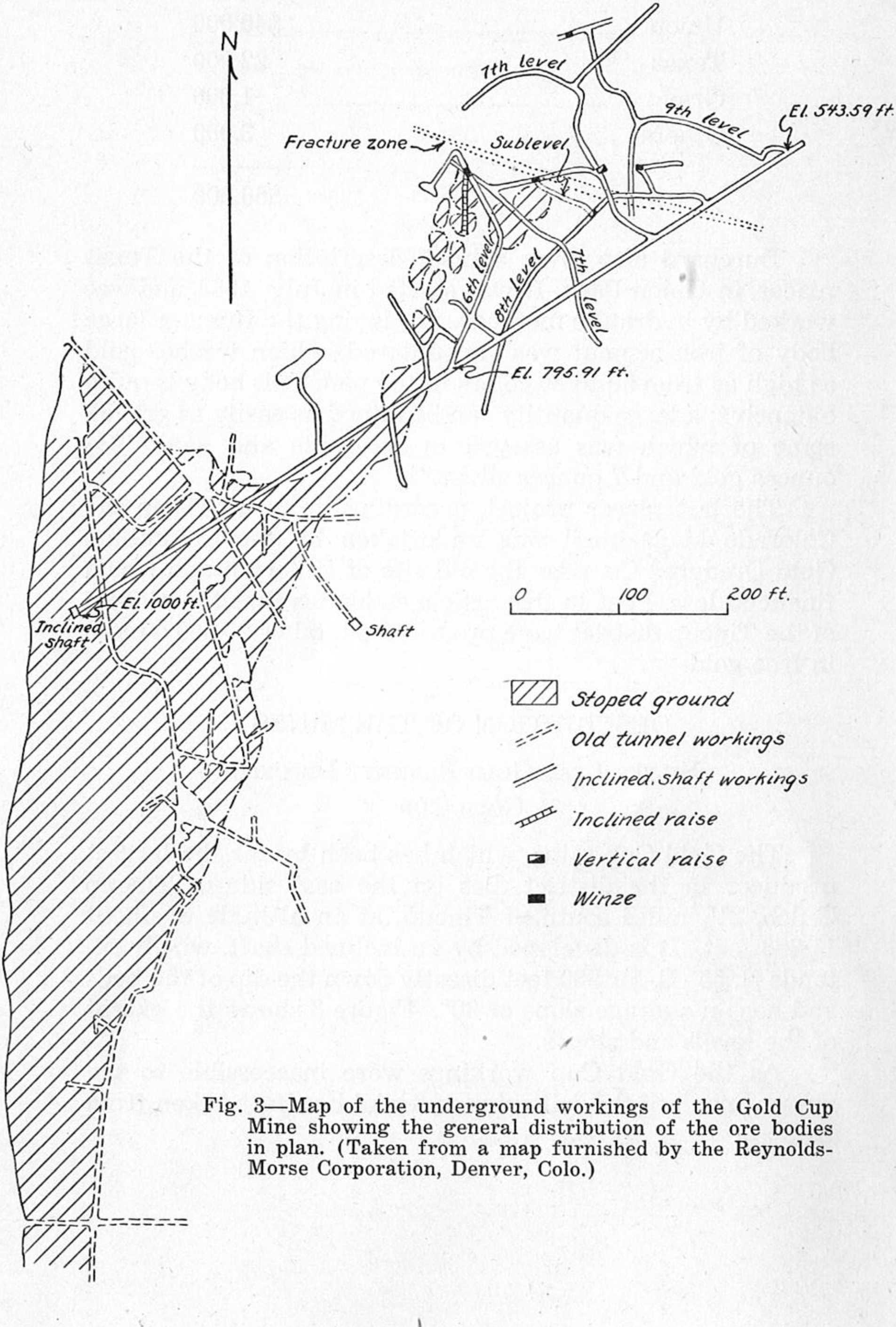

Fig. 3—Map of the underground workings of the Gold Cup Mine showing the general distribution of the ore bodies in plan. (Taken from a map furnished by the Reynolds-Morse Corporation, Denver, Colo.)