Bureau of Mines
Report of Investigations 4760

INVESTIGATION OF WEST BELT COPPER-ZINC MINES EL DORADO, AMADOR, CALAVERAS, AND MARIPOSA COUNTIES, CALIF.

BY FRANK J. WIEBELT, W. C. SANBORN, R. R. TRENGOVE, AND SPANGLER RICKER

United States Department of the Interior — February 1951

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UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary
BUREAU OF MINES
James Boyd, Director

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by

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INTRODUCTION AND SUMMARY

As a result of the examination of many copper-zinc properties in the West Belt area of California, nine were chosen for exploration projects by the Bureau of Mines. This was part of the Bureau's wartime mineral-development program aimed at maintaining production of essential metals and increasing ore reserves.

The properties explored were the El Dorado, El Dorado County; Copper Hill, Newton, and Gray House, Amador County; Constellation, North Keystone, and Collier, Calaveras County; and American Eagle and Akoz, Mariposa County.

In addition to surface sampling and mapping, 41 holes, aggregating 18,134 linear feet, were diamond-drilled. Detailed results of the work done on all properties except the El Dorado and Akoz are given in this report. The El Dorado and Akoz were discussed in Reports of Investigations 3896 and 4144, respectively. Figure 1 is an index map showing the location of the mines covered in this publication.

In this report, the general features of the West Belt are summarized, and mineral composition, characteristic types, and modes of occurrences of ore deposits are described. The work performed by the Bureau of Mines is reported in separate sections under the names of seven mines; each mine is described separately, with a concluding section covering the work performed by the Bureau of Mines.

Development and milling costs are reported in detail for the Keystone mine. The Appendix embraces diamond drill-hole logs for the Newton, Copper Hill, Gray House, and Constellation mines and contains other pertinent information of drill holes, samples, and analyses of samples. Analyses of drill-hole samples are shown in figures 3, 5, 6, 9, 11, and 13.

ACKNOWLEDGMENTS

Special acknowledgment is made to George Heyl of the Federal Geological Survey, for his aid on many of the geologic problems. A. C. Rice, of the Reno Rare and Precious Metals Experiment Station, Metallurgical Branch, supervised the analytical work.

The Bureau is indebted to the late Otto Schiffner, general manager of the Keystone Corp., for furnishing detailed cost data at the North Keystone during the difficult war years of 1943 and 1944.

GENERAL FEATURES

The West Belt copper-zinc-bearing zone traverses the western slope of the Sierra Nevada with unusual persistence from Butte County to Kern County, a distance of more than 300 miles. It ranks among the important producing areas

of copper-zinc ores in California. From the discovery of the Napoleon mine in 1860, there followed, in rapid succession, discovery of many of the typical mines such as the Union, Quail Hill, Collier, Keystone, Newton, and Campo Seco.

Reports of the State Division of Mines state that the first few years' production came from selected high-grade ores that were shipped from San Francisco to England or the Eastern States. By 1868, the "Mineral Resources of the United States west of the Rocky Mountains" reported seven noteworthy smelting plants for the reduction of copper ore in or adjacent to the West Belt area. Not until 1900 did the annual copper production reach appreciable amounts, and not until the recent world war did zinc production reach a creditable figure. From 1894 through 1946, the recorded copper and zinc production from Butte through to Kern County totals more than 200,000,000 pounds and 50,000,000 pounds, respectively.3/

Although the area contained such important past producers as the Penn mine, Union, and others, a great part of the production in recent years depended largely on premium metal prices for economical operations. The Penn and Newton were the only active mines during 1947.

The West Belt shows the characteristics typical of the western flanks of the Sierra Nevada at altitudes ranging from several hundred feet at the Penn mine, Calaveras County, to several thousand feet at the Big Bend in Butte County. Most properties are within easy access to good paved highways. Climatic conditions are ideal for mining. Summers are hot and dry and winters are moderate, with rainfall up to about 40 inches per year and at times some snow.

ORE DEPOSITS

The ore in general occurs as sulfide replacements of highly sericitized schists derived from various types of volcanics and intrusives. The principal economic minerals are chalcopyrite, sphalerite, gold, and silver. The more common associated minerals are pyrite, pyrrhotite, barite, bornite, calcite and quartz.

Some of the ore bodies in such mines as the Penn are made up of a mixture of both copper and zinc minerals in such proportions that both are of primary economic importance.

At the Penn, the gold and silver content of the ores is also of appreciable value. At other properties, such as the Union at Copperopolis and the Newton, only the copper minerals are important. The Blue Moon, Big Bend, and others have been worked primarily for their zinc content.

The ores as a rule consist of intimately mixed sulfides in lenticular masses ranging in width from a few feet to over 40 feet. In length, the ore bodies range from a few feet to more than 500 feet and some of them have been stoped to a depth of more than 1,200 feet. The mines as a whole have been

3/ Copper in California: California Min. Bur. Bull. 144, 1948, p. 15.

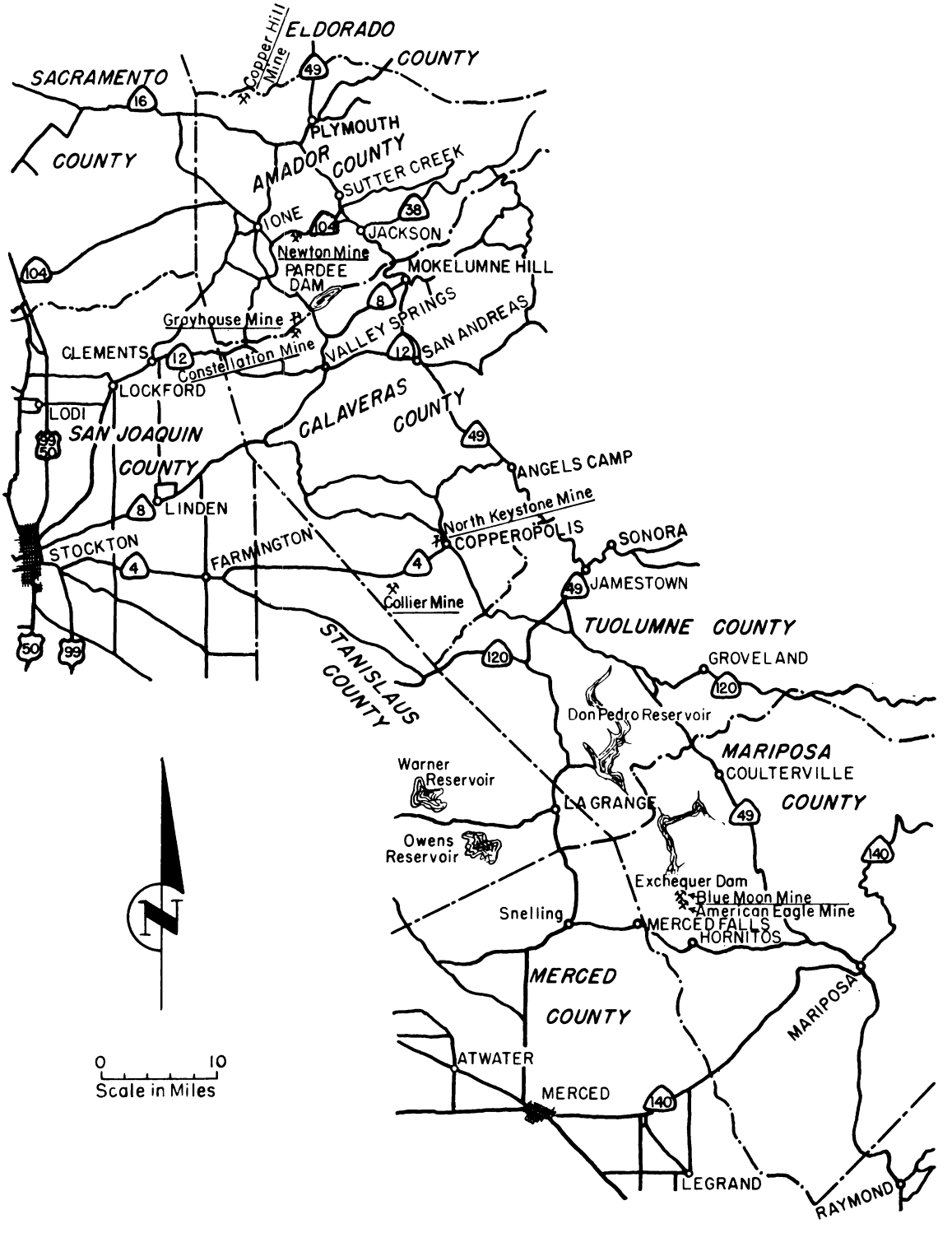


Figure 1. - Index map of some West Belt zinc-copper mines, California.

developed to comparatively shallow depths, but the Union and Penn mines have been productive to depths of 1,800 and 2,800 feet, respectively.

Prices of the metals have influenced the cut-off grade of ore mined. During the World War II, the average grade of copper ore mined at the North Keystone was about 2.25 percent copper,4/ whereas the ore reserves at the Blue Moon averaged 14 percent zinc and carried small amounts of gold, silver, and copper.5/ Ore reserves at the Penn mine before recent operations were reported to contain 3.96 percent copper, 9.36 percent zinc, 0.068 ounce gold, and 2.76 ounces silver.6/ The accompaning drill logs show the type of ore at the Newton and Copper Hill deposits.

Ore bodies are generally marked on the surface by an easily recognized gassan, and the oxidization extends from a few feet to around 75 feet in depth.

NEWTON MINE

Introduction

The Newton is in secs. 28 and 33, T. 6 N., R. 10 E., Mount Diablo base line and meridian, in the central part of the NW1/4 of the Jackson Quadrangle, Amador County, Calif. It can be reached by following Highway 88 northwest from Jackson for 7 miles or by following the same highway southeast from Ione for 4 miles.

The nearest railroad shipping point is Ione, Calif., a small town with a population of 1,000, situated on a branch line of the Southern Pacific Railroad.

The area in the vicinity of the mine is drained by Mountain Spring Creek, a northwesterly flowing feeder of Sutter Creek, which is a tributary of the Cosumnes River.

HISTORY

This was one of the first copper mines to be operated in California. It was opened in the early sixties and was worked vigorously before 1866. In 1887 it was reopened by the Newton Copper Co. and has been worked intermittently ever since. An 80-ton smelter was erected in 1889, and in 1891 leaching was done to recover cement copper. During 1900, 3,500 tons of 7-percent ore was mined and heap-roasted, after which 3,000 tons was smelted to make a 50-percent matte. The estimated ore production of this property up to date of recent operations was 33,000 tons, two-thirds of which had been beneficiated on the property.7/

4/ Schiffner, Otto (deceased), Manager, Keystone Copper Corp.
5/ J. H. A. Williams, New York City.
6/ Juhlihn, C. E., and Horton, F. W., Mineral Industries Survey of The United States. Part I - Calaveras Co., Calif.: U. S. Bureau of Mines Bull. 413, 1938, p. 115.
7/ Copper Resources of California: State Division of Mines, Bull. 50, 1908, pp. 223-224.

At the time of the Bureau of Mines exploration, the property was under lease from its present owners, F. Defrene and his sister, to J. H. Lester of Jackson, Calif. Later, it was taken over by the Bradley Mining Corp., under whose management 56,000 tons of ore yielding more than 6,500,000 pounds of copper was produced.8/

Geology and Mine Workings

The deposit is in a belt of amphibolite schist lying west of the Mother Lode and traversing the district in a northwesterly direction from the Mokelumne to the Cosumnes Rivers. The gossan-capped vein strikes west of north and dips approximately 70° east. Mineralization consists principally of chalcopyrite and pyrite and occurs as a massive lenticular ore body for a length of over 300 feet, as exposed on the 7th level. The vertical range has been proved, by drilling, to extend more than 800 feet along the dip. It ranges in width from a narrow seam to 6-1/2 feet.

The mine workings at the time of the project consisted of a 400-foot, inclined, 1-1/2-compartment shaft, 7 levels, and a number of winzes. The inclination of the shaft averaged 70°. Drifting, as indicated by old mine maps, totaled more than 2,000 feet. Both hanging and foot walls are firm, and very little timber is required in mining. A second shaft, 150 feet deep, is on higher ground 300 feet southeast from the main shaft but it is now caved and inaccessible.

Since the Bureau of Mines drilling was completed, the 400-foot incline has been sunk to the 775-foot level, from which a winze was sunk 143 feet. A great portion of the recent production came from the new workings between the 400- and 775-foot levels.

Work Performed by the Bureau of Mines

Five diamond-drill holes, ranging in length from 700 to 1,076 feet, were drilled. One drill operated two to three shifts per day 6 days per week. Contract drilling aggregated 4,258 feet and consisted of 50 feet of "NX" holes, 80 feet of "BX" hole, and 4,128 feet of "AX" hole. A total of 230 feet of casing was set. Core recovery from the 4,258 feet drilled totaled 3,068 feet, or 72 percent. From the 5 holes drilled, 29 samples, consisting of 19 core and 10 sludge, were taken for analysis. Holes 2, 3, and 5 encountered a downward extension of the vein. All of the holes had a marked tendency to become normal to the schistosity and were surveyed for dip at 100-foot intervals.

The holes were all in schists, and the ore zone was well-defined. The location, cross sections, and assays are shown on figure 2 and 3, and additional data are to be found in the appendix.

8/ P. R. Bradley Jr., San Francisco, Calif.

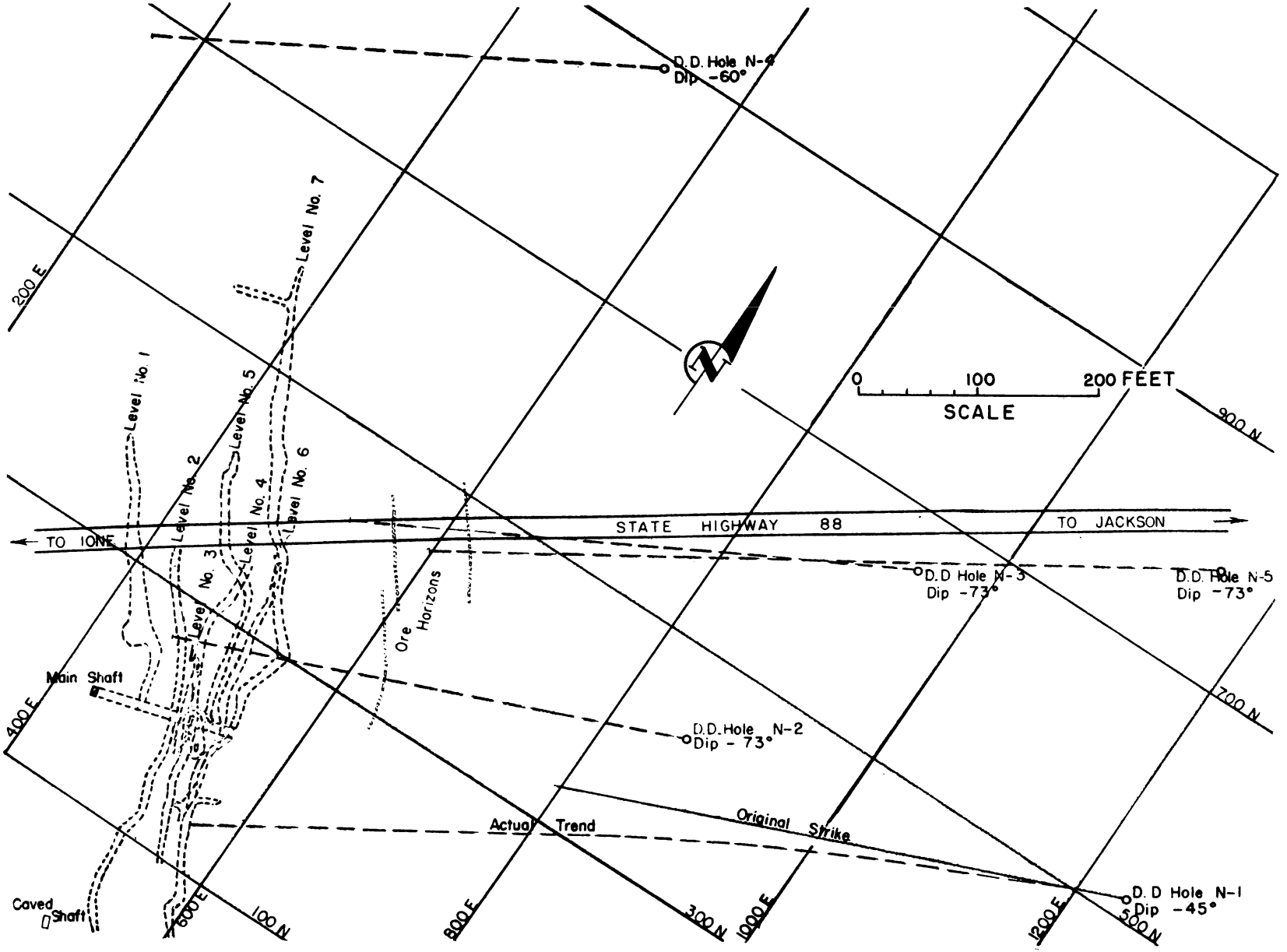


Figure 2. - Drill-hole locations and underground workings, Newton mine, Amador County.

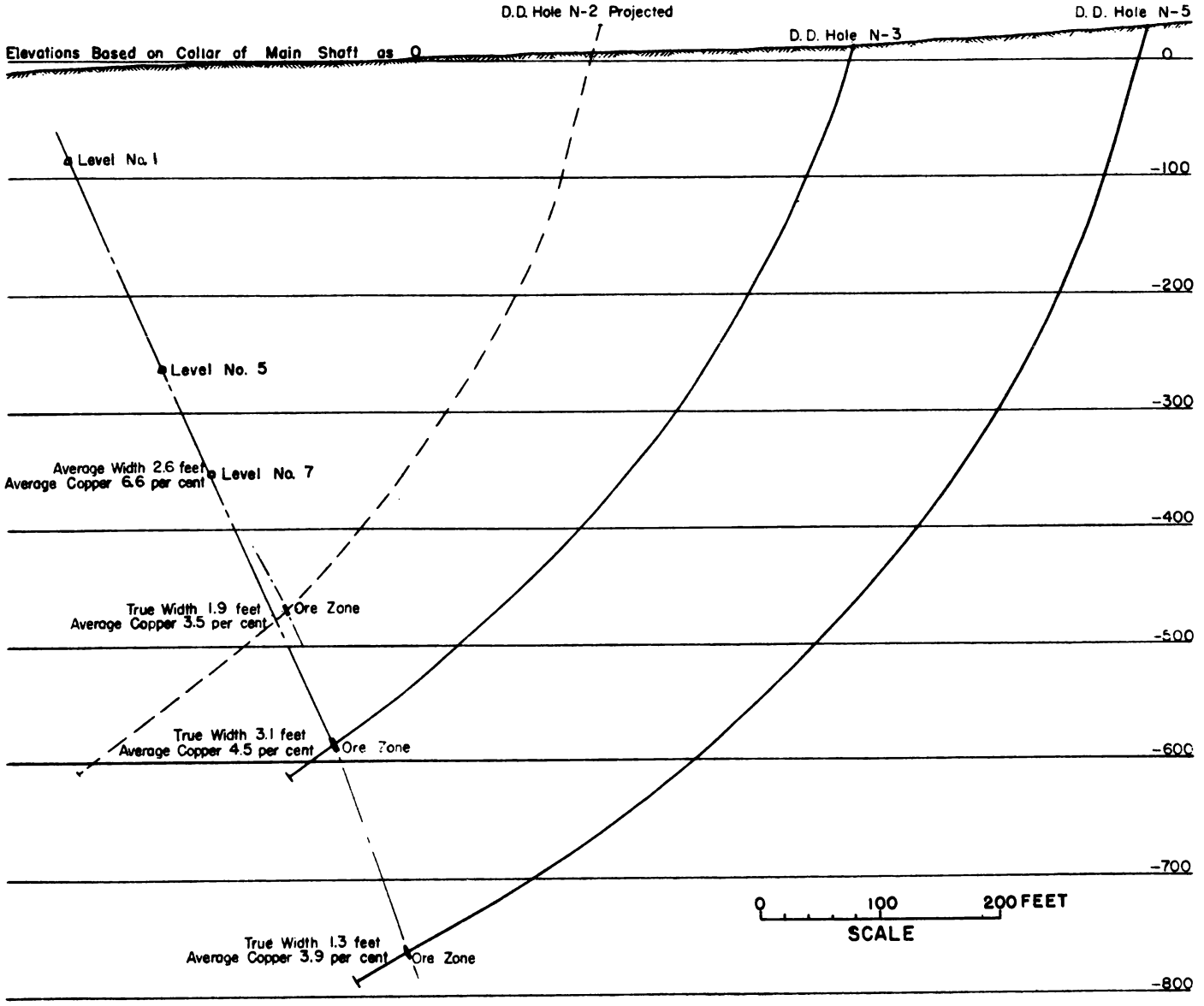


Figure 3. - Vertical section, looking N. W., showing drill holes 2, 3, and 5, Newton mine, Amador County (see fig. 2).

COPPER HILL MINE

The Copper Hill mine is situated in sec. 34, T. 8 N., R. 9 E.; NE 1/4 of sec. 3, T. 7 N., R. 9 E.; and NE 1/4 of NW 1/4 of sec. 3, T. 7 N., R. 9 E., M. D. B. & M., in the extreme northwest corner of the Jackson Quadrangle, Amador County, Calif. It may be reached by following a surfaced county road west from Plymouth, Calif., for 6 miles, past the Detert ranch, thence north on the Latrobe Road for 2 miles, and thence 2 miles west on a poorly conditioned dirt road to the mine. Sacramento is the nearest large supply center and is about 45 miles distant. Ione is the nearest rail shipping point.

The area in the vicinity of the mine is drained by Indian Creek, a northwestward flowing tributary of the Cosumnes River.

History

The history of this property is obscure as all old mine records and maps were destroyed by fire. Development and mining must have been carried out near the turn of the last century, as a California State Mining Bulletin dated 1906 states that "large slag dumps show that considerable ore had been produced in the past," and that "there are over 1,200 feet of shafts and over 1,800 feet of drifts on the property." Old smelter records attest the fact that the ore shipped from this mine contained a high percentage of copper and zinc as well as an appreciable amount of gold and silver.

The property is owned by the W. F. Detert estate, 1705 Mills Tower, San Francisco. At the time of the Bureau's exploration it was optioned to J. P. Donovan of San Francisco, who had, in turn, optioned it to the American Smelting & Refining Co.

Geology and Mine Workings

The deposits on this property occur in silicified amphibolite schists. Gossan-capped veins strike west of north and dip 45° to 65° eastward. The ore consists of an intimate mixture of fine-grained pyrite, chalcopyrite, and sphalerite and occurs in relatively short lenses of varying widths. Small amounts of gold and silver are contained in the sulfides. From surface indications it appears that there has been faulting between the main shaft and the Hobo shaft.

Work Performed by Bureau of Mines

Five diamond-drill holes ranging in length from 315 to 800 feet were drilled along the strike of the veins. The logs of these holes are given in the appendix. One drill, operating most of the time at a rate of three shifts per day, was operated 6 days a week under contract. This drilling (aggregating 2,864 feet) consisted of 38 feet of "NX" hole, 85 feet of "BX" hole, 1,781 feet of "AX" hole, and 960 feet of "EX" hole. Six hundred and ninty feet of casing was set, and 427 feet of hole was cemented. Core recovery was 72.8 percent. Forty-six core and 65 sludge samples were collected for analysis.

Ore indications were found in holes 2 and 4. Hole 5 was drilled 125 feet to the south of hole 4 but failed to prove an extension of the ore body to this point. The drilling did not intersect any extensions of the surface outcrop.

The ore consisted of massive sphalerite containing a high percentage of silver. The total ore width in hole 4 was 10.3 feet and comprised three separate intersections at depths of 183.5 to 189 feet, 191.5 to 193.6 feet, and 208 to 210.7 feet. Both core and sludge recovery were poor. Adjusted averages gave the following analysis: 22.37 percent zinc, 0.43 percent copper, 9.31 ounces silver, and 0.02 ounce gold.

Figure 4 shows the surface plan and location of diamond-drill holes. Figures 5 and 6 show sections of the only two holes in which ore was intersected.

GRAY HOUSE MINE

Introduction

The Gray House mine is in sec. 33, T. 5 N., R. 10 E., Mount Diablo base line and meridian, in the north-central part of the SW1/4 of the Jackson Quadrangle, Amador County, Calif. It is just across the Mokelumne River from the Penn mine and can be reached from Ione by following the surfaced road from Ione to Comanche via Buena Vista and Lancha Plana for a distance of 9 miles.

The area in the immediate vicinity of this property drains southeasterly into the Mokelumne River. The hills are moderately rugged and covered with scrub oak and heavy underbrush. The elevation is about 350 feet above sea level, and climatic conditions are similar to those at the Newton and Copper Hill mines.

History

A 200-foot vertical shaft was sunk on this property during the early activities in the district. In 1906 it was sunk 50 feet farther, and 1,000 feet of drifts and crosscuts were driven. There are no records of any production from this mine, and workings were inaccessible. It is owned by Lloyd W. Thayer, Inverness, Calif.

Geology

The zone on which this property has been developed consists of a belt of sericite schist and is a northerly extension of the Penn mine schist. Dumps of excavated material show very little mineral.

Work Performed by Bureau of Mines

One hole 833 feet long was drilled and it consisted of 60 feet of "NX", 20 feet of "BX", and 753 feet of "AX". Eighty feet of casing was set. A 45.2 percent core recovery was obtained. The hole was drilled near the entrance of a large open cut just west of the Buena Vista Lancha Plana road. The log of this hole is given in the appendix; no samples were taken.

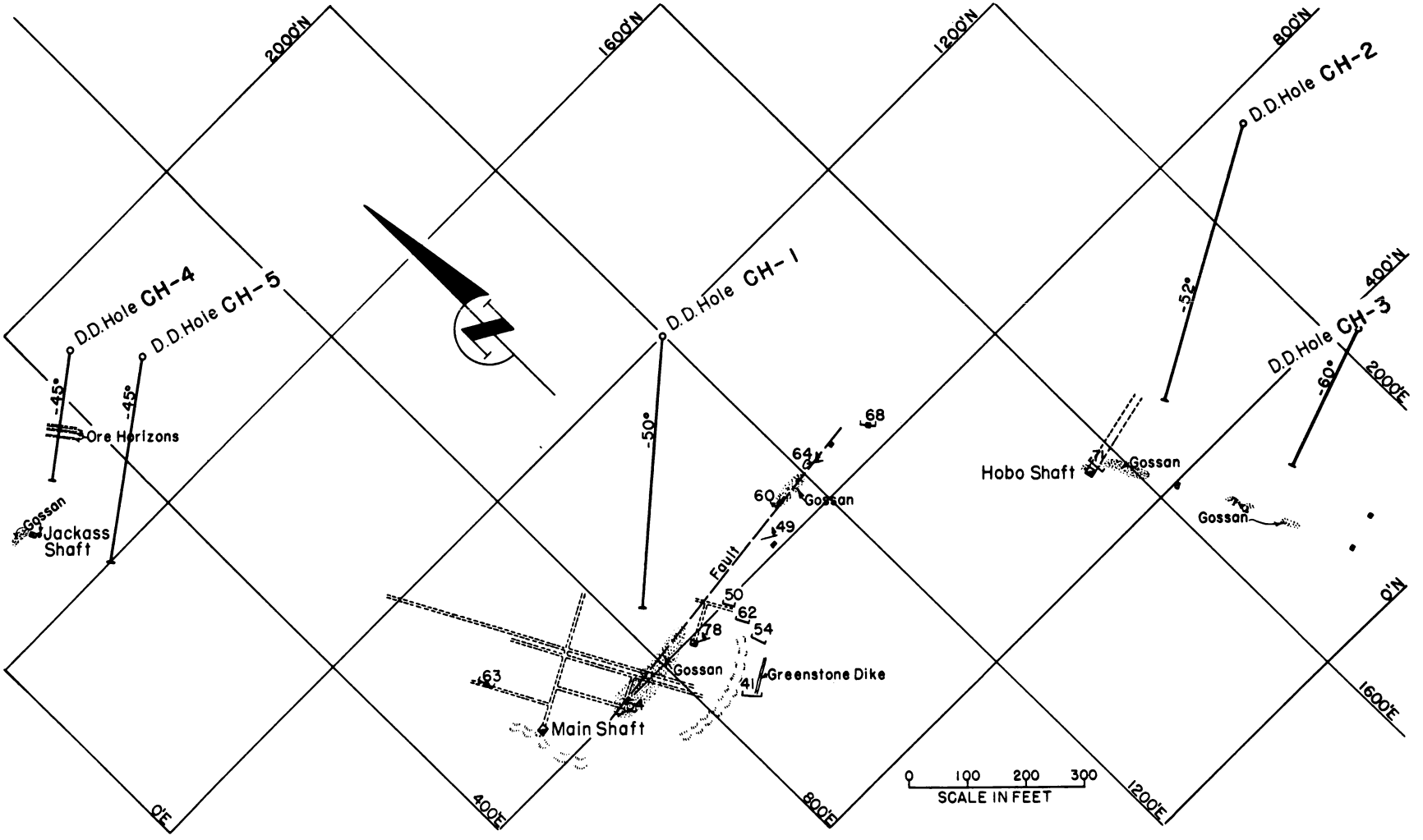
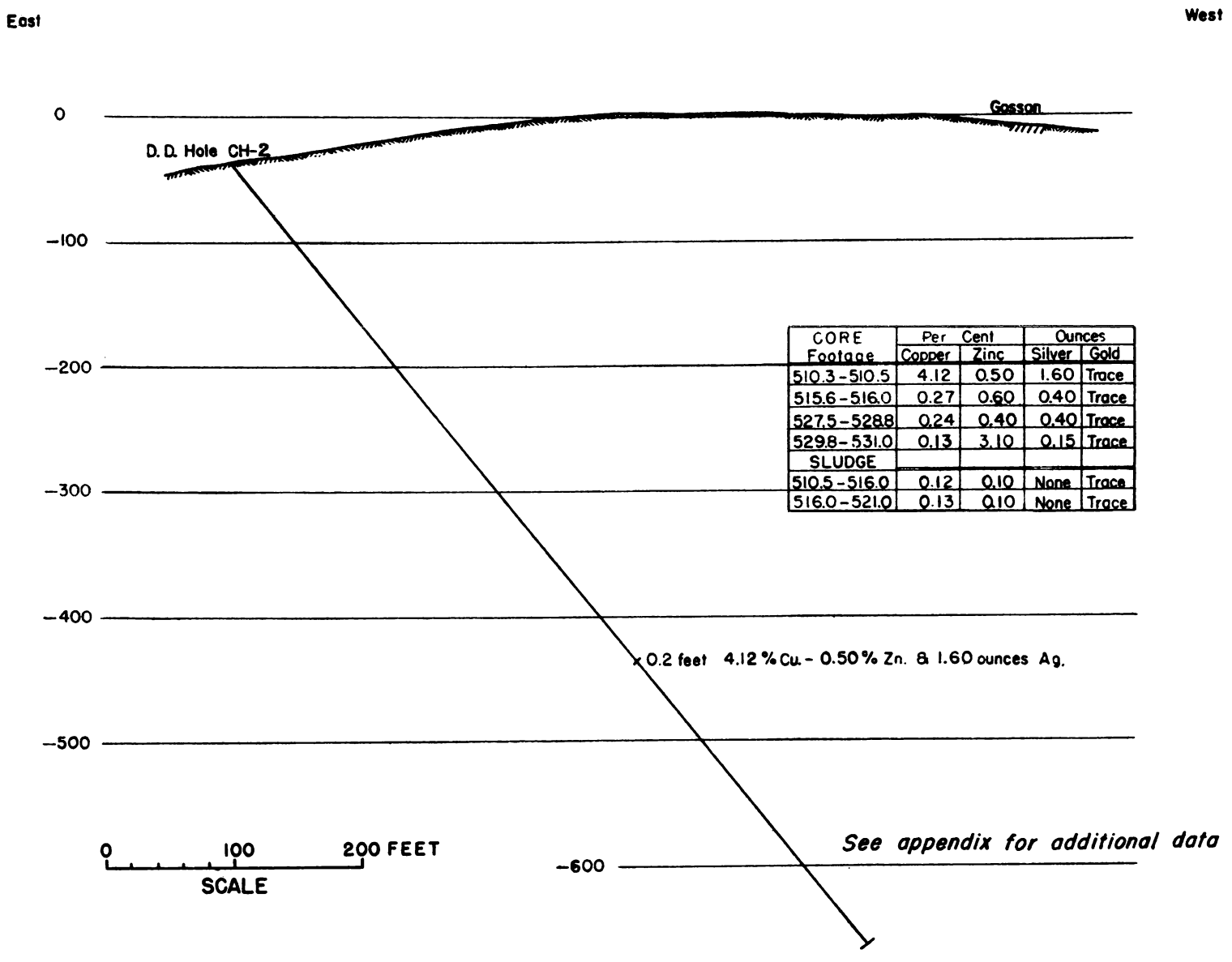
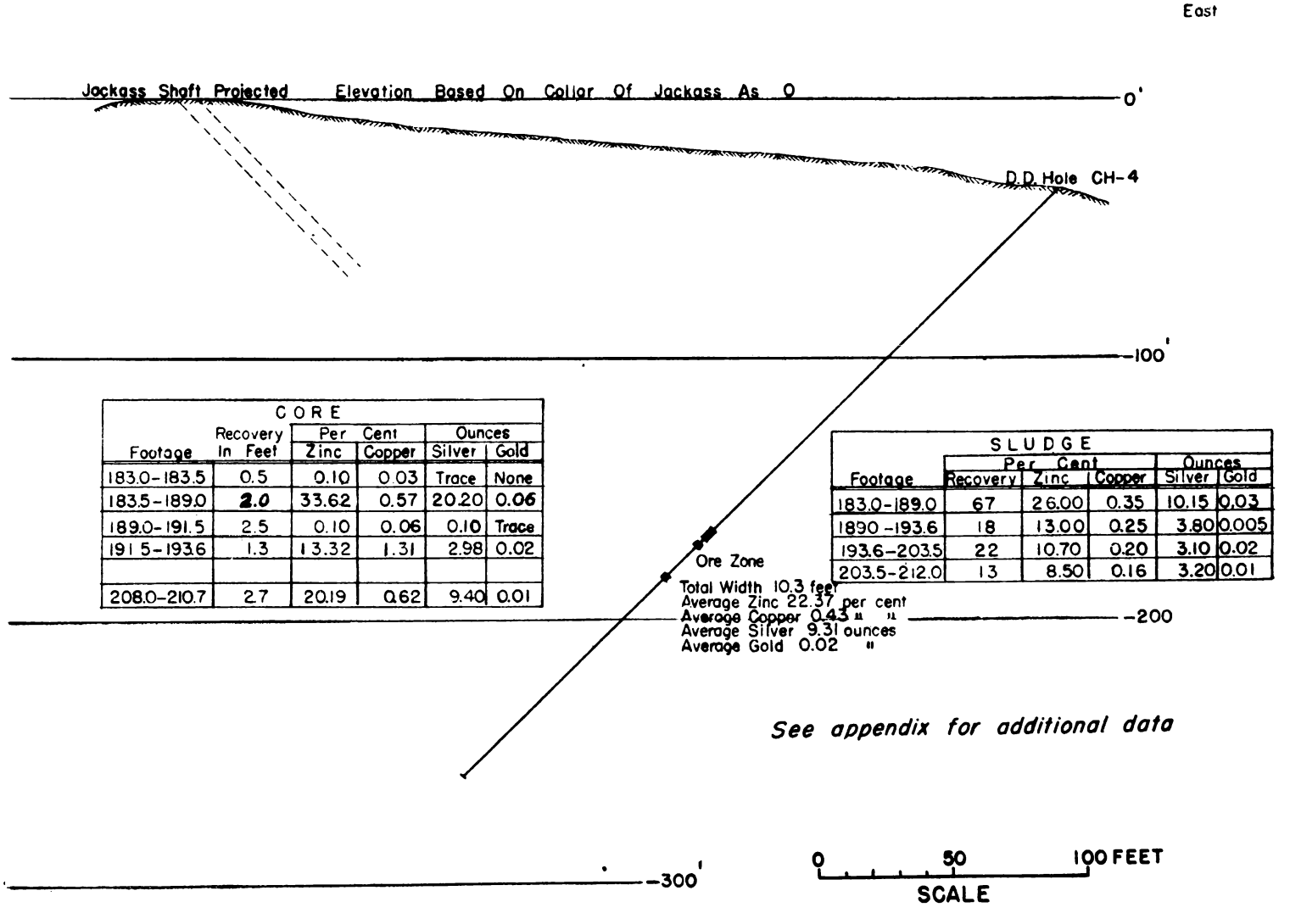


Figure 4. - Plan sketch showing diamond-drill holes CH 1, 2, 3, 4, and 5 and part of underground workings, Copper Hill mine, Amador County.



CORE Footage	Per Cent Copper	Per Cent Zinc	Ounces Silver	Ounces Gold
510.3 - 510.5	4.12	0.50	1.60	Trace
515.6 - 516.0	0.27	0.60	0.40	Trace
527.5 - 528.8	0.24	0.40	0.40	Trace
529.8 - 531.0	0.13	3.10	0.15	Trace
SLUDGE				
510.5 - 516.0	0.12	0.10	None	Trace
516.0 - 521.0	0.13	0.10	None	Trace

Figure 5. - Section through drill hole CH-2, Copper Hill mine, Amador County.



CORE					
Footage	Recovery In Feet	Per Cent Zinc	Per Cent Copper	Ounces Silver	Ounces Gold
183.0-183.5	0.5	0.10	0.03	Trace	None
183.5-189.0	2.0	33.62	0.57	20.20	0.06
189.0-191.5	2.5	0.10	0.06	0.10	Trace
191.5-193.6	1.3	13.32	1.31	2.98	0.02
208.0-210.7	2.7	20.19	0.62	9.40	0.01

SLUDGE					
Footage	Per Cent Recovery	Per Cent Zinc	Per Cent Copper	Ounces Silver	Ounces Gold
183.0-189.0	67	26.00	0.35	10.15	0.03
189.0-193.6	18	13.00	0.25	3.80	0.005
193.6-203.5	22	10.70	0.20	3.10	0.02
203.5-212.0	13	8.50	0.16	3.20	0.01

Figure 6. - Section through drill hole CH-4, Copper Hill mine, Amador County.

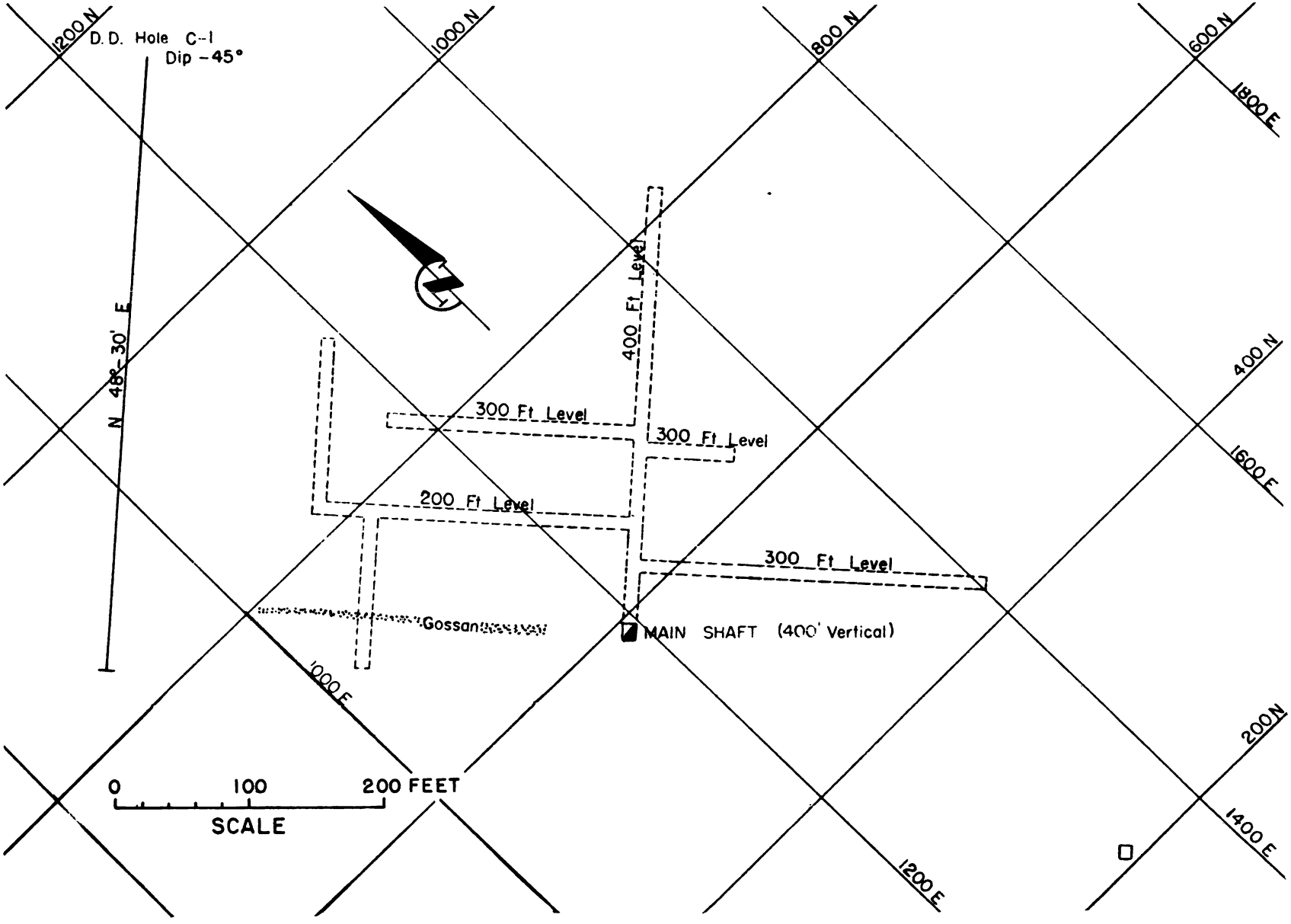


Figure 7. - Underground workings and diamond-drill hole C-1, Constellation mine, Calaveras County.

CONSTELLATION MINE

Introduction

This property is in Lots 3690 and 3690a, being Survey No. 269 in secs. 3 and 4; lots 5 and 9 of sec. 3; and Survey No. 4933 in sec. 3, all in T. 4 N., R. 10 E., M. D. B. & M., in the north-central part of the SW1/4 of the Jackson Quadrangle, Calaveras County, Calif. It adjoins the Penn mine on the south and may be reached by following a surfaced road from Valley Springs to Campo Seco a distance of 4 miles, thence northwest 2 miles on gravel road. The nearest rail shipping point is Valley Springs, population 400, on a branch line of the Southern Pacific Railroad.

The area in the vicinity of the Constellation mine is drained by Oregon Gulch Creek, a northwesterly flowing tributary of the Mokelumne River. The general physical conditions and topography are similar to those at the other properties discussed in this report.

History

The Constellation mine has been idle for more than 35 years. A vertical shaft has been sunk on the southern extension of the east vein of the Penn mine to a depth of 400 feet. Records show that more than 1,700 feet of drifting and crosscutting were done on three levels. Underground workings are inaccessible, and there is no record of production from this property.

The Constellation mine is owned by the Constellation Mining Co. and is now under lease to L. W. Thayer, Inverness, Calif.

Geology

The zone on which this property has been developed lies in a belt of sericite schist that strikes west of north and dips steeply to the east. Locally it is called the east vein, and it is a continuation of the east vein that strikes across the Penn property. The dump shows some of the material from the underground workings to be quartz, pyrite, chalcopyrite, and sphalerite. Gossan can be traced northward from the shaft to a point near the crest of a hill, where it is overlain by auriferous gravel tailings.

Work Performed by Bureau of Mines

One hole 667 feet long was drilled on this property; it comprised 11 feet of "NX" hole, 49 feet of "BX" hole, and 607 feet of "AX" hole. Casing set totaled 60 feet. Core recovery was 55 percent. Mineralized sections that would justify assaying were not encountered. Figure 7 shows a plan of the workings and location of drill hole. The log of this hole is given in the appendix.

NORTH KEYSTONE MINE

Introduction

Work at the North Keystone mine was undertaken by the Bureau of Mines in cooperation with the Federal Geological Survey for the purpose of finding

commercial copper ore in the unexplored area to the north of the mine openings. Initial drilling was done in March 1943, and subsequent drilling was undertaken in August 1943 and continued to December 1943.

The North Keystone mine, in sec. 34, T. 2 N., R 12 E., M. D. B. 8 M., is on the northern outskirts of the town of Copperopolis in southwestern Calaveras County, Calif. The area drains southeasterly into the Stanislaus River. Creeks flow only in winter, as summers are dry and warm and winters are mild. A reservoir built to supply water for a 300-ton mill lies 400 feet west of the main shaft. Buildings and equipment consist of a 70-foot head-frame, ore bins of 300 tons capacity, hoist house in which is installed a double-drum hoist and one large and three small stationary air compressors, a blacksmith shop, timber-framing shed, storehouse, lamp house, and an office. Electric power is obtained from the Pacific Gas & Electric Co. high-tension transmission lines, which traverse the property.

The district is accessible over hard-surfaced roads from Stockton by following State Highway 4 eastward for 40 miles. Angels Camp, 12 miles to the northeast, is the shopping center for the area. The nearest rail shipping point is Farmington, on a branch line of the Southern Pacific Railroad 25 miles west of Copperopolis via Highway 4.

History

The Copperopolis Lode was located in 1861. The furor resulting from this discovery was culminated by the staking of hundreds of claims. Only the Union, Keystone, Empire, and North Keystone claims have been productive. Approximately 72,600,000 pounds 9/ of copper was won from the ores of the Copperopolis Lode from 1861 through 1946, and mining operations have been carried to a depth of 1,800 feet.

Information as to early activity at the North Keystone is sketchy. The Engels Copper Co. developed and operated the property between 1927 and 1930 by sinking a 675-foot, 3-compartment, vertical shaft and by driving over 3,000 feet of development from four levels. Owing to the low price of 5 cents a pound for copper at the time, operations were stopped after considerable ore had been blocked out. In 1942, the property was leased by the owners, Calaveras Consolidated Mining Co., Ltd., to the Keystone Copper Co., a limited partnership, principals of which include H. Bush, C. W. Stewart, and C. E. Nuss. A pumping and rehabilitation program was inaugurated, and production was started immediately after its completion. In July 1943, the Keystone Copper Corp., principals of which are the Keystone Copper Co. of Copperopolis, Calif., and the Lava Cap Gold Mining Corp. of Nevada City, Calif., was formed to operate the property.

During the period from July 1942 to July 1, 1945, about 5,000 tons of copper was produced from the mine output of 225,549 tons of ore. 10/

9/ Copper in California: Division of Mines, State of California, Bull. 144, 1948, pp. 96-97.

10/ Otto, Schiffner, general manager, Keystone Copper Corp.

General Geology and Description of Deposits[11/]

The stratified rocks of the region, more than 2,000 feet thick and belonging to the Amador formation, consist largely of greenstones, green schists, and slates. Intercalated with the greenstone and schist in the vicinity of the mines are several layers of argillaceous slate 100 to 200 feet thick. These rocks are steeply tilted, so that they strike about N. 40° W. and dip 65° to 85° northeast. A regional schistosity strikes northwest and dips in general 70° to 85° northeast.

Intrusive rocks in the vicinity of the mines include granodiorite, diorite, serpentine, and hornblende diorite. Granodiorite, abundant in both the North Keystone mine and the area to the northwest, forms large and small lenticular bodies parallel to the strike and dip of the enclosing rocks.

A strong fault, prominent in the mine but not easily located on the surface because of poor exposures, trends parallel with the regional strike and dips 65 to 75 degrees northeast. It forms the footwall of a zone 5 to 45 feet wide in the mine, which contains all the proved ore bodies. The fault is therefore designated as the footwall fault. Between this fault and the greenstone in the hanging wall of the ore zone, the rocks consist of intensely chloritized slate, schist with varying degrees of chloritization, and granodiorite generally much sheared and partly chloritized.

Ore bodies in the mine are composed of innumerable anastomosing veinlets of fine-grained pyrite and chalcopyrite as well as veins a few inches to 2 feet wide of massive sulfides in chloritized slate or schist. The boundaries of the bodies are fairly sharp and are generally surrounded by halos of pyritized rock a foot or two thick. Bodies so far mined are confined to chlorizited slate. They are believed to be more or less elliptical in longitudinal section, with lenticular cross sections, and lie approximately parallel to the footwall fault and to the schistosity of the enclosing rocks. The widths of the ore lenses range from 2 to 20 feet, and the known strike lengths are 60 to 300 feet. In the direction of the rake, which is 75 to 80 degrees to the north, the larger bodies are probably 500 to 900 feet long. The rake of the bodies may be controlled by the pitch of rolls in the footwall fault, but exposures in the mine and the accuracy of existing surveys of the mine are insufficient to substantiate this. Where the granodiorite in the ore zone is abundant, thus restricting or pinching out the chloritized slate, as in the north part of the 375 level and at the north ends of the 525 and 675 levels, only stringers of chalcopyrite in narrow layers of chloritized slate or schist or in zones of sheared and chloritized granodiorite are found.

Mining

Previous to the present operations, the North Keystone property had been developed and operated on a modest scale through several small and relatively shallow shafts, but principally through the main shaft. Its three compartments, with over-all dimensions of 6 by 16 feet, extended vertically to a depth of

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11/ Hadley, J. B., U.S.G.S., Preliminary Report on Results of Bureau of Mines Exploration at the North Keystone Copper Mine, Dec. 18, 1943.

690 feet. During recent operations the upper portion of one of the old shafts was utilized for ventilation from the 375-foot level of the main shaft. Four levels with more than 3,000 feet of development had been driven from this shaft. From July 1943 to January 1944, the main shaft was sunk to a depth of 1,115 feet below the collar. A crosscut on the 875-foot level was driven eastward 270 feet. Drifting to the north from this crosscut aggregated 260 feet, whereas to the south the drifts extended more than 400 feet. Two stopes were opened to the south of the crosscut by shrinkage. Mining widths in these stopes average about 17 feet. Because of the chloritization of vein material as well as of the hanging wall, many pillars left in stopes have failed. As caving from the hanging wall and the consequent dilution exceeded the amounts anticipated, cut and fill mining was being considered. Ore at the rate of 270 tons per day was hauled in 18-ton Diesel trucks to the Mountain King mill, 6-1/2 miles distant.

Milling

After being crushed, the ore is ground in ball mills in two stages and floated. Initial grinding is 100 percent through 48-mesh, whereas the secondary stage is 100 percent through 80-mesh. Concentrate averaging 26 to 28 percent copper was obtained from ore containing 1.25 to 3 percent copper, recovery being 95 percent. During 1943, additions to the mill increased its capacity to 550 tons, the estimated daily mine production. As mine production has averaged 250 to 350 tons, the mill did not operate on a 24-hour schedule. Following is the production record from June 30, 1942, to June 30, 1945:12/

Period	Ore milled, tons	Copper content, pounds	Average grade, percent copper
June 30, 1942, to July 1, 1943	40,832	2,187,913	2.68
July 1, 1943, to Dec. 31, 1943	42,380	2,377,892	2.81
Jan. 1, 1944, to June 30, 1944	51,110	2,198,716	2.15
July 1, 1944, to Dec. 31, 1944	47,454	1,637,984	1.72
Jan. 1, 1945, to June 30, 1945 1/ ..	42,000	1,602,000	1.91
Total	223,776	10,004,505	2.23

1/ Estimated.

Development and Milling Costs

Shaft-Sinking Costs

Size: Approximately 7 by 17 feet, or an area of 120 square feet.

Total footage: Includes stations and pockets figures at 120 cubic feet as 1 foot of shaft.

12/ Otto, Schiffner, (deceased), general manager, Keystone Copper.

Footage sunk: 597.3 feet (began in July 1943 and completed in January 1944).

Material penetrated: Principally spotted schist and greenstone.

Account	Total cost	Cost per foot
Labor	$46,701.89	$78.188
Compensation insurances	2,348.30	3.931
Payroll taxes	1,588.43	2.659
Supplies	17,289.73	28.946
Explosives	2,441.04	4.087
Lumber	1,722.48	2.884
Transportation, drafting, supervision, office, etc.	222.42	.373
Truck expense and safety	90.00	.151
Group insurance	271.68	.454
Power	2,383.66	3.990
Equipment rental	11.40	.019
Total	75,071.03	125.682

Costs of drifts, crosscuts, and raises for 6 months period ended Dec. 31, 1943:

	897 feet of drifts and crosscuts		1,310 feet of raises	
Account	Total cost	Cost per foot	Total cost	Cost per foot
Labor	$6,787.42	7.567	$12,820.68	9.790
Compensation insurance	343.53	.383	660.26	.504
Payroll taxes	229.02	.255	452.20	.345
Supplies	2,091.25	2.331	2,858.21	2.182
Explosives	1,735.62	1.935	1,779.02	1.358
Lumber	89.77	.100	962.82	.735
Truck and safety expense	63.32	.071	138.90	.106
Equipment rental	503.10	.561	523.11	.399
Group insurance	79.14	.088	110.61	.084
Power	378.15	.422	688.54	.526
Transportation, engineering, drafting, supervision, office, etc.	-	-	108.60	.083
Total	12,300.32	13.713	21,102.95	16.112

Total drifting and crosscutting: For 1-year period ended June 30, 1944, 2,278 feet costing $32,165.52 for an average of $14.12 per foot.

Total raising: For 1-year period ended June 30, 1944, 3,561 feet costing $60,133.47 for an average of $16.889 per foot.

Milling costs for 6 months ended Dec. 31, 1943:

Tonnage milled: 42,380 tons dry ore

Account	Total cost	Cost per ton
Labor	$34,787.41	$0.821
Compensation insurance	2,122.28	.050
Payroll taxes	1,520.26	.036
Supplies	20,760.73	.490
Transportation, engineering, drafting, supervision, office, etc.	187.32	.004
Truck and safety expense	656.21	.016
Group insurance	333.65	.008
Equipment rental	1,878.00	.044
Power	9,582.51	.226
Ore haul to mill	13,768.16	.325
Rental charges on mill	14,833.11	.350
Assay expense	1,278.64	.030
Total	101,708.28	2.40

Work Performed by Bureau of Mines

Diamond drilling by the Bureau in March 1943 and subsequent drilling undertaken in August and continuing until December 2, 1943, explored a block of ground immediately north of the mine workings for a lateral extent of 800 feet and to a depth of 700 feet. Four holes totaling 2,642.5 linear feet were drilled. The location and cross sections of holes with assays are shown on figures 8 and 9. The assays are adjusted averages from core and sludge samples. Additional data are listed in the appendix.

Hole K-1 was drilled to intersect the downward projection of an attractive gossan outcrop. K-2 to K-4 were drilled to ascertain the attitude of the ore intersection of K-1 in depth. Hole K-3 explored the area under siliceous gossan to the north.

COLLIER MINE

Introduction

In May 1943 the lessee of the Collier requested the assistance of the Bureau of Mines in developing additional ore reserves so that production might be maintained after the ore then in sight would be depleted. A drilling project was started in July 1944 and concluded in September of the same year. Four holes aggregating 1,355 feet were diamond-drilled.

History

The property was first operated in the 1860's, when there was a small production from the oxidized gold ores of the outcrops. In 1917, a pocket of gold ore was discovered in a shallow shaft. After this pocket was mined, the

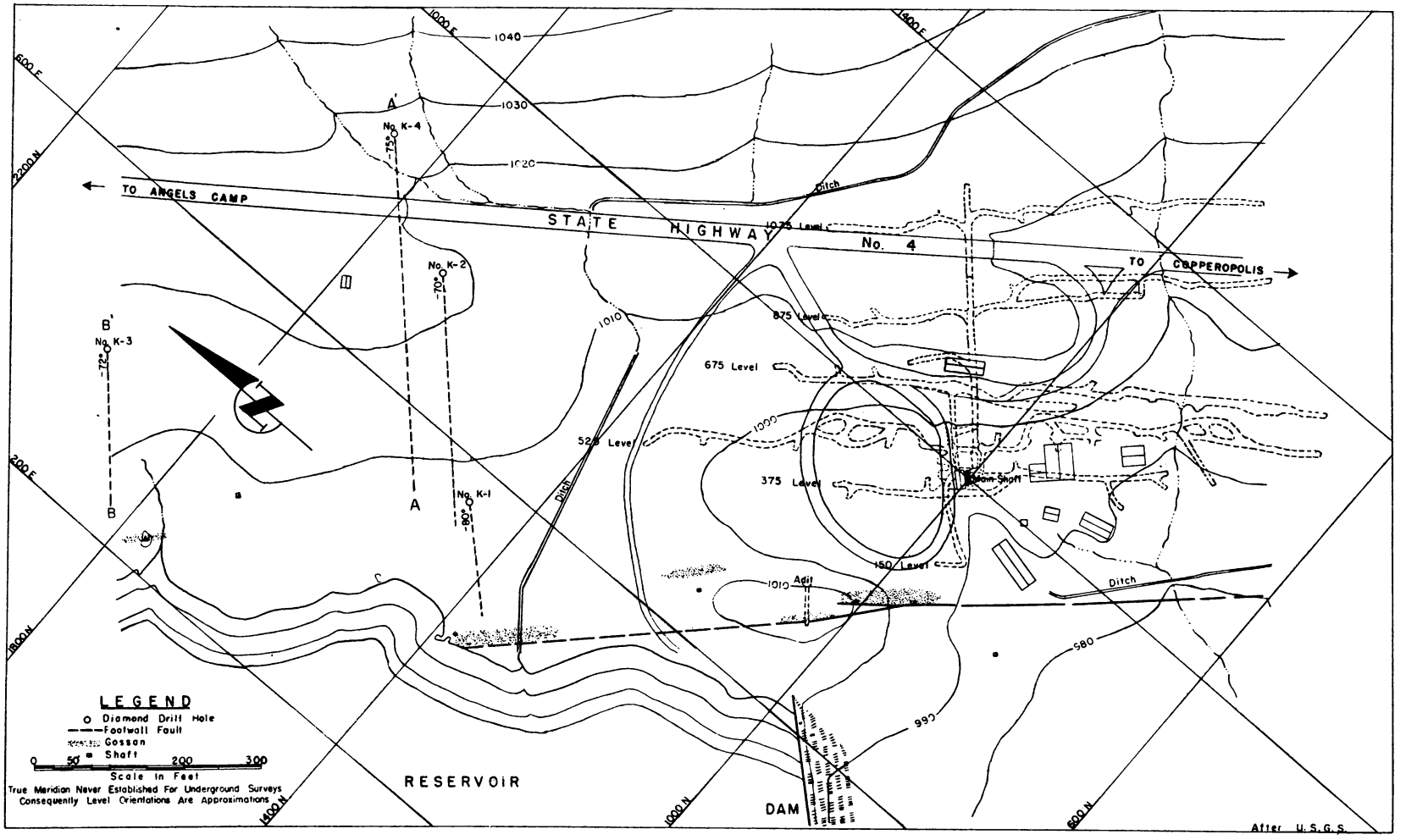


Figure 8. - Plan North Keystone mine, Copperopolis, Calaveras County.

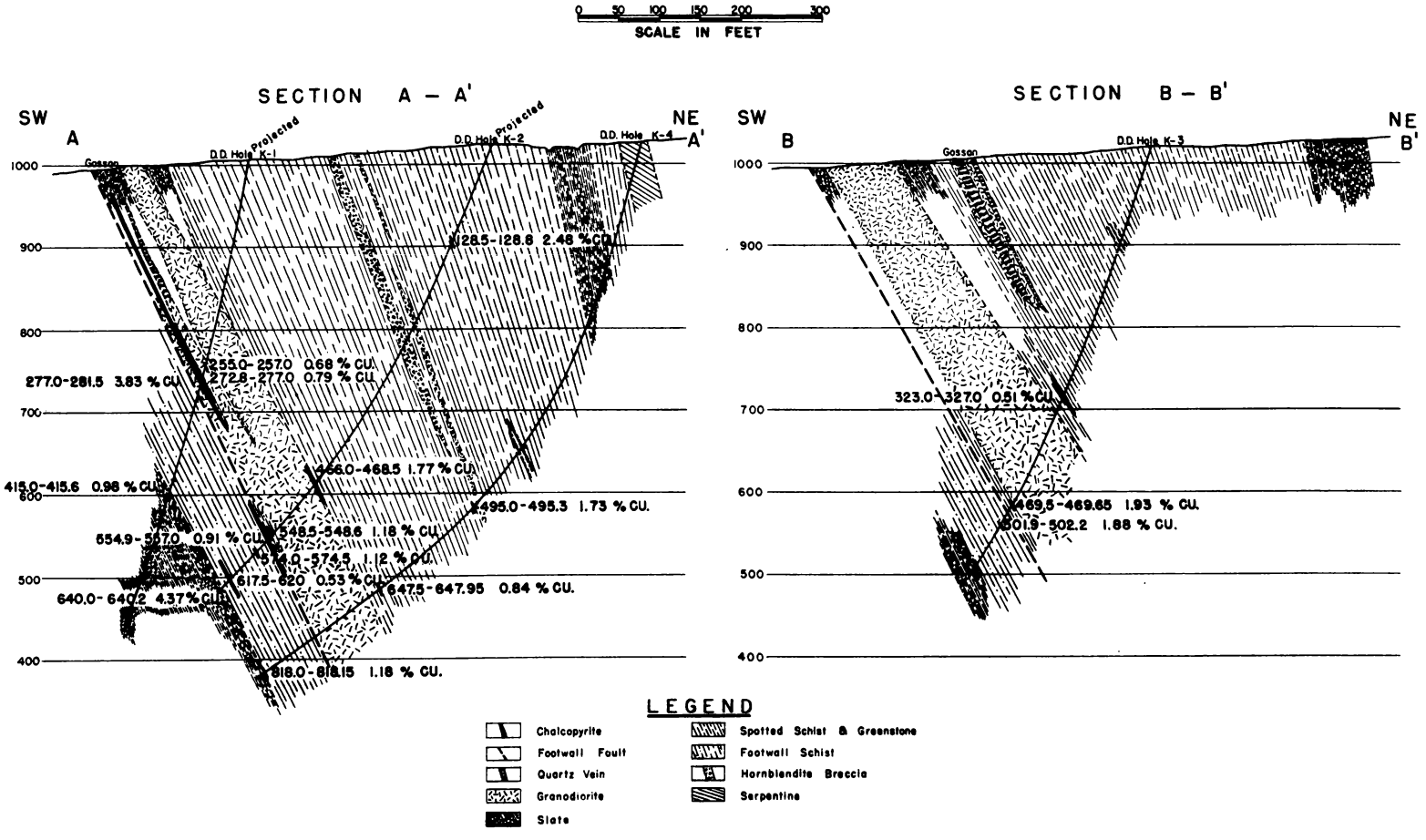


Figure 9. - Sections North Keystone mine, Copperopolis, Calaveras County.

shaft was continued to a depth of 58 feet, where two short drifts were driven along the shear zone. In 1918, two cars of complex ore was shipped from the shaft at a financial loss. In 1940, a shipment of 68 tons from the dump was reported to have assayed 0.27 ounce gold, 7.07 ounces silver, 1.7 percent copper, and 10.6 percent zinc.13/ The smelter paid only for the precious metals and the copper.

In September 1941, the owner, Mrs. Violet Likens, 2265 California Street, San Francisco, Calif., leased the property for 10 years to Jack B. Rice and Ernest A. Vogt, 407 Montgomery Street, San Francisco, Calif. They constructed a road to the mine and started production in May 1943. From that date to the cessation of operations in July 1944, 5,507 tons of ore with the following analysis was produced: 8.75 to 13.46 percent zinc, 1.17 to 1.90 percent copper, 0.26 to 0.91 percent lead, 0.070 to 0.112 ounce gold, and 2.94 to 4.92 ounces silver per ton.14/

Physical Features and Communications

The Collier mine is in the southwestern part of Calaveras County, Calif., and is easily reached by automobile over hard-surfaced highways and 3 miles of dirt road. Farmington, the nearest shipping point, is on the Southern Pacific Railroad, 17 miles distant. Copperopolis lies 11 miles to the east.

The property consists of a patented lode claim containing about 7-1/2 acres. It is at an altitude of 950 feet on the western slope of Gopher Range. Most of the land in this district is used for grazing. On the upper slopes are scrub oak and California oak of moderate size, but they are unsuitable for use as mine timbers. Water is scarce in summer, but enough water accumulated in the bottom level of the mine for diamond drilling. Climatic conditions are typical of the Mother Lode district.

Description of the Ore

The deposit, consisting of two known ore shoots about 800 feet apart, occurs in a shear zone in the typical metamorphosed volcanics of the Foothills Copper Belt. These siliceous ores are the sulfide replacement type in a shear zone that strikes northwest and dips northeast. The hanging wall is a hard, massive greenstone, and the footwall is schist.

The north ore shoot was mined in the early sixties. Surface indications of this work consist of only two depressions where shafts are caved and entirely obscured by overburden. From an old map, it appears that one vertical shaft was 112 feet deep, and the length of the ore shoot was 200 feet along the shear zone. No information on the thickness of the vein is available, but it is reported that it was mined to the 100-foot level.

The south ore shoot was mined through an inclined shaft 174 feet deep. It ranged from 2 to 7 feet in thickness, extended 180 feet along the shear zone, and pinched to an unminable width on the 167-foot level. This shoot, now mined, raked to the northwest. Ore was taken from the back of the inclined shaft and the shaft pillars, no support having been left for the shaft.

13/ E. A. Vogt, 407 Montgomery St., San Francisco.
14/ E. A. Vogt, 407 Montgomery St., San Francisco.

The ore minerals are sphalerite, pyrite, and chalcopyrite associated with barite and a siliceous gangue. Oxidation has extended 2 to 50 feet below the outcrop. Both ore shoots were mined originally for gold and silver.

Work Performed by Bureau of Mines

From July to September 1944, 1,355 feet of diamond drilling was completed. Surface plan and hole cross sections are shown on figures 10 and 11, and additional data are listed in the appendix.

Two holes, Nos. 1 and 2, explored the ground below the recent mine workings, and two holes, Nos. 3 and 4, were drilled below the old workings. Low-grade mineralized material was found in all holes.

AMERICAN EAGLE MINE

Introduction

Zinc production of California, which in 1943 totaled 3,712,000[15] pounds, has in general been of minor significance in the mineral production of the State. The quota-price basis for zinc purchase by the Metals Reserve Company placed the potential producers of this metal on a more favorable basis and justified exploration on some of the better prospects. The American Eagle property adjoins the Blue Moon property, which at the time of the Bureau's examination was being mined by Red Cloud Mines, Inc., a subsidiary of the Hecla Mining Co. of the Coeur d'Alene district of Idaho.

The Federal Bureau of Mines initiated a diamond-drilling program at the American Eagle mine based on an examination by one of its engineers[16] in June 1943. Drilling was done from January to March 1944.

History and Ownership

The American Eagle mine, first known as the Bullion Hill property, consists of three patented claims - Bonanza (5718), Blue Bell (5718), and American Eagle (5719).

Authentic information on past prospecting was not obtainable. It was reported that the American Eagle claim was located in 1893 as a gold claim and that it was patented in 1908.[17] Numerous shallow shafts and open pits, an adit level, a small glory hole, a winze, and old foundations for a mill are evidence that the property was prospected with considerable vigor and optimism.

The Blue Bell and Bonanza claims are held jointly by Edward C. Morrison of Korbel, Calif., and by Lorenzo J. Alonzo, Norbert C. Alonzo, Phillip T. Alonzo, and Andrew Valberde of Portola, Calif. The American Eagle claim is held equally by Valberde and Morrison and by Irene G. Kopp, of Santa Clara, Calif. J. H. A. Williams, of New York City, had a purchase option on the property.

15/ U. S. Bureau of Mines, Minerals Yearbook, 1943, p. 283.
16/ Butner, D. W., mining engineer, Region II, U. S. Bureau of Mines.
17/ J. H. A. Williams, New York City.

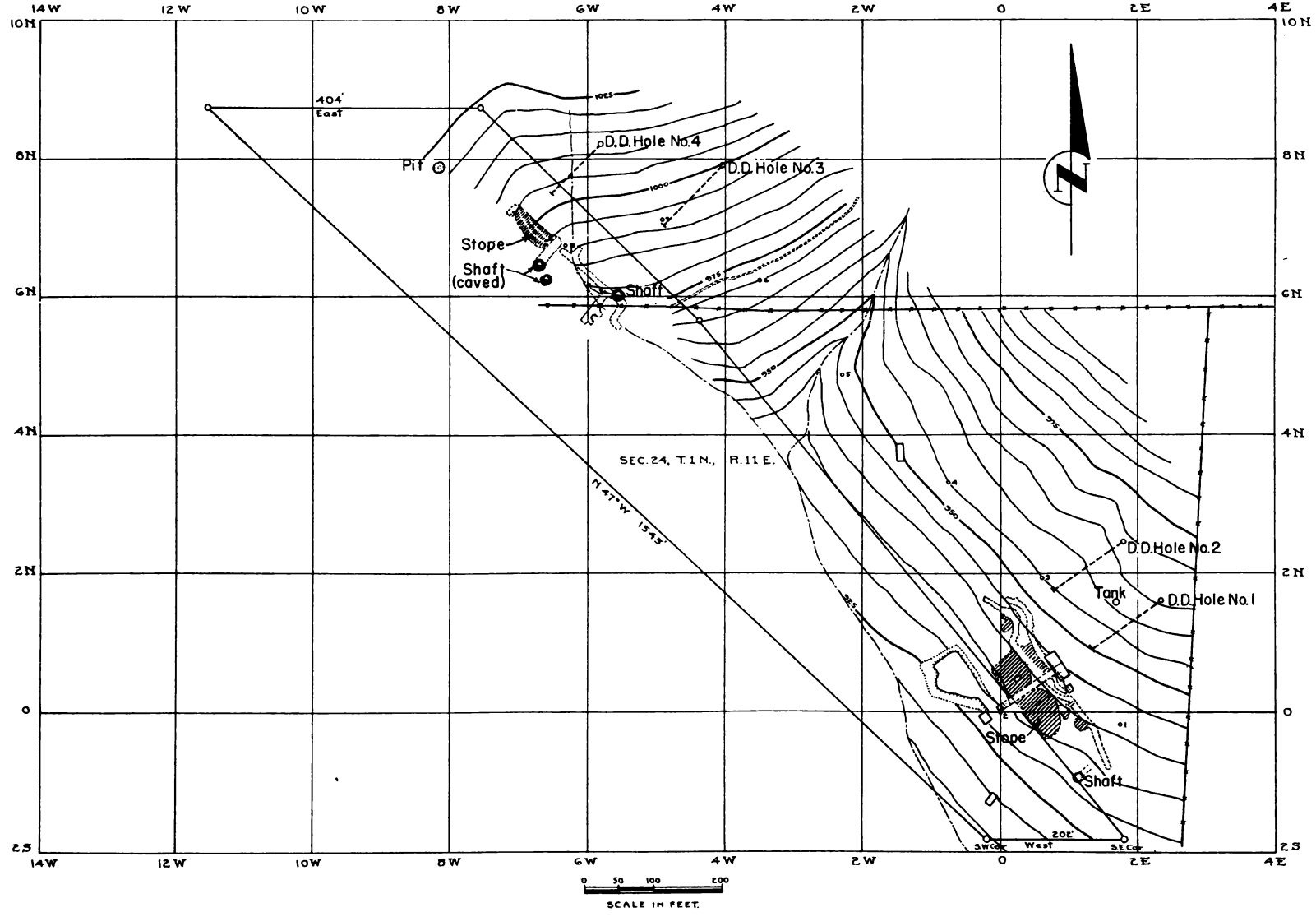


Figure 10. - Collier mine, Calaveras County.

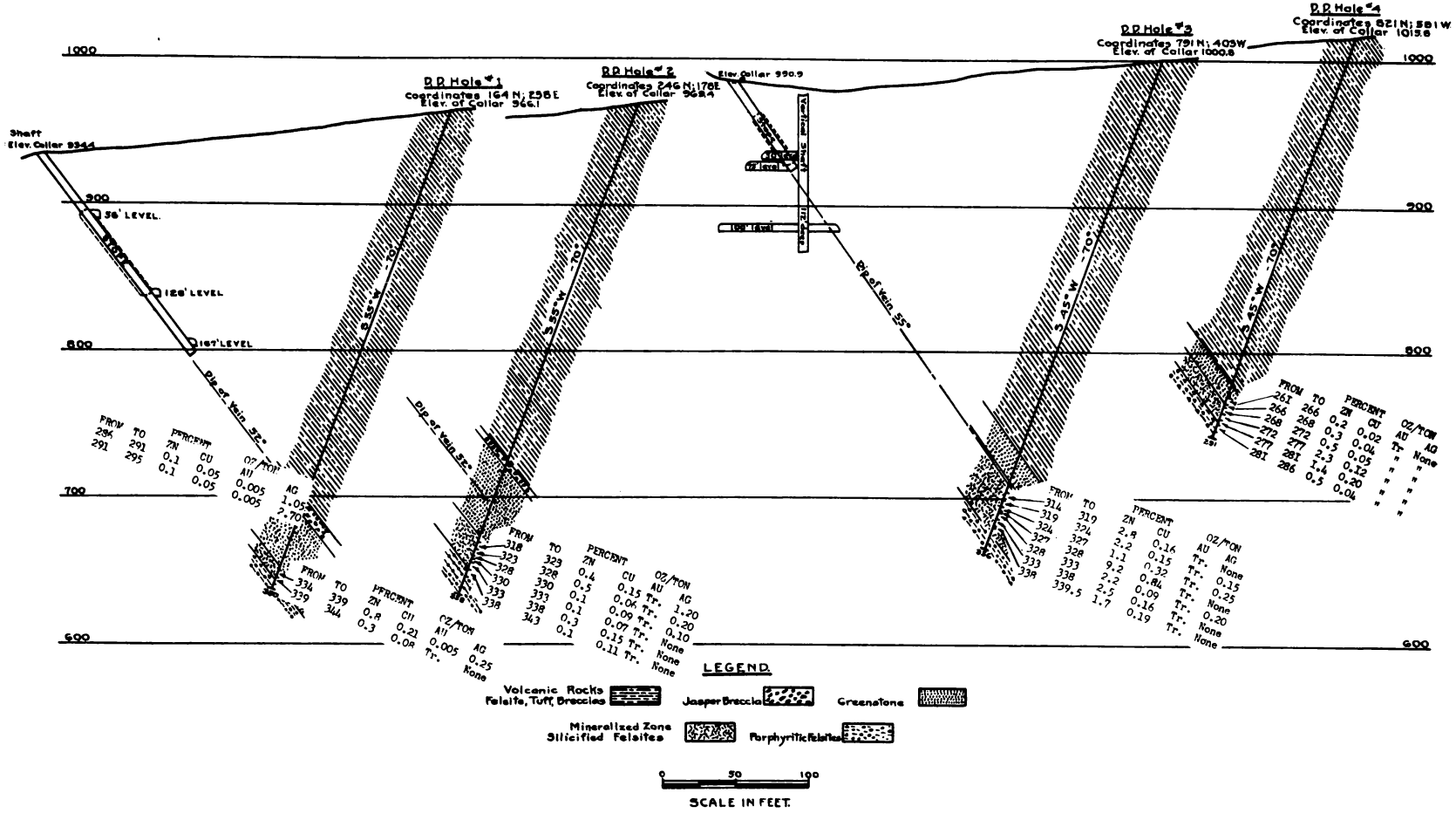


Figure 11. - Vertical sections through drill holes, Collier mine, Calaveras County.

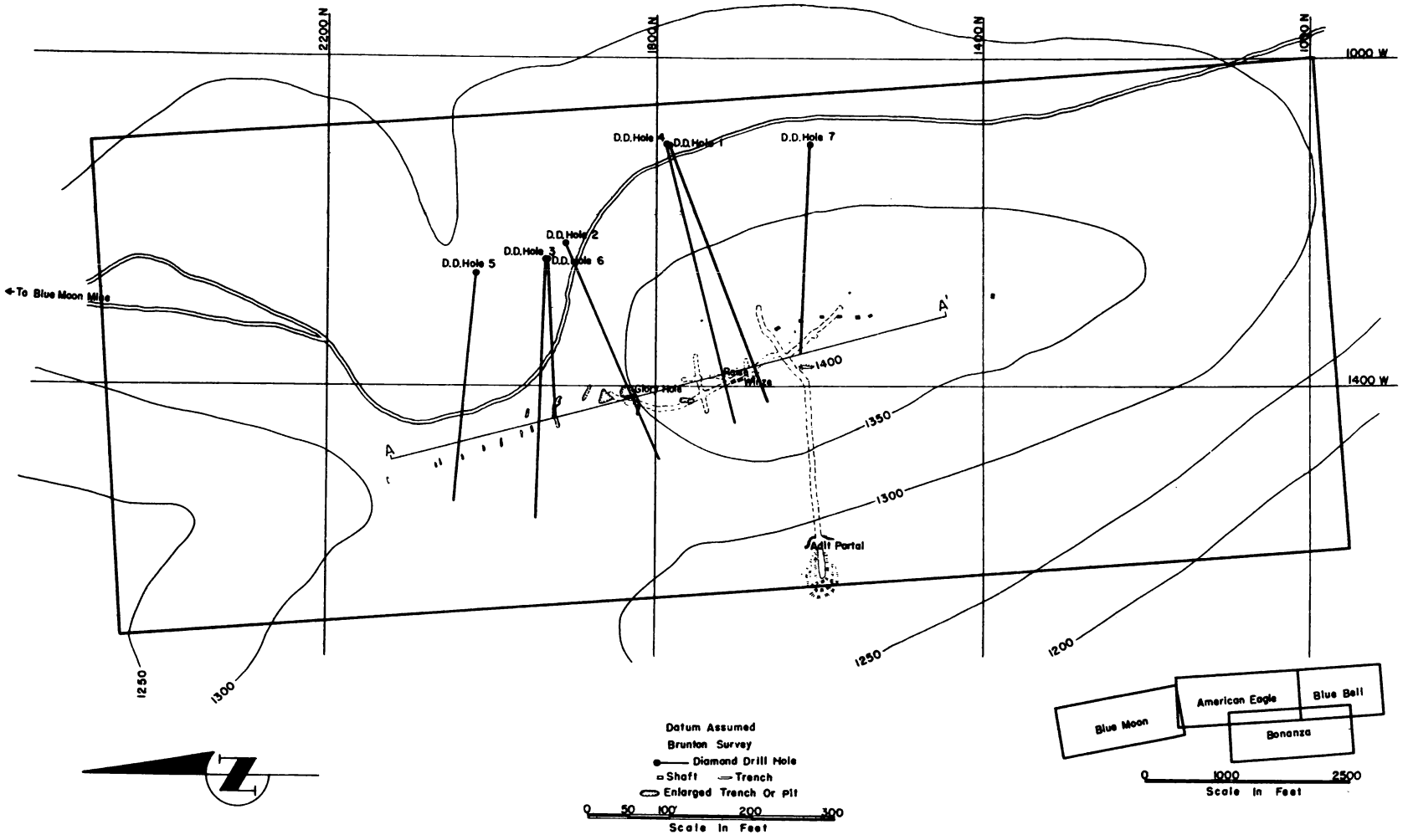


Figure 12. - Plan of American Eagle claim, Mariposa County.

Location, Physical Features, and Communications

These claims, in sec. 30, T. 4 S., R. 16 E., Mariposa County, Calif., lie on a ridge of the Sierra Nevada foothills at altitudes ranging from 1,300 to 1,500 feet. The ridge, which has a general north-south trend, is for the most part denuded and slopes sharply to the east and west for a relief of 500 feet. Climatic conditions are typical of the lower foothill belt; summers are long, dry, and hot, and winters are mild. An average of 16 inches of rain falls annually.

Vegetation consists principally of grass, but the upper parts of ridges and hills support brush, scrub oak, and pine. Drainage is westward and northward into the Merced River, which traverses the area. At a point approximately 1-1/2 miles west of the claims, the river elevation is 450 feet.

There are no buildings on the property, and it is wholly unequipped. It is accessible from Merced, Calif., via Snelling, Merced Falls, and Hornitos over 36 miles of surfaced State highway and 5 miles of road that was partly constructed and completely graveled through Federal access-road funds. The nearest rail shipping point was Merced Falls, 15 miles from the property, but is now abandoned.

Ore Deposits

There is no recorded production for this group of claims, although unconfirmed shipments of ore are supposed to have been made from the American Eagle. The only possible evidence in support of this is a small stope and glory hole from which a few tons of ore could have been mined.

Surface workings are made up of shallow shafts, test pits, open cuts, and trenches scattered throughout the claims. As shown in figure 12, underground development on the American Eagle consists of an adit crosscut extending eastward from its portal for a distance of 300 feet, and from this drifts to the north and south 230 and 190 feet long, respectively. In addition, from the drift to the north are several short crosscuts and drifts off from them, a 40-foot winze, a small stope, and two raises that hole through to the surface. There is no evidence that lateral underground prospecting was done on either the Blue Bell or the Bonanza claim.

In Mariposa County the foothill belt is characterized by a wide band of schist that extends along the western boundary for a strike distance of 40 miles. About midway in the belt lies the Blue Moon mine, which during the war produced more than 13,000,000 pounds[18/] of zinc and was the largest single zinc producer in the State.

The American Eagle claim adjoins the Blue Moon on the south, and their mineralization is similar. The prospect openings on the American Eagle group of claims are in a belt of steeply dipping sericite schist that traverses the property in a north-south direction.

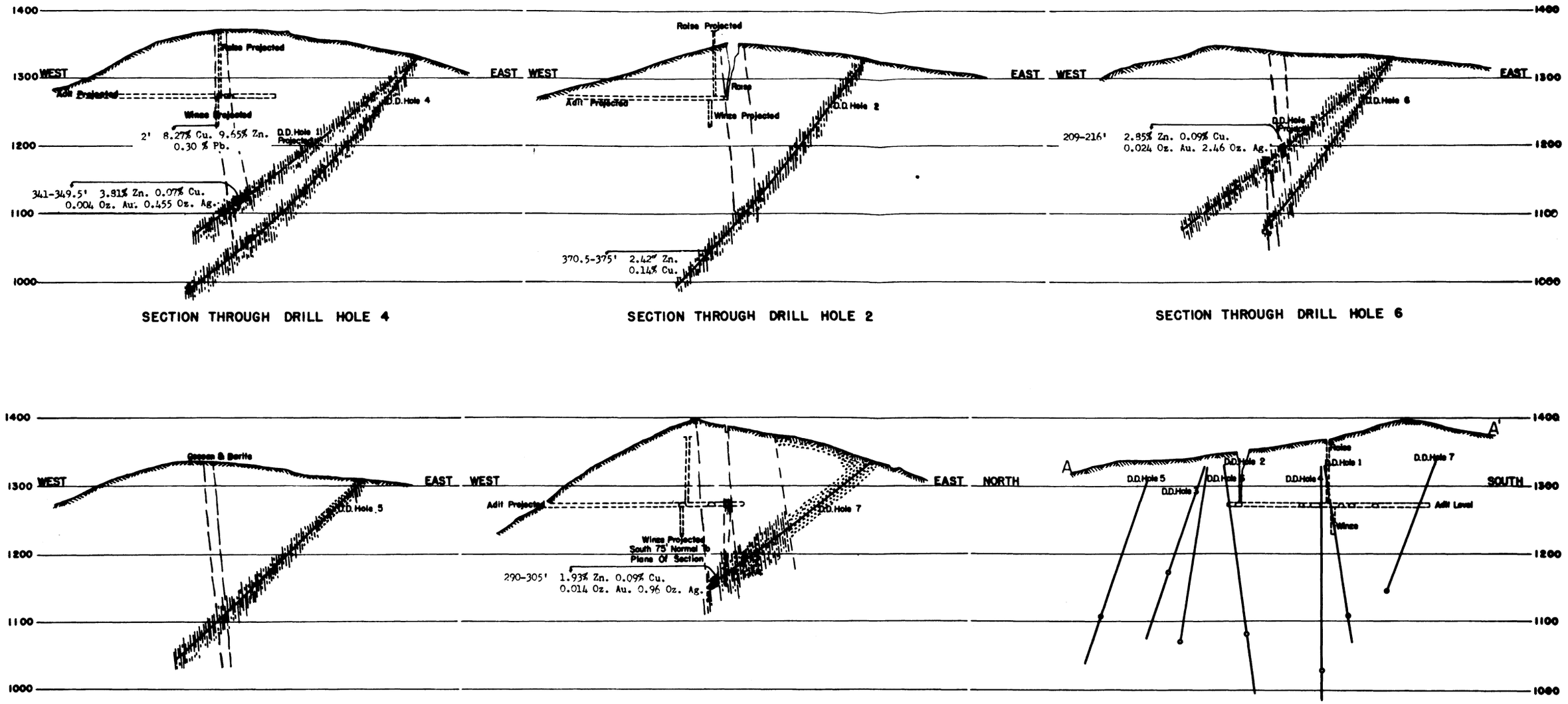
18/ U. S. Bureau of Mines, Minerals Yearbook, 1944 - p. 275, and 1945 - p. 282.

The schistosity in general strikes slightly east of north and dips eastward from 75 degrees to vertical, whereas the included shear zones strike north or slightly west of north. Within the schist belt, and most noticeable to the west of the prominent shears, are zones of silicification of varying dimensions and intensity. Numerous short, narrow streaks of gossan are in evidence in many places, as are zones in which barite is noticeable. Veins and short stringers of white quartz also show in the schist, frequently cutting the schistosity. Oxidation of the minerals apparently extends downward for a considerable distance, as the walls of the adit-level workings show evidence that the soluble sulfates have reacted strongly upon the rocks. Underground in the main zone of alteration, malachite and azurite stains color the formation in places, and at the bottom of the winze a band of friable sulfide ore exists. This band, consisting of sericite schist, pyrite, chalcopyrite, sphalerite, covellite, barite, and quartz, is about 4 feet wide on the northeast wall, where it appears to have converged. Mineralization on the southwest wall indicates a splitting of the vein into several stringers, and a sample taken across one stringer 2 feet wide assayed as follows: Copper, 8.27 percent; zinc, 9.65 percent; lead, 0.30 percent.

Work Performed by Bureau of Mines

Following preliminary investigations of the property, diamond drilling was recommended. Contract drilling operations were carried on from January 3, 1944, to March 31, 1944, and seven holes aggregating 2,804 feet were bored. As shown in figure 13, all holes were drilled on the American Eagle claim, and their penetrations crossed various horizons of the shear zone below the ore exposures in the adit level. With the exception of hole AE-7, drilling was for the most part in schist that had undergone varying degrees of sericitization. Over-all core recovery averaged 65.76 percent.

Mineralization was encountered in holes 1, 2, 3, and 7. The combined assay results from core and sludge are shown in figure 13, and additional data are listed in the appendix.



SECTION THROUGH DRILL HOLE 4

SECTION THROUGH DRILL HOLE 2

SECTION THROUGH DRILL HOLE 6

SECTION THROUGH DRILL HOLE 5

SECTION THROUGH DRILL HOLE 7

LONGITUDINAL SECTION A—A'

Figure 13. - Vertical sections, American Eagle claim, Mariposa County.

Record of diamond drill-hole values

Newton mine

Hole: N-2
Location: 429 N., 865 E.
Elevation of collar: 31 ft. above collar of main shaft.

Depth: 800 feet.
Dip: -76°
Bearing: S. 67° 45' W.

Core size: NX, 0-15 ft.; BX, 15-40 ft.; AX, 40-800 ft.

Footage			Percent core rec.	Size of core	Analyses							
					Core				Sludge			
From:	To:	Feet			Percent Cu	Percent Zn	Oz. Au	Oz. Ag	Percent Cu	Percent Zn	Oz. Au	Oz. Ag
568.9	569.5	0.6		AX	4.85	1/0.1	Trace	0.30				
569.5	571	.5		AX	1.30	.1	"	.20	3.08	0.4	Trace	0.40
571	571.3	.3		AX	.50	.6	"	.20	.10	.6	"	.10
571.3	573	1.7		AX	.05	.3	"	.20				
573	575.3	2.3		AX	.07	1.0	"	None	.15	.3	"	None
575.3	578	2.7		AX	.11	.3	"	"				
578	579	1.0		AX	.23	.3	"	0.10				
579	580.4	1.4		AX	.37	.6	"	None				
580.4	581.3	.9		AX	.21	.5	"	0.10	.23	.4	"	0.10
581.3	583	1.7		AX	.10	1/.1	"	None				

1/ Less than.

Newton mine

Hole: N-3
Location: 653 N.; 942 E.
Elevation of collar: 12 ft. above collar of main shaft.

Depth: 800 feet.
Dip: -73°
Bearing: S. 67° 45' W.

Core size: NX, 0-8 ft.; BX, 8-20 ft.; AX, 20-800 ft.

From:	To:	Feet	Percent core rec.	Size of core	Analyses							
					Core				Sludge			
					Percent Cu	Percent Zn	Oz. Au	Oz. Ag	Percent Cu	Percent Zn	Oz. Au	Oz. Ag
753	755	2.0		AX					0.65		Trace	0.30
753	756.5	3.5		AX	4.50	0.51	0.01	Trace				
756.5	757.7	1.2		AX	.52	.10	Trace	None				
757.7	761.5	3.8		AX	.91	.05	"	"				
761.5	765	3.5		AX	.61	None	None	Trace				
755	765	10.0		AX					.95		Trace	None
765	766.2	1.2		AX	1.23	.16	None	0.90				
765	770	5.0						.60			"	Trace

Hole: N-5
Location: 796 N.; 1148 E.
Elevation of collar: 28.7 ft. above collar of main shaft

Depth: 1,076 feet
Dip: -73°
Bearing: S. 57° 30' W.

Core size: NX, 0-6 ft.; BX, 6-20 ft.; AX, 20-1,076 ft.

146	156	10		AX			Trace	None				
156	158	2		AX			"	"				
1036.5	1037	0.5		AX	9.04		"	"	5.58	0.6	Trace	0.70
1037	1038	1		AX					2.93	.6	"	.50
1038	1040	2		AX	.02	1/0.1	"	0.30	1.00	.4	"	.30

1/ Less than.

APPENDIX

Newton Mine

Hole N-1

Location: 517 N., 1242 E.
Elevation of collar: 40 ft. above collar of main shaft.
Depth: 882 ft.

Bearing: S. 67° 30' W.
Dip: -45°
Core size, feet:
NX: 0-6
BX: 6-20
AX: 20-882

Footage From	Footage To	Percent core recovery	Description
0	20	31	Amphibolite schist.
20	35	23	Weathered green chlorite schist, lens and veinlet quartz.
35	41	50	Green chlorite schist, with semitransparent quartz, approximately base of weathering.
41	44	78	Green chlorite schist, quartz veinlets containing epidote.
44	54	8	Green chlorite schist, numerous quartz veins.
54	64	31	Green chlorite schist, large amounts of introduced epidote and quartz in first foot, occasional specks pyrite, chalcopyrite and carbonate.
64	67	90	Sericitic pale-green schist, greasy luster, 11 small veins calcite.
67	68	20	Quartz and fine-grained epidote in green schist.
68	72	85	Epidotized green schist, veins quartz and lesser calcite, some pyrite.
72	81	66	Epidotized green schist, white talc on certain planes, some calcite in quartz veins, small disseminated aggregates of pyrite, few specks of chalcopyrite (?).
81	91	45	Green chlorite schist, narrow bands of silicification, a 1-inch white quartz vein containing some calcite, some fine pyrite near vein.
91	101	31	Green chlorite schist, epidotized quartz veins, 1 grain of chalcopyrite.
101	111	45	Pale-green schist, central portion containing sericite and minor pyrite.
111	144	52	Green chlorite schist with epidotized zones, some of which contain abundant fine pyrite, some veinlets of white quartz, which generally contain a minor amount of calcite.

Hole N-1 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
144	165	60	Schist at 150 ft. has been crushed, brecciated, and recemented with quartz and calcite; otherwise same as above.
165	172	48	Green chlorite schist, epidotized zones, some quartz veinlets, minor pyrite.
172	192	41	Pale-green chlorite schist, bands sericite schist, some of which are silicified, epidotized, and sparsely pyritized.
192	222	69	Dark-green chlorite schist, some zones epidote and quartz with fine pyrite near white quartz veins.
222	242	41	Pale-green chlorite schist, silicified and containing pyritic disseminations, talc in thin layers along local planes of movement.
242	252	72	Green chlorite schist, little quartz veinlets, some pyrite.
252	291	51	Epidotized chlorite schist, numerous thin silicified bands showing some calcite and pyrite, some talc on certain slippage surfaces, a thin veinlet of quartz and fibrous greenish-white tremolite noticed at one place.
291	311	47	Green chlorite schist alternating with dark argillaceous bands, many of which contain hematite-epidote and silica introduced-some pyrite.
311	321	48	Green schist of uralite, chlorite, and some introduced epidote.
321	341	71	Pale-green amphibolite schist largely of fibrous uralite and green chlorite, veinlets of quartz, calcite, and white tremolite, zones of epidote, small lenses of pyrite.
341	351	72	Green chlorite schist, much calcite, little quartz and pyrite.
351	371	97	Pale-green amphibolite schist, spotted appearance, quartz, calcite, and green epidote carrying pyrite.
371	431	77	Pale-green amphibolite schist, lenticular masses of dark-green chlorite, occasional crystals of pyrite and lenticular veinlets of white quartz; epidote is present, especially where large amounts of quartz were introduced.
431	441	80	Epidotized green schist with large amounts of introduced silica.
441	451	53	Uralite schist, several 3-inch and 6-inch zones of chlorite schist.

Hole N-1 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
451	461	59	Pale-green uralite schist; dark-green chlorite is present in small lenticular masses, also epidote; some argillaceous material is present in the green schist; pyrite in very minor amounts.
461	671	59	Uralite schist containing varying amounts of epidote, some in disseminations, lenses and veinlets, numerous small veinlets of quartz and lesser calcite, some dark-green chlorite also is present in certain zones; some pyritic disseminations.
671	691	57	Uralite schist, chlorite, veinlets of calcite and quartz, disseminations of pyrite throughout.
691	704	42	Uralite schist rich in epidote, some chlorite, veinlets of white quartz and associated calcite, several silicified zones.
704	755	86	Uralite schist rich in epidote, numerous small lenses or red hematite, quartz, and calcite veinlets, some chlorite; hematite occurs only from 704 to 733 feet.
755	770	81	Spotted uralite chlorite schist might be porphyritic, minor amount of epidote, small veinlets of quartz and calcite.
770	808	87	Uralite chlorite schist with considerable epidote, porphyritic in appearance between 768 and 778 feet.
808	828	98	Epidotized amphybolite schist, thin layers dark-green chlorite schist, much introduced quartz, also some veinlets of quartz and calcite.
828	838	100	Chlorite schist, some epidotized, quartz and calcite veinlets, some hematite.
838	858	98	Epidotized chlorite schist with paler green intercalations of amphibolite schist, quartz, epidote, 6-inch crushed zone shows tremolite and quartz.
858	860	100	Uralite chlorite schist, vesicules of quartz, some epidote.
860	882	96	Intensely epidotized and silicified schist containing zones of chlorite and chlorite amphibolite schist, vesicules of epidote and quartz, pyrite is present only very sparsely as minute, small masses of white quartz and calcite occur at irregular intervals. This is the hanging wall of the Newton copper vein.

Hole N-2

Location: 429 N. 865 E.
Elevation of collar: 31 ft. above collar of main shaft.
Depth: 800 ft.

Bearing: S. 67° 45' W.
Dip: -73°
Core size, feet:
NX: 0-15
BX: 15-40
AX: 40-800

Footage From	Footage To	Percent core recovery	Description
0	36	40	Surface altered schist.
36	81	73	Pale-green amphibolite schist, few quartz veinlets.
81	82	97	Rose quartz.
82	101	71	Amphibolite schist, some disseminated epidote, some chloritization or schistosity planes.
101	203	49	Dark-green amphibolite chloritized schist, a few quartz veinlets, fine bands of pyrite 108 to 111 feet.
203	236	48	Pale-green chloritic schist with some epidote veinlets and disseminations of epidote.
236	256	52	Green chloritic schist, considerable banding of epidote and hematite.
256	286.5	61	Pale-green chloritic schist with much disseminations and veinlets of epidote.
286.5	346	86	Pale-green amphibolite schist, a few quartz veinlets, much epidote disseminations, some tremolite on certain planes of schistosity.
346	362	38	Pale-green amphibolite, some very massive, much epidote disseminations, minor amounts pyrite.
362	370	52	Dark-green amphibolite schist, many quartz veinlets, cube pyrite noticed.
370	383	68	Dark-green amphibolite cut by many quartz veinlets, much disseminated, and veinlets of epidote, part of zone chloritized, one foot of quartz at 374 feet.
383	424	70	Dark-green chloritized schist cut by quartz veinlets, numerous cubes of pyrite at certain intervals between 406 to 424 feet.
424	425	83	Lavender-colored schist, probably colored by iron.
425	439.7	88	Dark-green amphibolite schist cut by veinlets of quartz, disseminations and veinlets of epidote, some pyrite at 436 feet, some areas somewhat chloritized.
439.7	566	92	Amphibolite schist cut by epidote and quartz veinlets.

Hole N-2 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
566	571	70	Highly silicified and epidotized schist, brecciated and containing dark-gray gougelike material containing stringers of pyrite and chalcopyrite; these sulfides are distributed through this crushed zone as small irregular masses and veinlets.
571	583	97	Medium-gray, highly silicified schist containing abundant pyritic disseminations and veinlets, probably an intensely silicified and pyritized chlorite schist, mundick (?) of local miners.
583	602.5	100	Highly silicified and epidotized schist, occasional thin intervals of medium to dark-green chlorite schist.
602.5	712	98	Amphibolite schist, quartz veinlets, much epidote disseminations and veinlets, some banding of hematite, a few specks of pyrite.
712	714	100	Amphibolite schist, considerable quartz, few cubes of pyrite, and slightly chloritized.
714	722	100	Pale-green chloritized schist, a few quartz veinlets.
722	732	71	Amphibolite schist, two small quartz veinlets, a few specks of pyrite.
732	756	93	Pale-green chlorite schist, a few quartz veinlets.
756	794	100	Pale-green amphibolite schist with very few quartz veinlets, some chloritization on some planes of schistosity.
794	800	100	Pale-green highly silicified amphibolite schist with few quartz veinlets.

Hole N-3

Location: 653 N., 942 E.
Elevation of collar: 12 ft. above collar of main shaft
Depth: 800 ft.

Bearing: S. 67° 45' W.
Dip: -73°
Core size, feet:
NX: 0-8
BX: 8-20
AX: 20-800

Footage From	Footage To	Percent core recovery	Description
0	20	56	Partly altered green amphibolite schist considerably banded with hematite.
20	40	93	Green amphibolite schist considerably banded with seams of hematite, 3 feet of quartz at 28.5 feet.

Hole N-3 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
40	54	94	Pale-green silicified amphibolite schist, much epidote disseminated throughout, few small veinlets of white quartz.
54	92	71	Dark grayish-green amphibolite schist highly banded with hematite, few tiny veinlets of epidote and white quartz, somewhat chloritized from 68 to 84 feet.
92	140	83	Green amphibolite schist, considerable epidote disseminated and in veinlets, few small veinlets of white quartz, this interval banded occasionally by hematite and tiny calcite veinlets.
140	160	88	Pale-green amphibolite schist, 2-inch quartz veinlet at 150 feet, few tiny epidote and calcite veinlets.
160	175	87	Green amphibolite schist, numerous veinlets of quartz, few tiny veinlets of calcite, scattered cubes of pyrite, this interval slightly chloritized, a seam of pyrite at 174 feet.
175	215.5	98	Pale grayish-green amphibolite schist (uralite), few stringers of quartz and calcite, considerable pyritization, some chloritization on planes of schistosity.
215.5	255	99	Grayish amphibolite schist (uralite), few small quartz and calcite veinlets, some chloritization on planes of schistosity.
255	275	98	Light, pale-green amphibolite schist, several 3 inch veinlets of quartz, some calcite and epidote disseminations.
275	289	69	Green amphibolite schist, disseminations and veinlets of epidote, few specks of pyrite, some chloritization on planes of schistosity.
289	299	100	Greenish-gray amphibolite schist (uralite), slightly chloritized, veinlets of quartz and epidote.
299	344	98	Greenish-gray amphibolite schist (uralite), silicified, much epidote disseminations and veinlets at 317 feet, few very small quartz veinlets, some scattered pyrite.
344	369	78	Green chloritic schist, much epidote in small veinlets.
369	380	97	Light-green chlorite schist, many veinlets and disseminations of epidote.
380	409	85	Light-green schist considerably chloritized, few fine veinlets of quartz and calcite, some epidote.

Hole N-3 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
409	423	42	Greenish-gray chlorite schist, few veinlets of quartz and calcite.
423	436	90	Green amphibolite schist somewhat chloritized, quartz breccia (epidote and green schist cemented by white quartz) between 432 and 435 feet.
436	446	60	Green chloritic amphibolite schist with few white quartz veinlets, scattering of pyrite, disseminations and veinlets of epidote.
446	470	92	Light-green chloritized amphibolite schist, few quartz and epidote veinlets, epidote disseminations.
470	479	85	Green amphibolite schist finely banded by hematite and epidote, few white quartz bands, chloritized on schistosity planes.
479	483	95	Green amphibolite schist slightly chloritized.
483	519	94	Light-green silicified amphibolite schist, much epidote disseminations and veinlets, few quartz and calcite veinlets.
519	545	76	Green amphibolite schist, much epidote as veinlets, masses and disseminations, very few quartz veinlets.
545	570	92	Light, pale-green amphibolite schist, many epidote veinlets, few quartz veinlets, silicified.
570	580	98	Light greenish-gray chlorite schist showing scaly pyrite, much of this interval broken and cemented by quartz.
580	602	66	Green chlorite schist, many epidote veinlets.
602	636	32	Dark-green amphibolite schist, some epidote.
636	666	67	Green amphibolite schist, some disseminations and many veinlets of epidote, few tiny quartz veinlets (chloritized).
666	686	97	Grayish-green amphibolite schist (uralite), massive, with few tiny veinlets of white quartz slightly chloritized.
686	709	92	Grayish-green amphibolite schist, much epidote disseminations and veinlets, considerably silicified from 689 to 709 feet.
709	732	97	Light-green amphibolite schist, much epidote disseminations and veinlets, many tiny fractures filled with hematite giving speckled lavender appearance, somewhat silicified.
732	753	99	Green silicified amphibolite schist, much epidote disseminations and in masses, few quartz veinlets from 730 to 742 feet, scattered areas have tiny hematite filled fractures.

Hole N-3 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
753	765	98	Massive sulfide vein carrying pyrite and chalcopyrite.
765	770	92	Highly pyritized gray-green amphibolite schist considerably banded by seams of fine pyrite, may be so called mundick of local miners.
770	800	98	Light-green silicified amphibolite schist, much epidote disseminations, in masses and veinlets, few white quartz veinlets.

Hole N-4

Location: 892 N., 530 E.
Elevation of collar: 34 ft. above collar of main shaft
Depth: 700 ft.

Bearing: S. 60° W.
Dip: -60°
Core size, feet:
NX: 0-15
BX: 15-30
AX: 30-700

Footage From	Footage To	Percent core recovery	Description
0	30	38	Surface altered amphibolite schist, iron-stained on fractures and small rusty quartz veinlets.
30	94	27	Green amphibolite schist cut by occasional quartz and calcite, little epidote veinlets, slightly chloritized on planes of schistosity.
94	160	50	Pale-green amphibolite schist considerably chloritized, few white quartz and calcite veinlets, much massive, veinlets and disseminations of epidote, fractures filled with dark-green chlorite.
160	171	65	Green amphibolite schist, few quartz veinlets, considerable epidote in veinlets, generally quite massive.
171	210	58	Light-green amphibolite schist cut by a few tiny calcite veinlets, very little quartz, much epidote in thin veinlets and disseminations, slightly chloritized.
210	230	75	Greenish-gray schist (uralite?), considerable banding due to epidote in seams, fractures filled with dark-green chlorite, small amount of scaly pyrite.
230	245.5	57	Green amphibolite schist somewhat silicified, fractures filled with dark-green chlorite.

Hole N-4 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
245.5	247	70	White quartz with little calcite, intercalations of green amphibolite, minor pyrite in disseminations and in masses.
247	289	62	Green amphibolite schist, much dark-green chlorite, tiny epidote veinlets, somewhat chloritized, very few tiny veinlets of quartz and calcite.
289	295	100	Light-green amphibolite schist, numerous tiny epidote veinlets, some dark-green chlorite as fillings.
295	302	86	Light-green amphibolite schist cut by tiny calcite and quartz veinlets, scattered pyrite, fractures filled with dark-green chloride.
302	320	45	Brownish-green amphibolite, few milky calcite veinlets, scattered cubes, and very minute seams of pyrite.
320	347	55	Green amphibolite schist (uralite?), few quartz and calcite veinlets, disseminations and veinlets of epidote, few specks of fine pyrite, somewhat silicified, generally massive.
347	355	95	Green silicified amphibolite schist, veinlets and disseminations of epidote, scattered fine pyrite.
355	357	74	Brownish-red schist with green (chlorite?) planes.
357	370	91	Light-green amphibolite schist, scattered veinlets of quartz and calcite, much epidote veinlets and disseminations.
370	405	80	Light-green amphibolite schist highly banded by zones of lavender-colored schist, considerable epidote in veinlets and disseminations, all more or less chloritized on planes of schistosity, few calcite veinlets.
405	462	69	Light-green amphibolite schist, much epidote disseminations, few quartz veinlets, few intervals have lavender banding (hematite?), leached appearance.
462	490	48	Light-green amphibolite schist, much epidote disseminations, leached appearance, somewhat chloritized.
490	502	83	Green amphibolite schist, considerable disseminations of epidote, two 1-inch white quartz and calcite, quite massive.
502	510	41	Light gray-green, talcy, soft schist, highly chloritized yet compact.

Hole N-4 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
510	569	19	Green amphibolite schist, shattered, epidote veinlets, little quartz, few specks pyrite between 568 to 569 feet.
569	609	62	Light gray-green, silicified, amphibolite schist, some epidote in masses and tiny veinlets.
609	627	71	Gray-green massive amphibolite schist (uralite?).
627	641	41	Gray-green amphibolite schist, scattering of shaly pyrite, fractures filled with dark-green chlorite.
641	643	34	Blue-black argillite with scaly pyrite.
643	665	56	Light gray-green amphibolite schist, 4-inch white quartz at 648 feet, somewhat chloritized, parts leached.
665	678	80	Gray-green amphibolite schist.
678	679	95	Highly friable, talcy, light-gray schist having a leached appearance.
679	689	80	Green amphibolite schist, scattered scaly pyrite.
689	700	88	2-inch argillite at 692, balance light-green amphibolite schist, slightly chloritized on planes of schistosity.

Hole N-5

Location: 796 N., 1148 E.
Elevation of collar: 28.7 ft. above collar of main shaft.
Depth: 1,076 ft.

Bearing: S. 57° 30' W.
Dip: -73°
Core size, feet:
NX: 0-6
BX: 6-20
AX: 20-1076

Footage From	Footage To	Percent core recovery	Description
0	20	29	Surface altered amphibolite schist with considerable iron-stained veinlets of quartz.
20	71	49	Pale-green amphibolite schist, few quartz veinlets, some intervals silicified and others somewhat chloritized on planes of schistosity.
71	101	60	Green amphibolite schist with occasional quartz veinlets, epidote in scattered veinlets, minor amounts of pyrite scattered near the quartz veinlets.

Hole N-5 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
101	115	94	Pale-green amphibolite schist, few quartz stringers, disseminations of epidote throughout, somewhat chloritized.
115	146	79	Pale-green amphibolite schist, few quartz veinlets, disseminations of epidote throughout, scattering of pyrite, all somewhat chloritized.
146	147	56	Green chlorite schist, considerably pyritized.
147	166	58	Green chlorite schist, some intervals heavily pyritized, some disseminations and veinlets of epidote.
166	180.5	41	Green chlorite schist, some pyrite at 172 feet, few seams of epidote, some seams of hematite.
180.5	183	80	Quartz breccia.
183	221	79	Green chlorite schist, much epidote disseminations and some epidote veinlets, tiny hematite seams.
221	231	96	Pale-green amphibolite schist, much quartz, epidote in veinlets and masses, interval silicified.
231	244	97	Green amphibolite schist, considerable epidote disseminations and veinlets, much lavender banding due to hematite.
244	259	81	Green amphibolite schist, considerably chloritized little epidote and quartz in small veinlets.
259	289	96	Pale-green amphibolite schist, some chloritization on planes of schistosity, few small white quartz veinlets.
289	300	99	Pale-green amphibolite schist, much epidote disseminations, considerable chloritization.
300	305	95	Dark-green chloritic schist, veinlets of epidote.
305	344	65	Dark-green amphibolite schist considerably chloritized, few veinlets of quartz and epidote, some scattering of pyrite.
344	404	80	Pale-green, silicified, amphibolite schist, some epidote disseminations, few veinlets of quartz and epidote.
404	412	100	Green amphibolite schist, much epidote disseminations, some quartz veinlets and masses associated with epidote.
412	440	70	Green amphibolite schist, considerably chloritized, interval highly banded with tiny hematite seams, few intervals show epidote veinlets.

Hole N-5 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
440	463	77	Pale-green amphibolite schist considerably chloritized, epidote disseminations and veinlets, hematite banding between 457 and 459 feet.
463	502	100	Pale-green amphibolite schist all somewhat chloritized, some epidote in veinlets and disseminations.
502	539	80	Light pale-green amphibolite schist highly chloritized, much epidote disseminations, tiny cross veinlets of calcite and few small quartz veinlets.
539	551	70	Pale-green amphibolite schist, somewhat chloritized, some epidote disseminations and veinlets, a few tiny veinlets of calcite and quartz.
551	589	100	Massive, pale-green, amphibolite schist only slightly chloritized, a few tiny veinlets of quartz and calcite, little tremolite at 577.5 feet, this interval has spotted or porphyritic texture.
589	643.5	72	Green to pale-green amphibolite schist all considerably chloritized, few stringers of quartz, scattering of epidote veinlets and disseminations, numerous tiny calcite veinlets, pyrite scattered between 620 and 622 feet.
643.5	680	53	Green amphibolite schist considerably chloritized, 6-inch white quartz at 652 feet and 5-inch at 653 feet, fractured, occasional specks of pyrite.
680	687	91	Partly silicified, green, amphibolite schist, veinlets and disseminations of epidote, few quartz veinlets, some banding due to tiny seams of hematite.
687	701.5	98	Green silicified amphibolite schist, much epidote disseminations and some veinlets, few tiny veinlets of calcite and quartz, scattering of pyrite, few 1-inch bands of dark-green chloritic schist.
701.5	709	100	Green amphibolite schist, few tiny veinlets of quartz and calcite, quite massive.
709	728	100	Light, pale-green, speckled schist (uralite?) epidote disseminations, few veinlets of quartz and calcite, occasional specks of pyrite, interval somewhat silicified.
728	740	88	Light pale-green schist (uralite?), scattered pyrite, somewhat silicified yet chloritized on some planes of schistosity.

Hole N-5 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
740	850	70	Pale-green amphibolite schist, much epidote disseminations and some veinlets, few tiny veinlets of quartz and calcite, few specks pyrite, considerably silicified, banding due to hematite from 812 to 820 feet.
850	855	100	Green amphibolite schist, much quartz, some pyrite.
855	865	100	Grayish-green amphibolite schist, much epidote in tiny veinlets, few veinlets of quartz, scattered specks of pyrite.
865	880	91	Dark bluish-green silicified amphibolite schist, few small quartz veinlets, scattered pyrite.
880	883	100	Grayish-green amphibolite schist, many epidote veinlets.
883	890	100	Dark-green amphibolite schist, few tiny epidote veinlets, quartz veinlet at 889 feet.
890	910	67	Green amphibolite schist, few epidote veinlets, some fractures filled with dark-green chlorite, much quartz 905 to 910 feet, little pyrite scattering.
910	935	46	Light-green amphibolite schist, much disseminations and veinlets of epidote, few quartz veinlets, slightly chloritized on planes of schistosity.
935	940	80	Grayish-green amphibolite schist (uralite?) considerably chloritized.
940	970	90	Greenish-gray amphibolite schist (uralite?) considerably chloritized.
970	984	94	Light-green amphibolite schist, much epidote disseminations.
984	990	100	Green amphibolite schist, chloritized on planes of schistosity, some epidote disseminations.
990	1000	100	Yellowish-green amphibolite schist, much epidote disseminations, scattered fine bands of hematite.
1000	1030	44	Green amphibolite schist, considerable epidote disseminations, scattered bands of hematite, some quartz, considerably chloritized.
1030	1036.5	27	Green amphibolite schist, considerable disseminations of hematite and some hematite in bands, disseminations of epidote, considerably chloritized, leached appearance.
1036.5	1038	10	Sulfide vein showing good chalcopyrite and pyrite.

Hole N-5 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
1038	1040	90	Green amphibolite schist with fine bands of pyrite (mundick of the local miners?).
1040	1055	66	Green amphibolite schist more or less silicified, considerable epidote disseminations, some parts chloritized and some intervals show brownish coloration probably due to hematite, few tiny quartz veinlets.
1055	1076	100	Green amphibolite schist considerably chloritized, some epidote disseminations, few tiny veinlets of white calcite from 1,056 to 1,076 feet.

Copper Hill Mine

A. - Bureau of Mines Drill-Hole Logs

Hole CH-1

Location: 1200 N., 1200 E.
Elevation of collar: Level with collar of main shaft.
Depth: 730 feet.

Bearing: S. 49° W.
Dip: -50°
BX: 8-40 ft.
AX: 40-270 ft.
NX: 0-8 ft.
EX: 270-730 ft.

Footage From	Footage To	Percent core recovery	Description
0	36	37	Surface altered amphibolite, some iron stain on fractures, few tiny quartz veinlets.
36	57	67	Light-green amphibolite, few very small quartz veinlets.
57	85	64	Gray-green amphibolite, some fractures filled with dark-green chlorite.
85	102	44	Pale-green amphibolite, some of porphyritic texture.
102	149	57	Gray-green porphyry, fairly massive; light-colored, irregular bounded phenocrysts ground mass is uralite and some chlorite; few white quartz veinlets, few grain pyrite, also few veinlets of epidote.
149	199	91	Pale gray-green amphibolite, some small masses of dark-green chlorite-matrix is apparently largely uralite and quartz-veinlets of quartz and epidote and at 188 feet a 2-inch vein of white quartz containing cubes of pyrite and little white calcite.

Hole CH-1 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
199	206	98	Gray-green porphyry (matrix is uralite and quartz, some fine disseminated pyrite scattered throughout.
206	244	99	Pale greenish-gray massive rock, probably a graywacke or graywacke breccia-pyrite, is present in numerous fine veinlets.
244	251	81	Green amphibolite containing numerous small irregular masses of dark-green chlorite-pyrite is present in minute grains scattered.
251	291	77	Pale-green amphibolite containing numerous small, irregular masses of dark-green chlorite, occasional tiny veinlets of white quartz with epidote, and small amount of calcite.
291	315.5	87	Green amphibolite, few small veinlets of white quartz with epidote, and little calcite. Light-colored phenocrysts with irregular boundaries, aphanitic groundmass probably uralite, intercalations of green amphibolite with numerous small masses of dark-green chlorite.
315.5	356	76	Gray-green porphyry with dark-green phenocrysts in fine-grained matrix. Pale-green amphibolite schist, somewhat silicified. Scattered tiny masses of pyrite can be seen.
356	398	66	Pale-green, massive, silicified rock, some of it brecciated and recemented with silica; pyrite generally associated with quartz in thin veinlets and isolated masses as above to 280 feet. From 280 feet medium and dark-gray highly silicified rock, some resembling clastic structive and some a brecciated dark slate, abundance of finely disseminated pyrite as well as in masses.
398	406	84	Pale-gray, fine-grained, readily friable material probably gouge, mostly -60 mesh but some angular grains 20 mesh or greater.
406	445.5	91	Greenish-gray and dark-gray porphyry with light-colored phenocrysts-intercalation of silicified dark-gray to black argillite, much of which contains pyrite in veinlets and disseminated; lesser pyrite in the porphyry.

Hole CH-1 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
445.5	496	39	Black and dark-gray argillite containing veinlets of white quartz and calcite-abundance of pyrite as disseminations and masses, some chalcopyrite can be noticed intercalations of greenish-gray silicified amphibolite containing masses of pyrite which may have replaced dark-green chlorite.
496	600	73	Greenish-gray porphyry with numerous pale greenish-white phenocrysts, there are intercalations of nonporphyritic greenish-gray aphanitic rock and occasional thin streaks of dark-gray material. Pyrite is present as disseminations and small aggregates scattered but not abundant, a few milky quartz veinlets with little calcite are scattered through this interval.
600	624	79	As above to 602 feet; balance dark-gray to black argillite alternating with pale greenish-gray amphibolite; amphibolite contains masses of darker green mineral, probably chlorite. Pyrite is fairly abundant as small aggregates disseminations and veinlets; also quartz and calcite to 624 feet.
624	640	81	Pale-green amphibolite and porphyry, the latter containing greenish-white phenocrysts, there are intercalations of dark-gray to black argillite; pyrite is present in veinlets and aggregates, most abundant in the argillite.
640	649	52	Pyritized pale-green amphibolite and coarse-grained graywacke, streaks of black argillite.
649	686	69	Pale greenish-gray porphyry with large and small greenish-white phenocrysts, few quartz veinlets.
686	701	87	Highly silicified greenish-gray rock; pyrite is rather abundant as fine disseminations, grains, and lenticular aggregates.
701	730	49	Pale-green, partly silicified amphibolite, much of which contains irregular darker-green masses; pyrite is present as aggregates and grains particularly abundant at 704 feet.

Hole CH-2

Location: 755 N., 2152 E.
Elevation of collar: 36 ft. below collar of Hobo shaft.
Depth: 800 feet.

Bearing: S. 60° 45' W.
Dip: -52°
NX: 0-10 ft.
AX: 23-300 ft.
BX: 10-23 ft.
EX: 300-800 ft.

Footage From	Footage To	Percent core recovery	Description
0	16	8	Surface altered amphibolite.
16	19	76	As above, with few stained quartz veinlets.
19	26	59	Surface altered amphibolite.
26	39	62	Partly altered amphibolite (brownish).
39	43	55	Approximate bottom of surface alteration.
43	71	48	Pale-green amphibolite with scattered quartz veinlets (white).
71	82	100	Pale-green silicified amphibolite with few scattered veinlets of white quartz.
82	96.5	94	Pale-green amphibolite with few scattered veinlets of white quartz.
96.5	100	66	Pale-green amphibolite.
100	104.5	100	Green silicified amphibolite, some green chlorite?
104.5	118	83	Green amphibolite with white quartz veinlets; some epidote disseminated throughout.
118	128	100	Pale-green amphibolite with epidote in disseminations, some pyrite scattered through this interval.
128	133.5	100	Pale-green amphibolite with tiny veinlets of epidote.
133.5	143.5	88	Pale-green porphyry, light-colored phenocrysts, some epidote in tiny veinlets - silicified.
143.5	156	90	Light-green amphibolite with tiny veinlets of white quartz and epidote, graywacke from 151.5 feet on considerable white quartz at 155 feet.
156	189	86	Silicified light-green amphibolite with scattered white quartz veinlets.
189	233	72	Pale-green silicified amphibolite.
233	263.5	74	Pale-green silicified amphibolite with scattered tiny white quartz veinlets.
263.5	269	100	Light-green porphyry with cream-colored phenocrysts with irregular boundaries.
269	289	79	Light-green silicified amphibolite with a few tiny white quartz veinlets.
289	296	100	Pale-green silicified amphibolite.
296	300	77	Pale-green silicified amphibolite with quartz veinlets.
300	311	41	Pale-green silicified amphibolite.
311	321	34	As above with scattered white quartz veinlets.

Hole CH-2 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
321	329.5	83	Light-green silicified amphibolite.
329.5	334.5	88	Pale-green porphyritic amphibolite with quartz veinlets.
334.5	339	100	Silicified pale-green amphibolite with quartz veinlets.
339	361	81	Silicified pale-green amphibolite.
361	419	66	Pale-green silicified amphibolite with scattered tiny veinlets of white quartz and small intervals of pale-green porphyry with cream-color irregular, bounded phenocrysts.
419	464	75	Pale-green silicified amphibolite with scattered white quartz veinlets and small areas of porphyry.
464	474	86	Silicified amphibolite with white quartz veinlets.
474	496	85	Silicified uralite schist with veinlets and small lenses of white quartz and chlorite-epidote occurs in veinlets and disseminated a very minor amount of pyrite is disseminated throughout with a slight increase at 494 feet; few tiny veinlets of calcite are also present, but in general it is lacking.
496	510.2	48	Silicified porphyritic schist with chlorite phenocrysts; considerable amount of pyrite, both in large cubes and disseminations; large of epidote disseminated and in veinlets.
510.2	510.5	100	3 inches of silicified rock with irregular masses of tremolite and chlorite and a considerable amount of massive chalcopyrite
510.5	516	44	Silicified rock containing irregular masses of tremolite and chlorite and considerable disseminated pyrite 510.5 to 512 feet. Balance porphyry with phenocrysts altered to chlorite, contains short veinlets of chlorite-uralite in groundmass, and some tremolite is present; a considerable amount of disseminated pyrite.
516	521	100	Silicified graywacke containing small masses of chlorite and some disseminated epidote, a few calcite veinlets - some tremolite - pyrite is disseminated throughout this interval in moderate amount.
521	531	54	Uralite schist-silicified in some zones, 1 inch milky quartz veinlet at 525 feet, small masses and veinlets of chlorite, one small veinlet of calcite-a moderate amount of disseminated pyrite.

Hole CH-2 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
531	576	48	Silicified, light-green, amphibolite-scattered veinlets of white quartz, tiny masses of green chlorite, scattered disseminated pyrite.
576	601	89	As above, with occasional zones of pale-green porphyry; the phenocrysts are irregularly bounded and are greenish-white in color; aphanitic groundmass.
601	634	60	Pale-green, silicified amphibolite cut by scattered veinlets of white quartz.
634	646	93	Light-green, silicified amphibolite with scattered veinlets of white quartz and zones of porphyry.
646	651	100	Pale-green porphyry - cream, irregular, bounded phenocrysts and aphanitic matrix, more or less silicified.
651	667	56	Silicified pale-green amphibolite with scattered quartz segregations.
667	706	49	Silicified pale-green amphibolite cut by scattered veinlets of white quartz.
706	726	55	Light-green silicified amphibolite.
726	731	28	Light-green silicified amphibolite - pyritized black argillite, at 730 feet, also small zones of green porphyry - cream, irregular, bounded phenocrysts in a aphanitic groundmass.
731	753	37	Light-green silicified amphibolite.
753	763	59	Green, silicified, amphibolite schist.
763	780	38	Silicified pale-green amphibolite - scattered white quartz veinlets.
780	800	56	Silicified pale-green amphibolite, some quartz veinlets - minor amount of pyrite at 787 feet.

Hole CH-3

Location: N. 369, 2039 E.
Elevation of collar: Level with collar of Hobo shaft.
Depth: 519 feet.

Bearing: S. 70° W.
Dip: -60°
BX: 7-30 ft.
AX: 30-519 ft.
NX: 0-7 ft.

Footage From	Footage To	Percent core recovery	Description
0	32	46	Surface altered amphibolite, few quartz veinlets.

Hole CH-3 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
32	42	97	Pale-green amphibolite, few quartz veinlets.
42	60.5	98	Pale-green porphyry, few quartz veinlets. Pale-green amphibolite with few quartz veinlets.
60.5	84.5	93	Pale-green silicified amphibolite, few quartz veinlets.
84.5	94	100	Pale-green silicified amphibolite porphyry.
94	104	97	1 foot quartz vein 95 to 96 feet, balance silicified amphibolite and porphyry.
104	124	70	Pale-green, silicified amphibolite; zones of porphyry.
124	129	100	Pale-green, silicified amphibolite; some porphyry.
129	151.5	99	Highly silicified pale-green amphibolite and quartz veinlets.
151.5	186.5	99	Pale-green silicified amphibolite; quartz veinlets.
186.5	211.5	94	Highly silicified, pale-green amphibolite; numerous quartz veinlets.
211.5	266.5	87	Silicified pale-green amphibolite with quartz veinlets.
266.5	271.5	58	Silicified green amphibolite quartz veinlets, few specks pyrite at 270 feet.
271.5	276.5	54	Silicified green amphibolite quartz veinlets, little pyrite at 274 feet.
276.5	300	80	Silicified green amphibolite quartz veinlets.
300	321	92	Chlorite amphibolite; veinlets of quartz and epidote; also disseminated epidote.
321	328	81	Chlorite amphibolite; veinlets of quartz and epidote; also disseminated epidote. From 323 to 328 feet siliceous vein material carrying sulfides, mostly pyrite, some chalcopyrite.
328	336	100	Chlorite amphibolite; quartz veinlets; some talc on schistosity.
336	360	99	Chlorite amphibolite; quartz veinlets; some talc on schistosity planes.
360	406	79	Silicified amphibolite; few quartz veinlets and disseminated epidote; few specks pyrite.
406	429.5	71	Chloritized amphibolite.
429.5	439.5	45	Chlorite amphibolite.
439.5	456	53	Chlorite amphibolite to 442 feet; then 3 inch quartz stringer; rest chloritized amphibolite schist.
456	491	88	Chloritized amphibolite schist, minor amounts of disseminated pyrite; some talc on certain planes of schistosity.

Footage From	Footage To	Percent core recovery	Description
491	514.5	86	Green amphibolite schist somewhat chloritized, occasional quartz veinlets and segregations.
514.5	519	78	Pale-green amphibolite schist with few quartz veinlets.

Hole CH-4

Location: 1905 N., 465 E.
Elevation of collar: 34.5 ft. below collar of Jackass shaft.
Depth: 315 feet.

Bearing: S. 53° W.
Dip: -45°
BX: 7-10 ft.
AX: 10-315 ft.
NX: 0-7 ft.

Footage From	Footage To	Percent core recovery	Description
0	16	21	Surface altered amphibolite.
16	19	20	Approximate limit of surface alteration.
19	24	44	Light pale-green, silicified amphibolite.
24	26.5	48	Iron-stained amphibolite.
26.5	41	72	Iron-stained, silicified porphyry of aphanitic groundmass and irregular bounded, cream-colored phenocrysts to 33 feet; silicified porphyry as above to 40 feet, balance black argillite with thin scaley pyrite on fracture plances.
41	49	61	Light bluish-gray, silicified amphibolite with thin scaley pyrite on planes that fracture.
49	59.5	65	Above 51 feet light bluish-gray, silicified amphibolite with thin scaley pyrite on planes that fracture. Below 51 feet, green silicified amphibolite.
59.5	78	80	Light bluish-gray, highly silicified amphibolite; thin scaley pyrite on fracture planes.
78	80	88	Light-green silicified porphyry; green aphanitic matrix, cream-collored, irregular, bounded phenocrysts.
80	96	71	Light bluish-gray, highly silicified amphibolite; scattered thin, scaley pyrite on fracture planes.
96	98	87	Dark to black argillite.
98	100	87	Light-gray, highly silicified amphibolite.
100	101	87	Argillite and quartz.
101	115	94	Light-gray, highly silicified amphibolite with minor amounts of pyrite.
115	118	98	Argillite with thin seams of fine pyrite.
118	120	79	Light-gray silicified amphibolite with scaley pyrite.
120	125	79	Argillite with occasional thin seams of pyrite.

Hole CH-4 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
125	128	79	Bluish-gray highly silicified amphibolite.
128	137.7	97	Pale-green silicified amphibolite, scattered intervals of argillaceous material, with little quartz and scattered pyrite.
137.7	140.5	77	Light-colored siliceous material; pyritized.
140.5	141.5	77	Mineralized argillite.
141.5	149	100	Siliceous, mineralized material and argillite, with thin seams of pyrite.
149	150.5	96	Argillite with fine seams of pyrite.
150.5	155.7	96	Silicified amphibolite and light-colored siliceous material both carrying sulfides.
155.7	170.5	72	Pale-green silicified amphibolite with sulfides.
170.5	189.5	45	Pale-green amphibolite with sulfides, intervals of pale-green porphyry; cream-colored, irregular, bounded phenocrysts in an aphinitic groundmass.
189.5	212	95	Pale-green silicified amphibolite with specks of sulfides.
212	216	42	Silicified pale-green amphibolite, some porphyry, minor disseminated sulfides.
216	226	98	Pale-green amphibolite with specks of pyrite, gray siliceous material with sulfides (iron and zinc).
226	234	95	Pale-green amphibolite with intervals of porphyry, very little sulfides.
234	237	78	Gray siliceous material banded with sulfides.
237	243.9	83	Pale-green amphibolite, some porphyry, specks of pyrite.
243.9	247.7	97	Pale-green amphibolite and heavy sulfides.
247.7	251.2	97	Pale-green amphibolite with specks of pyrite.
251.2	265	80	Light bluish-gray, highly silicified amphibolite; pyrite as thin scales and in tiny seams.
265	281.5	70	Light bluish-gray, highly silicified amphibolite, minor amounts of pyrite is seams and scales.
281.5	284.5	87	Gray, silicified amphibolite with sulfides of iron and zinc.
284.5	315	67	Pale-green, silicified amphibolite, scattered scaley pyrite.

Hole CH-5

Location: 1810 N., 544 E.
Elevation of collar: Below collar of Jackass shaft.
Depth: 500 feet.

Bearing: S. 53-30° W.
Dip: -45°
BX: 6-20 ft.
AX: 20-500 ft.
NX: 0-6 ft.

Footage From	Footage To	Percent core recovery	Description
0	26	63	Altered amphibolite.
26	45.5	50	Pale grayish-green amphibolite; fractures iron-stained; a few tiny quartz veinlets.
45.5	88	88	Pale greenish-gray, silicified amphibolite with a few tiny quartz veinlets and 6-inch intervals of porphyry of same color; the phenocrysts are cream-colored and have no regular boundaries; the matrix is aphanitic.
88	128	49	Pale greenish-gray, silicified amphibolite, few tiny white quartz veinlets, small fractures filled with dark-green chlorite.
128	146.5	63	Pale greenish-gray, silicified porphyry; the phenocrysts are cream-colored and have no regular boundaries, a few white quartz veinlets, some fractures appear to be filled with green chlorite.
146.5	175	92	Pale-green, silicified amphibolite, a few tiny white quartz veinlets, occasional breaks show scaley pyrite.
175	233	84	Light grayish-green, silicified amphibolite, a few tiny white quartz veinlets, scattered scaley pyrite.
233	234	87	Silicified graywacke.
234	263	85	Pale-green to green silicified amphibolite; scattered scaley pyrite.
263	264	97	Silicified graywacke.
264	302	90	Light-green silicified amphibolite, a few tiny quartz veinlets, one of 6 inches at 297 feet considerable disseminations of fine pyrite.
302	352	76	Pale-green silicified amphibolite; new fractures of core show scaley pyrite.
352	389	78	Grayish-green silicified amphibolite, considerable scaley pyrite and some disseminations of pyrite.
389	413	76	Mineralized zone, siliceous amphibolite, copper, zinc, and pyrite, very low-grade, not ore.
413	436	65	Pale grayish-green, highly silicified amphibolite, scattered pyrite.

Hole CH-5 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
436	443	90	Gray siliceous material, quartz?, and scaley
452	478	59	Green, silicified amphibolite; scattered scaley pyrite; some intervals gray, siliceous material (quartz?).
478	490	62	Gray-green silicified amphibolite; some masses of dark-green chlorite.
490	495	66	Siliceous breccia.
495	496	63	Porphyry.
496	500	63	Gray-green silicified amphibolite.

Grayhouse Mine

A. - Bureau of Mines Drill-Hole Logs

Hole GH-1

Location: 548 feet East of Spring.
Elevation of collar: 25.5 feet above gossen at spring.
Depth: 833 feet

Bearing: S. 71° W.
Dip: -45°
BX: 60-60 ft.
AX: 80-833 ft.
NX: 0-60 ft.

Footage From	Footage To	Percent core recovery	Description
0	60	0	No core, sludge shows clay, gravel, and schist.
60	65	17	Iron-stained chloritic schist.
65	80	37	Green chloritic schist, some red (hematite?) streaks.
80	86	60	Greenish-brown, highly chloritized schist, containing epidote, hematite, and dark chlorite.
86	87	60	Chloritized conglomerate, black cementing material, pieces of white quartz.
87	100	49	Greenish-brown, highly chloritized schist containing epidote and hematite.
100	137	61	Brownish-green chloritized schist containing much epidote, some hematite, and little white quartz.
137	138	38	Iron-stained light-green schist.
138	193	49	Brownish-green chloritized schist, some intervals have a definite leached appearance, epidote is abundant in veinlets and disseminations; few tiny quartz veinlets and iron-stained streaks (hematite?).

Hole GH-1 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
193	210	21	Light-brown schist containing much white quartz.
210	215	42	Gray, dense schist.
215	220	42	Light-gray mottled schist and quartz veinlets, somewhat chloritized.
220	229	47	Grayish-green schist, some intervals leached to a porous state, 1 inch quartz veinlet at 220 feet.
229	230	47	Red cherty material with fractures filled with calcite.
230	256	30	Gray-green chloritized schist, epidote veinlets; some intervals have been leached.
256	260	23	Light-gray siliceous material having a somewhat leached appearance, yet is very hard.
260	270	19	Dark-gray schist (chloritized) with quartz veinlets.
270	278	54	Gray schist with tiny calcite veinlets.
278	298	79	Greenish-gray schist, epidote, and calcite veinlets; a few intervals show hematite coloration, 2 feet of leached quartz at 298 feet.
298	320	21	Gray schist with veinlets of white quartz, epidote, calcite, and a few tiny ones of hematite.
320	323	54	Light-gray siliceous schist, white quartz veinlets.
323	329	20	Dark grayish-brown siliceous material with some white quartz veinlets.
329	335	43	Gray siliceous schist, much quartz.
335	340	49	Light-gray sericite schist, considerable iron-stained quartz at 338 feet.
340	365	40	Gray sericite schist.
365	401	62	Greenish-gray schist, veinlets of epidote and calcite, some intervals have a leached appearance.
401	419	71	Gray, silicified schist showing veinlets of epidote, white quartz, and some hematite.
419	429	89	Rusty gray-colored schist.
429	438	91	Dark-gray, highly silicified sericite schist with veinlets of epidote, calcite, and white quartz.
438	448	66	Gray amphibolite schist somewhat porphyritic in appearance, a few white quartz veinlets.
448	455	56	Much white quartz and some hematite.
455	491	44	Gray sericite schist with veinlets of calcite and epidote, some intervals of white quartz.
491	492	43	White quartz and calcite.

4033

Hole CH-1 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
492	512	64	Dark-gray sericite schist with veinlets of calcite and epidote.
512	520	72	Grayish-green sericite schist, veinlets of epidote quartz and calcite.
520	585	48	Dark greenish-gray sericite schist with veinlets of epidote, calcite and white.
585	625	63	Grayish-green sericite schist with veinlets of epidote, calcite, and quartz, fine pyrite in seams between 603 and 605 feet.
625	643	71	Gray sericite schist, considerable white quartz in veinlets, scattered pyrite in tiny seams or bands.
643	663	87	Gray sericite schist, quartz veinlets; pyrite in tiny seams is scattered through this interval.
663	725	29	Gray sericite schist, few veinlets of white quartz and calcite, scattered pyrite in seams and disseminations.
725	758	52	Gray sericite schist, white quartz veinlets, scattered tiny seams and disseminations of pyrite.
758	822	35	Gray sericite schist, white quartz veinlets, pyritic disseminations throughout, some pyrite in tiny seams.
822	833	15	Dark grayish-green schist, tiny veinlets of quartz, very little scattered pyrite.

Constellation Mine

A. - Bureau of Mines Drill-Hole Logs

Hole C-1

Location: 1155 N., 1248 E.
Elevation of collar: 51.4 feet above collar of Berger shaft.
Depth: 667 feet.

Bearing: S. 48-30° W.
Dip: -45°
BX: 11-60 ft.
AX: 60-667 ft.
NX: 0-11 ft.

Footage From	Footage To	Percent core recovery	Description
0	27	25	Yellow-brown residual clay from rock below.1/
27	45	58	Weathered sericite schist, light buff color.
45	106	53	Sericite-talc schist, very fine-grained, considerably weathered (Mariposa slate?). Angle between cleavage and length of core is 75 degrees.

1/ Log by U. S. Geological Survey, March 1943.

Hole C-1 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
106	116	47	Same as below, weathered greenish-brown.
116	179	49	Chlorite-sericite-talc schist locally grading to light-green gneiss. Abundant lenticular fragments 1 inch or less in length in light-green matrix.
179	190	56	Greenish to purplish felsite; green color due to epidote in part; weak schistosity contains veinlets of quartz and epidote.
190	262	44	Chlorite-sericite-talc schist as above.
262	325	83	Fine-grained, dark greenstone with visible epidote and feldspar. Moderate, persitent schistosity. Becomes finer-grained downward. Quartz-epidote veins throughout, some as much as 6 inches wide.
325	380	28	Talcose schist as at 45 to 106 feet. Carries disseminated pyrite at 327 to 328 feet and at 336 to 339 feet; bleached at 336 to 339 feet.
380	413	25	Light-gray, talcose, sericite schist mostly carrying disseminated pyrite. At 393 feet it is somewhat silicified and carries maximum pyrite, perhaps 15 percent. No other sulfides recognized. Many milky quartz veins at 393 to 403 feet.
413	486	29	Fine-grained, pale-green sericite schist with talc. Several zones of light-gray (bleached?) color. Mostly carries disseminated pyrite in very small amounts. Locally slightly silicified, but not accompanied by additional pyrite. Angle between schistosity and core is 80 degrees.
486	488	98	Dense-textured greenish-gray felsite, translucent.
488	498	97	Gray sericitic schist with fine fragmental texture; disseminated pyrite locally. Contains visible quartz, feldspar, and sericite; and probably also epidote and chlorite. Texture suggests arkose or grit, but it may represent silicified pyroclastic rock.
498	502	96	Heterogeneous greenstone, weakly schistose, Grades downward into uniform epidote-greenstone (i.e. lacks schistosity in lower part).
502	504	92	White quartz veins with masses of fine-grained chlorite.

Hole C-1 (Cont'd.)

Footage From	Footage To	Percent core recovery	Description
504	531	92	Variable greenstone, with little schistosity mixed with green schist with moderate schistosity. Much of it mottled with irregular streaks and blebs of lighter-colored, fine-grained, epidote-feldspar rock.
531	534.6	71	White quartz vein.
534.6	560	62	Moderately schistose greenstone, in part fragmental. Color light green to gray; probably lacks epidote. Several quartz veins 3 to 10 inches wide.
560	570	90	Dense greenish-gray argillite; locally thin-bedded; also a few thin, gritty beds.
570	577	87	Massive rock mottled light green and white. Contains quartz and feldspar, meta-rhyolite
577	581	60	Bedded argillite and grit.
581	610	67	Variable greenstone as at 504 to 531 feet; a little argillite interbedded.
610	627	91	Bedded argillite and grit.
627	643	90	Mottled greenstone, more or less massive. Suggestion of fragmental texture. Much veined with quartz and zoisite?
643	667	86	Rather uniform chloritic greenstone, more or less schistose. Mottled and streaked surface suggests original fragments.

NOTE: A small but persistent sprinkling of tiny pyrite grains is present throughout the core below 325 feet.

Drill Hole Data

North Keystone Mine

Hole	Coordinates N	Coordinates E	Elevation of collar, ft.	Depth, feet	Dip	Bearing	Size of core
K-1	1468	551	1006	593	-80°	S43°W	NX: 0-5 ft.; BX: 5-10 ft.; AX: 10-593 ft.
K-2	1696.5	756	1023	646	-70°	S46°W	NX: 0-6 ft.; BX: 6-37 ft.; AX: 37-200 ft.; BX: 200-204 ft.; AX: 204-212.7 ft.; BX: 212.7-255 ft.; AX: 255-512 ft.; EX: 512-646 ft.
K-3	1966	394.5	1018	571	-72°	S47°30'W	NX: 0-7 ft.; BX: 7-221 ft.; AX: 221-447 ft.; EX: 447-571 ft.
K-4	1863.5	852	1026	833	-75°	S46°W	NX: 0-27 ft.; BX: 27-251 ft.; AX: 251-449 ft.; EX: 449-833 ft.

Record of Diamond Drill Hole Values

North Keystone Mine

Hole: K-1
Location: 1468 N.; 551 E.
Elevation of collar: 1,006 ft.

Depth: 593 feet
Dip: -80°
Bearing: S. 43° W.
Core size: NX: 0-5 ft.;
BX: 5-10 ft.;
AX: 10-593 ft.

Footage			Size of core	Analyses					
				Core			Sludge		
From:	To:	Feet		Cu, percent	Au, oz.	Ag, oz.	Cu, percent	Au, oz.	Ag, oz.
182.5	186.5	4.0	AX	-	-	-	0.23	-	-
192.5	202.5	10.0	AX	-	-	-	.10	-	-
212	220	8.0	AX	*0.02	-	-	-	-	-
220	221.6	1.6	AX	*.02	-	-	-	-	-
221.6	225	3.4	AX	*.02	-	-	-	-	-
225	230.5	5.5	AX	*.02	-	-	-	-	-
249	251	2.0	AX	-	-	-	.04	-	-
251	255	4.0	AX	*.02	-	-	.29	-	-
255	257	2.0	AX	.68					
257	260	3.0	AX	*.02	-	-	-	-	-
260	263	3.0	AX	.03	-	-	-	-	-
263	268	5.0	AX	*.02	-	-	-	-	-
268	272.8	4.8	AX	.05	-	-	-	-	-
272.8	277	4.2	AX	.79	0.29	0.01	1.31	Trace	None
277	278.3	1.3	AX	10.03	-	-			
278.3	281.5	3.2	AX	9.30	.19	.01	3.70	0.10	Trace
281.5	282.5	1.0	AX	.16	-	-	-	-	-
282.5	283.5	1.0	AX	.04	-	-	-	-	-
283.5	292.5	9.0	AX	-	-	-	.37	-	-
301.2	308.2	7.0	AX	-	-	-	.12	-	-
415	415.6	.6	AX	.98	-	-	-	-	-
425	435	10.0	AX	-	-	-	.06	-	-

*Less than.

Footage			Size of core	Analyses					
				Core			Sludge		
From:	To:	Feet		Cu, percent	Au, oz.	Ag, oz.	Cu, percent	Au, oz.	Ag, oz.
447	453	6.0	AX				0.05		
583	587	4.0	AX				.05		

Hole: K-2
Location: 1696.5 N.; 756 E.
Elevation of collar: 1,023 ft.

Depth: 646, feet
Dip: -70°
Bearing: S. 46° W.

Footage			Size of core	Analyses					
				Core			Sludge		
From:	To:	Feet		Cu, percent	Au, oz.	Ag, oz.	Cu, percent	Au, oz.	Ag, oz.
128.5	128.8	0.3	AX	2.48					
128.5	129.3	.8	AX				0.69		
466.0	466.3	.3	AX	7.05					
466.3	468.1	1.8	AX	.06					
465.2	473.7	8.5	AX				.56		
473.7	476.5	2.8	AX	.15					
473.7	480.5	6.8	AX				.15		
524.3	534.9	10.6	EX				.05		
534.9	541.9	7.0	EX				.01		
547.5	548.5	1.0	EX				.20		
548.5	548.6	.1	EX	1.18					
548.5	548.7	.2	EX				3.29		
549.0	549.8	.8	EX	.65					
553.9	554.8	.9	EX	.14					
548.8	554.9	6.1	EX				.16		
554.9	555.1	.2	EX	.29					
555.1	555.7	.6	EX	2.27					
555.7	556.5	.8	EX	.44					
554.9	565.1	10.2	EX				.19		
574.0	574.5	.5	EX	1.12					
565.1	575.1	10.0	EX				.12		

Hole K-2 (Cont'd.)

Footage			Size of core	Analyses					
				Core			Sludge		
From:	To:	Feet		Cu, percent	Au, oz.	Ag, oz.	Cu, percent	Au, oz.	Ag, oz.
593.1	603.2	10.1	EX				0.05		
613.4	618.5	5.1	EX				.12		
618.5	620.0	1.5	EX				.61		
617.7	619.5	1.8	EX	0.43					
619.5	620.5	1.0	EX				.79		
620.0	625.4	5.4	EX				.10		
625.4	631.9	6.5	EX				.04		
640.0	640.2	.2	EX	4.37					
635.4	645.4	10.0	EX				.10		

Hole: K-3
Location: 1966 N.; 394.5 E.
Elevation of collar: 1,018

Depth: 571 feet.
Dip: -72°
Bearing: S. 47° 30' W.

Footage			Size of core	Analyses					
				Core			Sludge		
From:	To:	Feet		Cu, percent	Au, oz.	Ag, oz.	Cu, percent	Au, oz.	Ag, oz.
90.6	92.3	1.7	BX	0.09					
92.3	94.0	1.7	BX	.10					
312.0	318.5	6.5	AX	.12	1/	1/			
313.8	314.0	.2	AX	.23					
312.0	320.0	8.0	AX				0.09		
320.0	321.3	1.3	AX	.11					
323.0	323.5	.5	AX	.49					
320.0	323.0	3.0	AX				.18		
323.5	325.4	1.9	AX	.07					
323.0	334.5	11.5	AX				.25		
334.6	337.0	2.4	AX	.05					
337.0	337.2	.2	AX	.12					
337.2	338.7	1.5	AX	.13					
465.1	466.7	1.6	EX	.32					
466.7	468.0	1.3	EX	.40	Trace	None			
468.0	469.5	1.5	EX	.11					

1/ Less than 0.2 foot at 313.8 feet.

Hole K-3 (Cont'd.)

Footage			Size of core	Analyses					
				Core			Sludge		
From:	To:	Feet		Cu, percent	Au, oz.	Ag, oz.	Cu, percent	Au, oz.	Ag, oz.
469.5	469.65	0.15	EX	1.93					
469.65	470.35	.70	EX	.38					
465.1	475.1	10.0	EX				0.18	Trace	0.10
475.1	481.7	6.6	EX	.09					
475.1	484.2	9.1	EX				.14		
494.3	501.9	7.6	EX	.01			.09		
501.9	502.2	.3	EX	1.88					
502.2	503.2	1.0	EX	.18					
501.9	506.9	5.0	EX				.36		
506.9	511.9	5.0	EX	.08			.11		
511.9	521.5	9.6	EX	.07					
511.9	521.9	10.0	EX				.23		
532.0	540.6	8.6	EX	.08					
540.6	550.4	9.8	EX	.09					
562.7	567.2	4.5	EX	.01					

North Keystone Mine

Hole: K-4
Location: 1863.5 N.; 852 E.
Elevation of collar: 1,026 ft.

Depth: 833 ft.
Dip: -75°
Bearing: S. 46° W.

Footage			Size of core	Analyses					
				Core			Sludge		
From:	To:	Feet		Cu, percent	Au, oz.	Ag, oz.	Cu, percent	Au, oz.	Ag, oz.
435.0	435.3	0.3	AX	1.73					
645.0	650.0	5.0	EX				0.09		
647.5	647.95	.45	EX	.84					
647.95	648.7	.75	EX	.05					
750.0	651.2	1.2	EX	.06					
650.0	652.5	2.5	EX				.05		

Hole K-4 (Cont'd.)

Footage			Size of core	Analyses					
				Core			Sludge		
From:	To:	Feet		Cu, percent	Au, oz.	Ag, oz.	Cu, percent	Au, oz.	Ag, oz.
652.5	653.5	1.0	EX				0.07		
653.5	656.6	3.1	EX				.02		
653.5	659.8	6.3	EX	0.02					
656.0	660.7	4.7	EX				.05		
661.4	662.6	1.2	EX	.03					
660.7	663.2	2.5	EX				.11		
697.0	706.9	9.9	EX				.04		
735.6	743.9	8.3	EX				.01		
743.9	750.7	6.8	EX				.05		
750.7	756.0	5.3	EX				.06		
752.45	753.55	1.1	EX	.06					
756.0	761.2	5.2	EX				.49		
761.2	770.5	9.3	EX				.09		
781.0	791.0	10.0	EX				.32		
791.0	801.6	10.6	EX				.08		
801.6	813.0	12.4	EX				.06		
813.0	823.0	10.0	EX				.08		
823.0	833.0	10.0	EX				.06		

Drill Hole Data

Collier Mine

Hole	Coordinates N	Coordinates W	Elevation of collar, ft.	Depth, feet	Dip	Bearing	Size of core
C-1	163.9	238.1	966.11	350	-70°	S.55° W.	NX: 0-22 ft.; BX: 22-29 ft.; AX: 29-350 ft.
C-2	246	178.5	969.4	358	-70°	S.55° W.	NX: 0-4 ft.; BX: 4-21 ft.; AX: 21-48 ft.; EX: 48-358 ft.
C-3	790.7	402.8	1000.8	356	-70°	S.45° W.	NX: 0-14 ft.; BX: 14-38 ft.; AX: 38-356 ft.
C-4	821.3	581.3	1015.8	291	-70°	S.45° W.	NX: 0-14 ft.; BX: 14-32 ft.; AX: 32-44 ft.; EX: 44-291 ft.

Record of Diamond Drill-Hole Values

Collier Mine

Hole: C-1
Location: 163.9 N.; 238.1 W.
Elevation of collar: 966.11 ft.

Depth: 350 ft.
Dip: -70°
Bearing: S. 55° W.
Core size: NX: 0-22 ft.;
BX: 22-29 ft.;
AX: 29-350 ft.

Footage			Percent core record	Size of core	Analyses							
					Core				Sludge			
From:	To:	Feet			Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
286	291	5	100	AX	0.05	0.1	0.005	1.05	0.05	0.1	0.005	0.90
291	295	4	75	AX	.05	.1	.005	2.70	.04	.3	.005	2.90
334	339	5	90	AX	.21	.8	.005	.25				
339	344	5	22	AX	.08	.3	Trace	None				

Hole: C-2
Location: 246 N.; 178.5 W.
Elevation of collar: 969.4 ft.

Depth: 358 ft.
Dip: -70°
Bearing: S. 55° W.
Core size: NX: 0-4 ft.;
BX: 4-21 ft.;
AX: 21-48 ft.;
EX: 48-358 ft.

Footage			Percent core record	Size of core	Analyses							
					Core				Sludge			
From:	To:	Feet			Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
318	323	5	25	EX					0.15	0.4	Trace	1.20
323	328	5	23	EX					.06	.5	"	.20
328	330	2	75	EX					.09	.1	"	.10
330	333	3	78	EX					.07	.1	"	None
333	338	5	23	EX					.15	.3	"	"
338	343	5	17	EX					.11	.1	"	"

Hole: C-3
Location: 790.7 N.; 402.8 W.
Elevation of collar: 1000.8

Depth: 356 ft.
Dip: -70°
Bearing: S. 45° W.
Core size: NX: 0-14 ft.;
BX: 14-38 ft.;
AX: 38-356 ft.

Footage			Percent core record	Size of core	Analyses											
					Core				Sludge				Adjusted Average			
From:	To:	Feet			Cu, Per-cent	Zn, Per-cent	Au, oz.	Ag, oz.	Cu, Per-cent	Zn, Per-cent	Au, oz.	Ag, oz.	Cu, Per-cent	Zn, Per-cent	Au, oz.	Ag, oz.
314	319	5	100	AX	0.21	2.8	Trace	None	0.10	2.8	Trace	None	0.16	2.8	Trace	None
319	322	3	100	AX	.17	2.4	"	"								
322	324	2	100	AX	.15	1.7	0.005	0.25	.15	2.4	"	0.05	.15	2.2	0.005	0.15
324	327	3	100	AX	.32	1.1	.005	.25								
327	328	1	100	AX	.84	9.2	Trace	None	.12	1.8	"	.15	.84	9.2	Trace	None
328	330	2	99	AX	.07	1.1	"	"								
330	333	3	99	AX	.09	1.9	"	0.20	.30	2.8	"	.20	.09	2.2	"	0.20
333	338	5	100	AX	.17	2.3	"	None	.15	2.7	"	None	.16	2.5	"	None
338	339.5	1.5	100	AX	.19	1.7	"	"								
339.5	343	3.5	100	AX					.22	1.1	"	"				

Hole No: C-4
Location: 821.3 N.; 581.3 W.
Elevation of collar: 1015.8

Depth: 291
Dip: -70°
Bearing: S. 45° W.
Core size: NX: 0-14 ft.;
BX: 14-32 ft.;
AX: 32-44 ft.;
EX: 44-291 ft.

Footage			Percent core record	Size of core	Analyses											
					Core				Sludge				Adjusted Average			
From:	To:	Feet			Cu, Per-cent	Zn, Per-cent	Au, oz.	Ag, oz.	Cu, Per-cent	Zn, Per-cent	Au, oz.	Ag, oz.	Cu, Per-cent	Zn, Per-cent	Au, oz.	Ag, oz.
261	266	5	10	EX					0.02	0.2	Trace	None	-	-	-	-
266	268	2	33	EX					.04	.3	"	"	-	-	-	-
268	272	4	100	EX	0.06	0.4	Trace	None								
					.05	1.4	"	"	.04	.3	"	"	0.05	0.5	Trace	None
272	277	5	83	EX	.34	4.3	"	"								
					.04	2.1	"	"	.09	1.8	"	"	.12	2.3	"	"
277	281	4	85	EX	.09	1.9	"	"								
					.52	2.4	"	"	.17	1.1	"	"	.20	1.4	"	"
281	286	5	100	EX					.04	.5	"	"	-	-	-	-

Drill Hole Data

American Eagle Mine

Hole	Coordinates N	Coordinates W	Elevation of collar, ft.	Depth, feet	Dip	Bearing	Size of core
AE-1	1786	1106	1331	426	-40°	S69°W	NX: 0-10 ft.; BX: 10-112 ft.; AX: 112-366 ft.; EX: 366-426 ft.
AE-2	1911	1225	1331	446	-52°	S66°W	NX: 0-10 ft.; BX: 10-191 ft.; AX: 191-446 ft.
AE-3	1935	1245	1329	406	-40°	N89°W	NX: 0-14 ft.; BX: 14-96 ft.; AX: 96-406 ft.
AE-4	1790	1104	1331	492	-51°	S76°W	NX: 0-20 ft.; BX: 20-182.5 ft.; AX: 182.5-492 ft.
AE-5	2028	1262	1310	391	-44°	N85°W	NX: 0-10 ft.; BX: 10-104 ft.; AX: 104-298 ft.; EX: 298-391 ft.
AE-6	1931.5	1245	1329	323	-55°	S87°W	NX: 0-10 ft.; BX: 10-111 ft.; AX: 111-323 ft.
AE-7	1613	1104	1337.5	320	-39°	N88°W	NX: 0-10 ft.; BX: 10-41 ft.; AX: 41-134.5 ft.; EX: 134.5-320 ft.

Record of Diamond Drill Hole Values

American Eagle Mine

Hole No: AE-1
Location: 1786 N.; 1106 W.
Elevation of collar: 1,331

Depth: 426
Dip: -40°
Bearing: S. 69° W.

Footage			Size of	Analyses							
				Core				Sludge			
From:	To:	Feet	core	Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
249.5	252.7	3.2	AX	*0.02	*0.1	Trace	None				
250.5	251.5	1.0	AX	*.05	*.1	"	"				
254.5	256.3	1.8	AX	.05	*.1	"	"				
313	315.5	2.5	AX	.14	*.1	"	"				
315.5	319.5	4.0	AX	.19	*.1	"	"	0.08	*0.1	Trace	None
319.5	323	3.5	AX	.03	*.1	"	"				
341	341.4	.4	AX	.05	6.7	0.005	0.30				
341.4	343.2	1.8	AX	.03	7.15	None	.50				
343.2	343.8	.6	AX	Trace	1.21	Trace	.10				
341	345	4.0	AX					.02	2.30	None	0.40
345	349.5	4.5	AX					.12	4.74	Trace	.60
349.5	350.3	.8	AX	0.20	*.1	Trace	None				
349.5	360	10.5	AX					.25	*.1	Trace	None
360	362.4	2.4	AX	.15	*.1	"	"				
360	366	6.0	AX					.15	*.1	"	"
366	371	5.0	EX					.14	*.1	"	"
371	374.8	3.8	EX	.10	*.1	"	"				
371	376	5.0	EX					.10	*.1	"	"
376	381	5.0	EX					.14	*.1	"	"
416	421	5.0	EX					.20	*.1	"	"

Hole: AE-2
Location: 1911 N.; 1225 W.
Elevation of collar: 1,331 ft.

Depth: 446 ft.
Dip: -52°
Bearing: S. 66° W.

Footage			Size of	Analyses							
				Core				Sludge			
From:	To:	Feet	core	Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
244	247.5	3.5	AX	*0.02	*0.1	Trace	None				
248	252.6	4.6	AX	.03	*.1	"	"				
252.6	257.2	4.6	AX	.02	*.1	"	"				
258	261.8	3.8	AX	*.02	*.1	"	"				
263	267.2	4.2	AX	*.02	*.1	"	"				
267.2	271.2	4.0	AX	.02	*.1	"	"				
363.5	364.7	1.2	AX	.43	3.8	"	"				
364.7	366.2	1.5	AX	.06	*.1	"	"				
366.2	367.7	1.5	AX	.03	*.1	"	"				
363.5	368	4.5	AX					0.05	0.7	Trace	None
368	370	2.0	AX	.04	*.1	"	"				
370	370.95	.95	AX	.02	*.1	"	"				
370.5	375	4.5	AX					.17	.4	"	"
370.95	372.1	1.15	AX	.40	5.8	"	"				
372.1	373.8	1.7	AX	.05	2.2	"	"				
373.8	374.4	.6	AX	.02	*.1	"	"				

Hole: AE-3
Location: 1935 N.; 1245 W.
Elevation of collar: 1,329 ft.

Depth: 406 ft.
Dip: -40°
Bearing: N. 89° W.

Footage			Size of	Analyses							
				Core				Sludge			
From:	To:	Feet	core	Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
205	206	1.0	AX	0.02	2.8	0.020	2.20				
206	207.4	1.4	AX	.05	2.2	.065	3.20				
206	209	3.0	AX					0.02	0.4	0.015	3.50
209	209.1	0.1	AX	.03	4.4						
209	210	1.0	AX					.05	3.4	.020	2.20
210	211.6	1.6	AX	.02	1.2	.030	2.35				
210	216	6.0	AX					.10	2.8	.025	2.50
216	216.8	.8	AX	*.02	.1	.020	2.60				
216	217.5	1.5	AX					.04	.5	.010	2.50
217.5	220.6	3.1	AX	.04	*.1	.15	3.00				
217.5	221	3.5	AX					.03	*.1	.015	3.75

*Less than.

Hole: AE-4
Location: 1790 N.; 1104 W.
Elevation of collar: 1,331 ft.

Depth: 492 ft.
Dip: 51°
Bearing: S. 76° W.

Footage			Size of	Analyses							
				Core				Sludge			
From:	To:	Feet	core	Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
240.5	243.5	3.0	AX	0.03	0.1	Trace	None				
243.5	245.6	2.1	AX	.07	.2	"	0.20				
245.6	248.3	2.7	AX	*.02	.2	"	.20				
261.5	264.5	4.2	AX	*.02	.3	"	.20				
265.5	266.7										
264.5	265.5	1.0	AX	*.02	.1	0.010	1.00				

*Less than.

Hole: AE-5
Location: 2028 N.; 1262 W.
Elevation of collar: 1,310 ft.

Depth: 391 ft.
Dip: -44°
Bearing: N. 85° W.

Footage			Size of	Analyses							
				Core				Sludge			
From:	To:	Feet	core	Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
288	290.7	2.7	AX	*0.02	*0.1	Trace	None				
288	292.5	4.5	AX					0.02	*0.1	Trace	None
292.5	294	1.5	AX	*.02	*.1	"	"	*.02	.1	"	"
294	295.9	1.9	AX	*.02	*.1	"	0.20				
294	296.5	2.5	AX					*.02	.6	"	0.20
296.5	297.5	1.0	AX	*.02	*.1	"	None				
296.5	298	1.5	AX					*.02	*.1	"	.20
298	300	2.0	EX	.07	.2	"	0.20				
298	301	3.0	EX					.02	.4	"	.20
301	305	4.0	EX	.03	.1	"	None				
301	305.5	4.5	EX					.04	.6	"	None

*Less than.

Hole: AE-6
Location: 1931.5 N.; 1245 W.
Elevation of collar: 1,329 ft.

Depth: 323 ft.
Dip: -55°
Bearing: S. 87° W.

Footage			Size of	Analyses							
				Core				Sludge			
From:	To:	Feet	core	Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
141	143.2	1.2	AX	0.07	*0.1	Trace	None				
143.2	144.1	.9	AX	.04	.1	"	0.35				
253	258.5	5.5	AX					*0.02	*0.1	Trace	0.20
258	258.5	.5	AX	.04	*.1	"	.25				
258.5	260.7	2.2	AX	.05	*.1	0.015	1.15				
261	265	4.0	AX	.05	*.1	.005	.75				
261	266	5.0	AX					.02	1.5	0.005	1.00
289	293	4.0	AX	*.02	*.1	Trace	None	*.02	.3	Trace	None
293	297.4	4.4	AX	*.02	*.1	"	"				
297.4	300.4	3.0	AX	*.02	*.1	"	"				

Hole AE-6 (Cont'd.)

Footage			Size of core	Analyses							
				Core				Sludge			
From:	To:	Feet		Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
300.4	302.8	2.4	AX	0.24	3.3	Trace	0.60				
293	303	10.0	AX					0.04	0.5	Trace	0.20
303	304.8	1.8	AX	.05	.9	"	None				
304.8	308.5	3.7	AX	*.02	*.1	"	"				
303	308.5	5.5	AX					*.02	.4	"	None
308.5	313	4.5	AX					.05	*.1	"	0.20

*Less than.

Hole: AE-7
Location: 1613 N.; 1104 W.
Elevation of collar: 1,337.5

Depth: 320
Dip: -39°
Bearing: N.88° W.

Footage			Size of core	Analyses							
				Core				Sludge			
From:	To:	Feet		Cu, percent	Zn, percent	Au, oz.	Ag, oz.	Cu, percent	Zn, percent	Au, oz.	Ag, oz.
240	250	10.0	EX					0.07	0.5	Trace	None
249.5	250	.5	EX	0.04	*0.1	Trace	0.40				
250	251.2	1.2	EX	.07	*.1	0.060	2.50				
250	255	5.0	EX					.13	.2	0.005	0.40
255	255.5	.5	EX	.18	.1	Trace	None				
255	260.0	5.0	EX					.03	*.1	Trace	.20
260	260.3	.3	EX	*.02	1.8	0.005	0.50				
260	265	5.0	EX					.05	*.1	"	.20
265	270	5.0	EX					*.02	.6	"	.55
270	272	2.0	EX	*.02	*.1	Trace	.30				
280	283.2	3.2	EX	.04	*.1	"	.20				
280	285	5.0	EX					*.02	.2	"	.20
285	286.7	1.7	EX	.15	2.2	0.08	2.90				
285	290	5.0	EX					.04	.1	0.015	1.60
290	290.8	.8	EX	.20	4.5	.05	2.70				
290	295	5.0	EX					.07	1.6	.025	1.50
295	295.1	.1	EX	.07	2.4	Trace	.40				
295	300	5.0	EX					.10	2.0	.010	.95
300	301.3	1.3	EX	.16	3.6	0.005	.45				
300	305	5.0	EX					.08	2.0	.005	.40
305	310	5.0	EX					.06	1.8	Trace	.45

*Less than.

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