INVESTIGATION OF THE YELLOW PINE
ZINC-LEAD MINE, CLARK COUNTY, NEV.

BY R. W. GEEHAN AND W. T. BENSON

BUREAU OF MINES
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ALASKA BRANCH
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A Century of Conservation

1849 1949

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

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R. W. Geehan¹/ and W. T. Benson¹/

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¹/ Mining engineer, Reno Branch, Mining Division, Bureau of Mines, U. S. Department of the Interior.

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INTRODUCTION AND SUMMARY

The Yellow Pine zinc-lead mine, situated about 3-1/2 miles northwest of Goodsprings, Clark County, Nev., was explored by core drilling during the fall of 1942 and the summer and fall of 1944 by the Bureau of Mines in cooperation with the Federal Geological Survey.

The Yellow Pine district was located in 1855. The original claims covering the Yellow Pine mine were located in the following years: Rover, 1892; Hilo, 1897; Bybsee, 1900; Radio and Como, 1906. The mine was operated by the Yellow Pine Mining Co. from 1906 to 1929. This company was dissolved in 1935. At a later date, S. E. Yount and the Security First National Bank of Los Angeles, Calif., acquired ownership of the mine. Since 1939, the mine has been operated in a small way by lessees.

Production has been at least 175,000 tons averaging about 10 percent lead and 25 percent zinc, with a gross yield of $5,785,174.2/ Virtually all ore produced by this mine consisted chiefly of oxidized zinc and lead minerals and came from long, pipelike shoots in the 100-foot thick Yellow Pine limestone. Ore shoots are sharply defined; elsewhere, the limestone is nearly barren. Numerous faults cut the mine into blocks. Ore is now mined in an open stope, but in the past, large tonnages were mined in stopes by square-set methods. Ore produced recently was shipped direct to smelters unprocessed; in the past, it was milled by gravity and produced separate lead and zinc concentrates.

The Bureau of Mines completed 99 holes having a combined length of 10,274 feet. As a result of this work, four small ore sections were discovered in widely separated parts of the mine.

Mine workings and Bureau of Mines core-drill holes have explored the mine rather thoroughly from the surface to the 900-foot level and from the vertical shaft on the north to the southernmost workings.

The large, high-grade stopes mined in the past were so profitable that additional exploration seemed justified, and the Coronado Copper & Zinc Co. started core drilling immediately following the close of the Bureau of Mines work. Subsequent drilling by this company and the present lessees has not disclosed any important new ore sections. Operation of the mine was recently stopped because of the lack of shipping-grade ore.

ACKNOWLEDGMENTS

Analytical work and beneficiation tests of this investigation were under the direction of the late E. S. Leaver and A. C. Rice of the Metallurgical Division of the Bureau of Mines.

Acknowledgment is made to S. G. Lasky, D. F. Hewitt,\(^3\) Claude C. Albritton, and John A. Reinemund, of the Federal Geological Survey, for cooperation in planning the drilling program, and to Arthur Richards and A. L. Brockway, also of the Federal Geological Survey for advice on geological problems encountered during the project. Acknowledgment is made to Basil Prescott, lessee of the mine, and to Roy W. Moore, manager of Coronado Copper & Zinc Co., for cooperation in arranging for underground drill stations, and to E. B. Kimney, superintendent of the Yellow Pine mine, for cooperation in all phases of the drilling.

This report was prepared under the supervision of A. C. Johnson, chief, Reno Branch, Mining Division.

LOCATION AND OWNERSHIP

The Yellow Pine holdings comprise 17 claims owned by S. E. Yount and the Security First National Bank, both of Los Angeles, Calif. The property was held under lease and option by the Coronado Copper & Zinc Co., 1206 Pacific Mutual Building, Los Angeles, and more recently by Roy Jacobson and Ralph Hamilton, who obtained a lease on the property after work was stopped and the lease was relinquished by the Coronado Copper & Zinc Co. The claims cover most of the ravine known locally as Porphyry Gulch, in secs. 17 and 20, T. 24 S., R. 58 E., Mount Diablo base and meridian (fig. 1).

HISTORY

The Yellow Pine district is reported to have been discovered by the Mormons in 1855, and 5 tons of metallic lead is said to have been reduced in that year. According to Hewitt,\(^4\) the earliest recorded locations at the Yellow Pine mine were the Rover and Hilo claims, located in 1892 and 1897, respectively. The Bybee claim, located by Addison Bybee in 1900, lies between the other two claims and covers the ore bodies that gave the mine its early importance. Since 1900, the workings have been extended and additional claims have been acquired. The original Yellow Pine Co. was organized by J. F. Kent in 1901 with 250,000 shares, but in 1906 it was reorganized with 1,000,000 shares of $1 par value.

The first shipment from the property was 18 tons of oxidized copper ore obtained in 1906 from a shallow working 500 feet south of the Hale shaft. Small bodies of mixed lead-zinc ores were mined in 1907 from workings in the Discovery shaft. A large body of zinc ore was struck in this shaft at a depth of 110 feet. This body was followed southwest, which led to the successive exploitation of deeper bodies still farther southwest, and in 1912 to the sinking of the main shaft from which all the ore bodies in the southern part of the mine to the 900-foot level were mined. The large ore bodies found in the northern part of the mine were explored and stoped from 1916 to 1929, and more recently by lessees.

\(^4\) Work cited footnote 3.

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Figure 1. - Location map.
Ore-production records of the Yellow Pine mine vary greatly; 175,457 tons, with a gross value of $5,785,174 from 1911 to 1940, was reported by the State. The Geological Survey states that 201,922 tons were mined from 1906 to 1928, and that less than 4,000 tons was produced prior to 1911. Geological Survey Professional Paper 162[1] contains statistics on production, costs, dividends, etc., by years, for the period 1907 to 1929. The Coronado Copper & Zinc Co. shipped 2,240 dry tons of ore from December 1942 to December 1944. It is reported that 3,000 tons additional has been produced and shipped by Jacobson and Hamilton, lessees, during the period 1945 to 1948. The Yellow Pine mine has been the largest single producer of zinc-lead ore in the Goodsprings District.

The original Yellow Pine Mining Co. paid dividends totaling $2,500,000 from 1915 to 1925. The company was dissolved in 1935, and the mine was acquired by the present owners. Production since 1939 has been relatively small, and no large ore bodies have been discovered. Several individuals and companies have worked the mine under lease, and considerable exploring has been done to find other large ore bodies, such as were mined during early operation of the mine. The most recent exploring was done by the Bureau of Mines in 1942 and 1944 and by the Coronado Copper & Zinc Co. on ore located by early Bureau of Mines work.

At present the Goodsprings District is nearly dormant, there being production from only a few properties and no large-scale operations. During the period when low-grade ore was purchased by the Metals Reserve Co. at the Jean stock pile, mining was stimulated in the area, but very little new ore was found; production was largely from remnants of old ore bodies.

**PHYSICAL FEATURES**

The Yellow Pine mine is in the foothills of the Spring Mountains near the southern end of the range. All workings are near the head of Porphyry Gulch, a tributary of Goodsprings Valley. Because of moderate relief in the area, shafts are required to develop the mines. Surface altitudes at the Yellow Pine mine range from 4,450 to 4,750 feet; the old mill at Goodsprings is at an altitude of 3,750 feet. The region is shown on the Federal Geological Survey maps that accompany Professional Paper 162[1] and on Federal Geological Survey topographical map of the Goodsprings quadrangle.

An ample supply of water for use at the mine is trucked from a well at Goodsprings, which also supplied the old mill during its various periods of operation and now supplies most of the town of Goodsprings.

The climate is typical of the southwestern desert country, summers being very hot and winters moderate. Annual precipitation averages 4.5 inches. No surface streams are within the area. The mine workings have been flooded once in 40 years, and the Goodsprings townsite has been damaged several times by flash floods. Sagebrush and joshua trees constitute almost the only vegetation. No timber suitable for mine use is in the district.

5/ Work cited in footnote 2.
6/ Work cited footnote 3, p. 130.
7/ Work cited in footnote 3.
Freight shipments are handled through Jean and Suter, both on the main line of the Union Pacific Railroad, 7.5 and 11.5 miles respectively, from Good springs. Suter is the nearest station with a loading ramp. Ore is trucked from the mine to Jean at a cost of $1.10 per ton and from the mine to Suter at a cost of $1.50 per ton. The freight rate on a typical ore shipment from Suter to Salt Lake City, Utah, is $3.75 per ton based upon valuation up to $15 per ton.

A 7.5-mile paved road connects Good springs with Jean and U. S. Highways 91 and 466 (fig. 1). An improved graveled road extends from Good springs to the mine. Mail is delivered at Good springs 6 days a week. Telegraph service is available at Jean, and the nearest long-distance telephone service is at Las Vegas. A 11,500-volt power line of the Southern Nevada Power Co. passes within 2 miles northeast of the mine. The rates charged the Keystone mine for power from this line varies from a minimum of $4 per month, or $1 per month per connected horsepower, to a maximum of 0.8¢ per kw.-hr. for connected horsepower in excess of 200.

This information was supplied by E. E. Kinney, manager of the Keystone mine and superintendent of the Yellow Pine mine.

HOUSING FACILITIES

The Good springs Hotel provides fair living quarters and board for about 35 men. A few houses and many shacks are for rent at Good springs. No housing, shower, or dry house are provided at the mine.

EQUIPMENT

The mine is equipped for small-scale operation. The surface plant consists of compressor and hoist-house, blacksmith shop, 180-ton sorting bin, 250-ton storage bin, and sundry tanks. Following is a list of the more important items of equipment:

Blacksmith shop:

1 Large drill-sharpening machine.
1 Drill press with gas-engine power.
1 Set of hand blacksmith tools and acetylene welding outfit.

Compressor and hoist house:

1 Vertical, single-cylinder, hot-head Diesel, 40-horsepower, direct-connected to
1 Single-drum hoist, 4-foot drum.
1 Vertical, 2-cylinder, hot-head Diesel, 80-horsepower, belt-connected to
1 Horizontal, 2-stage, Corliss-type compressor, approximate displacement, 500 cu. ft. free air per minute.
1 Belt-driven (by compressor engine) generator complete with switchboard. This equipment has not been in use for several years.
Figure 2. - Mine map, showing principal workings and drill holes.
Horizontal, combined, hot-head engine and compressor.
(This piece of equipment has not been used in several
years and is said to be unsatisfactory).

Underground equipment;

Sundry rock drills, tuggers, skips, cars, etc.

In addition to these items, there are two electric hoists and a gas-engine
hoist, all out of use for many years and of doubtful value.

MINE WORKINGS (FIGURE 2)

All ore produced by the Yellow Pine mine came from underground stopes
worked through shafts. At one time there were seven working shafts, but at
present only the main inclined shaft is in operating condition. Mine workings
are extensive and have partly prospected the mineralized area through a verical
range of about 700 feet and over a strike length of roughly 2600 feet.

At present, the Yellow Pine mine is worked through a 2-compartment (hoist
and manway), 30-degree, inclined shaft with levels designated as 200, 300,
500, 600, 700, 800, and 900. The 1,000 and 1,200 levels are reached through
the south winze from the 900, and levels known as the 1,000 and 1,100 have
been driven from the north winze, also collared at the 900. The only active
stopes is on the 970 level, which is reached through the 70-foot No. 970 winze.
In following small stringers, ore bodies have been stope by using open-stull
and pillar-supported stopes. A maze of short inclines, raises, and drifts
also have contributed considerable tonnage. Square setting was the method
employed in stoping and was used primarily for staging purposes, as the walls
are firm and require little or no support.

In the stoping operation, it is estimated that for each 2,000 tons of
ore shipped, approximately 1,000 tons of waste was broken. From each ton
classed as ore underground, 10 percent is discarded as waste on the surface
sorting table. Based upon the size of waste dumps and upon reports from
"old-timers," a large percentage of the material broken, even in the best
stopes, was discarded as waste.

From December 1942 to December 1944, the Coronado Copper & Zinc Co., pro-
duced and shipped 2,000 dry tons from the 970 stope, 148 tons from the Little
C stope, and approximately 90 dry tons from all other underground work. In
addition, a large tonnage of mill slime was shipped to the Government stock
pile at Jean, Nev., about 11 miles southeast of the property. Recent ship-
ments by the lessees, Jacobson and Hamilton, amounted to about 3,000 tons
taken from newly found ore sections and from old stope fills.

EFFECT OF LOCAL GEOLOGY UPON MINING METHODS

As at some mines, the choice of mining methods has been dictated by local
geological conditions. The following are believed to have been the important
factors at the Yellow Pine mine:

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Virtually all the ore has been found as long, pipelike shoots in the 100-foot thick Yellow Pine limestone. This member is underlain by the 10-foot-thick Arrowhead "thin beds," which are next above the 300-foot-thick Bullion limestone. Above the Yellow Pine limestone is a 50-foot bed of Birdspring sandstone, and next above is a porphyry sill several hundred feet thick. Average dip of all members if 40°. Numerous minor faults cut the entire series, and a few major faults offset the beds as much as 250 feet horizontally. Ore shoots tend to follow the strike of the bedding and pitch from nearly flat to 30°, with very irregular local variations. Minor faults complicate local features, and major faults cut off the ore shoots and divide the mine into blocks.

**Exploration**

The pipelike nature of the ore bodies makes exploration an expensive and long operation. The original ore discovery was fortuitous, as there are very few outcrops of ore. Operators have used various theories as guides to exploration; but fundamentally all are based upon probing the Yellow Pine member more or less systematically.

**Development**

After finding ore bodies, it is necessary, because of their irregular and sinuous nature, to first follow them with combined exploration-development workings. In small ore bodies, such as the present 970, this type of work overlaps exploitation, and this tends to be true even on large ore bodies. Because of the pipelike shoots and the variations in pitch, past operators found it necessary to drive miles of development drifts and scores of raises. No concrete plan for a development program can be worked out in advance of exploration.

Shafts sunk in limestone remain open indefinitely, whereas those sunk through porphyry require considerable retimbering.

**Exploitation**

Past operators found the unfilled square-set method ideal for stoping large ore bodies, owing to the great variations in size, shape, and trend of the shoots. Square sets were used primarily for staging and were frequently removed for reuse in later work. After removal of the timber, many of the old stopes have remained open for about 20 years with only a moderate amount of sloughing. Limestone wall rock stands well, even where badly fractured, and some open stopes in broken ground have a transverse span of over 50 feet; but the sandstone is less firm and tends to slab off in unsupported areas. Porphyry is very weak. One large stope with a sandstone hanging wall began to cave before ore extraction was completed and is now completely caved because the sandstone slabbad off and exposed the porphyry; unfilled square sets could not support this ground.

Observations in the present stopes make it clear that the extensions of the ore bodies are not certain until developed and that a large quantity
of waste is broken in mining. This makes the great flexibility of the open square-set method a factor of considerable importance, as it facilitates following the ore in any direction. At present, no ore bodies large enough to require square sets are known, and stalls and pillars are used for staging and support.

The great lateral extent of the ore in proportion to tonnage mined requires an unusually large footage of shafts, drifts, and raises. The irregular ore bodies make systematic underground gobbing of waste impractical, and much of this material has been hoisted to surface dumps. Exploration along numerous small cross faults has produced winding workings, and where these are used as haulageways the short-radius curves prevent mechanical tramming. Large faults further complicate haulageways, because their locations favored development through numerous short shafts, which were sunk to avoid excessive drifting from one faulted segment to another.

Ore in past and present stopes has been firm, and no running ground has been found. All workings in limestone are dry, whereas those in porphyry are damp or wet. The Yellow Pine mine was once inundated by a flash flood, but the water drained off in a few weeks through fractures in the limestone. On the levels, timber is used only in the porphyry. Except in dead-end workings with no ventilation, the timber lasts almost indefinitely, but in stub raises it rots in a few years. To sum up, local geology limits mining to the employment of costly methods.

GEOLOGY OF THE YELLOW PINE MINE

The sedimentary rocks of the Yellow Pine mine consist of a thick section of Monte Cristo (Mississippian) limestone and dolomite beds overlain by the basal sandstone of the Bird Spring (Pennsylvanian and Permian) formation. The beds strike north-northeast and dip at an average of 40° west. The sediments are cut by dikes and sills of granite porphyry.

The oldest rocks belong to the Bullion member of the Monte Cristo limestone. The 200 feet of Bullion exposed in the workings consists of gray dolomite with vugs up to a centimeter across filled with milky calcite. Bedding is obscure, and it is commonly difficult or impossible to determine strike and dip. Lenticels of brownish chert up to 1 foot thick are locally present, as are coral heads, which may form reefs as much as 12 feet long and 3 feet thick.

Overlying the Bullion is 10 feet of thin-bedded dolomite designated by Howitt as the Arrowhead member and locally called the "thin beds" or "two-inch beds." Individual beds range in thickness from a fraction of an inch to 3 inches. Separating them are shaly partings a fraction of an inch thick.

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Above the Arrowhead is the productive Yellow Pine member of the Monte Cristo - a hundred feet of dense, gray dolomite and limestone bedded in units from a few inches to several feet in thickness. Locally, zones as thick as 30 feet in the upper part of the Yellow Pine are silicified.

Overlying the Yellow Pine member is the Bird Spring formation, represented in the mine by a basal sandstone 30 feet thick. The sandstone has a sugary texture that can generally be recognized without the aid of a hand lens. In some places it is weakly cemented; elsewhere it is quartzitic.

The sedimentary rocks are cut by dikes and sills of quartz porphyry. The largest porphyry body is a sill that has separated the basal sandstone of the Bird Spring formation from the overlying beds.

The sediments are broken along the strike by thrust faults that dip west. Four master thrust zones, each inclined at an angle less than the dip of the beds, divide the section into imbricate blocks. Displacements, as measured along the dip of individual thrusts, are small and amount to only a few score of feet. The master thrusts are linked by subsidiary thrusts, some of which follow the bedding and others of which are inclined at angles steeper than the bedding.

Breciation along the master faults varies in amount from place to place. Locally, the shearing may be distributed through a zone as thick as 20 feet, within which the rocks are fragmented. Elsewhere the shears appear as sharp breaks that cut cleanly through the rock. Those variations are believed to bear on the localization of the ore, but they have not yet been satisfactorily explained. The admittedly inconclusive evidence at hand suggests that the brecciation along the thrusts is more extensive at places where the bedding shears and high-angle thrusts branch from the master thrusts.

The thrusts are displaced by two systems of moderately to steeply dipping faults along which the movement is largely horizontal. The older of the two systems includes faults that trend between northwest and west-northwest; the younger, or Alice system, includes arcuate faults that generally trend north. The greatest horizontal displacement along a single fault in these systems amounts to 250 feet. Both sets of faults are believed to be premineral.

As a consequence of an early stage of thrusting followed by two stages of high-angle faulting, the ground in and around the mine is generally broken throughout.

The Yellow Pine ore bodies have their longest dimension parallel or nearly so, to the strike of the local bedding. At least 90 percent of the ore mined has come from the Yellow Pine member of the Monte Cristo limestone. It is believed, however, that the controls are structural rather than stratigraphic. The location of the brecciated ground along the thrusts is the important factor in the localization of the ore bodies.

The main ore run of the Yellow Pine mine has an over-all length of 2,000 feet. The center of the run is within 100 feet of the surface east of the
inclined shaft. To the south, the run plunges at about 15° to the 700 level and crosses the inclined shaft between the 600 and 700 levels. At the 600 level a branch from the run climbs to the south at about 25° to the 300 level. This south half of the run is continuous, although now locally back-filled. To the north, the main run encounters the Bybee fault zone ("K" faults on geologic map). Starting at this fault zone, the stopes are gradually stepped down to the north to the 900 level. Several smaller runs, such as the Copper and Bullion stopes, roughly parallel the main run. The main run of stopes is entirely in the Yellow Pine member, but the Copper and Bullion stopes are in the Arrowhead and Bullion members, respectively.

Presumably, the primary ore bodies were predominantly sulfides, of which the two most important minerals were galena and sphalerite. Subsequent to its deposition, the ore has been oxidized to some unknown depth below the deepest workings in the mine. This alteration has changed the original sphalerite to smithsonite (ZnCO₃), calamine (H₂ZnSiO₅), and hydrozincite (2ZnCO₃·Zn(OH)₂). Galena remains as the only observed representative of the primary assemblage, but it, too, has undergone local alteration, partial or complete, to cerussite (PbCO₃) and anglesite (PbSO₄). There has been some migration, both downward and laterally away from the sites of primary ore bodies. However, it is believed that the amount of such migration has been small in comparison with the amount of ore, which remained essentially at the site of the primary deposition.

Judging by the exposures around the little Copper stope and the 970 winze, the typical ore is porous and poorly indurated. It consists of aggregates of loosely coherent calamine crystals coated with limonite. Cerussite forms pods and stringers as much as a foot long and 3 inches thick, which may enclose nuclei of galena. Between the richer stringers of ore are barren ribs of dolomite, which may be as thick as 10 feet but which in the richer zones average less than 1 foot and comprise less than 20 percent of the material mined.

The Bureau of Mines drilling program has tested the favorable area adjacent to the present mine workings south of the vertical shaft and above the 900 level for occurrence of sizable ore bodies. Except for the relatively shallow north and south winzes, the 970 winze, and a few drill holes, very little exploring has been done below the 900 level.

THE ORE

Ore now being shipped from the 970 stope is a porous mass of calamine crystals stained with limonite and containing variable amounts of galena, cerussite, and anglesite. Unreplaced dolomite and sandstone form the gangue. Ore produced in the past from other stopes is said10/ to have been largely hydrozincite.

No zinc sulfide is in the ore. The lead sulfide, galena, is in nearly all the workings, with no apparent increase in the ratio of galena to oxidized lead minerals at depth. Traces of malachite are in most ores.

10/ Work cited footnote 3.
With the exception of hydrozincite, all the lead-zinc minerals are commonly in grains over 1/16 inch and under 1/4 inch in length. Most hydrozincite specimens that can be seen in the old stopes are in earthy masses. Nodules of galena up to 6 inches in diameter are not uncommon.

All the ore that can be examined in the mine at present is physically strong, from the miners' standpoint. Blasting with light loads brings it down as a "sandy" product, with only a few large boulders over 6 inches in diameter.

Any future ore discovered within 300 feet of present mine workings will probably be oxidized. No reliable estimates of the depth to the water table and sulfide ore can be made.

MILLING

During the productive period, the ore was treated in a series of mills at Goodsprings. The following is quoted from Hewitt:11/

In order to ship products that would yield the greatest profit, the company has faced a peculiar milling problem. Most of the stopes have yielded an intimate mixture of galena and oxidized lead and zinc minerals rather free from gangue minerals. It has been the purpose to separate, as far as possible, the lead and zinc minerals and to throw nothing away.

The first mill used by the company in treating the ore from the Yellow Pine mine was that built in 1899 by lessees of the Columbia and Bosc mines. When remodeled to treat Yellow Pine ore, it contained rolls, screens, Harz jigs to treat the coarse sizes, Richards classifier, and Overstrom tables. In 1919, after a fire at the mine, the mill was remodeled, and eight Diester-Overstrom tables, screens, jigs, and five oil-fired calcining furnaces were installed. About 1920, the company permitted the United States Bureau of Mines to make exhaustive tests in an experimental plant to determine the feasibility of separating the lead and silver from the zinc by chloride volatilization. Although the tests were encouraging, no attempt has been made to change the milling plant. The remodeled mill was burned in September 1924 and has since been replaced by a new mill.

This mill was destroyed by fire in 1929. A new mill that employed flotation was completed in 1930 but did not prove successful. It was dismantled and sold after 2 weeks of operation.

PLAN OF PROJECT

In September 1942, the Bureau of Mines proposed exploration of the Yellow Pine mine by core drilling. This proposal included underground and surface

Figure 3. - Assay logs of drill holes 30 to 34, 700-foot level, shown on section through holes parallel to and near center of section line H-H' shown on figure 2.
Figure 4. - Plan and vertical section YHU showing drill holes YHU-1 and 2, 900-foot level (see fig. 2).
Figure 5. - Plan and vertical section YNS showing drill holes YNS-1 to 3 from surface (see fig. 2).
Figure 6. - Plan and vertical section YJU showing drill holes YJU-1 and 2, 900-foot level (see fig. 2).
Figure 7. - Plan and vertical section YBS showing drill holes YBS-1 to 8 from surface (see fig. 2).
Figure 8. - Plan and vertical section YIU showing drill holes YIU-1 to 10, 800-foot level (see fig. 2).
Figure 9. - Plan and vertical section YAS showing drill holes YAS-1 to 8 from surface (see fig. 2).
Figure 10. - Plan and vertical section YCS showing drill holes YCS-2 to 8 from surface and section holes.
Figure 11. - Plan and vertical section YDU showing drill holes YDU-1 to 9 from 200-foot level; section YKS showing drill holes YKS-1 to 3 from surface; and section YMS showing drill holes YMS-1, 2, and 3 from surface (see fig. 2).
Figure 12. - Vertical section B-B' showing drill holes H25 and H29 from surface (see fig. 2).
Figure 13. - Vertical section G'-G' showing drill holes H50 to H53 from 900-foot level, and drill holes Y1U-1 and 2 from 800-foot level (see fig. 2).
Figure 14. - Vertical section N-N' showing drill holes 60 and 61 from surface (see fig. 2).
SECTION "49-49A"

Figure 15. - Vertical section 49-49A showing drill holes 49 and 49A from 900-foot level (see fig. 2).
SECTION D-D'

Figure 16. - Vertical section D-D' showing drill holes 43 to 45 from 700-foot level and 40 to 42A from 900-foot level (see fig. 2).
Figure 17. - Vertical section along North winze showing section drill hole 48 from 900-foot level; three drill holes by the Coronado Copper & Zinc Co. from the 1,100-foot level; and holes YHU-1 and 2, shown in figure 4, from 700-foot level (see fig. 2).
Figure 18. - Vertical section H-H', showing drill holes 30 to 34 from 700-foot level and 36 to 39A from 300-foot level (see fig. 2).
drilling to test possible faulted blocks indicated by mine mapping. The Bureau of Mines and the Geological Survey proposed additional core drilling. This proposal included holes designed to test areas indicated by a study of the mine by the Geological Survey.

WORK PERFORMED BY THE BUREAU OF MINES:

The original Bureau of Mines program in 1942 comprised exploration by surface and underground diamond drilling. Drilling was done under contract; 33 holes from surface set-ups and 31 holes from underground stations had an aggregate length of 5,161 feet. Drilling indicated three mineralized areas in widely separated parts of the mine.

No abnormal difficulties in drilling were encountered. Core recovery varied greatly because of the broken character of the limestone, the oxidized sections encountered, and the character of the ore. Sludge recovery was poor, especially in the mineralized zones, and reaming and casing was often necessary to seal off large cavities.

Subsequent work by the Bureau of Mines in 1944 continued the exploration of favorable areas by diamond drilling. Drilling was again done under contract; 9 surface and 26 underground holes, having a total length of 5,113 feet, were drilled. No large ore bodies were indicated by this work.

Surface holes were drilled vertical and presented no unusual difficulties. Underground drilling comprised "up" and "down" holes, the former varying from flat angle holes to vertical.

Surface and underground "down" holes were slower and more expensive to drill owing to frequent cementing and reaming and casing required to obtain adequate water recovery. Core recovery ranged from 31 percent in the underground "down" holes to 51 percent in underground "up" holes and 36 percent in surface holes.

Figure 2 (mine map) shows the locations of diamond-drill holes, and figures 4 to 18 (plans and vertical sections) show mine workings and structural geologic positions of rock formations. The sections serve as graphic drill-hole logs of rock formations penetrated. Appendix A embodies analyses of samples from drill hole 32, shown in figure 3, in tabular form.
# APPENDIX A

## Analyses of Diamond-drill Hole Samples

**Hole 32 (see figs. 2 and 18)**

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<th>To-</th>
<th>Feet</th>
<th>Percent recovery</th>
<th>Core</th>
<th>Analyses</th>
<th>Adjusted Average</th>
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### Hole 32-A (see figs. 2 and 18)

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### Hole 33 (see figs. 2 and 18)

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1/ Less than.

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APPENDIX A (Cont'd.)

Hole 34 (see figs. 2 and 18)

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