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Bureau of Mines
Report of Investigations 4860

DIAMOND DRILLING AT TORPEDO COPPER MINE, ORGAN MINING DISTRICT, DONA ANA COUNTY, N. MEX.

BY JOHN H. SOULÉ

United States Department of the Interior—March 1952

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* * * * * * * * * Report of Investigations 4860

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary
BUREAU OF MINES
J. J. Forbes, Director

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March 1952

DIAMOND DRILLING AT TORPEDO COPPER MINE, ORGAN MINING DISTRICT, DONA ANA COUNTY, N. MEX.

by

John H. Soulé[1]

CONTENTS

	Page
Introduction and summary	1
Acknowledgments	1
Location and accessibility	1
General information	2
General geology	2
Diamond-drilling equipment	3
Diamond-drilling procedures	3
Drilling data and costs	5
Core recovery	7
Conclusions	10

TABLES

1.	Drilling costs	6
2.	Diamond losses and costs by bit type and size	7
3.	Diamond losses and costs by diamond quality	7
4.	Core recoveries obtained in materials drilled	8
5.	Core recoveries obtained by bit sizes	8
6.	Core recoveries obtained by tool types	8
7.	Combination of tables 4 and 5	9
8.	Bureau of Mines drill hole logs	11

ILLUSTRATIONS

Fig.		Follows page
1.	Location map	2
2.	Topographic and surface map	2
3.	Bit assemblies	2
4.	Backhead assemblies	2

1/ Mining engineer, Bureau of Mines.

Report of Investigations 4860

INTRODUCTION AND SUMMARY

The Torpedo Copper mine in the Organ Mining District, Dona Ana County, N. Mex., was discovered in 1899. Production was begun immediately and continued until 1907. Since 1907 very little ore has been produced, although many individuals and companies have been interested in the property at one time or another. Approximately 6,621 feet of diamond-core drilling had been completed on the property before 1949. The results from some of this drilling were unsatisfactory because of the poor core recovery. In addition to its investigation of the Torpedo ore deposits, attention was given by the Bureau of Mines to obtaining better core recovery through the use of special equipment and techniques.

This project was begun October 3, 1949, and was completed April 30, 1950. Four diamond-drill holes totaling 2,140.5 feet, which includes 18.2 feet of overlap in a deflected hole, were drilled. All drilling was done with a Government-owned hydraulic-feed drill with some special rods and core barrels, in addition to the usual equipment.

The over-all core recovery was 89.5 percent. Omitting the drilling in overburden where little or no core was desired, the recovery was 94.6 percent. Core recovery in the ore zones averaged 95.2 percent.

This paper describes the location, the general features of the area, the geology, the Bureau of Mines procedures, and the results attained by these procedures.

ACKNOWLEDGMENTS

Acknowledgment of assistance rendered is due to W. R. Storms, chief, Arizona-Nex Mexico Branch, Mining Division, Region IV, Bureau of Mines, and to W. D. McMillan, supervising engineer of the New Mexico Field Office of Region IV, Bureau of Mines, for critical advice, and to A. E. Long, mining engineer of the Mount Weather, Va., Branch, Bureau of Mines, for assistance rendered at the start of the project.

Acknowledgment also is due to H. W. Foester, representative of the E. J. Longyear Co., for his cooperation and suggestions in the testing of the experimental L-Series core barrel and bits.

LOCATION AND ACCESSIBILITY

The Bureau of Mines drilling was confined to the Torpedo claim, in the NW1/4 sec. 1, T. 22 S., R. 3 E., in the Organ mining district, Dona Ana County, N. Mex. This area is 1/2 mile east of the town of Organ and is just

south of U. S. Highway 70 (see fig. 1). The property is easily accessible from Organ, as dirt roads reach each drill site as well as other parts of the area. Organ is 12.5 miles northeast of Las Cruces.

GENERAL INFORMATION

The foothill topography of the Torpedo and adjoining claims is not generally rugged, and the relief is not great. The mountains become steep and rugged southeast of the mine. The altitude of the project area vari s from 5,160 to 5,340 feet, as shown in figure 2.

The weather is generally good, although windy in the spring. Summers are not too hot, and the freezing weather in the winter is neither prolonged nor intense. The average annual precipitation is about 10 inches, largely as summer thundershowers. Winter snows are usually light and stay on the ground for only short periods of time.

There are no permanent streams, and the water table is about 300 feet below the surface. Drilling water was pumped from a depth of 317 feet in an old shaft. The country is arid, and the usual desert flora are present.

There is no skilled labor at Organ, and all such must be imported. The Bureau of Mines procured its labor from the Central mining district in Grant County, 125 miles to the northwest. Living accommodations at Organ are limited and primitive, and only the barest necessities may be purchased.

The Torpedo mine was discovered in 1899 and actively operated until 1907. Since that time, production has been sporadic, although many individuals and companies have been interested in the district. The total production from the Torpedo mine has been about 3,500,000 pounds of copper and a little silver.

GENERAL GEOLOGY

The most prominent geological feature of the Torpedo mine is the strong north-south trending, steeply dipping shear zone between the monzonite on the east and the Paleozoic limestones on the west. This zone contains the ore bodies and consists largely of monzonite, which has been silicified and highly altered, brecciated, and recemented with silica. Some altered limestone was noted in the drill core from the zone. A number of the faults of this shear zone apparently had considerable displacement, and the over-all displacement in the shear zone was large.

The monzonite is weathered at the surface and usually is covered by a few feet of rock overburden. Beneath the weathering, the monzonite is quite fresh and remains so, although some silicification may occur. Hydrothermal alteration is noticed before reaching the breccia zone, but the general texture of the monzonite is retained.

As shown in Bureau of Mines hole 4, the limestone is usually only slightly altered for the most part, although some beds are garnetized or otherwise silicated. Garnetization was noted over 200 feet from the breccia zone in some beds.

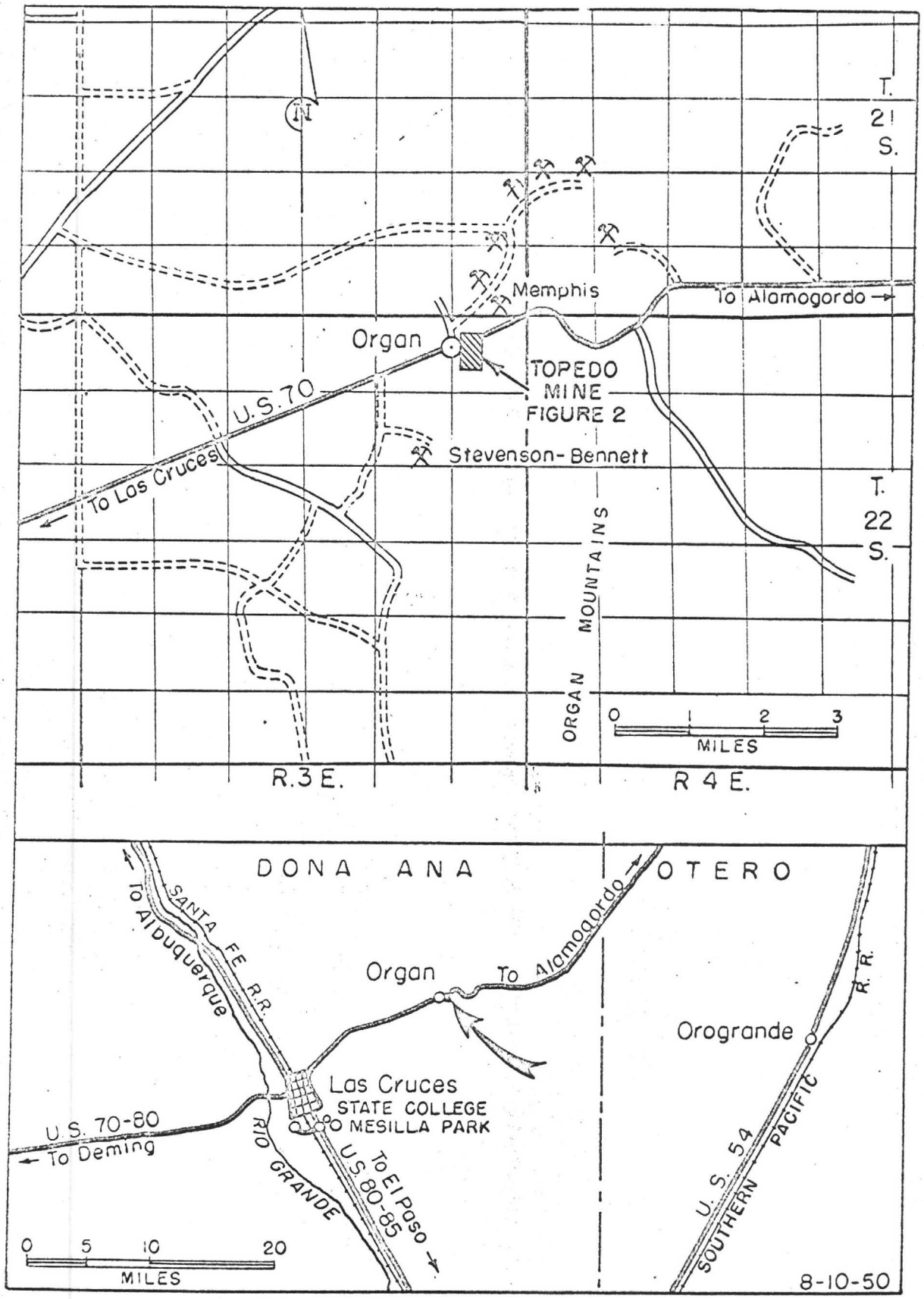

Figure 1. - Location map, Torpedo copper deposit, Dona Ana County, N. Mex.

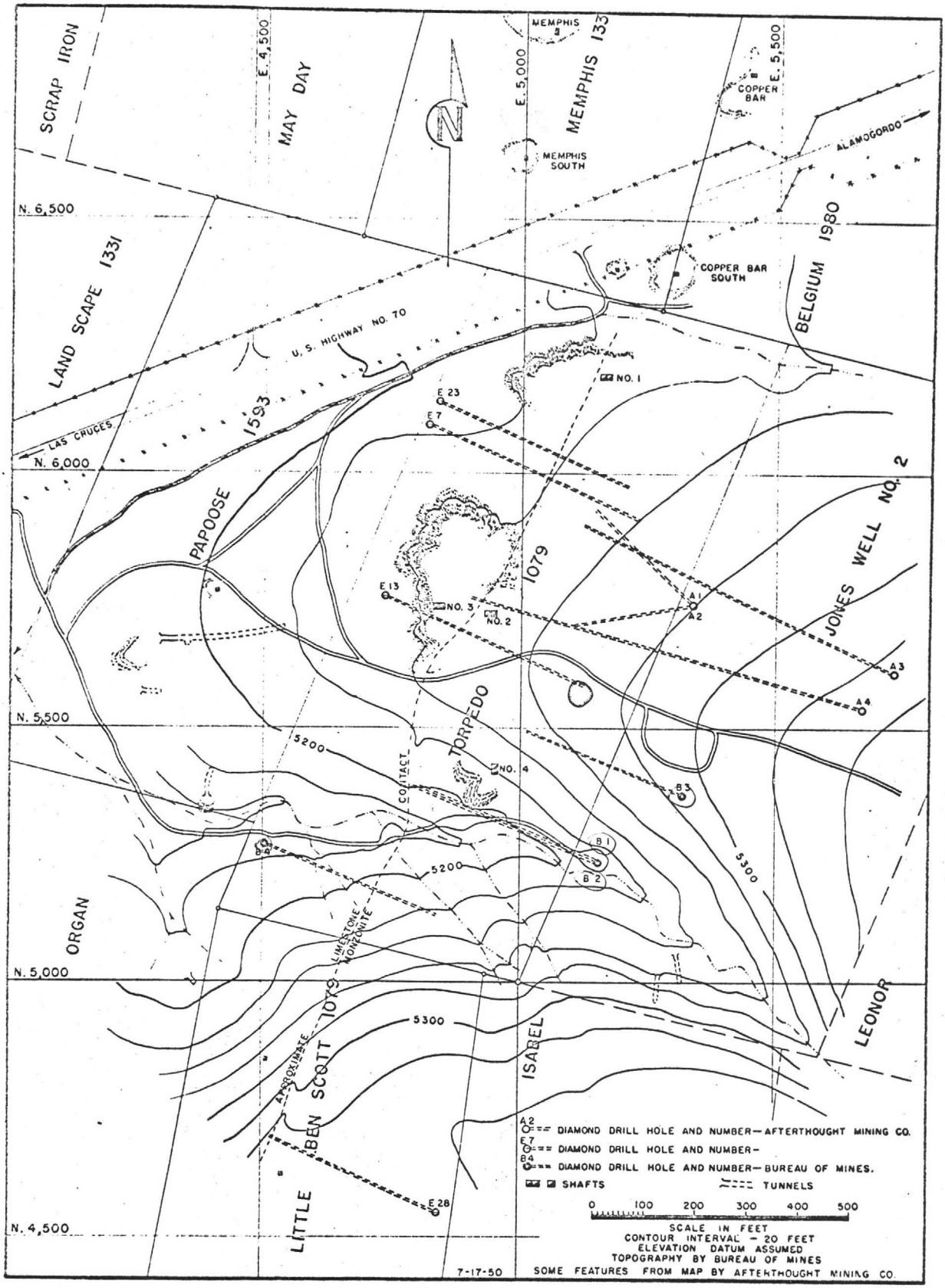

Figure 2. - Topographic and surface map.

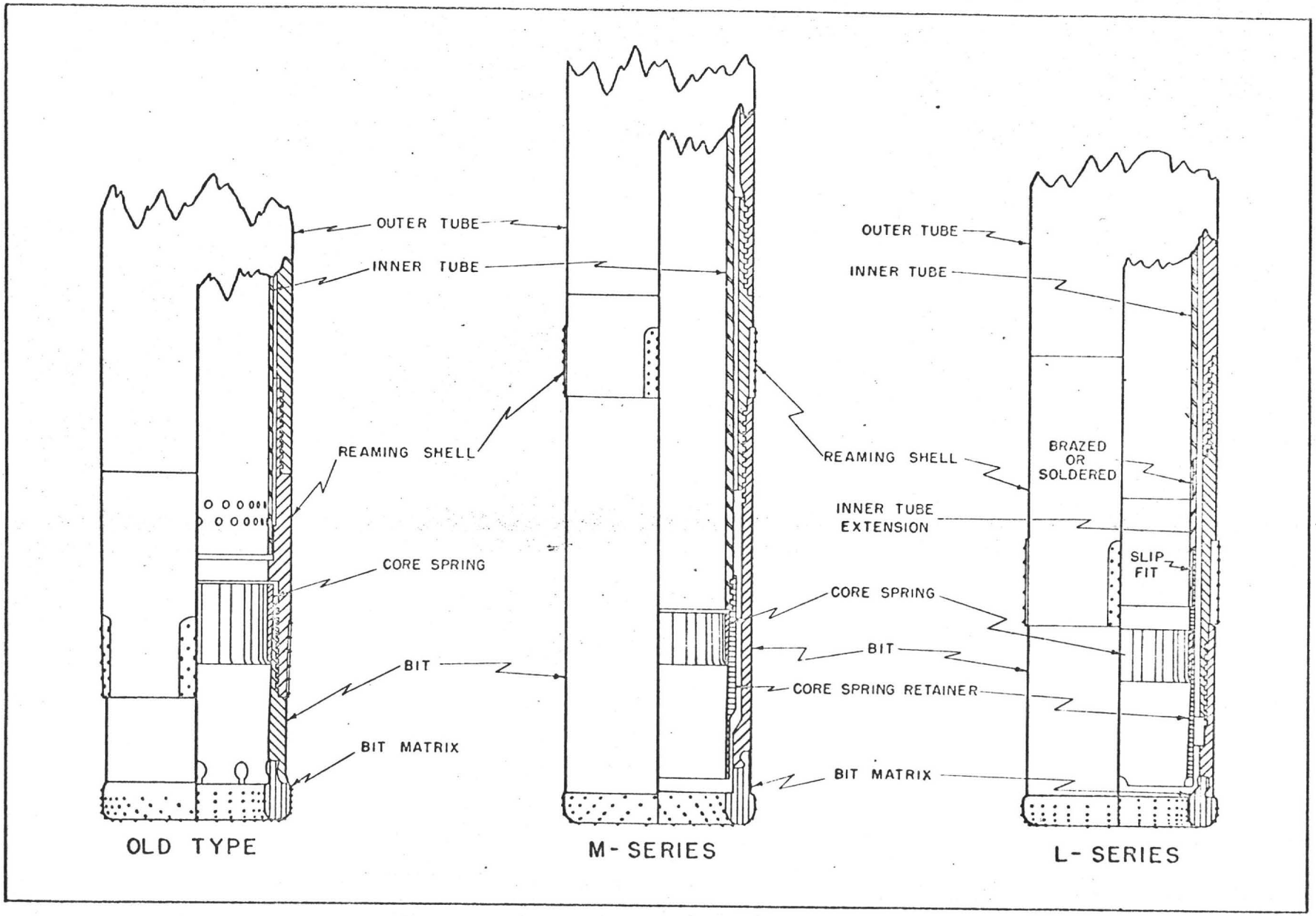

Figure 3. - Core-barrel diamond-bit assemblies.

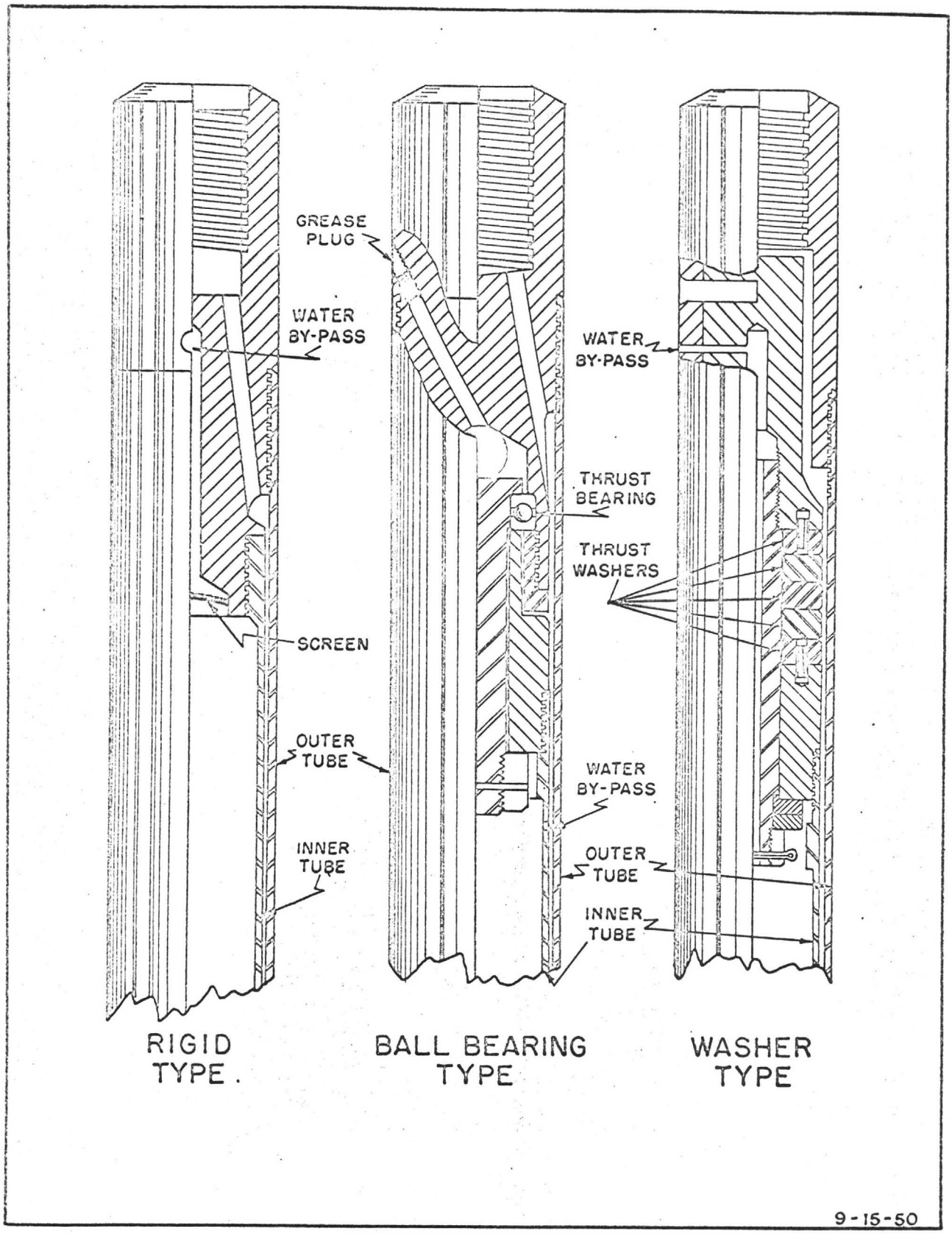

Figure 4. - Core-barrel backhead assemblies.

All of the rocks are jointed and fractured, and a piece of core over 2 feet long, was rarely taken from the core barrel, most pieces being 6 inches or less. This characteristic, as well as the fault gouges and breccias, may be in part responsible for the poor core recovery in previous drilling.

DIAMOND-DRILLING EQUIPMENT

A Government-owned, gasoline-engine-powered, skid-mounted drill having a rated capacity of 1,400 feet of A rod was used in this drilling. The drill was equipped with a closed-circuit, oil-activated hydraulic-feed head quilled for an A rod. The water was circulated by a three-cylinder, plunger-type, gasoline-engine-powered pump having porcelain-coated cylinder liners. A bail-type water swivel was used most of the time. A full complement of accessories, fishing tools, and other tools was available, as well as oxyacetylene welding equipment, which proved very useful a number of times. A heavy pole tripod was standard equipment.

Standard rods, fittings, and casing were available for AX drilling. Those used for NX and BX drilling were largely of special types or sizes and were purchased for the project. Most BX and NX casing was the heavy-duty-drive type used in anticipation of driving through the overburden; however, driving was not necessary. All larger-size rods were special, being termed BXO and NXO. The following tabulation describes the difference between the special rods and old standards.

	Outside diameter, inches	Wall thickness, inches	Weight per 10 feet, pounds
B rod.....	1-7/8	1/4	45
BXO rod.....	2-3/16	1/4	56
N rod.....	2-3/8	3/16	49
NXO rod.....	2-3/4	3/16	60

Most of the drilling was done with M-series core barrels and bits; a little work was done near the end of the project with an experimental L-series core barrel and bits in BX size. Figure 3 shows the lower or bit-end assemblies of the Standard, M-series, and L-series core barrels.

Figure 4 shows the back-head assemblies tried in this work. The bearing type, with a later replacement containing tapered roller bearings, was used most of the time. The washer type was used only in part of the last hole.

DIAMOND-DRILLING PROCEDURES

Only one of the drill operators had had any previous experience with a hydraulic feed head. The ability of the operators ranged from excellent to poor.

The need for special techniques of operation did not arise. The usual precautions any first-class drill operator would follow were used. Core recovery rather than speed was stressed repeatedly. Immediate pulling upon sign of a block was emphasized, but it is suspected that this was not always

done, especially after a very short run. It also was desired to use as little water as possible consistent with good drilling practice, but only the most-experienced men followed this. The less-experienced men seemed unable to grasp the idea and always tended to use an excess of water.

Care of the equipment was demanded at all times, but there was a tendency for the less-experienced men to forego greasing the machine and equipment and keeping it in perfect operating condition. It was difficult to keep the equipment clean at all times, usually because of neglect. It was standard practice to clean the equipment during delays owing to cementing or other causes.

The usual cementing techniques were followed. In cementing for cave or if cementing for water loss below the water table, all cement was inserted through the drill rods, which were cleaned immediately after the operation. The use of pellets of moist cement was resorted to a few times when it seemed that moving water in the hole would wash away cement inserted in a slurry form. In general, cementing was not particularly difficult, and rarely was a section of hole cemented more than two times to effect the desired results. One high-early-strength hydraulic cement was used throughout most of the work. Other cements tried when the hydraulic cement was not available were unsatisfactory, although some were of the high-early-strength type.

Most casing was thoroughly greased before being inserted in the hole, and no greased casing was lost. It appeared that one of the most important precautions to follow in casing a hole is to effect a perfect seal with the bottom of the hole. This will prevent return water from coming up outside the casing and washing away the grease, as well as serve to keep the fine cuttings from entering and settling around the outside of the casing. This was noted a time or two when a perfect seal was not effected and virtually all grease was washed from the casing and some sludge had settled behind it. One hundred fifty-three feet of BX casing was lost in hole 1 because the casing was not greased and, also, probably because the hole was under gage. No reaming shells were available at the start of this hole, and bits were issued in progressively smaller gage.

The drill rods were kept well-greased, two different greases being used. A universal joint grease was tried first and appeared to be beneficial in preventing caving of small particles in the hole, but it did not remain on the rods as well as was desired. The other grease was excellent for rods but may not be heavy enough to hold the walls of a hole in those areas where the slight support of a heavy grease might be advantageous.

All core was removed from the core barrel into a trough, made of an 11-foot piece of 2-1/2-inch pipe split lengthwise, with a piece of mild steel welded to one end to prevent its tipping over. The core was washed, if necessary, measured, and transferred to cardboard core boxes holding about 10 feet of core. Boxed core was then taken to the weighing shed where it was logged, remeasured, weighed, and split if desired. One half of the split portions were analyzed, and the remaining core was sent to a permanent core storage in Tucson, Ariz.

DRILLING DATA AND COSTS

A total of 2,140.5 feet was drilled in four holes, of which 18.2 feet was overlap drilling in an unintentionally deflected hole. Two holes were inclined at minus 50°, one at minus 45°, and one at minus 37°. All holes were drilled with an NX casing bit through the overburden to bedrock, then cased, and continued with NX size. Size was reduced when necessary or desirable.

In drilling 2,140.5 feet of hole, 413 pulls were made, an average of 5.18 feet drilled before blocking. With the NX double-tube, rigid type core barrel 5 ft. long, used before the receipt of the M-series equipment, an average of 3.73 feet was drilled before a block occurred. All other core barrels were 10 feet long. The remaining NX drilling averaged 5.23 feet per block, the BX drilling averaged 4.97 feet, and the AX drilling averaged 5.31 feet. Bit size seemed to have little effect on the frequency of blocking.

The 2,140.5 feet of hole were drilled in 197 drill shifts, an average of 10.87 feet per shift. Omitting six shifts spent jarring casing out of hole 1 but including every other delay, such as repairing equipment, moving, and setting up, waiting for cement to set, and other delays, drilling used 191 shifts, with an average of 11.21 feet per drill shift. Total labor amounted to 552 man-shifts, of which 192 were charged to sampling and the remainder to drilling.

The 111 bits used during the project are tabulated below.

Bit size and type	Number used
NX casing bits	8
NX standard bevel wall bits	3
NX M-series bits	62
BX M-series bits	29
BX L-series bits	5
AX M-series bits	4

The average footage drilled per bit was 19.28.

In addition to the drilling, 1,531 feet of casing was inserted into the holes. This includes overlap, and only 1,270 feet of hole was cased. A total of 684.8 feet of cemented hole was drilled out. Seventy samples were split from the cores and analyzed.

The drilling cost for the project was $14,327.51, which does not include the full cost of new equipment purchased. A portion of the cost of the new special rods, casing, and other equipment was charged according to the estimated amount of use they received. All transportation costs on equipment, as well as the cost of equipment lost or damaged, was fully charged to the project. All repair costs were fully charged, as well as an estimated cost for the use of equipment not purchased. No sampling costs are included.

The following table shows the distribution of the charges and the cost per foot:

TABLE 1. - Drilling costs

Item	Amount	Cost per foot
Labor	$4,941.07	$2.308
Supplies 1/	2,139.47	1.000
Supervision	2,904.55	1.357
Transportation 2/	294.81	0.138
Diamond bits	4,047.61	1.891
Total	$14,327.51	$6.694

1/ Includes an estimated amount for core barrels.
2/ Does not include express or freight on supplies. These are charged to supplies. Transportation includes the use of automotive equipment to haul water and for use around the project.

All diamond bits were handled through the Mount Weather, Va., Branch of the Bureau of Mines. All worn bits were sent to the Mount Weather Station, where they were examined and pertinent data were recorded; they then were sent to a bit manufacturer for resetting. The diamonds were reclaimed from the used bits, those not usable in a new bit being replaced with new stones. The cost of the new stones plus the setting charge, which consists of a new blank bit and the setting of the stones in their matrix in the blank, constitutes the cost of the bit. The setting charges vary from $6.20 to $24 per bit depending upon the bit type and size. The diamonds cost $4.20 to $11 per carat, depending on the grade. Table 2 shows the diamond consumption of each size and type of bit, while table 3 shows the diamond consumption for each different grade of diamond. These figures are indicative and not necessarily conclusive for two reasons: First, in some of the items not enough data are presented, being based upon the results obtained from too small a number of bits; and second, the distribution of the quality of the diamonds between the different bit sizes and types as well as the type of ground drilled is not constant. However, this distribution is broad enough to give credence to some of the figures.

Two major things are noted from the results given in table 2. Neglecting the BX L-series item, the per-foot bit costs are directly comparable to the size of the bit. It will be noticed that the bit costs decrease as the bit size decreases. Second, it is noted that bit costs rise when core is ground as shown in the NX casing and BX L-series items.

Table 3, based on the quality of the diamonds used and neglecting the two entries where only one bit was used, shows an advantage in using the cheaper diamonds. The use of cheapest diamonds resulted in less diamond wear as well as lower diamond costs per foot drilled.

TABLE 2. Diamond losses and costs by bit type and size

Item	Bits used	Feet drilled1/	Diamond loss		Diamond loss, carats		Cost in dollars2/	
			Carats	Dollars2/	Per bit	Per ft.	Per bit	Per ft.
NX casing	8	128.0	67.71	791.27	8.464	3/0.529	$98.91	3/$6.182
NX bevelwall	3	100.0	13.15	181.74	4.383	.132	60.58	1.817
NX M-Series	62	1,210.4	200.22	1,807.07	3.229	.165	29.15	1.493
BX M-Series	29	511.6	80.65	762.85	2.781	.158	26.31	1.491
BX L-Series	5	109.7	44.45	389.12	8.890	3/.405	77.82	3/3.547
AX M-Series	4	113.9	9.93	115.56	2.483	.087	28.89	1.015
Total	111	2,173.6	416.11	$4,047.61				
			Over-all average		3.749	.191	$36.46	$1.862

1/ Includes small footage drilled on other projects and machine anchors but no cement.
2/ Includes setting charge.
3/ Excessive figures owing to grinding core.

TABLE 3. - Diamond losses and costs by diamond quality

Diamond cost per carat	Bits used	Feet drilled1/	Diamond loss		Diamond loss, carats		Cost in dollars2/	
			Carats	Dollars2/	Per bit	Per ft.	Per bit	Per ft.
$11.00	5	127.5	46.95	$624.45	9.930	0.368	$124.89	$4.898
8.60	1	1.8	6.95	79.77	6.95	3/3.861	79.77	3/44.317
8.00	6	122.7	51.47	469.28	8.578	.419	78.12	3.825
7.75	17	341.7	57.24	664.21	3.367	.168	39.07	1.944
7.40	1	15.6	.55	18.82	.55	3/.035	18.82	3/1.206
4.20 4/	81	1,564.3	252.95	2,191.08	3.123	.162	27.05	1.401
Total	111	2,173.6	416.11	$4,047.61				
			Over-all average		3.749	.191	$36.46	$1.862

1/ Includes small footage drilled on other projects and machine anchors but no cement.
2/ Includes setting charge.
3/ Figures inconclusive because data based on the use of only one bit.
4/ Congo diamonds.

CORE RECOVERY

Good core recovery was one of the major problems of the project. The data obtained from the logs shown in table 8 at the end of this report are combined and broken down into the following tables. Some of these data are not conclusive, although they are indicative.

TABLE 4. - Core recoveries obtained in materials drilled

Item	Feet drilled	Core lost	Core recovery	
			Feet	Percent
Overburden	128.0	115.9	12.1	9.5
Weathered monzonite	17.5	.7	16.8	96.0
Fairly fresh monzonite	924.9	11.4	913.5	98.8
Hydrothermally altered monzonite	293.8	5.0	288.8	98.3
Siliceous breccia and gouge	334.7	54.8	279.9	83.6
Slightly altered limestone	295.6	30.0	265.6	89.9
Garnetized limestone	35.1	4.0	31.1	88.6
Silicated limestone, other than garnet	29.9	.0	29.9	100.0
Massive friable pyrite	20.6	.0	20.6	100.0
Vein (ore-bearing rocks)	60.4	2.9	57.5	95.2
Total	2,140.5	224.7	1,915.8	89.5

As far as this project was concerned, the last item was most important as recovery in the ore-bearing zone. Core recovery was satisfactory, the largest single loss being due to drilling overburden, which accounted for over half of the core lost.

TABLE 5. - Core recoveries obtained by different bit sizes

Item	Feet drilled	Core recovery	
		Feet	Percent
NX casing bit (3-1/2-in.)	128.0	12.1	9.5
NX bit	1,295.7	1,270.3	98.1
BX bit	622.1	560.1	90.0
AX bit	94.7	73.3	77.4

Table 4 indicates an increase in the core recovery with an increase in bit size, neglecting, of course, the 3-1/2-inch drilling where core was ground. It must be recognized that the smaller sizes encountered the most adverse conditions as they were necessarily used in the deeper sections of the holes, including the ore zones.

TABLE 6. - Core recovery obtained, by tool types

Item	Feet drilled	Core recovery	
		Feet	Percent
NX casing (single tube 3-1/2-in.)	128.0	12.1	9.5
NX rigid double tube	97.0	91.2	94.0
M-series tools	1,805.8	1,740.6	96.4
L-series tools (experimental)	109.7	71.9	65.5

The above table indicates exceptional recovery for the M-series tools as all types of ground were drilled. The standard NX bevelwall tools were used in good coring ground, and the NX casing tools were used in the overburden. The L-series tools were used in good coring ground, but core was lost through a defect in the bits. This defect will be explained later.

TABLE 7. - Combination of tables 4 and 5

Item	Feet drilled	Core recovery	
		Feet	Percent
NX casing - single tube barrel.....	128.0	12.1	9.5
NX rigid double tube bbl.	97.0	91.2	94.0
NX M-series.....	1,198.7	1,179.1	98.3
BX M-series - bearing backhead.....	505.3	481.1	95.2
BX M-series - washer backhead.....	7.1	7.1	100.0
BX L-series - no bevel, washer backhead.....	83.6	49.1	58.6
BX L-series - no bevel, bearing backhead.....	10.5	7.4	70.4
BX L-series - Beveled, bearing backhead.....	15.4	15.4	100.0
AX M-series.....	94.7	73.3	77.4

The major points of interest in the above table are the exceptional core recoveries obtained with the M-series equipment and the improvement in the core recovery obtained by the bevel in the bit of the L-series tools. This bevel pertains to the inner shoulder of the bit. The bevel in itself seems not so important as is the decrease in distance from the core barrel inner tube to the face of the bit. In the original bits the distance from the face of the bit to the inner shoulder was about 3/4 inch. Operations with these bits were difficult, in that the drill machine vibrated and it was impossible to tell when a block had occurred. At the suggestion of H. W. Foester, representative of the E. J. Longyear Co., a bevel of 60° was cut in this shoulder making the distance from the face of the bit to the shoulder about 3/8 inch. The results are shown in the next to the last item of table 7. Subsequent drilling on another project with L-series bits where the shoulder to face distance was about 3/8 inches showed great improvement of core recovery. In this subsequent work, different angles of bevels were used on the inner shoulder, but the critical point was the distance from the core spring retainer or end of the inner tube to the face of the bit. This distance should be as small as possible, about 3/8 inch.

The use of the bearing type and the washer type backheads in BX drilling also are shown in table 7. Used with the L-series equipment, the bearing type of backhead appeared to be more satisfactory in obtaining core recovery, although there are not enough data to prove this point. Subsequent work also showed that the bearing backhead gave better core recovery.

To drill additional footage after a block occurs is almost impossible in hard rock. As soon as the core is blocked in the core-barrel inner tube, the bit will cut itself clear of the rock, usually resulting in a free spin, and the pressure is transferred from the bit to the block, to the inner tube, and thence to the bearings. This excessive pressure damages the bearings, or the washers in the washer type backhead, necessitating replacement of the bearings or washers. If the ruined bearings are too badly broken, damage to the bearing space of the backhead may result. This means replacement of the backhead. For extended life of the backhead, as well as for an increase in core recovery, it is of utmost importance to stop drilling and pull the tools as soon as possible after a block occurs. The larger-sized bearings in the larger backheads are able to withstand greater pressure, and bearing breakage was more frequent in the smaller sizes.

One possible solution to the problem, especially with less-experienced drill operators, would be to use a spring-activated backhead that would tend to decrease or shut off the flow of water, thus increasing the pressure at the pump gage, when pressure on the backhead bearings becomes excessive. This would serve as a positive warning that a block had occurred and that further drilling would be useless. Naturally, the spring should allow an increase to normal of the water flow when the excessive pressure is released. Different spring strengths probably would be necessary for different types of material - strong springs for hard ground and weaker springs for the softer grounds.

It is difficult to determine the effect on core recovery of the oversized rods in NX and EX drilling. Very little vibration was noticed when these rods were used, and some slight part of the improved core recovery may have been due to these rods. Minor disadvantages of these rods was the increased weight to be handled and, in the NXO size, the lack of a foot clamp large enough to use with the rods. A knife dog was used, but a fitted clamp would have been much more satisfactory. Advantages of these rods are smoother operation, straighter holes, and virtually no shoulder between the core barrel and rods to catch on obstructions and small pieces of caved material.

Table 8 presents detailed logs of the four holes by each pull, showing core recovery, water return, tools used, and material penetrated.

CONCLUSIONS

The use of M-series core barrels was probably the major factor in obtaining improved core recovery on this project. Grinding core is difficult with these barrels, although some of the softer material may be crushed, ground, and washed away if drilling is attempted after blocking occurs. Progress might have been faster with standard tools; but, if rigid adherence to good drilling practice is maintained, it is doubtful if drilling progress would be any better. The results show that core recovery with standard tools in good coring ground is inferior to that obtained with the M-series equipment.

Constant emphasis on core recovery and the consequent greater care given to drilling practices also aided in improving core recovery.

Bit size appears to have had some effect on core recovery. After the overburden had been penetrated, better core recovery was obtained with the larger-size tools. One possible explanation for this is that the larger tools were used in better coring ground. However, it seems obvious that the larger core is more difficult to crush and grind than the smaller core and that the larger core can stand more erosion by the water action at the bit.

Core recovery was unsatisfactory with the experimental L-series equipment as received from the manufacturer.2/ A modification of the bit, reducing

2/ Since completion of the Torpedo mine project the manufacturers have made modifications in the design of the L-series core barrels, some on the basis of the work done here, which have materially improved the results obtained with this equipment.

the distance from the face of the bit to the inner shoulder, showed greatly improved core recovery.

The use of oversize rods in the BX and NX drilling reduced or eliminated rod whip and vibration, resulting in smoother operation. The tendency of the core barrel to wobble under pressure is reduced or eliminated; and this may contribute in some measure to improve core recovery.

Three other points were indicated by this drilling. The first is that the diamond loss per bit and cost per foot decrease with a decrease in bit size. The second is that the diamond loss and bit costs increase sharply when core is ground. Third, that the use of the cheapest and lowest-quality diamonds, "Congos", resulted in lower bit costs as well as less diamond wear per foot of hole drilled.

TABLE 8. - Bureau of Mines drill-hole logs

Log of hole 1

Location: N. 5,239, E. 5,152.
Elevation: 5,215 ft.
Dip: -50°
Bearing: N. 67°41' W.

Hole started: 11/4/49
Hole completed: 12/15/49
Depth: 597.7 ft.

Footage			Core recovery		Appar. wtr. ret.,	Tools: size, bit, barrel,	
From	To	Feet	Feet	Percent	percent	backhead	Geology
0.0	24.0	24.0	0.0	0.0	100	NX casing, single tube	Overburden.
24.0	27.0	3.0	2.8	93.3	100	NX	Monzonite.
27.0	29.0	2.0	1.7	85.0	100	rigid	Do.
29.0	33.0	4.0	4.0	100.0	100	double	Do.
33.0	35.0	2.0	1.8	90.0	100	tube	Do.
35.0	40.0	5.0	5.0	100.0	100	do.	Do.
40.0	44.6	4.6	3.6	78.3	100	do.	Do.
44.6	50.0	5.4	5.0	92.6	100	do.	Do.
50.0	55.0	5.0	5.0	100.0	100	do.	Do.
55.0	60.0	5.0	4.6	92.0	100	do.	Do.
60.0	65.0	5.0	5.0	100.0	100	do.	Do.
65.0	69.5	4.5	4.5	100.0	95	do.	Do.
69.5	75.0	5.5	5.0	90.9	95	do.	Do.
75.0	77.5	2.5	2.5	100.0	95	do.	Do.
77.5	81.0	3.5	3.5	100.0	95	do.	Do.
81.0	85.0	4.0	4.0	100.0	95	do.	Do.
85.0	88.5	3.5	3.5	100.0	95	do.	Do.
88.5	92.0	3.5	3.5	100.0	95	do.	Do.
92.0	97.0	5.0	5.0	100.0	95	do.	Do.
97.0	100.0	3.0	3.0	100.0	95	do.	Do.
100.0	104.0	4.0	2.5	62.5	95	do.	Do.
104.0	106.0	2.0	2.0	100.0	95	do.	Do.
106.0	108.0	2.0	2.0	100.0	95	do.	Do.

Log of hole 1, (Cont.)

Footage			Core recovery		Appar. wtr. ret.,	Tools: size, bit, barrel,	
From	To	Feet	Feet	Percent	percent	backhead	Geology
108.0	113.0	5.0	4.5	90.0	95	NX	Monzonite
113.0	116.5	3.5	3.5	100.0	95	rigid	Do.
116.5	120.0	3.5	2.7	77.1	95	double	Do.
120.0	121.0	1.0	1.0	100.0	95	tube	Do.
121.0	126.4	5.4	5.4	100.0	95	NX M-series	Do.
126.4	132.5	6.1	6.1	100.0	95	do.	Do.
132.5	138.5	6.0	6.0	100.0	95	do.	Do.
138.5	144.5	6.0	6.0	100.0	95	do.	Do.
144.5	152.0	7.5	7.5	100.0	95	do.	Do.
152.0	153.4	1.4	1.2	85.7	95	do.	Do.
153.4	163.4	10.0	10.0	100.0	95	do.	Do.
163.4	173.4	10.0	10.0	100.0	95	do.	Do.
173.4	180.0	6.6	6.5	98.5	95	do.	Do.
180.0	190.0	10.0	9.8	98.0	95	NX M-series	Monzonite.
190.0	200.0	10.0	10.0	100.0	95	do.	Do.
200.0	210.0	10.0	10.0	100.0	95	do.	Do.
210.0	218.5	8.5	8.5	100.0	95	do.	Do.
218.5	223.5	5.0	4.5	90.0	95	do.	Do.
223.5	231.5	8.0	8.0	100.0	95	do.	Do.
231.5	240.5	9.0	8.9	98.9	95	do.	Do.
240.5	250.5	10.0	10.0	100.0	95	do.	Do.
250.5	252.4	1.9	1.9	100.0	95	do.	Do.
252.4	259.5	7.1	7.1	100.0	95	do.	Do.
259.5	265.0	5.5	5.4	98.2	95	do.	Do.
265.0	269.9	4.9	4.9	100.0	95	do.	Do.
269.9	276.7	6.8	6.8	100.0	Lost	do.	Do.
276.7	286.2	9.5	9.5	100.0	0	do.	Do.
286.2	289.2	3.0	3.0	100.0	0	do.	Do.
289.2	297.5	8.3	8.3	100.0	85	do.	Do.
297.5	303.0	5.5	5.5	100.0	85	do.	Do.
303.0	313.0	10.0	10.0	100.0	85	BX M-series	Do.
313.0	323.0	10.0	10.0	100.0	85	do.	Do.
323.0	331.5	8.5	8.5	100.0	85	do.	Do.
331.5	341.5	10.0	10.0	100.0	85	do.	Do.
341.5	349.2	7.7	7.7	100.0	85	do.	Do.
349.2	359.2	10.0	10.0	100.0	85	do.	Do.
359.2	369.0	9.8	9.6	98.0	85	do.	Do.
369.0	378.5	9.5	9.5	100.0	85	do.	Do.
378.5	388.5	10.0	10.0	100.0	85	do.	Do.
388.5	393.5	5.0	5.0	100.0	85	do.	Do.
393.5	398.0	4.5	4.5	100.0	85	do.	Do.
398.0	403.0	5.0	5.0	100.0	85	do.	Do.
403.0	408.0	5.0	5.0	100.0	85	do.	Do.
408.0	413.0	5.0	5.0	100.0	85	do.	Do.
413.0	418.0	5.0	5.0	100.0	85	do.	Do.
418.0	423.0	5.0	5.0	100.0	85	do.	Do.
423.0	427.7	4.7	4.7	100.0	85	do.	Do.
427.7	431.7	4.0	4.0	100.0	85	do.	Do.

Log of hole 1, (Cont.)

Footage			Core recovery		Appar. wtr. ret., percent	Tools: size, bit, barrel, backhead	Geology
From	To	Feet	Feet	Percent			
431.7	434.5	2.8	2.8	100.0	85	BX M-series	Monzonite.
434.5	439.0	4.5	4.5	100.0	85	do.	Do.
439.0	443.5	4.5	4.5	100.0	85	do.	Do.
443.5	448.0	4.5	4.5	100.0	85	do.	Do.
448.0	453.0	5.0	5.0	100.0	85	do.	Do.
453.0	458.0	5.0	5.0	100.0	85	do.	Do.
458.0	462.5	4.5	4.5	100.0	85	do.	Do.
462.5	467.0	4.5	4.5	100.0	85	do.	Do.
467.0	471.0	4.0	4.0	100.0	85	do.	Do.
471.0	475.5	4.5	4.5	100.0	85	do.	Do.
475.5	480.0	4.5	4.5	100.0	85	do.	Vein.
480.0	486.0	6.0	3.5	58.3	85	do.	Do.
486.0	491.0	5.0	5.0	100.0	85	do.	Do.
491.0	495.0	4.0	4.0	100.0	85	do.	Do.
495.0	499.0	4.0	4.0	100.0	85	do.	Do.
499.0	503.0	4.0	4.0	100.0	85	do.	Siliceous breccia.
503.0	507.5	4.5	4.5	100.0	85	do.	Do.
507.5	512.0	4.5	4.5	100.0	85	do.	Do.
512.0	517.0	5.0	5.0	100.0	85	do.	Do.
517.0	522.0	5.0	5.0	100.0	85	do.	Do.
522.0	526.5	4.5	4.5	100.0	85	do.	Do.
526.5	531.0	4.5	4.5	100.0	85	do.	Do.
531.0	535.5	4.5	4.5	100.0	85	do.	Do.
535.5	540.0	4.5	4.5	100.0	85	AX M-series	Do.
540.0	545.0	5.0	5.0	100.0	85	do.	Do.
545.0	550.0	5.0	5.0	100.0	85	do.	Do.
550.0	554.5	4.5	4.5	100.0	85	do.	Do.
554.5	559.0	4.5	4.5	100.0	85	do.	Do.
559.0	565.5	6.5	6.5	100.0	85	do.	Do.
565.5	572.0	6.5	3.1	47.7	85	do.	Breccia and gouge.
572.0	582.0	10.0	4.0	40.0	75	do.	Do.
582.0	590.0	8.0	1.0	12.5	75	do.	Do.
590.0	594.3	4.3	1.3	30.2	50	do.	Do.
594.3	597.7	3.4	2.4	70.6	50	do.	Do.

Log of hole 2

Location: N. 5,240, E. 5,150
Elevation: 5,216
Dip: -37°
Bearing: N. 67°41'W.

Hole started: 12/16/49
Hole completed: 1/25/50
Depth: 489.5

Footage			Core recovery		Appar. wtr. ret., percent	Tools: size, bit, barrel, backhead	Geology
From	To	Feet	Feet	Percent			
0.0	9.5	9.5	2.1	22.1	100	NX casing, single tube	Overburden.
9.5	18.0	8.5	.0	.0	100	do.	Do.
18.0	25.0	7.0	1.0	14.3	100	do.	Do.
25.0	26.4	1.4	1.4	100.0	100	do.	Do.
26.4	27.5	1.1	.7	63.6	100	do.	Do.
27.5	31.0	3.5	2.3	65.7	100	do.	Do.
31.0	34.0	3.0	2.9	96.7	100	do.	Do.
34.0	35.0	1.0	1.0	100.0	100	NX M-series	Monzonite.
35.0	37.0	2.0	2.0	100.0	100	do.	Do.
37.0	38.0	1.0	1.0	100.0	100	do.	Do.
38.0	42.5	4.5	4.5	100.0	100	do.	Do.
42.5	50.1	7.6	7.6	100.0	95	do.	Do.
50.1	55.6	5.5	5.5	100.0	95	do.	Do.
55.6	60.7	5.1	5.1	100.0	95	do.	Do.
60.7	66.0	5.3	5.3	100.0	95	do.	Do.
66.0	69.6	3.6	3.6	100	95	do.	Do.
69.6	75.0	5.4	5.4	100	95	do.	Do.
75.0	83.0	8.0	8.0	100	95	do.	Do.
83.0	86.5	3.5	3.5	100	95	do.	Do.
86.5	89.5	3.0	3.0	100	95	do.	Do.
89.5	95.0	5.5	5.5	100	95	do.	Do.
95.0	99.6	4.6	4.6	100	95	do.	Do.
99.6	105.0	5.4	5.4	100	95	do.	Do.
105.0	108.0	3.0	3.0	100	95	do.	Do.
108.0	113.5	5.5	5.5	100	95	do.	Do.
113.5	118.0	4.5	4.5	100	95	do.	Do.
118.0	120.0	2.0	2.0	100	95	do.	Do.
120.0	126.0	6.0	6.0	100	95	do.	Do.
126.0	133.0	7.0	7.0	100	95	do.	Do.
133.0	138.0	5.0	5.0	100	95	do.	Do.
138.0	143.0	5.0	5.0	100	95	do.	Do.
143.0	149.3	6.3	6.3	100	95	do.	Do.
149.3	154.0	4.7	4.7	100	95	do.	Do.
154.0	158.0	4.0	4.0	100	95	do.	Do.
158.0	164.0	6.0	6.0	100	95	do.	Do.
164.0	166.0	2.0	2.0	100	95	do.	Do.
166.0	170.0	4.0	4.0	100	95	do.	Do.
170.0	176.4	6.4	6.4	100	95	do.	Do.
176.4	182.0	5.6	5.6	100	95	do.	Do.
182.0	187.0	5.0	5.0	100	95	do.	Do.
187.0	189.9	2.9	2.2	75.9	95	do.	Do.

Log of hole 2. (Cont.)

Footage			Core recovery		Appar. wtr. ret	Tools: size, bit, barrel, backhead	Geology
From	To	Feet	Feet	Percent	percent		
189.9	197.4	7.5	7.5	100	95	NX M-series	Monzonite.
197.4	205.9	8.5	8.5	100	95	do.	Do.
205.9	213.0	7.1	7.1	100	95	do.	Do.
213.0	220.8	7.8	7.8	100	95	do.	Do.
220.8	223.8	3.0	3.0	100	95	do.	Do.
223.8	230.8	7.0	7.0	100	95	do.	Do.
230.8	235.8	5.0	5.0	100	95	do.	Do.
235.8	241.0	5.2	5.2	100	95	do.	Do.
241.0	245.0	4.0	4.0	100	95	do.	Do.
245.0	249.0	4.0	4.0	100	95	do.	Do.
249.0	253.6	4.6	4.6	100	Lost	do.	Do.
253.6	256.0	2.4	2.4	100	100	do.	Do.
256.0	262.6	6.6	6.6	100	100	do.	Do.
262.6	266.6	4.0	4.0	100	100	do.	Do.
266.6	272.0	5.4	5.4	100	100	do.	Do.
272.0	273.5	1.5	1.5	100	100	do.	Do.
273.5	280.0	6.5	6.5	100	100	do.	Do.
280.0	287.0	7.0	7.0	100	Lost	do.	Do.
287.0	290.6	3.6	3.6	100	90	do.	Do.
290.6	294.0	3.4	3.4	100	90	do.	Do.
294.0	296.0	2.0	2.0	100	90	do.	Do.
296.0	299.5	3.5	3.5	100	90	do.	Do.
299.5	301.0	1.5	1.5	100	90	do.	Do.
301.0	307.5	6.5	6.5	100	90	do.	Do.
307.5	313.5	6.0	6.0	100	90	do.	Do.
313.5	323.5	10.0	10.0	100	90	do.	Altered Monzonite.
323.5	333.5	10.0	10.0	100	90	do.	Do.
333.5	341.5	8.0	8.0	100	90	do.	Do.
341.5	349.0	7.5	7.5	100	90	do.	Do.
349.0	358.6	9.6	9.6	100	90	do.	Altered monzonite and limestone.
358.6	368.6	10.0	10.0	100	90	do.	Limestone.
368.6	378.6	10.0	10.0	100	90	do.	Do.
378.6	388.6	10.0	10.0	100	90	do.	Do.
388.6	395.6	7.0	7.0	100	90	do.	Breccia and gouge.
395.6	400.0	4.4	4.4	100	90	do.	Do.
400.0	403.0	3.0	1.6	53.3	90	do.	Do.
403.0	405.0	2.0	1.6	80.0	90	do.	Do.
405.0	408.0	3.0	2.6	86.7	90	do.	Vein; massive pyrite.
408.0	412.0	4.0	4.0	100	90	do.	Do.
412.0	419.0	7.0	7.0	100	90	do.	Pyrite; siliceous breccia.
419.0	422.0	3.0	3.0	100	90	do.	Siliceous breccia.
422.0	424.0	2.0	2.0	100	90	do.	Do.
424.0	427.0	3.0	3.0	100	90	do.	Do.
427.0	433.0	6.0	6.0	100	90	do.	Do.

4640

Log of hole 2 (Cont.)

Footage			Core recovery		Appar. wtr. ret., percent	Tools: size, bit, barrel, backhead	Geology
From	To	Feet	Feet	Percent			
433.0	442.0	9.0	9.0	100	90	NX M-series	Siliceous breccia.
442.0	444.6	2.6	2.5	96.2	90	do.	Breccia; alt. rocks.
444.6	453.0	8.4	7.6	90.5	90	do.	Do.
453.0	463.0	10.0	10.0	100	90	do.	Do.
463.0	468.0	5.0	5.0	100	90	do.	Do.
468.0	474.0	6.0	5.0	83.3	90	do.	Do.
474.0	478.0	4.0	2.0	50	90	do.	Do.
478.0	482.2	4.2	4.2	100	90	do.	Do.
482.2	486.5	4.3	4.3	100	90	do.	Do.
486.5	489.5	3.0	2.5	83.3	90	do.	Do.

Log of hole 3

Location: N. 5,367, E. 5,317
Elevation: 5,286
Dip: -50°
Bearing: N. 67°41' W.

Hole started: 1/26/50
Hole completed: 3/14/50
Depth: 524.6

0.0	15.0	15.0	0.7	4.7	95	NX casing, single-tube	Overburden.
15.0	18.0	3.0	.6	20	95		Do.
18.0	26.0	8.0	.0	0	95	do.	Do.
26.0	33.0	7.0	.4	5.7	95	do.	Do.
33.0	49.0	16.0	.0	0	Lost	do.	Do.
49.0	50.0	1.0	1.0	100	95	NX M-series	Weath. monzonite.
50.0	51.0	1.0	1.0	100	95	do.	Do.
51.0	52.5	1.5	1.5	100	95	do.	Do.
52.5	55.5	3.0	3.0	100	95	NX M-series	Do.
55.5	56.0	.5	.5	100	95	do.	Do.
56.0	60.0	4.0	4.0	100	95	do.	Do.
60.0	62.5	2.5	1.8	72	95	do.	Do.
62.5	63.5	1.0	1.0	100	95	do.	Do.
63.5	66.5	3.0	3.0	100	95	do.	Do.
66.5	69.0	2.5	2.5	100	95	do.	Monzonite
69.0	71.4	2.4	2.4	100	95	do.	Do.
71.4	75.9	4.5	4.5	100	95	do.	Do.
75.9	79.1	3.2	3.2	100	95	do.	Do.
79.1	82.9	3.8	3.6	94.7	90	do.	Do.
82.9	84.8	1.9	1.9	100	90	do.	Do.
84.8	91.3	6.5	6.5	100	80	do.	Do.
91.3	98.7	7.4	7.4	100	80	do.	Do.
98.7	102.0	3.3	3.3	100	80	do.	Do.
102.0	109.6	7.6	7.6	100	80	do.	Do.
109.6	114.9	5.3	5.3	100	80	do.	Do.
114.9	119.0	4.1	4.1	100	80	do.	Do.
119.0	122.8	3.8	3.8	100	80	do.	Do.
122.8	124.6	1.8	1.2	66.7	80	do.	Do.
124.6	133.0	8.4	7.3	86.9	80	do.	Do.
133.0	135.0	2.0	2.0	100.0	80	do.	Do.

Log of hole 3 (Cont.)

Footage			Core recovery		Appar. wtr. ret.,	Tools: size, bit, barrel,	
From	To	Feet	Feet	Percent	percent	backhead	Geology
135.0	142.5	7.5	7.5	100	80	NX M-series	Monzonite
142.5	148.0	5.5	5.5	100	80	do.	Do.
148.0	154.5	6.5	6.5	100	80	do.	Do.
154.5	164.5	10.0	9.8	98	80	do.	Do.
164.5	172.1	7.6	7.6	100	Lost	do.	Do.
172.1	180.0	7.9	7.7	97.5	80	do.	Do.
180.0	189.9	9.9	9.7	98	80	do.	Do.
189.9	199.9	10.0	10.0	100	Lost	do.	Do.
199.9	208.9	9.0	9.0	100	90	do.	Do.
208.9	213.0	4.1	4.1	100	90	do.	Do.
213.0	218.0	5.0	5.0	100	90	do.	Do.
218.0	220.5	2.5	2.5	100	90	do.	Do.
220.5	228.2	7.7	7.1	92.2	90	do.	Altered monzonite.
228.2	238.2	10.0	10.0	100	90	do.	Do.
238.2	248.2	10.0	10.0	100	90	do.	Do.
248.2	255.6	7.4	7.4	100	90	do.	Do.
255.6	259.3	3.7	3.7	100	90	do.	Do.
259.3	263.9	4.6	4.6	100	90	do.	Do.
263.9	268.8	4.9	4.9	100	90	do.	Do.
268.8	273.8	5.0	5.0	100	90	do.	Do.
273.8	278.8	5.0	5.0	100	90	do.	Do.
278.8	283.8	5.0	5.0	100	90	do.	Do.
283.8	290.8	7.0	7.0	100	90	do.	Do.
290.8	294.0	3.2	3.2	100	90	do.	Do.
294.0	296.6	2.6	2.6	100	90	do.	Do.
296.6	300.2	3.6	2.9	80.6	90	do.	Do.
300.2	307.2	7.0	7.0	100	90	do.	Do.
307.2	308.2	1.0	1.0	100	90	do.	Do.
308.2	318.2	10.0	10.0	100	90	do.	Do.
318.2	328.2	10.0	10.0	100	90	do.	Do.
328.2	331.0	2.8	2.8	100	90	do.	Do.
331.0	336.0	5.0	5.0	100	90	do.	Do.
336.0	342.0	6.0	6.0	100	90	do.	Do.
342.0	348.6	6.6	6.4	97	90	do.	Do.
348.6	354.9	6.3	6.3	100	90	do.	Do.
354.9	363.0	8.1	8.1	100	85	do.	Do.
363.0	373.0	10.0	9.1	91	80	do.	Do.
373.0	382.0	9.0	9.0	100	50	do.	Do.
382.0	387.1	5.1	5.1	100	90	do.	Do.
387.1	390.7	3.6	3.6	100	90	do.	Do.
390.7	400.7	10.0	10.0	100	90	do.	Do.
400.7	410.7	10.0	10.0	100	90	do.	Do.
410.7	420.7	10.0	10.0	100	90	do.	Do.
420.7	422.5	1.8	1.8	100	90	do.	Do.
422.5	427.7	5.2	5.2	100	90	do.	Do.
427.7	434.4	6.7	6.7	100	90	do.	Do.
434.4	436.0	1.6	1.6	100	90	do.	Do.

Log of hole 3 (Cont.)

Footage			Core recovery		Appar. wtr. ret., percent	Tools: size, bit, barrel, backhead	Geology
From	To	Feet	Feet	Percent			
436.0	438.0	2.0	1.8	90	90	NX M-series	Altered monzonite.
438.0	446.6	8.6	7.8	90.7	90	do.	Do.
446.6	448.6	2.0	2.0	100	90	do.	Do.
448.6	450.0	1.4	1.3	92.9	90	do.	Do.
450.0	455.0	5.0	4.6	92	90	do.	Do.
455.0	460.0	5.0	4.7	94	90	BX M-series	Do.
460.0	462.7	2.7	2.7	100	90	do.	Do.
462.7	464.0	1.3	1.1	84.6	90	do.	Do.
464.0	466.1	2.1	2.1	100	90	do.	Do.
466.1	467.6	1.5	1.0	66.7	90	do.	Do.
467.6	468.1	.5	.5	100	90	do.	Do.
468.1	470.1	2.0	2.0	100	90	do.	Do.
470.1	472.7	2.6	2.6	100	90	do.	Do.
472.7	474.4	1.7	1.7	100	90	do.	Do.
474.4	478.8	4.4	4.3	97.7	85	do.	Do.
478.8	482.2	3.4	3.4	100	80	do.	Vein.
482.2	487.0	4.8	4.8	100	80	do.	Do.
487.0	493.0	6.0	6.0	100	75	do.	Do.
493.0	498.7	5.7	5.7	100	60	do.	Vein; siliceous breccia.
498.7	499.5	.8	.8	100	75	do.	Siliceous breccia, gouge.
499.5	500.6	1.1	.8	72.7	75	do.	Do.
500.6	502.6	2.0	.0	0	75	do.	Do.
502.6	503.6	1.0	.4	40	75	do.	Do.
503.6	513.6	10.0	2.0	20	75	do.	Do.
513.6	515.3	1.7	1.0	58.8	75	do.	Do.
515.3	515.8	.5	.5	100	75	do.	Do.
515.8	522.8	7.0	7.0	100	75	do.	Do.
522.8	524.6	1.8	1.6	88.9	75	do.	Do.

Log of hole 4

Location: N. 5,269, E. 4,502
Elevation: 5,173
Dip: -45°
Bearing: S. 67°41' E.

Hole started: 3/13/50
Hole completed: 4/25/50
Depth: 510.5

0.0	21.0	21.0	0.0	0	100	NX casing, single-tube	Overburden.
21.0	23.0	2.0	2.0	100	100	NX M-series	Garnet.
23.0	26.2	3.2	3.2	100	100	do.	Do.
26.2	28.0	1.8	1.8	100	100	do.	Do.
28.0	29.1	1.1	1.1	100	90	do.	Do.
29.1	31.5	2.4	1.3	54.2	90	do.	Do.
31.5	32.6	1.1	1.1	100	90	do.	Do.
32.6	33.4	.8	.8	100	90	do.	Do.
33.4	34.4	1.0	.8	80	90	do.	Do.
34.4	36.3	1.9	1.9	100	90	do.	Do.

Log of hole 4. (Cont.)

Footage			Core recovery		Appar. wtr. rot., percent	Tools: size, bit, barrel, backhead	Geology
From	To	Feet	Feet	Percent			
36.3	39.1	2.8	0.8	28.6	90	NX M-series	Garnet.
39.1	40.0	.9	.8	88.9	90	do.	Do.
40.0	41.6	1.6	1.1	68.8	90	do.	Do.
41.6	43.0	1.4	1.4	100	90	do.	Do.
43.0	44.0	1.0	1.0	100	90	do.	Do.
44.0	45.0	1.0	1.0	100	90	do.	Do.
45.0	47.3	2.3	2.3	100	90	do.	Do.
47.3	52.1	4.8	4.7	97.9	90	do.	Do.
52.1	56.1	4.0	4.0	100	90	do.	Do.
56.1	61.6	5.5	5.5	100	90	do.	Altered silicated limestone.
61.6	64.6	3.0	3.0	100	90	do.	Do.
64.6	65.6	1.0	1.0	100	90	do.	Do.
65.6	71.6	6.0	6.0	100	90	do.	Do.
71.6	77.6	6.0	6.0	100	90	do.	Do.
77.6	78.6	1.0	1.0	100	90	do.	Do.
78.6	79.9	1.3	1.3	100	90	do.	Do.
79.9	86.0	6.1	6.1	100	90	do.	Limestone slightly altered.
86.0	94.0	8.0	8.0	100	80	do.	Do.
94.0	104.0	10.0	10.0	100	75	do.	Do.
104.0	113.6	9.6	9.6	100	75	do.	Do.
113.6	114.4	.8	.8	100	90	do.	Do.
114.4	124.4	10.0	10.0	100	90	do.	Do.
124.4	132.4	8.0	8.0	100	90	do.	Do.
132.4	142.4	10.0	10.0	100	90	do.	Do.
142.4	144.1	1.7	1.7	100	90	do.	Do.
144.1	154.1	10.0	10.0	100	90	do.	Do.
154.1	161.0	6.9	6.9	100	90	do.	Do.
161.0	164.2	3.2	3.2	100	90	do.	Do.
164.2	168.2	4.0	4.0	100	90	do.	Do.
168.2	176.2	8.0	8.0	100	90	do.	Do.
176.2	180.6	4.4	2.8	63.6	90	BX L-series, no bevel, washer	Limestone slightly altered.
180.6	190.6	10.0	10.0	100	90	BX M-series, bearing	Do.
190.6	198.6	8.0	7.7	96.3	90	BX L-series, no bevel, washer	Do.
198.6	206.9	8.3	8.3	100	90	BX M-series, bearing	Do.
206.9	214.9	8.0	8.0	100	90	BX L-series, no bevel, washer	Do.
214.9	221.8	6.9	6.9	100	90	BX M-series, bearing	Do.

Log of hole 4, (Cont.)

Footage			Core recovery		Appar. wtr. rot., percent	Tools: size, bit, barrel, backhead	Geology
From	To	Feet	Feet	Percent			
221.8	229.0	7.2	7.2	100	90	BX M-series, bearing	Limestone, slight altered.
229.0	234.0	5.0	3.9	78	90	BX L-series, no bevel, washer	Do.
234.0	237.2	3.2	3.2	100	90		Do.
237.2	247.2	10.0	10.0	100	90	BX M-series, bearing	Do.
247.2	249.6	2.4	2.4	100	90	BX L-series, no bevel, washer	Do.
249.6	252.3	2.7	2.7	100	90	BX M-series, bearing	Do.
252.3	262.0	9.7	5.0	51.5	90	BX L-series, no bevel, washer	Do.
262.0	272.0	10.0	10.0	100	90	BX M-series, bearing	Do.
272.0	275.0	3.0	3.0	100	90	Do.	Do.
275.0	279.6	4.6	2.0	43.5	90	BX L-series, no bevel, washer	Do.
279.6	279.8	0.2	0.2	100	90	BX M-series, bearing	Do.
279.8	289.8	10.0	3.7	37	90	BX L-series, no bevel, washer	Do.
289.9	292.1	2.3	2.3	100	90	BX M-series, bearing	Do.
292.1	298.7	6.2	2.2	33.3	90	BX L-series, no bevel, washer	Do.
298.7	304.2	5.5	5.5	100	90	BX M-series, bearing	Do.
304.2	310.2	6.0	6.0	100	90	Do.	Do.
310.2	318.7	8.5	1.9	22.4	90	BX L-series, no bevel, washer	Do.
318.7	328.2	9.5	9.5	100	90	BX M-series, bearing	Do.
328.2	331.0	2.8	2.8	100	90	BX L-series, no bevel, washer	Do.
331.0	337.4	6.4	6.2	96.9	90	BX M-series, bearing	Do.
337.4	342.0	4.6	2.4	52.2	90	BX L-series, no bevel, washer	Do.
342.0	343.0	1.0	0.9	90	90	BX M-series, bearing	Siliceous breccia.
343.0	347.5	4.5	.4	8.9	90	BX L-series, no bevel, washer	Do.
347.5	352.0	4.5	4.5	100	90	BX M-series, bearing	Do.
352.0	356.1	4.1	4.1	100	90	Do.	Do.
356.1	360.4	4.3	3.4	79.1	90	Do.	Do.
360.4	364.9	4.5	4.5	100	90	Do.	Do.
364.9	368.9	4.0	4.0	100	90	Do.	Do.
368.9	375.1	6.2	5.3	85.5	90	Do.	Do.
375.1	377.1	2.0	2.0	100	90	Do.	Do.
377.1	380.0	2.9	2.7	93.1	90	Do.	Do.
380.0	386.0	6.0	5.7	95	90	Do.	Fault gouge.
386.0	387.5	1.5	.7	46.7	90	BX L-series, no bevel, washer	Do.
387.5	394.6	7.1	7.1	100	90	BX M-series, washer	Fault gouge, breccia.

Log of hole 4, (Cont.)

Footage			Core recovery		Appar. wtr. ret., percent	Tools: size, bit, barrel, backhead	Geology
From	To	Feet	Feet	Percent			
394.6	400.0	5.4	5.4	100	90	BX L-series,	Siliceous breccia.
400.0	410.0	10.0	10.0	100	90	beveled, bearing	Do.
410.0	414.0	4.0	3.3	82.5	90	BX L-series, no	Do.
414.0	418.5	4.5	3.7	82.5	90	bevel, bearing	Do.
418.5	420.5	2.0	.4	20	90	do.	Do.
402.3	409.0	6.7	6.3	94	90	BX M-series, bearing	Siliceous breccia;
409.0	412.7	3.7	3.7	100	90	do.	hole deflected.
412.7	417.2	4.5	4.5	100	90	do.	Do.
417.2	423.2	6.0	3.3	55	90	do.	Do.
423.2	425.3	2.1	2.1	100	90	do.	Do.
425.3	432.0	6.7	6.1	91	90	do.	Do.
432.0	435.2	3.2	3.2	100	90	do.	Do.
435.2	440.0	4.8	2.5	52.1	90	do.	Do.
440.0	442.8	2.8	2.8	100	90	do.	Vein
442.8	450.0	7.2	7.2	100	90	do.	Do.
450.0	453.0	3.0	3.0	100	90	do.	Siliceous breccia.
453.0	458.0	5.0	5.0	100	90	do.	Do.
458.0	460.7	2.7	2.7	100	90	do.	Do.
460.7	464.5	3.8	3.8	100	90	do.	Do.
464.5	470.6	6.1	6.1	100	90	do.	Do.
470.6	478.0	7.4	7.4	100	90	do.	Monzonite.
478.0	479.5	1.5	1.3	86.7	90	AX M-series	Do.
479.5	484.5	5.0	5.0	100	90	do.	Do.
484.5	491.0	6.5	6.5	100	90	do.	Do.
491.0	496.0	5.0	5.0	100	90	do.	Do.
496.0	503.5	7.5	7.5	100	90	do.	Do.
503.5	504.5	1.0	.2	20	90	do.	Do.
504.5	510.5	6.0	6.0	100	90	do.	Do.

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INVESTIGATION OF THE TORPEDO COPPER DEPOSIT ORGAN MINING DISTRICT, DONA ANA COUNTY, N. MEX.

BY JOHN H. SOULÉ

* * * * * * * * * * Report of Investigations 4791

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

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May 1951

INVESTIGATION OF THE TORPEDO COPPER DEPOSIT, ORGAN MINING DISTRICT, DONA ANA COUNTY, N. MEX.

by

John H. Soule[1]

CONTENTS

	Page
Introduction and summary	1
Acknowledgments	1
Location and accessibility	1
Property and ownership	2
Labor and living conditions	2
Physical features and climate	2
History and production	3
Geology and ore deposits	4
Development	5
Work by the Bureau of Mines	5

TABLE

1. Torpedo mine production 4

ILLUSTRATIONS

Fig.		Follows page
1.	Location map	2
2.	Topographic and surface map	2
3.	Sections on Bureau of Mines drill holes	4
4.	Sections on drill holes A1, A2, A3, and A4	4
5.	Sections on drill holes E7, E13, E23, and E28	4
6.	Underground workings	4

1/ Mining engineer, Bureau of Mines.

Report of Investigations 4791

INTRODUCTION AND SUMMARY

The Torpedo copper mine in the Organ Mining District, Dona Ana County, N. Mex., was discovered in 1899, and production of copper from oxidized-ore deposits was begun in 1900. Production continued through 1907, but operations were only intermittent from 1907 through 1921. The production of copper during these periods amounted to about 3,500,000 pounds. Reserves of primary sulfide copper ore were believed to occur below the old workings, and after a detailed examination of accessible workings and a study of drilling records of several private companies by an engineer of the Bureau of Mines,2/ a development program of diamond core drilling was initiated.

This investigation was started October 3, 1949, and completed April 30, 1950. Four holes totaling 2,122.3 feet were diamond-drilled, and 70 samples were analysed. All drilling was done with a Government-owned hydraulic-feet drill having special rods and core barrels to increase the recovery of core in critical zones.

This report describes the location, history, ore deposits, and factual data obtained by the Bureau of Mines from the drilling.

ACKNOWLEDGMENTS

Acknowledgment is made of the assistance given by W. R. Storms, chief, Arizona-New Mexico Branch, Mining Division, Region IV, Bureau of Mines, and by W. D. McMillan, supervising engineer of the New Mexico Field Office of Region IV, Bureau of Mines. All samples were analysed at the Tucson laboratory of the Bureau of Mines under the supervision of J. Bruce Clemmer, chief, Southwest Experiment Station, Metallurgical Branch, Region IV, Bureau of Mines. Production figures were obtained from the Statistical Branch, Region IV, of the Bureau of Mines, through the courtesy of A. J. Martin, supervising engineer.

Acknowledgment is also due A. S. Putney, president and trustee of the Torpedo Mining Co., for the use of old maps of the Torpedo mine and for permission to publish the maps and production figures.

LOCATION AND ACCESSIBILITY

The Torpedo copper mine is in the Organ Mining District, Dona Ana County, N. Mex. It is half a mile east of the town of Organ on the northwestern slope of the Organ Mountains, in sec. 1, T. 22 S., R. 3 E. (see fig. 1).

2/ W. R. Storms, N. Mex. Field Office, then Tucson Branch, Mining Division, Silver City, N. Mex.

The mine may be reached by going east from Organ on paved U. S. Highway for half a mile to the gate in the fence that borders the highway on the south. Passing through this gate, unimproved roads lead to various parts of the property, all within 1 mile of the gate (see fig. 2). Organ is 12.5 miles northeast of Las Cruces, N. Mex., via U. S. Highway 70.

Postal service is available at Organ and telephone, telegraph, and rail connection are available at Las Cruces, N. Mex. Minor supplies are obtainable at Las Cruces, but major mining items must be obtained at El Paso, Tex., 43 miles south of Las Cruces.

A high-tension power line traverses the Torpedo property, but Organ receives single-phase power from Las Cruces. The capacity of the Organ power line would be inadequate for any but the most limited power requirements.

PROPERTY AND OWNERSHIP

The Torpedo mine is on the patented Torpedo mining claim, which is owned by the Torpedo Mining Co. An extension of the mineralized zone continued south on the patented Little Ben Scott claim. The Torpedo and Little Ben Scott claims were located in 1896 and patented in 1902. In addition to these claims, the Torpedo Mining Co. owns other claims, both patented and unpatented, including the Memphis claims north of the Torpedo and the Stevenson-Bennett claims to the south.

A. S. Putney, of Mikana, Wis., and Judge E. Mecham, of Las Cruces, N. Mex., are trustees for the Torpedo Mining Co. The Torpedo Mining Co. property is now (August 1950) under lease to J. H. Brown, of Organ, N. Mex. Brown plans to reopen the mine, as well as others in the district, and is now concentrating his efforts on the Memphis mine adjoining the Torpedo on the north.

S. A. Walters, of Organ, N. Mex., claims the Jones' Well claims east of the Torpedo, and Miss Judith Shipe owns the unpatented Organ claim west of the Little Ben Scott (see fig. 2).

LABOR AND LIVING CONDITIONS

All labor for mining in the Organ area must be imported. Las Cruces is the nearest source of labor, and it is doubtful whether there is any skilled mining labor closer than the Central Mining District, near Silver City, N. Mex., 120 miles to the west and north.

Housing accommodations at Organ are primitive and inadequate for more than a few men. There are two cafes, where meals may be procured. These establishments cater largely to transient tourist trade.

PHYSICAL FEATURES AND CLIMATE

The Torpedo mine is on the edge of the bolson plains that flank the Organ Mountains. The topography is not rugged, and the relief is low. Altitudes range from 5,160 to 5,340 feet (see fig. 2). Southeast of the Torpedo claim, the Organ Mountains are very rugged and reach an altitude slightly over 9,100 feet.

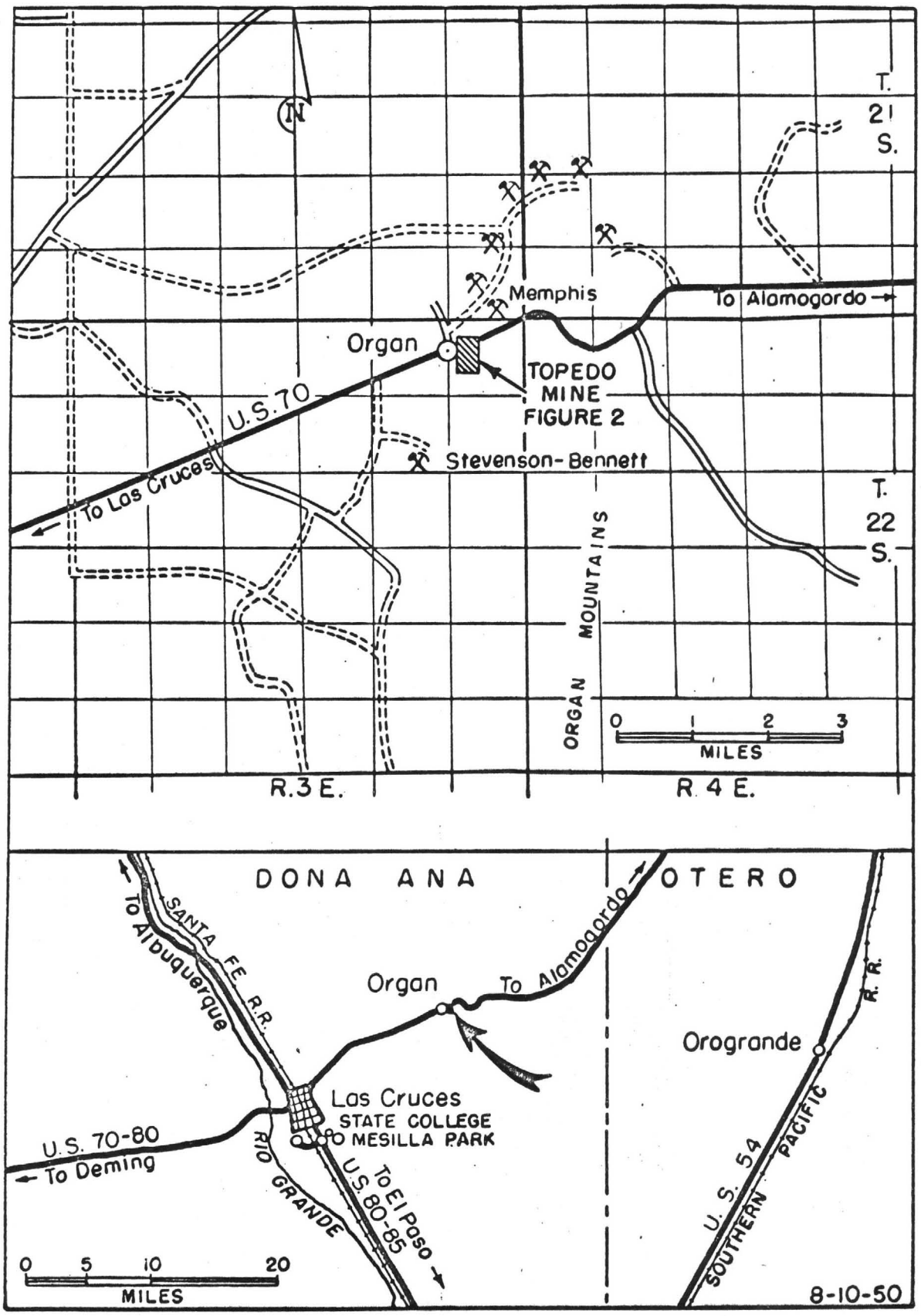


Figure 1. - Location map.

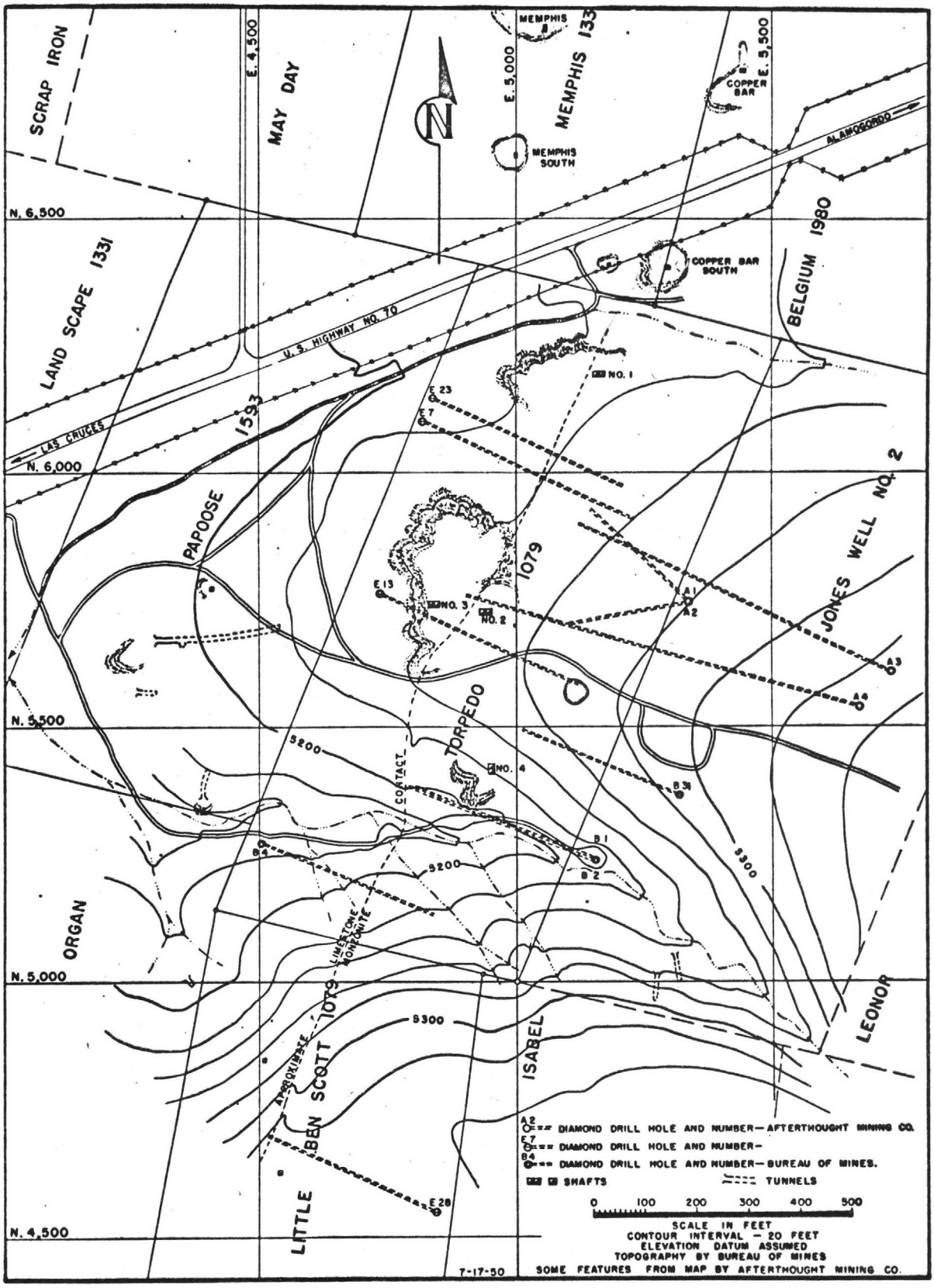


Figure 2. - Topographic and surface map.

The weather is typical of south-central New Mexico. Mining will be hampered little by the weather, which is generally mild in winter and warm in summer. Extreme cold is rare, although some freezing weather occurs in the winter. Snowfall is usually light and remains on the ground for only short periods. Summer rains and flash floods contribute the bulk of the annual precipitation, which averages about 10 inches.

There is no timber for mining operations on any of the claims, and the stands of Ponderosa pine in the higher reaches of the Organ Mountains are inaccessible. Timbering is a major industry at Alamogordo, N. Mex., some 57 miles to the northeast.

Greasewood, mesquite and various cactuses, shrubs, and other desert flora constitute the relatively sparse vegetation in the vicinity of the mine.

There are no permanent streams in the area, and almost all of the drinking water is rain water collected in cisterns. A few wells with windmills supply some water. The permanent water table is a little over 300 feet below the surface, as shown in the Copper Bar and Stevenson-Bennett shafts. Water from the Copper Bar shaft was used for drilling and contained considerable dissolved solids. No attempt was made to determine its potability. Reported estimates on the quantity of underground water range from 500 to 1,000 gallons per minute. The former figure seems more nearly correct.

HISTORY AND PRODUCTION

The history of the Organ Mining District dates back to 1849 with the discovery of the Stevenson-Bennett mine.[3] Legend indicates even earlier mining in the area. The Torpedo mine was discovered in 1899 by Henry Foy, although the claim was located in 1896. This was the last of the larger mines to be discovered.

Numerous parties have been interested in the Torpedo mine. A mining company purchased the mine from Foy shortly after its discovery and began production immediately. A little later, G. E. Fitzgerald acquired and operated the property. The Torpedo Mining Co. controlled the property in 1902 and is the present owner. Various lessees and sublessees have leased the mine, and many have done considerable work. The Torpedo Mining Co. operated the property until 1907, when it was leased to R. McCart, who held it until 1914. The Phelps-Dodge Corp. leased the mine in 1916-17 and did a considerable amount of development work. It was leased to the Organ Ore Co. in 1921; to Griffith and Phelps in 1928-29, who sank the No. 4 shaft; to the Willett Mining Co. from 1939 to 1944 and subleased to the Afterthought Mining Co., which did considerable exploratory work in 1941-42; and finally to J. H. Brown, the present lessee. The E. J. Longyear Co. subleased from Brown and, in conjunction with the New Jersey Zinc Exploration Co., carried out extensive exploration in 1946-47. Figures 4 and 5 show sections of drilling done by the companies. M. Drunzer subleased the Torpedo mine in 1949 and shipped some of the old dumps for siliceous fluxing ore to the El Paso, Tex., smelter.

3/ Dunham, K. C., Geology of the Organ Mountains: New Mexico School of Mines, State Bur. of Mines and Min. Resources, Bull. 11, 1935, p. 185.

Production from the Torpedo mine was almost continuous from its discovery to 1907. Subsequent production has been small and sporadic. The mine has produced no ore since 1921,[4] until Drunzer shipped some dump material in 1949. The total production from the Torpedo mine since its discovery has been about 3,500,000 pounds of copper and some silver. Production, by years, is shown in table 1.

TABLE 1. - Torpedo mine production

Year	Crude ore, tons	Ounces		Pounds	
		Au	Ag	Cu	Pb
1900.....	-	-	-	1/712,358	-
1901.....	-	-	-	1/515,162	-
1903.....	-	-	-	1/611,796	-
1904.....	-	-	-	1/40,000	-
1905.....	-	-	-	1/96,058	-
1906.....	-	-	-	1/434,000	-
1907.....	-	-	-	1/776,125	-
1908.....	102	-	289	6,569	-
1918 2/.....	605	-	1,859	75,534	930
1919 2/.....	1,797	-	3,980	317,876	11,659
1920.....	944	-	689	156,951	-
1928 3/.....	303	0.38	220	35,000	625
1929 3/.....	90	-	37	5,893	-
1937 3/.....	20	-	258	264	6,751
1939 3/.....	1	-	1	141	-
1949.....	969	-	138	26,202	-
Total.....	Incomplete			3,809,929	

1/ County production, largely from Torpedo, but other mines included.

2/ Production from adjoining mines probably included.

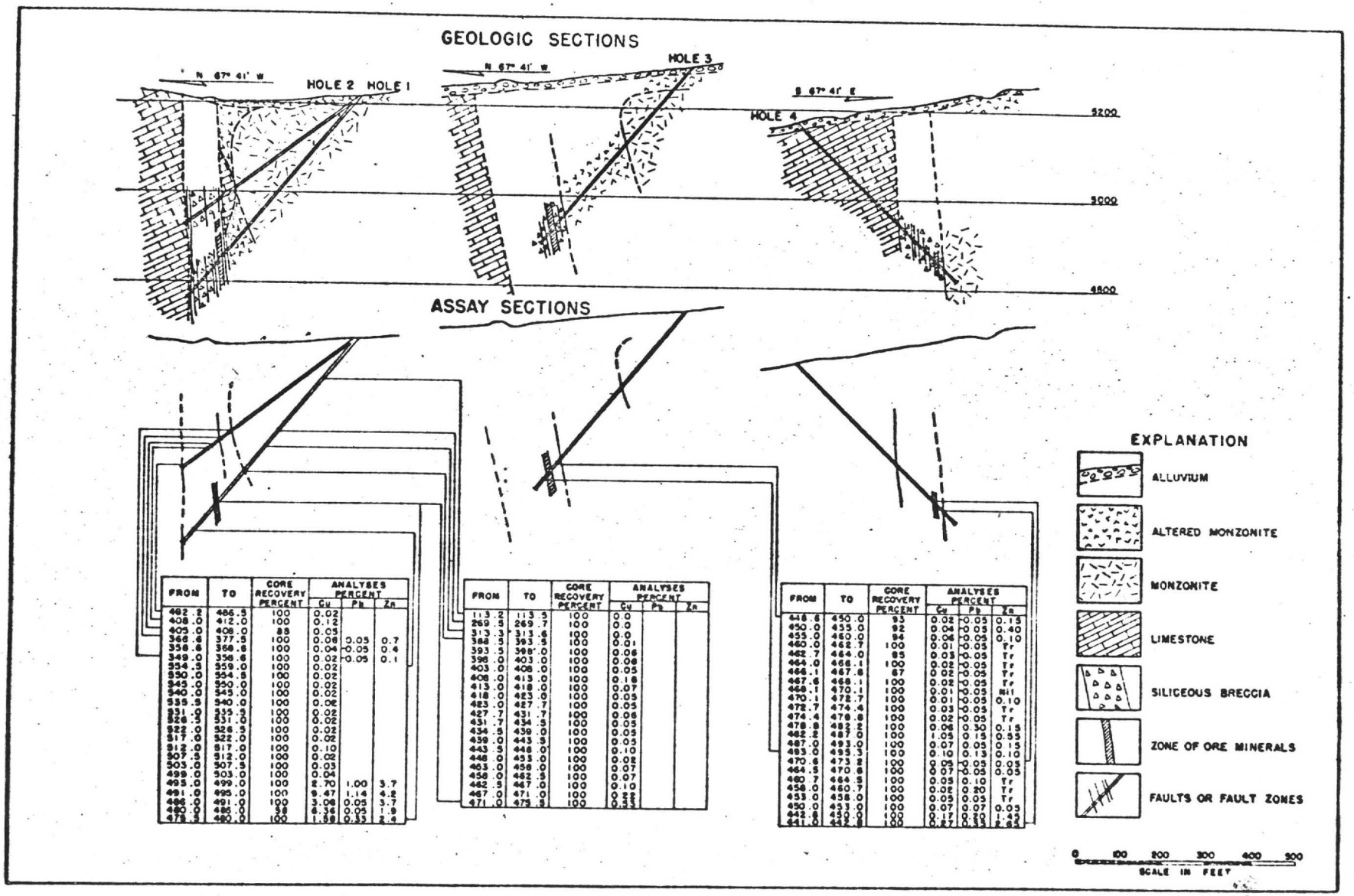
3/ Production believed entirely from adjoining mines of group, as the Torpedo mine itself has been reported idle from 1921 to 1949.

GEOLOGY AND ORE DEPOSITS

The Torpedo ore bodies occur in a north-south trending zone between monzonite on the east and Pennsylvanian limestones on the west. This zone averages about 100 feet in thickness, as shown in Bureau of Mines drill holes (see fig. 3). It dips steeply to the east but may overturn at depth, as shown in the log of hole A4 (see fig. 4). This apparent overturn may be due to faulting or a deviation in strike of the bore hole, which was surveyed for dip but not for strike.

The zone consists of some limestone, but mostly monzonite, which has been silicified and highly altered, brecciated, and recemented with silica. A number of faults traverse the zone, apparently more or less parallel with the zone itself. Some of these faults indicate considerable movement, but data are insufficient to measure the displacement.

4/ L. B. Bentley, oral communication.



FROM	TO	CORE RECOVERY PERCENT	ANALYSES PERCENT Cu	Pb	Zn
492.2	486.5	100	0.02		
408.0	412.0	100	0.12		
405.0	408.0	88	0.05		
366.6	377.5	100	0.08	0.05	0.7
358.8	368.8	100	0.04	0.05	0.4
349.0	358.6	100	0.02	0.05	0.1
354.5	359.0	100	0.02		
350.0	354.5	100	0.02		
345.0	350.0	100	0.02		
340.0	345.0	100	0.02		
335.5	340.0	100	0.02		
331.0	335.5	100	0.02		
326.5	331.0	100	0.02		
322.0	326.5	100	0.02		
317.0	322.0	100	0.02		
312.0	317.0	100	0.10		
307.5	312.0	100	0.02		
303.0	307.5	100	0.03		
499.0	503.0	100	0.04		
495.0	499.0	100	2.70	1.00	3.7
491.0	495.0	100	9.47	1.14	4.2
486.0	491.0	100	3.08	0.05	3.7
480.0	486.0	38	6.36	0.05	1.9
478.5	480.0	100	1.68	0.55	2.4

FROM	TO	CORE RECOVERY PERCENT	ANALYSES PERCENT Cu	Pb	Zn
113.2	113.5	100	0.0		
269.5	269.7	100	0.0		
313.3	313.6	100	0.0		
388.5	393.5	100	0.01		
393.5	398.0	100	0.06		
398.0	403.0	100	0.08		
403.0	408.0	100	0.05		
408.0	413.0	100	0.18		
413.0	418.0	100	0.07		
418.0	423.0	100	0.05		
423.0	427.7	100	0.05		
427.7	431.7	100	0.06		
431.7	434.5	100	0.05		
434.5	439.0	100	0.05		
439.0	443.5	100	0.05		
443.5	448.0	100	0.10		
448.0	453.0	100	0.02		
453.0	458.0	100	0.07		
458.0	462.5	100	0.07		
462.5	467.0	100	0.10		
467.0	471.0	100	0.22		
471.0	475.5	100	0.55		

FROM	TO	CORE RECOVERY PERCENT	ANALYSES PERCENT Cu	Pb	Zn
448.6	450.0	95	0.02	0.05	0.15
450.0	455.0	92	0.04	0.05	0.40
455.0	460.0	94	0.04	0.05	0.10
460.0	462.7	100	0.01	0.05	Tr
462.7	464.0	85	0.03	0.05	Tr
464.0	466.1	100	0.02	0.05	Tr
466.1	467.6	87	0.02	0.05	Tr
467.6	468.1	100	0.02	0.05	Tr
468.1	470.1	100	0.01	0.05	Nil
470.1	472.7	100	0.01	0.05	0.10
472.7	474.4	100	0.03	0.05	Tr
474.4	478.8	100	0.02	0.05	Tr
478.8	482.2	100	0.06	0.30	0.15
482.2	487.0	100	1.05	0.15	0.55
487.0	493.0	100	0.07	0.05	0.15
493.0	493.3	100	0.10	0.15	0.10
470.6	473.2	100	0.05	0.05	0.05
464.5	470.6	100	0.07	0.05	0.05
460.7	464.5	100	0.05	0.10	Tr
458.0	460.7	100	0.02	0.20	Tr
453.0	458.0	100	0.05	0.05	Tr
450.0	453.0	100	0.07	0.07	0.05
442.6	450.0	100	0.17	0.20	1.45
441.0	442.6	100	0.27	0.55	2.65

Figure 3. - Sections on Bureau of Mines drill holes.

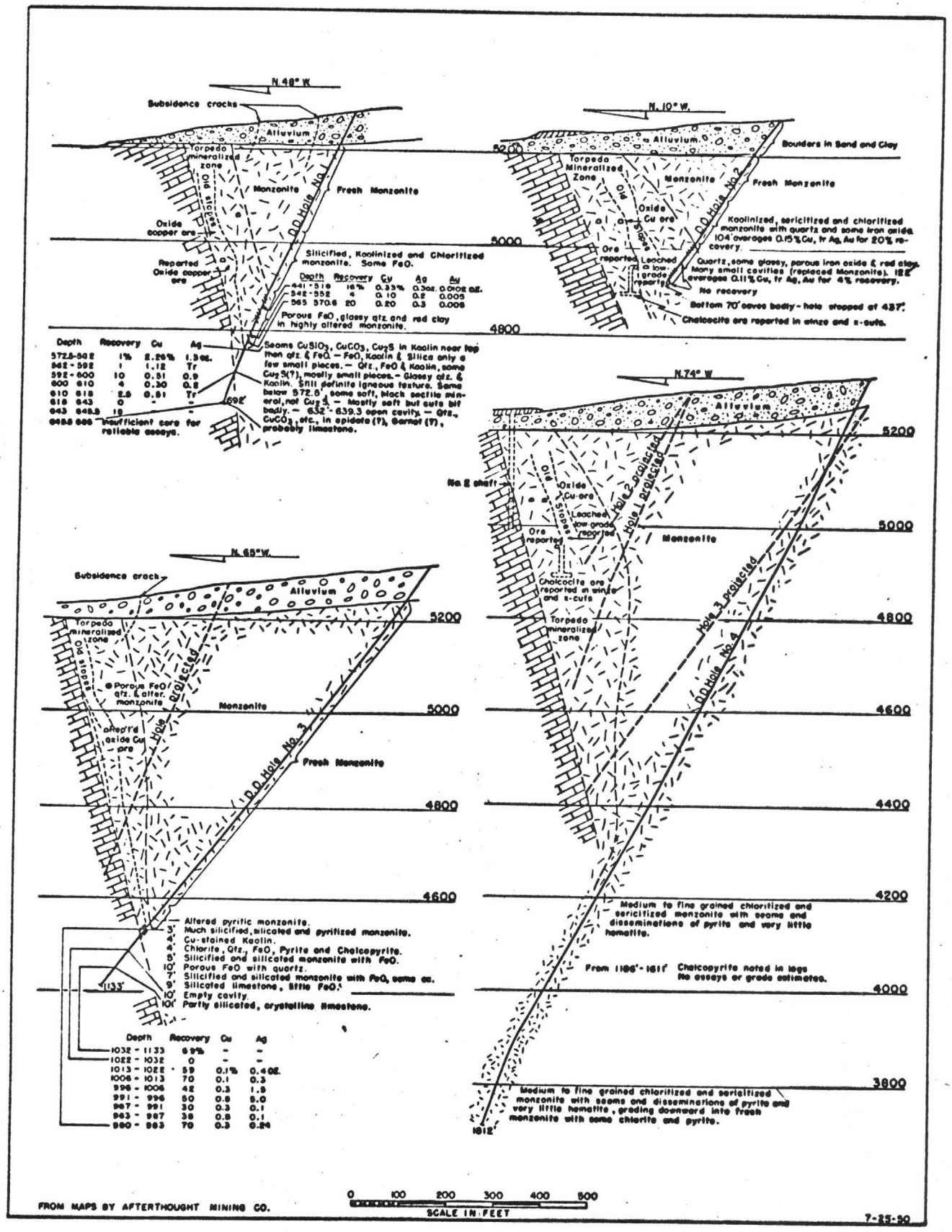


Figure 4. - Sections on drill holes A1, A2, A3, and A4.

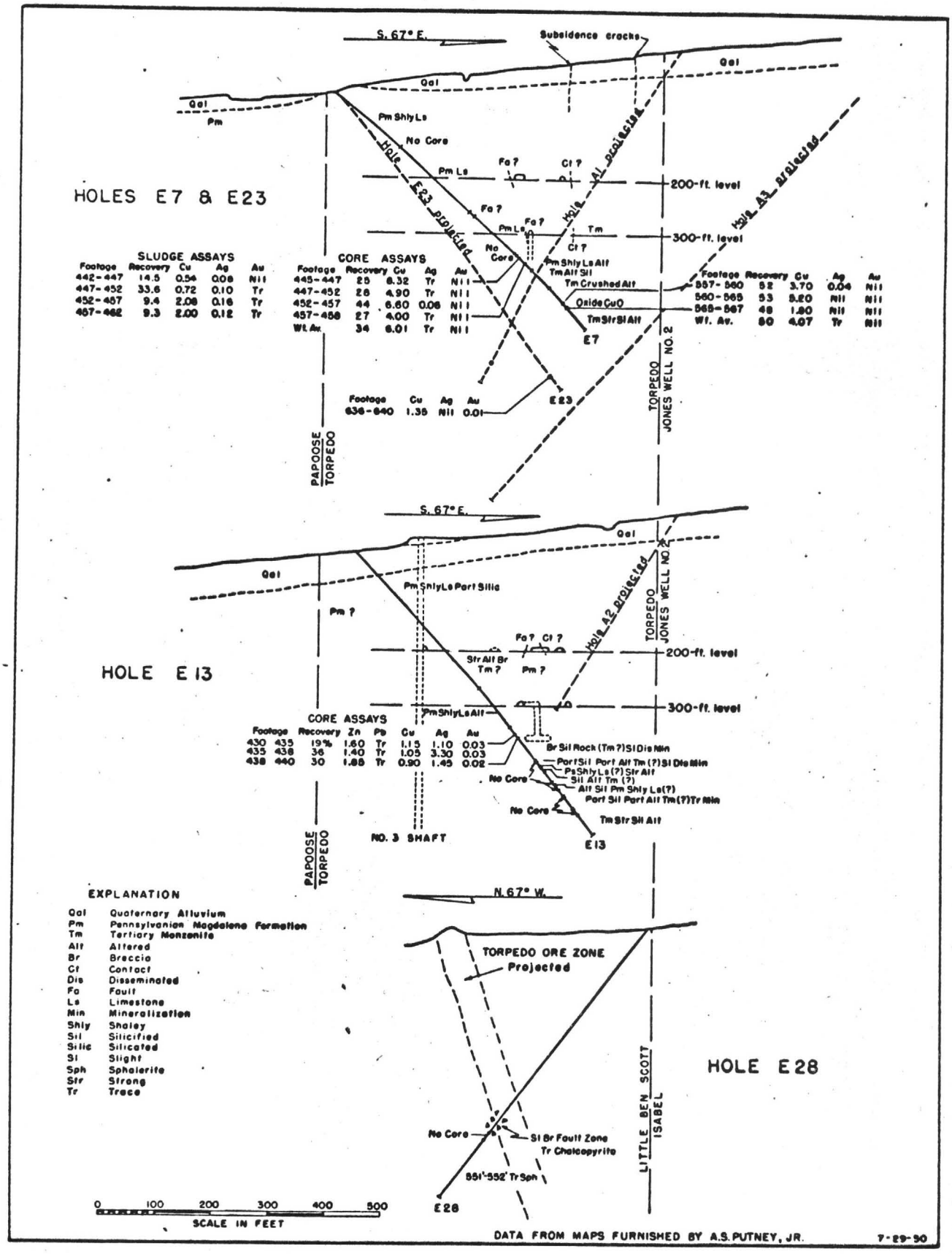


Figure 5. - Sections on drill holes E7, E13, E23, and E28.

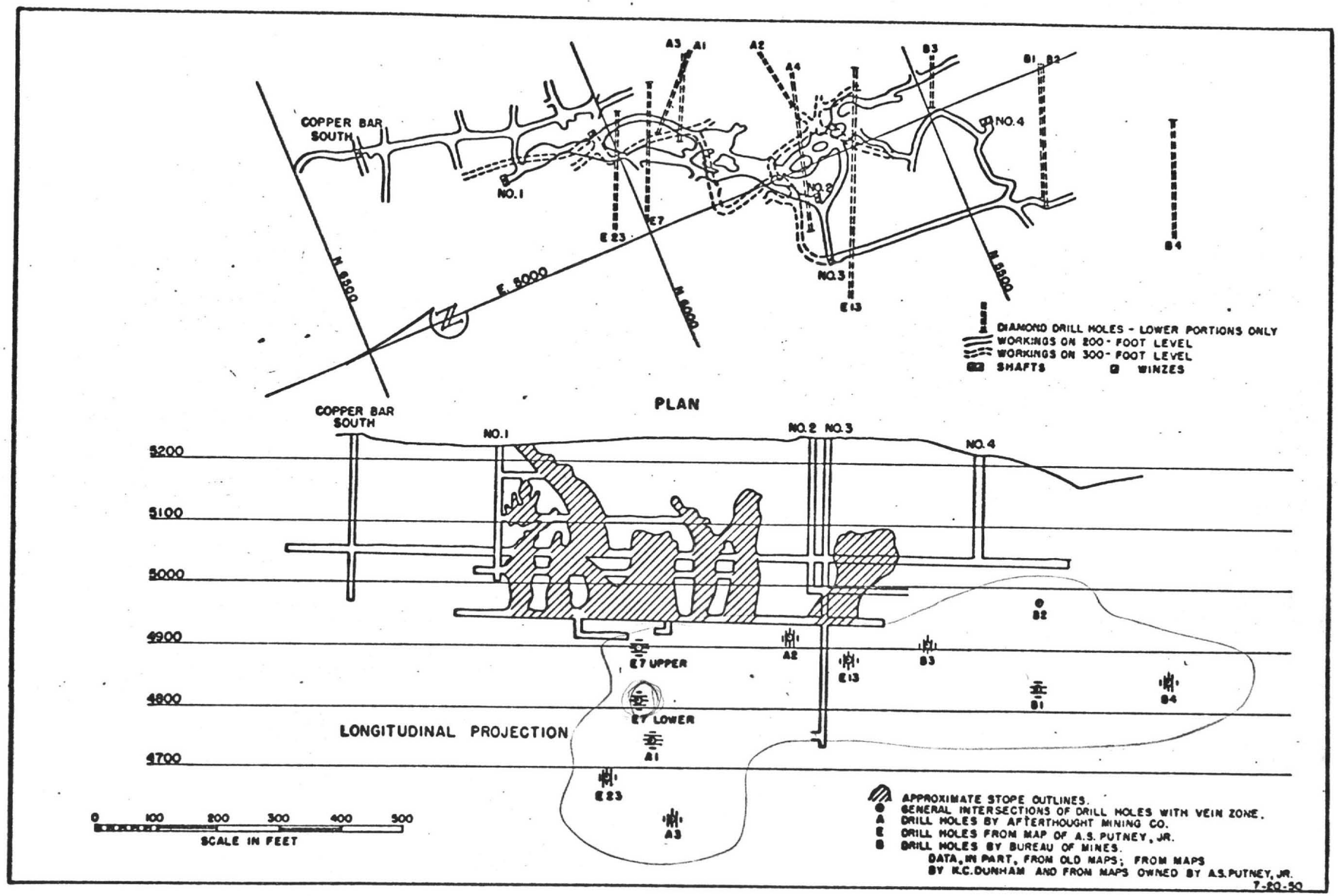


Figure 6. - Underground workings.

The monzonite east of the zone of ore bodies shows weathering effects near the surface. It becomes fresh with depth and contains specks and small stringers of pyrite. It is virtually barren of copper. Upon approaching the mineralized zone, it becomes hydrothermally altered but still retains its texture.

The limestone west of the zone is garnetized and silicified in part, although much of the limestone shows only slight alteration. The garnetization apparently extends, in favorable beds, over 200 feet from the monzonite contact. A few specks of sphalerite and galena were noted at rare intervals in the limestone core.

The above data are derived mainly from study of cores obtained by the Bureau of Mines. The underground workings were not accessible for inspection.

Judging from the stoped areas (see fig. 6) the individual ore bodies were elliptical in plan and generally steeply plunging, whereas the zone of the ore bodies seems to have a definite rake to the south. Only one of the ore bodies outcrops, and the discovery was made here. According to old smelter settlements,5/ most of the ore was produced from above the 300-foot level and was oxidized. The sulfur content was very low until the lower levels were mined. The ore mineral was chrysacolla with local occurrences of native copper. All ore minerals noted in the drill cores were the sulfides chalcopyrite, sphalerite, and galena. The gangue mineral seen in drill cores was silica, usually as the siliceous breccia.

DEVELOPMENT

The Torpedo mine was developed through four vertical shafts. No. 1 shaft is near the discovery and is shown to be a little over 200 feet deep (fig. 6). Shaft 2 is 250 feet deep, No. 3 is 500 feet, and No. 4 is 165 feet. All of these shafts are interconnected by lateral workings, which also extend north and connect with the Copper Bar south shaft. Most of the stopes were between No. 1 and No. 2 shaft, with another shown just south of No. 2 shaft. None of these workings were accessible in April 1950.

WORK BY THE BUREAU OF MINES

The development work by the Bureau of Mines was started October 3, 1949, and completed April 30, 1950. Because none of the mine workings were accessible, the work was confined to diamond core drilling, and all data were obtained therefrom. Four holes were drilled for a total of 2,122.3 feet.

All drilling was done with a Government-owned, medium-sized machine with hydraulic-feet drill head. Special large rods and special core barrels were used to obtain better core recovery in the critical zones than was possible with the standard-type tools previously used in this area. Core recovery in the ore zones is shown in figure 3, and total core recovery is shown in the summary logs that follow.

Seventy samples were split from the cores and analysed. Many were known to be low-grade. Analyses of the samples are shown in figure 3 and in the following summary logs of the drill holes.

5/ Dunham, K. C., op. cit., p. 217.

TORPEDO COPPER DESPOSIT

Log of Hole 1

Location: N. 5238.82, E. 5151.77
Elevation of collar: 5,215 ft.
Depth: 597.7 ft.
Dip: -50°
Bearing: N. 67°41' W.

Date begun: Nov. 4, 1949.
Date completed: Dec. 15, 1949.

Footage			Recoveries				Core	Analyses, percent			
			Core		Percent						
From	To	Feet	Feet	Grams	Core	Wtr.	size	Cu	Pb	Zn	Description and remarks
0.0	24.0	24.0	0	-	0	100	3-1/2"				Weathered monzonite, overburden.
24.0	65.0	41.0	38.5	61,131	94	100	NX				Monzonite.
65.0	100.0	35.0	34.5	52,904	99	95	NX				Monzonite.
100.0	113.2	13.2	11.2	15,829	85	95	NX				Monzonite, scant pyrite.
113.2	113.5	0.3	0.3	525	100	95	NX	0.01			Do.
113.5	269.4	155.9	153.9	263,687	99	95	NX				Do.
269.4	269.7	0.3	0.3	525	100	95	NX	.01			Do.
269.7	269.9	0.2	0.2	350	100	95	NX				Do.
269.9	289.2	19.3	19.3	35,168	100	0	NX				Do.
289.2	303.0	13.7	13.7	23,581	100	85	NX				Do.
303.0	313.3	10.3	10.3	9,291	100	85	BX				Do.
313.3	313.6	0.3	0.3	300	100	85	BX	.01			Do.
313.6	388.5	74.9	74.7	77,023	99	85	BX				Do.
388.5	393.5	5.0	5.0	4,865	100	85	BX	.01			Altered monzonite, scant sulfides.
393.5	398.0	4.5	4.5	5,606	100	85	BX	.06			Do.
398.0	403.0	5.0	5.0	6,578	100	85	BX	.08			Do.
403.0	408.0	5.0	5.0	5,135	100	85	BX	.05			Do.
408.0	413.0	5.0	5.0	5,023	100	85	BX	.16			Do.
413.0	418.0	5.0	5.0	5,850	100	85	BX	.07			Do.
418.0	423.0	5.0	5.0	6,138	100	85	BX	.05			Do.
423.0	427.7	4.7	4.7	5,280	100	85	BX	.05			Do.
427.7	431.7	4.0	4.0	4,666	100	85	BX	.06			Do.
431.7	434.5	2.8	2.8	2,936	100	85	BX	.05			Do.
434.5	439.0	4.5	4.5	4,591	100	85	BX	.05			Do.
439.0	443.5	4.5	4.5	4,912	100	85	BX	.05			Do.

4224

Hole 1 (Cont.)

Footage			Recoveries				Core size	Analyses, percent			Description and remarks
			Core		Percent						
From	To	Feet	Feet	Grams	Core	Wtr.		Cu	Pb	Zn	
443.5	448.0	4.5	4.5	5,148	100	85	BX	0.10			Altered monzonite, scant sulfides.
448.0	453.0	5.0	5.0	5,091	100	85	BX	.02			Do.
453.0	458.0	5.0	5.0	4,720	100	85	BX	.07			Do.
458.0	462.5	4.5	4.5	4,413	100	85	BX	.07			Do.
462.5	467.0	4.5	4.5	3,786	100	85	BX	.10			Do.
467.0	471.0	4.0	4.0	5,068	100	85	BX	.22			Do.
471.0	475.5	4.5	4.5	4,871	100	85	BX	.53			Do.
475.5	480.0	4.5	4.5	4,526	100	85	BX	1.58	0.33	2.4	Do.
480.0	486.0	6.0	3.5	3,921	58	85	BX	6.36	.05	1.9	Do.
486.0	491.0	5.0	5.0	4,643	100	85	BX	3.08	.05	3.7	Do.
491.0	495.0	4.0	4.0	3,368	100	85	BX	9.47	1.14	4.2	Siliceous breccia with sulfides.
495.0	499.0	4.0	4.0	3,725	100	85	BX	2.70	1.00	3.7	Do.
499.0	503.0	4.0	4.0	3,680	100	85	BX	.04			Siliceous breccia, scant sulfides.
503.0	507.5	4.5	4.5	4,151	100	85	BX	.03			Do.
507.5	512.0	4.5	4.5	3,444	100	85	BX	.02			Do.
512.0	517.0	5.0	5.0	3,406	100	85	BX	.10			Do.
517.0	522.0	5.0	5.0	3,993	100	85	BX	.02			Do.
522.0	526.5	4.5	4.5	2,690	100	85	BX	.02			Do.
526.5	531.0	4.5	4.5	2,133	100	85	BX	.02			Do.
531.0	535.5	4.5	4.5	4,310	100	85	BX	.02			Do.
535.5	540.0	4.5	4.5	2,897	100	85	AX	.02			Do.
540.0	545.0	5.0	5.0	1,996	100	85	AX	.02			Do.
545.0	550.0	5.0	5.0	2,013	100	85	AX	.02			Do.
550.0	554.5	4.5	4.5	2,185	100	85	AX	.02			Do.
554.5	559.0	4.5	4.5	2,173	100	85	AX	.02			Do.
559.0	565.5	6.5	6.5	2,613	100	85	AX				Do.
565.5	594.3	28.8	9.4	3,012	33	75	AX				Siliceous breccia and fault gouge.
594.3	597.7	3.4	2.4	673	71	50	AX				Fault gouge, limestone fragments.

Log of Hole 2

Location: N. 5240, E. 5150
Elevation of collar: 5,216 ft.
Depth: 489.5 ft.
Dip: -37°
Bearing: N. 67°41' W.

Date begun: Dec. 16, 1949.
Date completed: Jan. 25, 1950.

Footage			Recoveries				Core size	Analyses, percent			Description and remarks
			Core		Percent						
From	To	Feet	Feet	Grams	Core	Wtr.		Cu	Pb	Zn	
0.0	9.5	9.5	2.1	2,329	22	100	3-1/2"				Weathered monzonite, overburden.
9.5	34.0	24.5	8.3	17,404	34	100	do.				Do.
34.0	42.5	8.5	8.5	13,267	100	100	NX				Monzonite, scant pyrite.
42.5	249.0	206.5	205.8	355,467	99	95	do.				Do.
249.0	253.6	4.6	4.6	7,585	100	0	do.				Do.
253.6	280.0	26.4	26.4	45,043	100	100	do.				Do.
280.0	287.0	7.0	7.0	11,710	100	0	do.				Do.
287.0	313.5	26.5	26.5	45,871	100	90	do.				Do.
313.5	349.0	35.5	35.5	62,325	100	90	do.				Do.
349.0	358.6	9.6	9.6	17,603	100	90	do.	0.02	0.05	0.1	Altered limestone.
358.6	368.6	10.0	10.0	20,220	100	90	do.	.04	.05	.4	Do.
368.6	377.0	8.4	8.4	13,447	100	90	do.	.08	.05	.7	Do.
377.0	388.6	11.6	11.6	21,535	100	90	do.				Do.
388.6	405.0	16.4	14.6	21,183	88	90	do.				Fault gouge and breccia.
405.0	408.0	3.0	2.6	4,075	88	90	do.	.05			Crumbly pyrite.
408.0	412.0	4.0	4.0	7,520	100	90	do.	.12			Do.
412.0	442.0	30.0	30.0	42,705	100	90	do.				Siliceous breccia, fault gouge, pyrite.
442.0	482.2	40.2	36.3	48.635	90	90	do.				Breccia, shale?, sandstone?, pyrite.
482.2	486.5	4.3	4.3	5,102	100	90	do.	.02			Breccia, silicated material, scant pyrite.
486.5	489.5	3.0	2.5	3,934	83	90	do.				Brecia, shale, and calcite.

4224

Log of Hole No. 3

Location: N. 5367.21, E. 5317.11
Elevation of Collar: 5286.46
Depth: 524.6 ft.
Dip: -50°
Bearing: N. 67°41' W.

Date begun: January 26, 1950
Date completed: March 14, 1950

Footage			Recoveries				Core	Analyses Percent			
			Core		Percent						
From	To	Feet	Feet	Grams	Core	Wtr.	size	Cu	Pb	Zn	Description and remarks
0.0	49.0	49.0	1.7	3,762	3	95	3-1/2"				Weathered monzonite, overburden.
49.0	66.5	17.5	16.8	21,520	96	95	NX				Weathered, altered monzonite.
66.5	220.5	154.0	151.5	268,569	98	90	do.				Monzonite, scant pyrite.
220.5	448.6	228.1	224.7	389,629	99	90	do.				Altered monzonite, disseminated pyrite.
448.6	450.0	1.4	1.3	1,979	93	90	do.	0.02	-0.05	0.15	Do.
450.0	455.0	5.0	4.6	6,464	92	90	do.	.04	-.04	.04	Do.
455.0	460.0	5.0	4.7	3,798	94	90	BX	.06	-.05	.1	Do.
460.0	462.7	2.7	2.7	2,215	100	90	do.	.01	-.05	Tr	Do.
462.7	464.0	1.3	1.1	800	85	90	do.	.03	.05	Tr	Do.
464.0	466.1	2.1	2.1	1,923	100	90	do.	.02	-.05	Tr	Do.
466.1	467.6	1.5	1.0	551	67	90	do.	.02	-.05	Tr	Do.
467.6	468.1	0.5	0.5	100	100	90	do.	.02	-.05	Tr	Do.
468.1	470.1	2.0	2.0	1,419	100	90	do.	.01	-.05	Nil	Do.
470.1	472.7	2.6	2.6	1,491	100	90	do.	.01	-.05	0.1	Do.
472.7	474.4	1.7	1.7	1,468	100	90	do.	.03	-.05	Tr	Do.
474.4	478.8	4.4	4.3	2,931	98	85	do.	.02	-.05	Tr	Do.
478.8	482.2	3.4	3.4	3,204	100	80	do.	.06	.30	0.15	Vein material.
482.2	487.0	4.8	4.8	4,579	100	80	do.	1.05	.15	.55	Do.
487.0	493.0	6.0	6.0	4,404	100	75	do.	.07	.05	.15	Do.
493.0	498.7	5.7	5.7	4,982	100	60	do.	.10	.13	.1	Do. Sample to 495.3, then breccia
498.7	499.5	0.8	0.8	612	100	75	do.				Siliceous breccia.
499.5	524.6	25.1	13.3	9,848	53	75	do.				Do.

4224

Log of Hole 4

Location: N. 5268.66, E. 4502.33
Elevation of Collar: 5,172.71 ft.
Depth: 510.5 ft.
Dip: -45°
Bearing: S. 67°41' E.

Date begun: Mar. 13, 1950.
Date completed: Apr. 25, 1950.

Footage			Recoveries				Core size	Analyses, percent			Description and remarks
			Core		Percent						
From	To	Feet	Feet	Grams	Core	Wtr.		Cu	Pb	Zn	
0.0	21.0	21.0	0.0	0	0	100	3-1/2"				Overburden.
21.0	26.2	5.2	5.2	10,829	100	100	NX				Garnet.
26.2	44.0	17.8	13.9	17,542	78	90	do.				Garnet and breccia.
44.0	56.1	12.1	12.0	23,305	99	90	do.				Garnet.
56.1	86.0	29.9	29.9	44,859	100	100	do.				Altered, silicated limestone.
86.0	176.2	90.2	90.2	173,525	100	87	do.				Slightly altered limestone.
176.2	342.0	165.8	135.8	140,511	82	90	BX				Do.
342.0	380.0	38.0	31.8	27,067	84	90	do.				Siliceous breccia and pryite.
380.0	394.6	14.6	13.5	8,315	92	90	do.				Fault gouge.
394.6	400.0	5.4	5.4	5,885	100	90	do.				Siliceous breccia.
400.0	420.5	20.5	17.4	15,711	85	90	do.				Siliceous breccia and pyrite.
402.3	440.0	37.7	31.7	25,545	84	90	do.				Do. Hole deflected at 402.3.
440.0	442.8	2.8	2.8	2,253	100	90	do.	0.27	0.35	2.65	Siliceous breccia with sulfides at 441 ft.
442.8	450.0	7.2	7.2	5,970	100	90	do.	.17	.20	1.45	Siliceous breccia with sulfides.
450.0	453.0	3.0	3.0	2,590	100	90	do.	.07	.07	.05	Breccia with pyrite.
453.0	458.0	5.0	5.0	4,928	100	90	do.	.05	.05	Tr	Do.
458.0	460.7	2.7	2.7	2,936	100	90	do.	.02	.02	Tr	Do.
460.7	464.5	3.8	3.8	4,603	100	90	do.	.05	.10	Tr	Do.
464.5	470.6	6.1	6.1	5,651	100	90	do.	.07	-.05	.05	Do.
470.6	478.0	7.4	7.4	7,499	100	90	do.	.05	-.05	.05	Do. Sample to 473.2, then monzonite.
478.0	510.5	32.5	31.5	16,440	97	90	AX				Monzonite.

4224
Interior - Bureau of Mines, Pittsburgh, Pa.

LEAD ZINC AND COPPER DEPOSITS OF THE ORGAN DISTRICT, NEW MEXICO

(With a Supplement on Occurrence of Bismuth)

Claude C. Albritton, Jr. and Vincent E. Nelson

CONTENTS

Page

Abstract..... 1
Introduction..... 2
Geology..... 3
Sedimentary rocks..... 3
Bliss formation (Cambrian)..... 3
Ordovician and Silurian limestone and dolomite..... 3
Percha formation (Devonian)..... 3
Lake Valley formation (Carboniferous)..... 4
Magdalena series..... 4
Igneous rocks..... 4
Pre-Cambrian granite..... 4
Tertiary monzonitic rocks..... 5
Monzonite..... 5
Quartz monzonite..... 5
Quartz-bearing monzonite..... 5
Quartz monzonite porphyry..... 5
Rhyolite..... 6
Andesite..... 6
Metamorphic rocks..... 6
Structural geology..... 7
Ore deposits..... 8
Vein deposits..... 9
In the Tertiary batholith..... 9
In the pre-Cambrian granite..... 9
Replacement deposits..... 10
Of the Hilltop-Merrimac area..... 10
Related to the Bliss-El Paso contact..... 10
Related to the Fusselman-Percha contact..... 10
Related to the Percha-Lake Valley contact..... 11
Around the Excelsior rhyolite laccolith..... 12
Along the Torpedo-Bennett fault zone..... 13
Copper Buckle..... 13
Memphis..... 13
Torpedo..... 14
Stevenson-Bennett..... 14

Page

Reserves..... 16
Mines and Prospects..... 17
Vein deposits in igneous rocks..... 17
Corpus Christi prospect..... 17
Sunrise mine..... 17
Hornspoon group..... 19
Other mines and prospects..... 21
Replacement deposits in limestone and monzonite..... 21
R. C. and R. J. Lodge prospect..... 21
Hilltop mine..... 22
Rickardite mine..... 24
Little Buck mine..... 26
Mullins prospect..... 28
Black Prince mine..... 28
Merrimac mine..... 28
Tish prospect..... 30
Excelsior mine..... 30
Cowpuncher mine..... 30
Copper Buckle prospect..... 31
Memphis mine..... 32
Torpedo mine..... 33
Stevenson-Bennett mine..... 35
Philadelphia group..... 36
Homestake mine..... 36

Supplementary report on bismuth investigations..... 37
Investigations..... 37
Memphis mine..... 37
Merrimac mine..... 37
Cowpuncher mine..... 37
Homestake mine..... 38
Rickardite mine..... 38
Hilltop mine..... 38
Texas Canyon mine..... 38
Summary..... 38

ILLUSTRATIONS

Plate

1. Geologic map of the Organ District.
2. Geologic map of Merrimac-Little Buck area (with overprint showing topography and location of mines).
3. Surface geology, Corpus Christi mine.
4. Plan of underground workings, Corpus Christi mine.
5. Plan of Sunrise mine.
6. Plan of Hilltop mine.
7. Plan of Rickardite No. 1, No. 2, and No. 3 workings.
8. Plan of Little Buck workings No.'s 1-7.
9. Plan of Merrimac workings.

9a. Plan and section of Foy workings.

Plate

10. Geologic map of Cowpuncher-Excelsior area.
11. Map of Copper Buckle prospect.
12. Plan of 140 level, South shaft, Memphis mine.
13. Plan of 200 level, Torpedo mine.
14. Plan of 300 level, Torpedo mine.
15. Surface map of Torpedo area.

Figure

1. Index map showing location of Organ District.(Not included with this report).
2. Plan of Lodge prospect.
3. Plan of Little Buck No. 8 mine.
4. Plan of Mullins prospect.
5. Plan of Tish prospect.
6. Plan of underground workings, Cowpuncher mine.
7. Section along Drill hole 1, Torpedo mine.
8. Section along Drill Hole 2, Torpedo mine.
9. Section along Drill Hole 3, Torpedo mine.
10. Section along Drill Hole 4, Torpedo mine.

INTRODUCTION

The Organ mining district covers an area of approximately 55 square miles in the east-central part of Dona Ana County, New Mexico. (Fig. 1) It includes the extreme southern end of the San Andreas Mountains and the northern part of the Organ range. The small town of Organ is situated near the western boundary of the area.

Most mines and prospects in the district are easily accessible by road. A paved highway (U.S.70) crosses the center of the area and connects Organ with Las Cruces, fifteen miles to the west. Las Cruces is served by a branch of the Santa Fe railway which has a terminal 60 miles south in the smelting district of El Paso, Texas.

Mining dates back to 1849, when the Stevenson mine was opened. Construction of the railway through the county in 1881 stimulated mining and prospecting to the extent that the larger ore bodies were discovered by 1900. The interval 1900-1909 has been the most productive in the history of the district. A second period of activity began with the first world war. At the end of the war production virtually ceased, and the district has been essentially idle until 1942 when the present campaign of prospecting and development began.

Between 1884 and 1933 Dona Ana County produced 779,781 ounces of silver, 2263 ~~4,282,783 pounds~~ of copper, ~~14,754,002 pounds~~ 7,412 of lead, and ~~[illegible] pounds~~ 132 of zinc.1/ Nearly all this production was from the Organ district. In June 1942, the Merrimac mine was reopened, and its production to May 1943, has been 2400 tons of 15 percent zinc ore.2/ This increases the total production of zinc for the district to between ~~three-quarters of a million and one million pounds.~~ 375 and 500 tons.

The most recent and comprehensive publication on the district is that of K. C. Dunham. 3/, whose excellent and detailed account summarizes all previous contributions to the geology and contributes much new material. The mines and prospects are described in detail commensurate with their size and productivity. Petrologic and petrographic data on igneous rocks are included, and the problems relating to ore deposition are treated at length.

Field work on which this report is based was completed between January 1 and May 25, 1943. The accessible parts of all known mines and prospects in the district were examined. The more important workings were surveyed, except where Dunham's earlier work rendered mapping a useless duplication of effort. Surface geology of the district was mapped on enlargements of aerial photographs.

The writers are indebted to all the operators and prospectors in the district for providing full access to their properties. Mr. L. B. Bentley of Organ was generous in supplying maps, assay data, and general information on the mines. Messrs. C. H. Johnson and W. R. Storms of the Federal Bureau of Mines cooperated throughout the course of the project and made possible an examination of some of the shafts. Mr. Storms joined the writers in mapping the Memphis mine.

GEOLOGY

The district centers around a composite batholith of probable Tertiary age, consisting of three types of monzonite. The intrusive cuts pre-Cambrian granite and sedimentary rocks ranging in age from Cambrian to Carboniferous. The general areal geology is shown on Plate 1.

Sedimentary Rocks

Sedimentary rocks within the area mapped belong to the Paleozoic and Cenozoic. The Paleozoic sequence aggregates more than 3300 feet and consists mostly of limestone and dolomite, with lesser amounts of shale and sandstone. Cenozoic rocks include alluvial bodies of several ages and types, including terrace deposits, fan deposits, and pediment gravels. The various kinds of alluvium are not differentiated on the geologic map and are not further treated in this report.

Bliss Formation (Cambrian)

The Bliss formation consists of brown-weathering sandstone, quartzite, and hard sandy shale bedded in thin units and aggregating approximately 140 feet in thickness. Many of the sandy beds are perforated by worm borings, which appear to be the only fossils that have been preserved. The formation rests on pre-Cambrian granite and grades upward into calcareous beds of the El Paso formation.

Ordovician and Silurian Limestone and Dolomite

Overlying the Bliss formation is a sequence of limestone and dolomite totaling 1250 feet in thickness and including the El Paso, Montoya, and Fusselman formations, in order from oldest to youngest. The El Paso is 800 feet thick and consists of thin limestone layers that weather gray. A disconformity, locally marked by fine sandy and conglomeratic layers, separates the El Paso from the overlying Montoya formation. The Montoya and Fusselman together form an apparently conformable sequence of gray-weathering to white-weathering dolomitic limestones, containing chert nodules at many horizons. Throughout the entire section fossils are rare, and where present are generally too poorly preserved for identification. No attempt was made to differentiate between the three Ordovician and Silurian formations in the course of areal mapping.

Percha Formation (Devonian)

The Percha formation consists of dark fissile shale that locally encloses small limy concretions. Thin limestone layers occur near the top. The basal layers rest disconformably on the Fusselman, filling small channels that may be as much as 20 feet across and five feet deep. Within the area mapped, the shale averages approximately 100 feet in thickness.

Lake Valley Formation (Carboniferous)

The Lake Valley formation includes approximately 800 feet of limestone and shale. Limestone is the predominant rock; it is white or light gray and is bedded in units ranging in thickness from a few inches to three feet. Many of the layers are coarsely crystalline, and some of them abound with crinoid stems and coral fragments. Chert forms nodules and thin layers at many horizons. The shale is calcareous, occurring in minor quantities as partings between limestone beds.

The Lake-Valley-Percha contact is one of apparent conformity.

Magdalena Series (Carboniferous)

The Magdalena series consists of alternating thin layers of impure limestone, shale, and calcareous sandstone. The total thickness has not been determined, but it must be in excess of 2,000 feet. At the base is a bed of dark gray or brown shale that locally contains plant remains. This bed is similar to others higher in the section so that in areas where bedrock is poorly exposed it is often difficult to locate the Lake Valley-Magdalena contact. In general, however, the two formations may be distinguished from a distance by their contrasting shades of weathering: the Lake Valley weathers white or light gray whereas the Magdalena weathers to shades of darker gray or of brown.

Igneous Rocks

The principal types of intrusive rock are granite and monzonite. The granite is pre-Cambrian; the monzonitic rocks together form a composite batholith of probable Tertiary age. The oldest phase of the batholith, a dark monzonite, is cut by quartz monzonite, which in turn is cut by a stock of quartz-bearing monzonite. Related in origin to the batholith are dikes, sills and small laccoliths of quartz-monzonite porphyry and of rhyolite.

Extrusive rocks cover large parts of the southern Organ mountains, but are limited within the area mapped to a faulted outlier of andesite.

An extended treatment of the igneous geology is to be found in Lunham's bulletin. 4/

Pre-Cambrian Granite

The granite is a medium to coarse-grained rock in which orthoclase is the predominant mineral and quartz and biotite are easily visible without the aid of a lens. The orthoclase crystals may be as long as 20 mm.; they commonly show parallel orientation. Fresh rock is gray but on weathering a reddish color develops.

Enclosed by the granite are small monoliths of schist and quartzite, and cutting it are pegmatite and aplite dikes that generally do not exceed a few feet in thickness. Cutting the pegmatite and aplite in turn are dark gray or black diabase dikes, now altered to epidiorite.

Tertiary Monzonitic Rocks

Monzonite.- The earliest phase of the Tertiary batholith is a dark medium-grained monzonite containing oligoclase, perthite, enstatite, augite, hornblende, biotite, and accessories. The rock is not exposed within the area mapped, but crops out around the Sunrise copper mine in Tomas Canyon. Here it is invaded by quartz monzonite constituting the second and most widely distributed phase of the batholith.

Quartz monzonite.- This rock is composed largely of feldspar-- perthite and oligoclase having been identified in thin section by Dunham, who gives the average length of feldspar crystals as 7 mm. The plagioclase is zoned, typical crystals showing pinkish centers and margins of lighter color. On weathering, the inner zones decompose more rapidly than the outer, causing exposed surfaces to have the pitted appearance that provides a helpful criterion for field identification. Quartz is present, though it cannot generally be seen in the hand specimen. Biotite and hornblende occur locally in small amounts.

Quartz-bearing monzonite.- The third and youngest phase of the batholith is coarse-grained quartz-bearing monzonite that is gray on fresh exposure and brown on weathered surfaces. The rock is predominantly oligoclase and perthite. Feldspar crystals average about 10 mm. in length although exceptional individuals may be as long as 25 mm. Hornblende and biotite may also be recognized in the hand specimen, but careful examination with a lens is required to detect the small amounts of quartz that are present. The rock contains abundant xenoliths of dark color believed by Dunham to represent altered masses of monzonite from the earliest phase of the batholith. These xenoliths have rounded outlines and generally do not exceed two feet in longest dimension.

The quartz-bearing monzonite is cut by numerous thin sheets of aplite and it encloses large, irregular bodies of pegmatite.

In the field the three phases of the batholith may generally be distinguished by differences in color and texture -- the monzonite by its dark color, the quartz monzonite by its medium texture and zoned feldspars, the quartz-bearing monzonite by its light color and coarse texture. From the pre-Cambrian granite the monzonitic rocks may be recognized by the fact that the quartz is not present in sufficient amounts to show conspicuously on weathered surfaces.

Quartz-monzonite porphyry.- This rock forms dikes cutting theyoungest phase of the batholith, and sills intruded into the Paleozoic sedimentary rocks around the batholith. The sills are generally so highly altered that little can be judged regarding their original composition. Quartz and feldspar occur as phenocrysts, but the feldspar is mostly replaced by sericite. The rock is white on fresh exposure but turns brown on weathering.

The dikes are less altered than the sills, and Dunham has identified the common phenocrysts of certain examples as oligoclase and perthite. The fine groundmass is of quartz and feldspar.

Rhyolite

The granite, the Paleozoic sedimentary rocks, and the Tertiary monzonitic rocks are cut by numerous rhyolite dikes. The rhyolite is a dense white to grayish rock which locally contains small phenocrysts of quartz and feldspar but which generally shows no mineral constituents that can be recognized in hand specimen. The dikes range in width from a foot to 30 feet; they have vertical or nearly vertical sides and commonly show closely spaced joints parallel to the walls. The greater number are arranged en echelon. Long dikes, as those around San Agustin Peak, show abrupt bends along their outcrops. Easterly, northeasterly, and northwesterly systems may be recognized on the geologic map.

North of the Big Three mine is a small rhyolite laccolith in the Lake Valley formation. This evidently was fed by the long dike that terminates on the west near the Excelsior mine.

Andesite

The andesite is a gray, brown-weathering porphyritic rock with phenocrysts of feldspar and hornblende. The phenocrysts are commonly several millimeters long, and they are so closely spaced as to equal or exceed the volume of the groundmass. On the hill west of Copper Buckle prospect the bedding of the lava is obscure. Tentatively Dunham 5/ has correlated these croppings with the Orejon andesite of the southern Organ mountains.

Metamorphic Rocks

Along the margins of the Tertiary batholith Paleozoic rocks show metamorphic effects that vary with their original composition and with their proximity to the intrusive.

The pre-Cambrian granite and the Percha shale, even where directly in contact with the batholith at its northern end, show no metamorphic changes that serve to obscure their identity. On the other hand the Paleozoic limestone and dolomites have been recrystallized, replaced with silica, or converted to garnetite.

Replacement of limestone by silica is most widespread in the lower (El Paso) beds of the Ordovician-Silurian sequence, which show silicified zones at many horizons to the northern limit of mapping. The dolomitic fraction of the same sequence has been less susceptible to such replacement, and generally the silicified zones that do occur lie within a few hundred feet of the batholith.

The dolomites are recrystallized along the northern part of the area to the limit of mapping. Likewise the Lake Valley formation, along its outcrop between the Little Buck and Excelsior mines, is for the greater part changed to coarse-textured marble. Limestones of the Magdalena group show similar alteration in the Memphis mine area.

Garnetized layers are common in the basal El Paso beds, especially within the lower 40 feet. Dense garnet beds are also common in the Lake Valley formation, particularly in the lower part around the Merrimac mine, as well as in the middle and upper parts around the Excelsior mine and along the contact with the rhyolite laccolith to the east. In the Memphis area limestones of the Magdalena series have been altered to coarse garnetite that carries considerable specularite. This alteration is most pronounced in two zones, the more westerly of which is 300 feet away from the contact with the monzonite.

Small bodies of massive green serpentine are found throughout the dolomitic parts of the Ordovician-Silurian sequence. Veinlets of asbestos are commonly associated with the serpentine.

Structural Geology

Stresses operating during emplacement of the Tertiary batholith resulted in arching and folding of the Paleozoic sediments at the northern end of the area. An anticline trending northwest and plunging in the same direction developed along a line between the Silver Coinage and Merrimac workings. Strata along the western flank were irregularly and discordantly invaded by the quartz-bearing monzonite and were cut by dikes and sills of quartz monzonite. North of the area affected by this fold the strikes in the Paleozoic rocks turn more northerly and the regional dip is westward at angles averaging between 30 and 40 degrees.

Superimposed on the nose and northeast flank of the anticline are minor flexures which trend between north-northwest and northwest and which plunge northwest with the axis of the major fold. These small structures are best developed around the Marrimac mine and the Rickardite mine, but similar flexures were also mapped at the Milltop mine. They are inconspicuous and can hardly be defined without the aid of detailed mapping; yet their economic significance is considerable, as lead-zinc replacement bodies are commonly localized along their crests.

Along the western side of the district the Paleozoic rocks have a prevailing westerly dip, but the structure here is complicated and dominated by a system of north-trending normal faults which make up what Dunham has named the Torpedo-Bennett fault zone. This zone extends beyond the limits of mapping, both to the north and the south; it is only a few feet wide at the Copper Buckle prospect on the north, but it widens southward and is nearly a quarter of a mile in width at the Stevenson-Bennett mine. Most faults along this zone dip at high angles toward the east, although westward-dipping and vertical fractures are also present. Traces of the major faults are commonly marked by silicified breccia which weathers in relief to form miniature hogbacks.

As the faults of the Torpedo-Bennett zone displace the youngest phase of the Tertiary batholith, it follows that fracturing occurred after the magma was largely consolidated; yet the faults must have formed before the stage of Tertiary mineralization was completed. That they have exerted a major control on ore deposition is indicated by the fact that the largest mines in the district are located along the fracture zone.

A second system of normal faults has a general easterly trend. Faults of this system displace those of the Torpedo-Bennett zone and evidently were formed after mineralization was completed. Such faults are especially numerous in the area of the Hilltop mine where their complexly branching pattern divides the Paleozoic terrain into a series of small blocks.

ORE DEPOSITS

Mineralizing solutions responsible for the ore deposits were active during and for some time following emplacement of the Tertiary batholith. Within the intrusive itself, sulphides were segregated inside bodies of pegmatite or also were precipitated along fissures to form veins.

Solutions moving out of the batholith were guided by fractures and further influenced in their courses by the structural attitude of impervious strata that resisted infiltration. The type of deposit formed depended largely on the solubility and reactivity of the country rock. Where solutions traveled along fissures in the relatively unreactive pre-Cambrian granite they deposited minerals as narrow vein-fillings. Where the fissures lead through limestone or dolomite, the easily soluble and highly reactive rock was locally replaced by sulphides. Along the Stevenson-Bennett fault zone the mineralizing agents locally permeated ramifying cracks in the batholithic rock itself and there formed bodies of low-grade ore.

A simple scheme of classification divides the ore bodies into three groups: (1) segregations in pegmatites, (2) veins in igneous rocks, and (3) replacement bodies in limestone, dolomite, and monzonite. This classification has the advantage of dividing the deposits into categories of differing economic importance insofar as the base metals are concerned. The pegmatite deposits have no possibilities for producing lead, zinc, and copper except in negligible amounts as by-products of precious metals. The veins in igneous rocks are marginal in their possibilities for producing base metals; most of them are valuable only for their content of gold and silver, but some may produce small amounts of lead and zinc as well as high-silica copper ore. It is from the replacement bodies that by far the greater amounts of base metals have been produced and from which any future production is likely to come.

Attention is thus confined in this report to the vein and replacement deposits. Examination of the pegmatites at the Ben Nevis, Gray Eagle, and Quickstrike mines added nothing to the account that Dunham has already given.[5]

Vein Deposits
In the Tertiary Batholith

The Tertiary batholith is cut by numerous quartz veins, some of which carry high percentages of metallic minerals. The veins are generally nearly vertical and their prevailing trend is easterly. Only a few exceed a foot in width, although exceptional examples may locally be as much as ten feet across. Individual veins cannot ordinarily be traced for more than a hundred feet, although vein systems related to a single set of fractures may persist for several thousand feet along the strike.

The veins were formed by the filling of fissures. Generally the sulphides are concentrated toward the central portions. The common sulphides are sphalerite, galena, and pyrite. Tetrahedrite, argentite, and tetradymite--$Bi_2(Te,S)_3$--are locally present, and cerargyrite has been mined from some of the oxidized croppings. The silver for which the veins are generally prospected is associated with galena, argentite, and tetrahedrite, especially tetrahedrite which may carry around 10 percent silver according to Dunham's estimate. 7/

Many such veins have been mined and prospected in the northern part of the batholith, as at the Big Three mine, the Rainbow prospect (formerly the Crested Butte), the Davy King, the Hornspoon (formerly the Hawkeye) group, the Amy prospect, the Silver King prospect, the Silver Coinage mine, and the Corpus Christi prospect. South of the highway are the Galloway, Poor Man's Friend, and Sunrise (formerly the Texas Canyon) mines.

Sulphides within the veins may form almost solid lenticular bodies or may be distributed throughout the quartz gangue as discrete crystals. In the first type the ore minerals form shoots a few inches across and generally not more than a few score feet in longest dimension. Assays of such bodies of course give high percentages for lead and zinc. The volume of the vein deposits is so small, however, that they cannot be profitably mined except where there are good values in silver.

Where the sulphides occur as scattered crystals, as at the Sunrise mine, assays show that copper, lead, and zinc do not individually exceed a few percent. Such deposits could be mined for base metals only if there is demand for high-silica ores for use as enriching fluxes.

In the Pre-Cambrian Granite

The majority of veins in the pre-Cambrian follow along the sides of epidiorite dikes, but there are also fissure veins similar in trend and structure to those of the Tertiary batholith.

The veins are important only for their content of precious metals, chiefly gold, and less commonly for their fluorspar. Examination of a large number of mines and prospects showed conclusively that no production of copper, lead, or zinc may be expected from these deposits. The workings investigated included accessible parts of the Rainbow prospect, Black Hawk prospect, Buck Bear prospect, Dona Dora prospect, Dummy B prospect, Eureka prospect, Green Girl prospect, Maggie G mine, Mormon mine, Pagoda prospect, Rock of Ages prospect, Sally mine, Santa Cruz prospect, and Tennessee mine. All except the first and last named have been described by Dunham. 8/

Replacement Deposits

Of the Hilltop-Merrimac Area

In the northern part of the district, between the Hilltop mine on the east and the Merrimac mine on the west, replacements are localized above or below contacts between calcareous formations and formations of shale or sandstone. Three mineralized zones may be recognized. The lowest is related to the Bliss-El Paso contact and includes the basal 40 feet of El Paso limestone. The medial and upper zones occur respectively below and above the Percha shale. The medial zone includes the upper 10 feet of Fusselman dolomite and the upper lies within the basal 40 feet of the Lake Valley limestone. Only these last two zones have to date been productive of lead, zinc and copper.

Related to the Bliss-El Paso contact.- Along the plunging anticline directly north of the batholith the basal 40 feet of the El Paso contains numerous garnetized zones. These are lenticular in form with their long dimensions parallel to the bedding. The largest garnet body observed was 10 feet thick and could be traced for 50 feet along the strike. Limy beds adjacent to garnet zones are locally replaced with sulphides, of which pyrite, chalcopyrite, and sphalerite are the most common. Galena is a minor constituent. The sulphides form narrow shoots a few feet across, not more than six feet thick, and elongated with the direction of dip in the beds they replace. Within the shoots, sulphides occur as closely-spaced lentils that rarely exceed an inch in thickness.

The numerous short drifts, shallow shafts and trenches that explore the favorable zone do not reveal any sulphide bodies that could be classed as ore. The only prospect that offers some promise for production is the Lodge. Here the sulphide zone is four feet thick; lateral dimensions and form have not been determined. The material in the face would probably average not more than five percent zinc and a percent each for lead and copper.

Related to the Fusselman-Percha contact.- Beds in the upper 10 feet of the Fusselman are locally replaced by sulphides and tellurides. Ore bodies of this zone have been worked at the Hilltop, Richardite, and Little Buck mines, and have been prospected at the Mullins workings.

The ore bodies may occur directly below the Percha shale, as in parts of the Hilltop mine, or their upper levels may lie as much as five feet below the contact as in portions of the Richardite. The maximum thickness of the sulphide bodies now exposed is about four feet, but stopes in some of the old workings suggest that in places the mineralized zones were as much as six feet thick. In form the ore shoots are flat-lenticular, parallel with the bedding of the Fusselman. They are irregular in plan, and most are elongated with the general line of dip in the country rock. The greatest lateral dimension of individual ore bodies probably would not exceed a few score feet.

In the Hilltop and Richardite areas the ore bodies are localized along the crests of minor anticlinal folds which trend between west-northwest and north-northwest and plunge with the dip of the country rock. As mineralized

The chief ore minerals are sphalerite and chalcopyrite. Galena is a minor constituent that carries a small amount of silver. Pyrite is abundant, especially along the margins of the shoots where it locally occurs virtually to the exclusion of other sulphides. The gangue is of milky quartz, calcite, and garnet. Within the mineralized zone the sulphides are intergrown to form lentils that may be as much as a foot thick and three feet in longest dimension. Taken as a whole the mineralized zone will average between 8 and 10 percent zinc and between a half and one percent copper. The silver is highly variable, but has not yet exceeded one and a half ounces per ton in the sorted ore that has gone to the smelter.

The value of the deposit remains to be determined, as there has been no effort to block out reserves prior to extraction. It is probable that there are three more or less distinct shoots--one exposed in the Foy workings and two others in the main workings. The Foy shoot, which has an average thickness of nearly two feet, is about 40 feet across. No exploratory work has been done with the view of determining the downward extent of this body toward the northwest. The two shoots that apparently exist in the main workings average four feet in thickness and vary in width between 20 and 40 feet. There is no reliable information to indicate limits of their downward extensions toward the northwest.

Around the Excelsior Rhyolite Laccolith

In the vicinity of the rhyolite laccolith north of the Big Three workings the limestone beds in the upper Lake Valley and lower Magdalena formations are garnetized at many horizons. Some of the altered beds have been replaced with copper and zinc sulphides.

Beds of the Lake Valley directly below the laccolith are commonly stained with copper carbonates, and a number of these leads have been prospected by short inclined drifts. The situation at the Tish prospect is typical. Here the copper is contained as films and lentils of malachite associated with limonite and hematite in a zone of thin-bedded limestone a foot thick. Mineralization is sporadic, and the entire deposit would not average one percent of copper. The workings do not extend below the oxidized zone. Here as elsewhere along the rhyolite-limestone contact the deposit is too small and of grade too low to be counted as ore.

West of the laccolith, along or near the contact between the Lake Valley and the Magdalena, are replacement deposits explored by the Excelsior and Cowpuncher mines. The Excelsior, which has produced copper, is entirely inaccessible, and there is no direct information regarding the size and nature of the ore body. Judging by materials on the dump the deposit was a replacement of chalcopyrite and other sulphides in recrystallized Lake Valley limestone that also carries considerable garnet. The conditions were perhaps similar to those observed on a smaller scale in the nearby Cowpuncher mine. Here the replacements in limy beds occur both in the lower Magdalena and the upper Lake Valley. Deposits at the higher stratigraphic level have been for the greater part removed; evidently they consisted of oxidized copper ore with malachite the principal mineral. Smelter returns indicate eight percent copper in the one small shipment from the oxidized zone. Judging by the form

shears are associated with these folds it would seem that the structural control is ultimately due to fissuring of the anticlinal crests at the time the folds were produced. Ascending solutions followed these fissures to the basal Percha, were checked by the impervious shale, and deposited their mineral content in the subjacent dolomite.

The ore minerals are sphalerite and galena. Altaite (PbTe) and richardite (Cu_2Te_3) are occasionally found, and native tellurium is locally present in the Hilltop workings. Gold and silver have been produced at the Little Buck, but the mineralogy of these deposits is not recorded, and the deposits themselves are greatly exhausted.

The lead-zinc ratio varies progressively along the strike of the Percha-Fusselman contact between the Little Buck and Hilltop mines. In the Little Buck area zinc predominates and the ratio is roughly 1:2. The lead is still subordinate but is relatively more abundant at the Richardite, where the ratio is about 1: 1.7. At the Hilltop, lead predominates over zinc, the ratio being around 1.35: 1.

Two types of mineralization may be recognized. The sulphides may be scattered through the dolomite as discrete crystals or they may form solid masses of interlocking crystals. Deposits of the first type remain in some of the Little Buck workings. They are too low in grade for profitable mining and do not constitute ore reserves under present conditions. Deposits of the second type are seen in the Little Buck No. 4, in the Richardite, in the Mullins, and at the Hilltop. At the Hilltop, the richest ore of this type carries around 38 percent lead and 28 percent zinc. At the Richardite No. 1, the heavy sulphide bodies average 18 percent lead and approximately 30 percent zinc. These sulphide bodies, while rich, are never more than a few feet thick. The thickest mass of sulphides exposed is in the face of the Richardite No. 1, where the ore body is four feet from top to bottom. At the Hilltop, the richest sulphide body is only eight inches thick.

The value of ore bodies in the upper Fusselman dolomite is problematical. Richness of ore will hardly compensate for the thinness and relatively small volume of the bodies unless mining is done with care and economy. Present explorations do not indicate the order of magnitude of reserves. ~~A campaign of core-drilling is needed to determine the potentialities of the medial zone.~~

Related to the Percha-Lake Valley contact.- So far as is now known these are limited to the area around the Merrimac mine. Here a salient of quartz-bearing monzonite extends northward to within a few feet of the contact. (Plate 2) North of the salient the shale and limestone are thrown into a series of small anticlines and synclines. These minor folds trend northwest; the longest fold axis that was mapped extends through the Foy workings and can be traced for 400 feet on the surface. The basal Lake Valley beds are garnetized. Near the top of the main garnet zone, and with its base approximately 35 feet above the top of the Percha, is the replacement deposit followed by the Merrimac workings. The ore zone varies in thickness between 1.5 and four feet. Mineralization appears to be structurally controlled here, as at the Hilltop and Rickardite, by the minor folds along the crests of which the ore shoots are localized.

of the stope the deposit was a lens eight feet in maximum thickness abutting on the south side against a fault and tapering to an edge a few feet away to the north. Below the level of oxidation there are lentils of sphalerite replacing favorable beds in the Lake Valley. None of these are of sufficient size to justify further developments.

Until the Excelsior mine is made accessible for examination and the controls of mineralization there are determined, the possibilities for further production of copper and zinc from this area cannot be known.

Along the Torpedo-Bennett Fault Zone

Copper Buckle.- Near the northern end of the fault zone at the Copper Buckle prospect, limestone beds of the Magdalena have been replaced with sulphides along the east side of a fault that brings Tertiary andesite in contact with Carboniferous sediments. Prospecting has revealed a zone of almost solid pyrite 15 feet across, but the lateral extent and limits of downward continuation are not known. The pyritized material contains a few hundredths of a percent copper, suggesting chalcopyrite as an accessory. The deposit as now exposed has no value, but in view of its size it would seem to deserve exploration down along the fault.

Memphis.- The Memphis workings explore the ground directly west of a fault separating quartz-bearing monzonite on the east from limestone and shale of the Magdalena on the west. Some limy beds of the Magdalena have been altered to massive garnetite. Peripheral to and between the garnetized layers limestone beds were locally replaced by sulphide bodies which trend north with the regional strike and dip west at angles between 40 and 55 degrees. Four favorable zones, the most westerly of which lies 300 feet from the monzonite, have been mined. The general inaccessibility of the workings, together with conflicting reports on the composition of the ore, renders impossible any adequate notion regarding the value of the ground.

Examination of the main workings that lead from the South shaft indicated that the ore shoots were aligned along a north-south belt and that they formed tabular bodies of elliptical plan with long axes trending north in some examples and east in others. Most of the bodies did not exceed 30 feet in maximum linear dimension, but a large stope south of the shaft indicates the former presence of a body that must have extended at least 100 feet both laterally and down the dip. The thickness of the ore bodies evidently varied between three and six feet. Judging by material remaining along the sides of the stopes the primary ore consisted of chalcopyrite and sphalerite with some galena, all set in a gangue of milky quartz, calcite and pyrite. Oxidation has produced variable amounts of azurite, malachite, chrysocolla, and calamine. Tetradymite is reported to have been a common constituent in places, but the stope from which high-bismuth ores were reputedly taken was found to have been backfilled to the level of the main drift.

Dunham's compilation of average assays for sulphide ores taken from the main workings shows 10.0 ounces of silver, 6.6 percent copper, 15.4 percent zinc, and 7.1 percent lead. 9/

Torpedo.- The Torpedo ore body occurs in altered quartz-bearing monzonite between two faults of northerly trend. The western fault separates altered monzonite on the east from Magdalena limestone and shale on the west. The eastern fault cuts the igneous rock and roughly defines the eastern limit of the cuprifferous zone. Both faults are inclined toward the east at angles averaging between 70 and 80 degrees. Near the surface they are between a hundred and a hundred and fifty feet apart. As the fault surfaces are curved and not strictly paralle, the thickness of the mineralized zone ranges between 30 and 200 feet, as measured approximately normal to the planes of the bounding faults.

Primary ore consists of chalcopyrite, which, with pyrite and quartz, fills numerous closely spaced veinlets in the shattered monzonite betwen the two faults. This material contains between 1 and 3 percent copper. The richer ores that have been mined in the past had formed by oxidation of this protore. Chrysocolla has been the chief ore mineral, although malachite, azurite and native copper have been mined. These oxidized bodies have been found to extend to the limit of exploration 300 feet below the surface. The stopes to this depth attain maximum widths of about 40 feet. These are now inaccessible, and no sampling could be done. According to L. B.Bentley the ore that was mined averaged not less than 5 percent copper.

Value of deposits that may remain above the 300 level in the oxidized zone cannot be determined until the mine is reconditioned. The only ore body that can now be observed is one of low grade crossed by the 200 level from No. 4 shaft. The workings prove that this body has a length of 275 feet and a width of 75 feet.10/ Indicated ore at this level amounts to 17,000 tons of material containing between 1 and 3 percent copper. At present nothing can be inferred regarding the limits of this body above or below the 200 level.

Stevenson-Bennett.- Ore bodies in the accessible parts of the Stevenson-Bennett mine have been depleted; accordingly the lengthy description of this mine given by Dunham 11/ will not be duplicated here.

Dunham's mapping showed that the three ore bodies which have accounted for the past production of lead and silver are tabular replacements of dolomite. Mineralization is related to faults and fissure zones and to contacts between dolomite and intrusive sheets of quartz monzonite porphyry. The largest, or Bennett, ore body follows a fracture zone trending north and dipping 70° west. As determined by explorations from the No. 1, No. 2, and No. 3 levels, and at the level of the drainage tunnel, the body was 500 feet long, 20 or more feet thick in the richer portions, and extended downward along the dip for a known distance of 600 feet. Pyrite, galena and sphalerite are the common primary sulphides in the mineralized zone; these are set in a quartz gangue. The upper oxidized portions contain limonite, cerussite, and wulfenite, with lesser amounts of anglesite and smithsonite. Assays preserved by L. B. Bentley indicate that the sulphide body carried between 10 and 15 percent each of lead and zinc, and between 2 and 11 ounces in silver.

The Stevenson ore body lay 350 feet east of the Bennett across the strike. At the surface it follows eastward dipping shear planes, but the mineralization continues downward only about 50 feet along the fault; thence the ore body extended west following along the lower side of a quartz monzonite sill.

It has been mined from the No. 6 and No. 7 workings and in open cuts to the south. (Plate 1) The body was of the order of 200 feet in length along the strike. As it cropped out along the surface and extended only a few tens of feet below, it was mostly of oxidized material, with residual pods of galena and sphalerite set in masses of cerussite and smithsonite.

Between the Stevenson and Bennett ore bodies is a smaller replacement called the Paige. This appears at the surface south of the No. 4 workings and has been mined in the No. 1, No. 3, and No. 4 workings. The ore is generally similar in its oxidized portions to that of the Stevenson body and in its unoxidized portions to that of the Bennett.

The three ore bodies have been mined to the point of depletion. Nothing of any value remains above the level at which water stands in the main shaft, 250 feet below the collar. If reserves exist they must lie below this level, but there is no direct information at hand to indicate the possibilities of ore remaining in the flooded parts of the mine.

RESERVES

In the past there has been little effort to block reserves prior to extraction of ore, and such exploratory work as is in progress is not so far advanced as to define the ore bodies that are indicated to exist. Consequently the reserves must be classed as "indicated" or "inferred" rather than "measured".

Between 2500 and 3000 tons of 15 percent zinc ore are indicated in the downward continuations of the ore shoots in the main workings of the Merrimac mine. About 1,000 tons of ore are inferred to exist in the downward continuation of the nearby Foy orebody. If production continues at the same rate as during the past few months, between 200 and 300 tons should be shipped each month.

Indicated at the 200 level from Number 4 shaft of the Torpedo mine are 17,000 tons of material containing between 1 and 3 percent copper. Unless a much larger body of this low-grade ore is established by future exploration, it is doubtful that mining can be done profitably. At present there is no basis for inferring the existence of such a large body of ore.

Indicated reserves at the Sunrise mine amount to between 6000 and 7000 tons of material averaging two percent copper and carrying values in gold. Whether this can be mined under present conditions may depend entirely on the market for siliceous copper ore. If premium prices are to be paid for high-silica ores, the Sunrise is likely to become a producer. However, financial considerations stand in the way of immediate production, and an access road must be constructed if shipments are to be made.

Because of inaccessibility nothing can be said regarding reserves that may exist in the flooded parts of the Stevenson-Bennett, or in the main workings of the Torpedo, Philadelphia, Homestake, and Excelsior, as well as in parts of the Memphis.

Further exploratory work is required to establish values for the promising but unproved ground on the Lowe, Hilltop, Nickerdite, and Little Buck claims. Structural controls of mineralization seem to be well defined on parts of these claims, but little consideration has been given them in the course of past developments. No production can reasonably be expected from any of these claims within the next three months.

The pyritized zone is best exposed in the main prospect, an L-shaped pit near the crest of the hill. At the west end of the pit a shaft has been started; it is now filled to a level 16 feet below the surface, though, judging by the volume of materials on the dump, it was never more than a few feet deeper. Along the west side of the shaft is silicified Magdalena limestone. The sulphide body extends from this wall 15 feet to the east where it gives way to crystalline limestone crossed by veinlets of pyrite. Within the sulphide zone the limestone has been almost entirely replaced by sulphides.

Prospecting north and south of this pit has established neither areal pattern nor downward extent of the sulphide body. An eight-foot rectangular pit 65 feet to the south reveals garnetized and silicified limestone cut by thin stringers of pyrite, now largely altered to limonite. Two trenches have been dug north of the main prospect pit. The massive pyrite shows at the south end along the west wall in Trench 1. The zone does not show at all in Trench 2. The proved linear extent of the mineralized zone is thus 40 feet - the distance between the main prospect and the head of Trench 1. The maximum proved thickness is 15 feet, and the maximum downward extent below the surface is 16 feet.

A composite sample from the pyrite zone exposed in the main prospect was collected by the writers and assayed by L. B. Bentley. It contained 0.03 percent copper. Whereas the deposit as presently known is of no value, it nevertheless deserves further exploration. This is the most conspicuous sulphide body exposed at the surface in the Organ district. Elsewhere, as at the Merrimac and Little Buck No. 8 mines similar heavy pyrite has been found marginal to commercial deposits of zinc and copper.

Memphis Mine

The mine area is a third of a mile northeast of Organ. Highway 70 passes through the southeastern corner of the Memphis patented claim, and dirt roads in poor condition branch east from the Merrimac road and lead to the larger of the old workings. The property is owned by the Torpedo Mining Co.

The ground is credited with a production between $200,000.00 and $400,000.00 in copper, zinc and silver. Extraction of ore is said to have begun in 1882, and in 1884 the ore was being smelted at the mine. Little has been recorded regarding subsequent history; the last systematic work seems to have been done between 1927 and 1929 when the Memphis Corporation completed work at the Roos shaft.

Location of the workings is shown on the geologic map (Plate 1); none of the more extensive of these are entirely accessible and most of the shafts are entirely inaccessible. Examination was limited to the upper parts of the zinc stope, and to the 160-foot level of the south shaft which had to be reached by use of a windlass.

The zinc stope follows down a mineralized zone four feet thick, a replacement of Magdalena limestone. Like the unmineralized beds above and below it, this tabular ore body dips west approximately 55°. Its outcrop makes a broad arc convex toward the west and about 200 feet from end to end. Open stopes now partly caved and too dangerous to be thoroughly explored follow the ore bed for as much as 75 feet down the dip, while near the northern end an inclined drift leads 300 feet down the dip from the surface. No ore remains in the accessible parts of the stopes or in the upper part of the inclined drift. The material that was mined here was oxidized; malachite, azurite and calamine were the chief minerals. It is reported that primary sulphide ore was struck at the bottom of the inclined drift and that massive sphalerite remains in the face, but this could not be verified by an examination.

What could be learned regarding the ore bodies that were mined from the south shaft at the 160-foot level has already been noted in the foregoing section of this report. The plan of the workings is shown on Plate 12. A short cross-cut at the bottom of the shaft leads west to the main drift which extends 516 feet to the north and for an accessible distance of 300 feet to the south. The drift follows the strike of Magdalena limestone which dips west at angles of about 65°. All the stopes connect with the main drift; five lie along the workings north of the shaft and three - including the main stope - lie to the south. Cross-cuts were driven at intervals. The longest lie near the north end of the drift and explore the terrain 150 feet to the east and for the same distance west. No ore was cut in any of the lateral workings.

The workings from the Roos shaft are inaccessible. According to records of the Memphis Corporation the shaft is 200 feet deep with levels at 27, 55, 65, 100 and 200 feet. It is evident that most of the mining was done between the 27-foot and 65-foot levels, and according to local reports the material extracted was chalcocite. It is further reported that the ore body has been exhausted.

No evaluation of the Memphis ground can be given here since little of the old workings could be seen. The parts examined contain no reserves. It would be worth while to recondition parts of the zinc stope and also the Roos and other shafts for examination. It is very likely that such investigations would lead to recommendations regarding further exploratory work around the zinc stope and east of a line joining the Roos and South shafts.

Torpedo Mine

The Torpedo Mining property is located immediately south of U. S. Highway 70 approximately a quarter of a mile east of Organ in the NW 1/4 and SW 1/4, Sec. 1, T. 22 S., R. 3 E. It consists of two patented claims, the Torpedo and Little Ben Scott, and one unpatented claim, the Papoose.

The Torpedo deposit was discovered in 1899 by William Foy and acquired in the same year by an unknown company which mined $100,000.00 worth of copper ore before June, 1900. In 1904 the mine passed into the hands of the Torpedo

Mining Company and subsequently has been leased numerous times. The last work to be done on the property was in 1941-42 when the International Smelting and Refining Company held a lease on it and carried out a short diamond drilling campaign. At the present time it is idle and held by the Torpedo Mining Company.

Total production figures from the mine are not available but local estimates place them as high as $800,000.00. Almost all of this production was prior to 1921.

Geological relationships in the vicinity of the mine may be seen on the geologic map of the Organ District (Plate 1), and a descript of the ore body has already been given on p. 14 of this report.

The mine workings include four shafts designated by numbers as the No. 1, No. 2, No. 3 and No. 4. They are 165, 300, 500 and 165 feet deep respectively. The stopes and drifts on the 200-foot level between the No. 1 and No. 2 shafts have caved. The No. 3 shaft is in such condition that it also is inaccessible. Thus it was impossible to gather any first hand information on the greater part of the underground workings. Plates 13 and 14 show the plans of the 200 and 300-foot levels, and Plate 15 shows the regional relations of the workings.

It was possible to examine a part of the 200-foot level from the No.4 shaft by use of a portable hand windlass. Figure 7 shows the plan of these workings and accessible portions are indicated on the map. Within the accessible workings a part of the low grade primary ore body may be seen. However, reliable sampling of the ore was not possible for the walls of the drift have acquired a post-mining bloom of chalcanthite which would produce too high a figure for copper content in rock at the surface and in turn result in too low a figure for copper content immediately beneath the surface. Blasting would be necessary if sampling is to be done with any degree of accuracy.

The diamond drilling completed by International Smelting and Refining Company in 1941-42 yields some important data on the Torpedo ore body. Four holes were put down. Their horizontal projections are plotted on the surface map of the mining area (Plate 15).

The No. 1 drill hole was started at the surface 515 feet east of the No. 3 shaft and about 350 feet east of the ore body. Figure 7-A shows its relationship to the ore body and also gives pertinent assay data where the hole intersects the ore zone. The No. 2 hole (Fig. 8) was started at the same portion on the surface but was extended in a southwesterly rather than northwesterly direction. Upon striking the supposed ore horizon difficulty was encountered because of caving. The hole had to be abandoned before reaching the limestone-monzonite contact and no samples could be obtained from the supposed ore horizon for assaying.

The surface location of the third drill hole is 427 feet in a S. 71° E. direction from the No. 1 hole. Figure 9 portrays adequately its relation to the ore body and gives assay data of samples taken from the ore zone. The fourth diamond drill hole (Fig.10) was started at a point 100 feet S.43° W.

of hole No. 3. It is interesting to note that this test never reached the mineralized zone, indicating that the two faults which control it, after having an eastward dip from the surface downward for several hundred feet, apparently assume a westward dip.

Although the drilling campaign was unsatisfactory, some inferences may be made from it. Even though the recovery of samples in the ore zone was poor, there is no indication of a rich, continuous secondary sulphide zone immediately below the explored oxidized zone. The record also indicates that the two faults defining the ore body are converging with depth, causing the ore zone to narrow downward. The tests which cut the lime-monzonite contact showed no mineralization in the limestone. It seems strange that some replacement bodies are not present within the limestone near the contact. This suggests that the faulting in the region may have taken place in two stages. Faulting could have occurred prior to mineralization, these faults serving to guide the solutions; then renewed movement may have dropped the mineralized block down against the unmineralized Magdalena limestone. The second period of movement is also suggested by the relationships of oxidized to unoxidized ore. At the eastern end of the area the oxidized ore goes down at least 300 feet below the surface, while at the No. 4 shaft primary ore is encountered 165 feet below the surface. The renewal of movement could have opened parts of the shear zone sufficiently to allow easy access to surface waters with the resulting deep oxidation.

The question of reserves at the Torpedo property has been discussed in the section dealing with ore bodies, page 14. Some exploratory work might well be justified along the zone of faulting south of the No. 4 shaft, for here lies considerable ground which has not been prospected adequately.

Stevenson-Bennett Mine

The Stevenson-Bennett mine is located 1½ miles south of Organ along the western slopes of the Organ Mountains (SE 1/4, Sec. 11 and NE 1/4, Sec. 14, T. 22 S., R. 3 E). The property can be reached by car by a dirt road south from U. S. Highway 70. It consists of three patented claims and one unpatented claim, owned by the Torpedo Mining Company.

The Stevenson ore body was discovered in 1847. Between that time and 1882 the ore was mined for its silver content and production amounted to about $150,000.00. In 1887 the Bennett ore body was discovered and proved to be much larger than the Stevenson. At this time the mine became an important producer of lead. Several lessors have had the mine since that time, including the Phelps-Dodge and the American Smelting and Refining Companies.

Only a very small amount of work has been done at the mine since the American Smelting and Refining Company relinquished its lease in 1920. In 1941 the International Smelting and Refining Company drilled one diamond drill hole on the property. The hole was put down 420 feet S. 81° W. of the main shaft in a S. 74½° E. direction and at an angle of dip of 45°. The drill hole is reported to have been 411 feet deep and intended primarily for assessment work. No assay data were obtained from core samples.

Production from the Stevenson-Bennett mine probably totals more than $1,200,000.00. The mine was idle in May 1943.

The local surface geology is shown on the areal geologic map of the Organ District. Dunham 20/ has given an excellent and detailed account of the mine. His map of the underground workings shows all that are accessible. The writers spent four days in March, 1943, examining the mine. There are no reserves in the accessible parts and in view of Dunham's work nothing could be gained by remapping.

Philadelphia Group

The group includes shafts and inclined drifts which explore the limestones and shales of the Magdalena group. The ground is covered by three patented claims belonging to Emmett Isaacks of Organ. It is reported that oxidized lead-silver ore has been produced and that in 1934 the dumps were reworked. No ore is apparent in the shallow pits, whereas the main workings are inaccessible. It is thus impossible to establish controls for such mineralization as may be present or to evaluate the ground for future production.

As the main workings are aligned northwest along the apparent continuation of a shear zone exposed in the arroyo to the north, it is possible that mineralization is controlled by fissures of this trend.

Homestake Mine

The Homestake is 3/4 mile north of Organ, and is connected with Highway 70 by a dirt road in fair condition and passable throughout the year. The ground is claimed by E. D. Shipe of Las Cruces. Production of lead-silver ore from this property was estimated to have totaled $25,000 as of 1927. In 1937 two shipments, amounting to approximately eight tons each, were sent to the smelter at El Paso. There is no record of more recent shipments; evidently the mine has been idle for the past six years.

The ore body is a replacement of Magdalena limestone beneath a porphyry sill that dips northward between 35° and 40°. 21/ The primary ore consists chiefly of pyrite and argentiferous galena; oxidized ore contained limonite, cerussite and argentojarosite ($Ag_2O \cdot 3\ Fe_2O_3 \cdot 4SO_3 \cdot 6\ H_2O$), according to Dunham. The workings are now completely inaccessible, and it is doubtful if they can be profitably reopened.

Smelter assays for the last ore shipped indicate between 7 and 9 ounces in silver, .01 ounce gold, between 2.6 and 8.6 percent lead, between 0.1 and 6.3 percent zinc, and between 0.07 and 0.40 percent copper. Bismuth was reported in amounts between 0.04 and 0.08 percent.

Inaccessibility of the workings make any evaluation of the ground impossible.

SUPPLEMENTARY REPORT ON BISMUTH INVESTIGATIONS, ORGAN MINING DISTRICT

During the course of investigations on lead, zinc, and copper recources in the Organ District a request was made for a similar investigation on bismuth.

In the past bismuth has been reported as having been found associated with the ores from several of the mines in the district. The element appears to be most abundant in mine workings along the western slopes of the San Andreas Mountains in an arcuate belt 2½ miles long and 1/2 mile wide, beginning around the Merrimac mine, extending west and south so as to include the Excelsior, Cowpuncher, Homestake and Memphis mines, and ending near U. S. Highway 70.

Investigations

Memphis Mine

Past history reveals that ores from the Memphis mine have carried the largest amounts of bismuth.. Dunham [22]/reports that oxidized ore taken from an open cut on the property carried 13.65 percent of the element. The writers collected a sample from this open cut and had an assay run which yielded negative results. According to Mr. L. B. Bentley, local assayer , bismuth ore was taken from an underhand stope developed from the 165-foot level at the Number 4 shaft. Examination of the workings from this shaft revealed that the stope had been back filled to drift level, making sampling impossible.

Merrimac Mine

A shipment of ore from the Merrimac mine in January, 1943, was penalized rather severaly for bismuth at the smelter. Shortly after this, samples were gathered from the stope yielding the ore. Six chip samples were taken around the stope, each sample including material from the top to the bottom of the ore horizon. Assay data on these samples failed to reveal any bismuth, indicating that bismuth is probably concentrated as pods of tetradymite which are not common in the ore body. Later shipments from the mine have not carried any important quantities of the element.

Cowpuncher Mine

One shipment of approximately 7 tons of ore has been made from the Cowpuncher mine. Smelter returns revealed that this ore carried 0.53 percent bismuth. However, there are no ore reserves at this mine, so no bismuth production can be expected.

Homestake Mine

The last ore taken from the Homestake Mine was in January 1937, when two shipments of approximately 8 tons each were made. The one shipment carried .04 percent bismuth and the other .03 percent. The mine workings are inaccessible at the present so it is impossible to evaluate this ore body.

Rickardite Mine

Samples were collected from the Numbers 1, 2, and 3 workings of the Rickardite mine. These were assayed for bismuth as well as for their lead and zinc content. Only one of the samples showed a trace of bismuth, the others yielding negative results.

Hilltop Mine

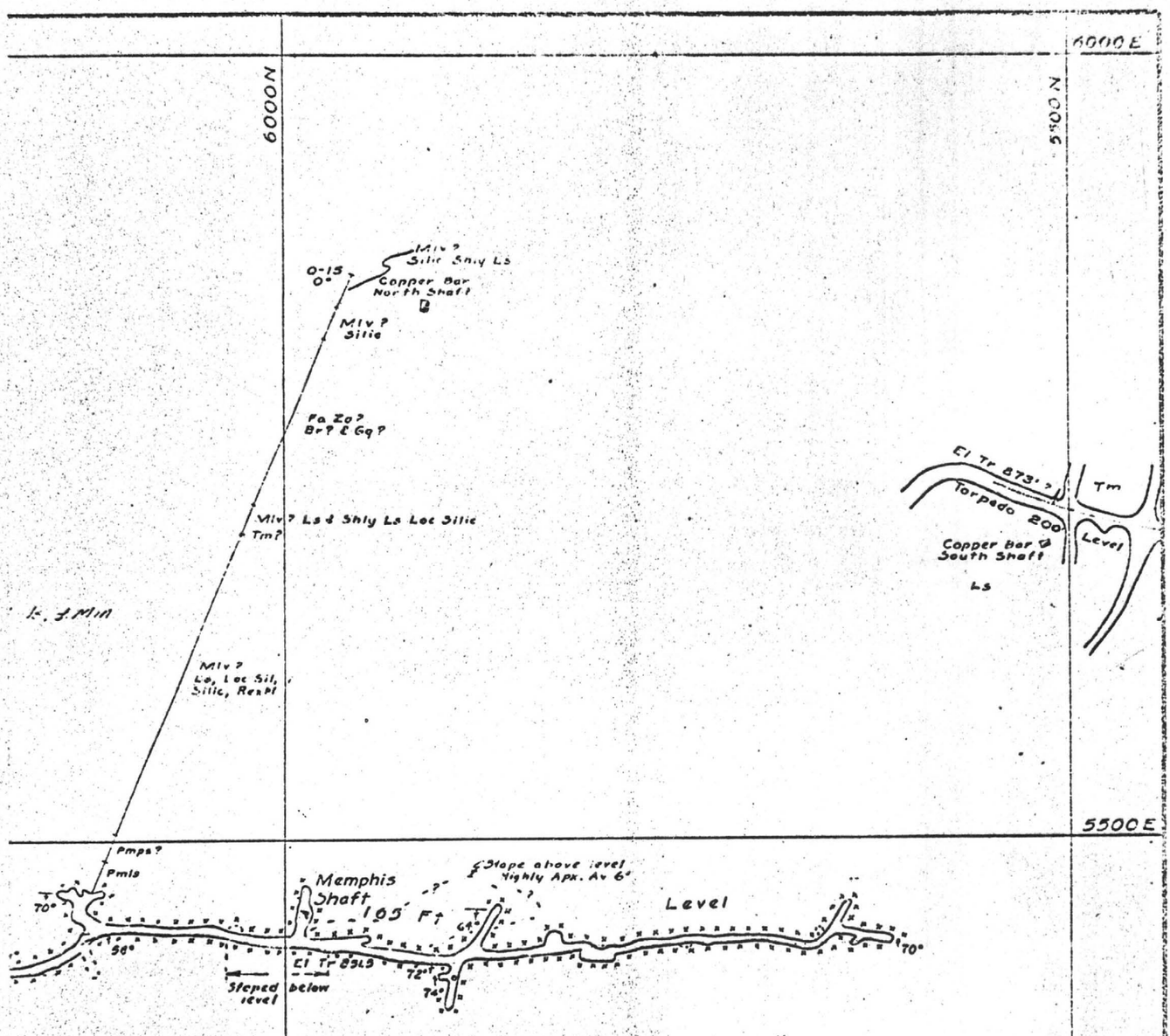
L. O. Menoray, superintendent at the Hilltop mine, stated that complete analyses have been made of numerous samples of ore from that mine and none of these have shown bismuth.

Texas Canyon Mine

The one shipment of ore that has been made by the present owners of the Texas Canyon mine carried .10 percent bismuth. This shipment of 12½ tons came from the uppermost tunnel. Samples collected on the dump showed crystals of tetradymite up to 2½ mm. long. The mineral is not abundant, however, as a careful search was required to find very few specimens. The mineral does not seem to be present in the part of the vein exposed by the other workings.

Summary

The only mine in the district which seems to have uncovered large enough quantities of bismuth to be a potential producer of this element is the Memphis. The condition of the mine at present makes it impossible to evaluate any reserves of bismuth which might exist. Pulps from samples collected in the Merrimac, together with a sample from the upper end of the filled stope in the Memphis, are on hand and will be forwarded on request.



While we believe this information to be correct, we make no representation with respect to, nor do we assume any responsibility for, the correctness thereof.

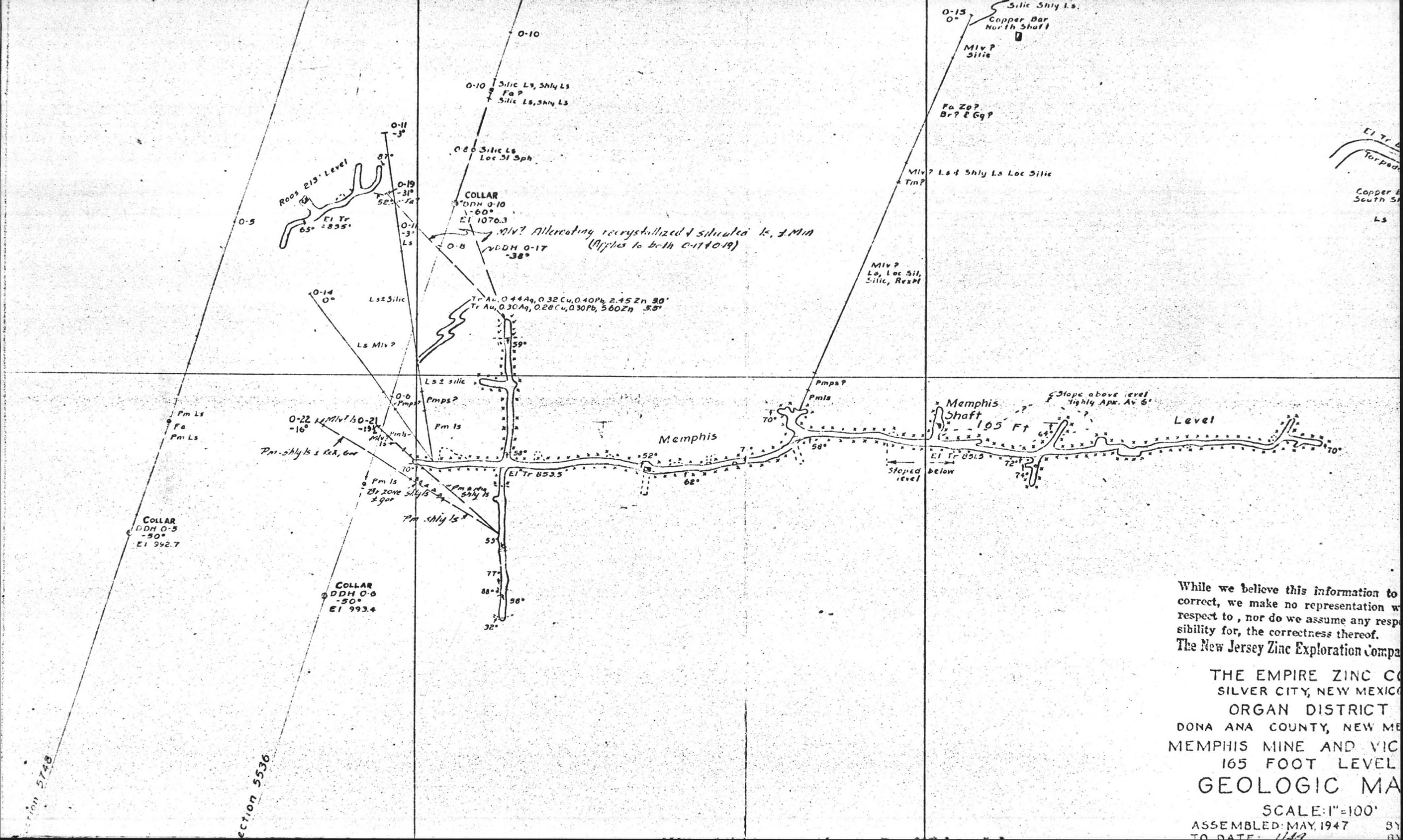
The New Jersey Zinc Exploration Company

THE EMPIRE ZINC CO
SILVER CITY, NEW MEXICO
ORGAN DISTRICT
DONA ANA COUNTY, NEW MEXICO
MEMPHIS MINE AND VICINITY
165 FOOT LEVEL
GEOLOGIC MAP

SCALE: 1" = 100'
ASSEMBLED: MAY, 1947 BY RMK
TO DATE: 1/49 BY EFJ

FILE NO.

Note: All geology projected to 165' level (T.F.C.W.)



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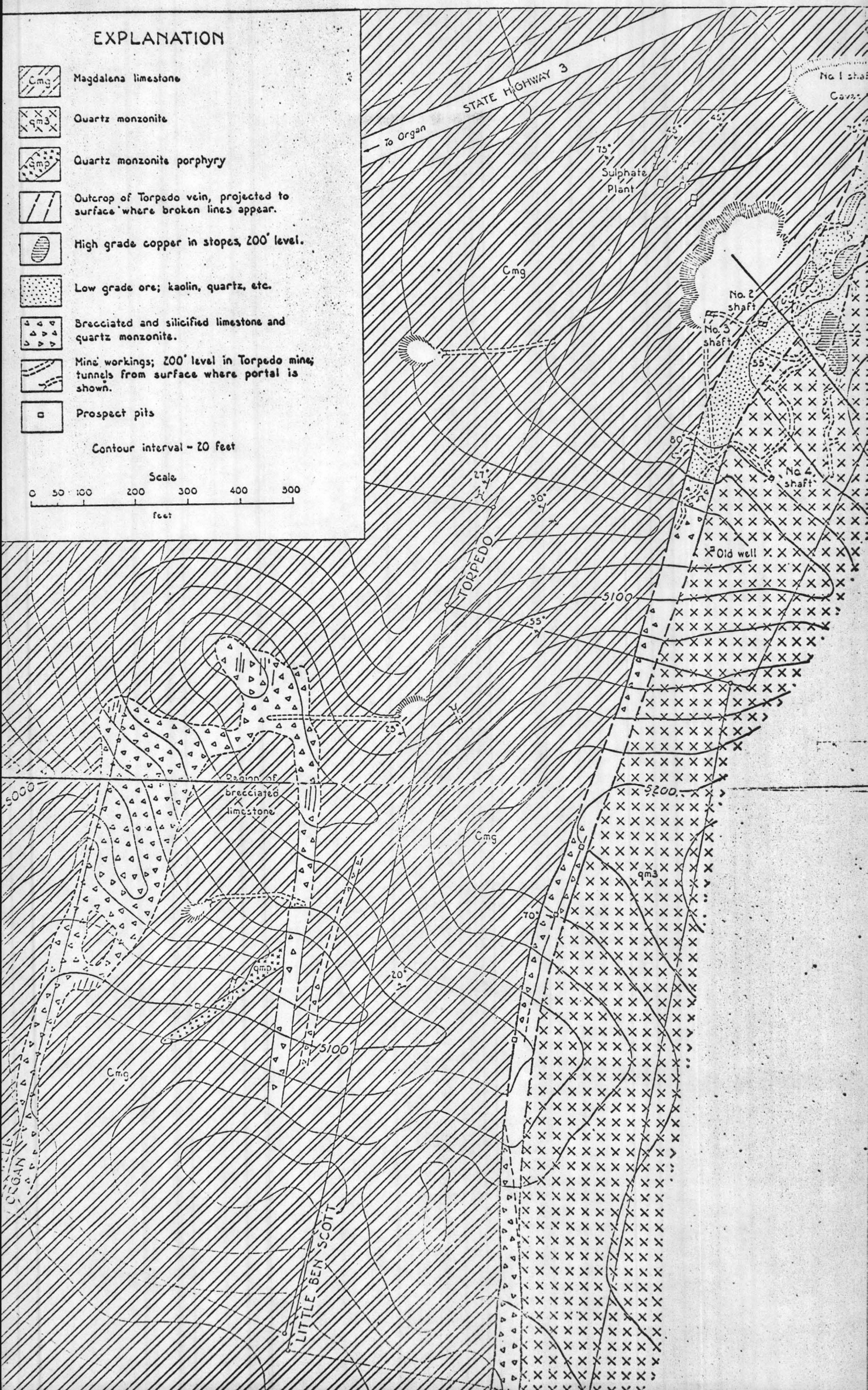

EXPLANATION
Cmg
Magdalena limestone
qm3
Quartz monzonite
qmp
Quartz monzonite porphyry
Outcrop of Torpedo vein, projected to surface where broken lines appear.
High grade copper in stopes, 200' level.
Low grade ore; kaolin, quartz, etc.
Brecciated and silicified limestone and quartz monzonite.
Mine workings; 200' level in Torpedo mine; tunnels from surface where portal is shown.
Prospect pits
Contour interval - 20 feet
Scale
0 50 100 200 300 400 500
feet
STATE HIGHWAY 3
To Organ
Sulphate Plant
Cmg
No. 2 shaft
No. 3 shaft
No. 4 shaft
Old well
TORPEDO
5100
5200
5000
Region of brecciated limestone
qmp
qm3
LITTLE BEN SCOTT
ORGAN

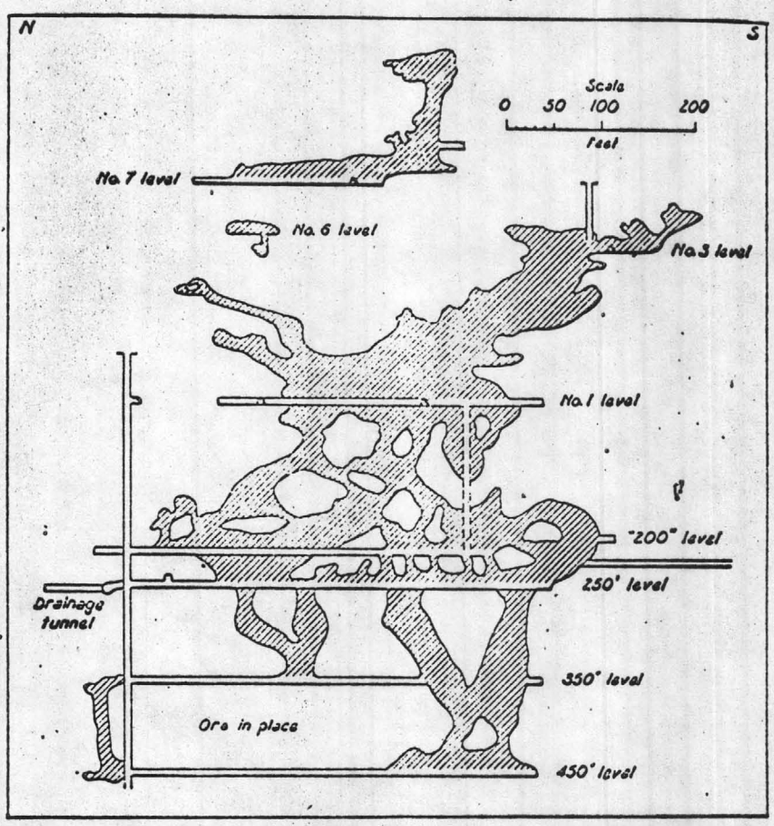
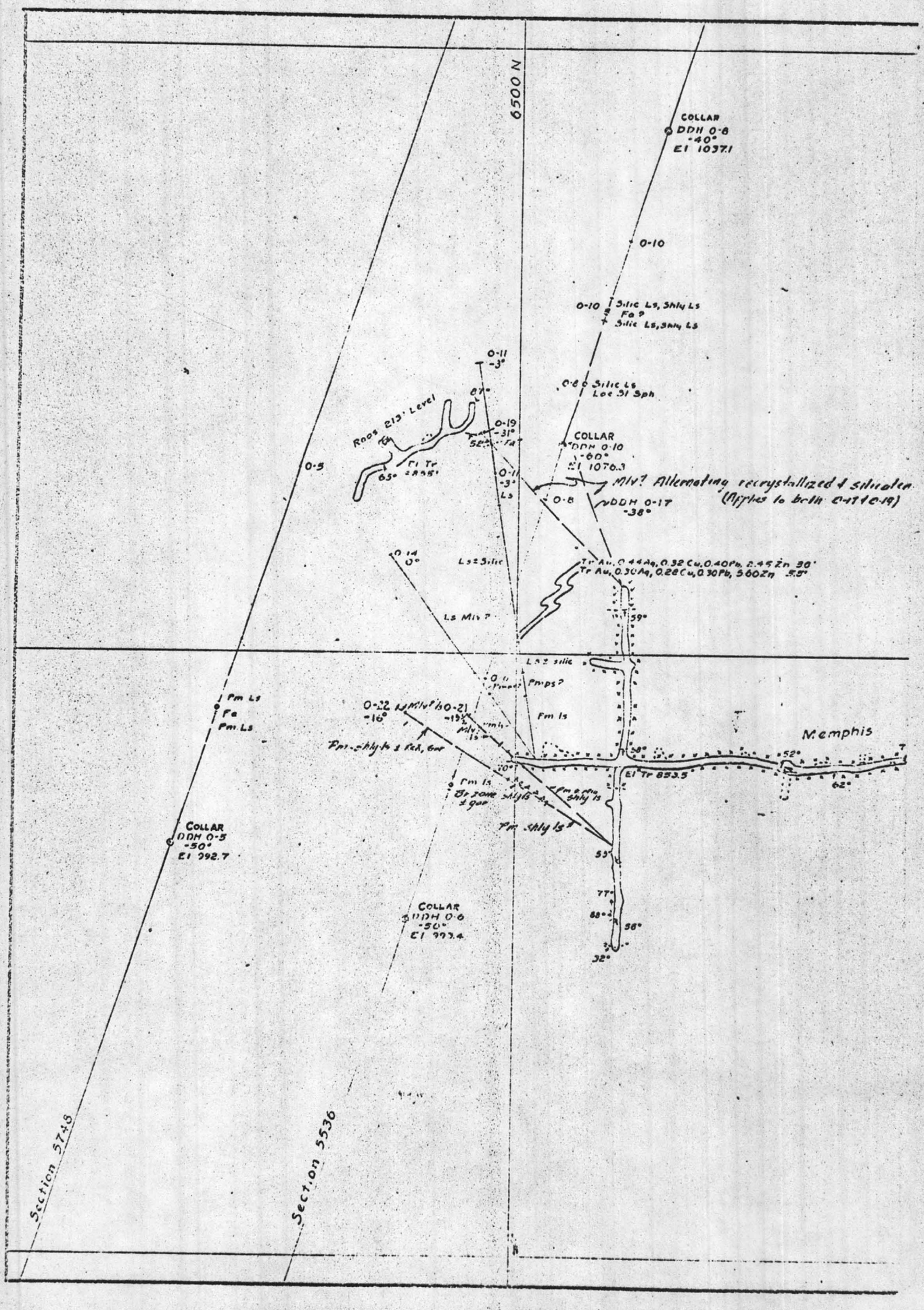


FIGURE 17.—Vertical projection parallel to the Bennett orebody, Stevenson-Bennett Mine.

Shaded areas indicate stopes. The workings on Nos. 6 and 7 levels are on the Stevenson orebody; the rest are on the Bennett orebody.


6500 N
COLLAR
DDH 0-8
-40°
El 1037.1
0-10
0-10
Silic Ls, Shly Ls
Fe ?
Silic Ls, Shly Ls
0-11
-3°
0-8
Silic Ls
Loc 51 Sph
Roos 213' Level
0-19
-31°
COLLAR
DDH 0-10
-60°
El 1070.3
0-5
0-11
-3°
Ls
0-8
DDH 0-17
-38°
Alternating recrystallized & silicated
(Appears to be both 0-17 & 0-19)
0-14
0°
Ls ± Silic
Tr Au, 0.44 Ag, 0.32 Cu, 0.40 Pb, 2.45 Zn 30°
Tr Au, 0.30 Ag, 0.28 Cu, 0.30 Pb, 5.60 Zn 5.5°
Ls Mlv ?
59°
Ls ± silic
Pm Ls
Fe
Pm Ls
0-22
-16°
0-21
Pm Is
Memphis
52°
El Tr 853.5
62°
Pm Is
Br zone
± gar
Pm Shly Is
COLLAR
DDH 0-5
-50°
El 992.7
55°
77°
88°
56°
32°
COLLAR
DDH 0-6
-50°
El 993.4
Section 5745
Section 5536

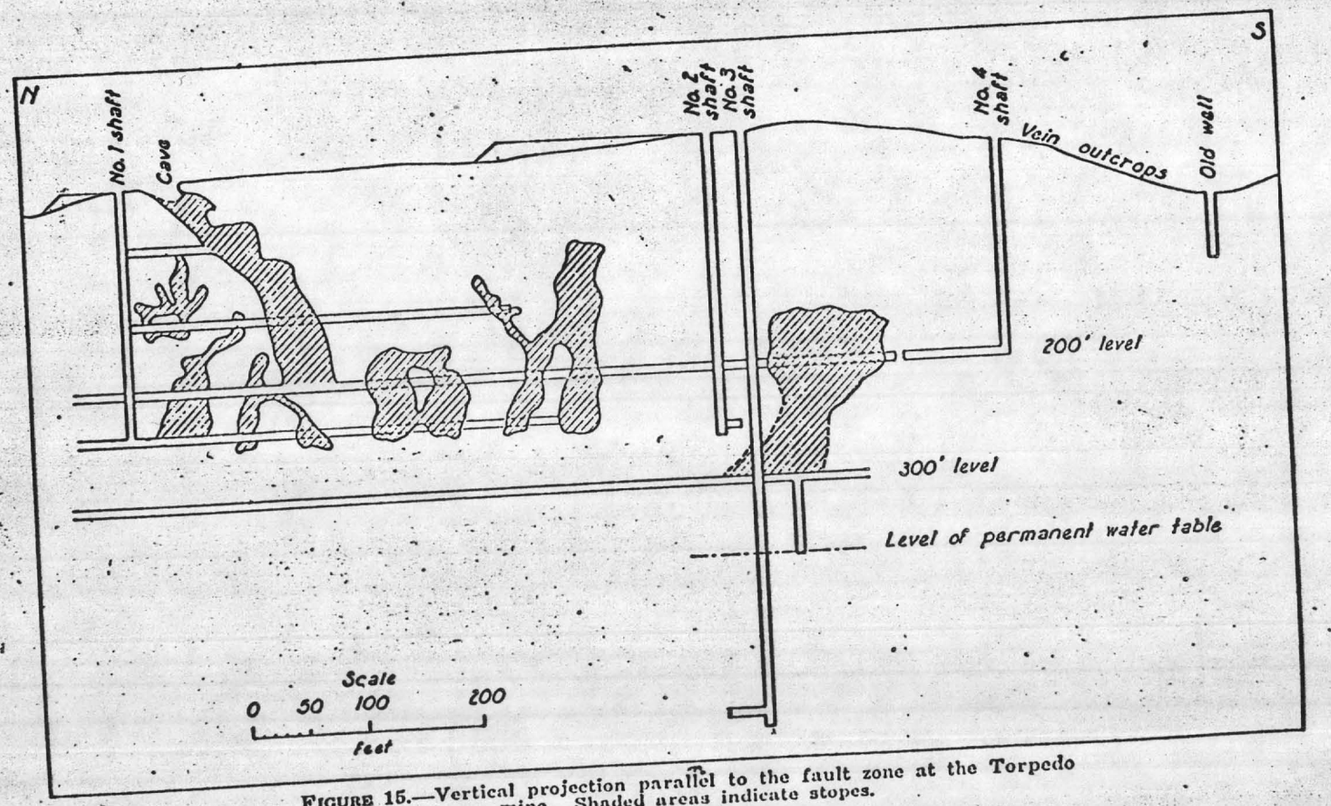


FIGURE 15.—Vertical projection parallel to the fault zone at the Torpedo mine. Shaded areas indicate stopes.

consisting partly of enriched copper ore, partly of hypogene ore high in zinc.

South of the mine a prominent vein is exposed in the limestone, paralleling the monzonite contact. This has a heavy, barren gossan, and has not been explored in depth.

LADY HOPKINS PROSPECT
(SW.¼, Sec.26, T.21 S., R.4 E.)

This property was prospected prior to 1882; there has been little work since then. A pyrometasomatic deposit in pre-Cambrian granite has been explored here. Structurally, the deposit has many features in common with the hydrothermal veins cutting the pre-Cambrian complex. It appears to be a replacement deposit related to fracturing along the footwall of an epidiorite dike. The minerals, which replace everything but the orthoclase phenocrysts in the granite, include augite, biotite, magnetite, and specularite. Apparently later than these, there are pods of quartz with pyrite and pyrrhotite. The developments include a tunnel 248 feet long at 4975 feet elevation, a tunnel 255 feet long at 5105 feet, and a shaft about 50 feet deep at 5225 feet. The deposit contains no valuable metals in quantities greater than traces. Mr. Bentley informs me that he has detected nickel in the sulphide material.

MEMPHIS MINE
(NW.¼, Sec.36, T.21 S., R.3 E.)

History and Production.—The Memphis mine was discovered prior to 1882. During 1884 a small water-jacket smelter was operated on the property.[1] There has been intermittent activity up to the present time, and a considerable amount of work has been done; indeed there has been more activity on this property than on any other in the district, the Stevenson-Bennett excepted. It was one of the group held under option by the Phelps Dodge Copper Company, but their activities were confined entirely to the Torpedo mine. The last work done was the sinking of the Roos shaft in 1927-1928 by the Memphis Corporation. The property is owned at present by the Torpedo Mining Company, which has recently offered the property, consisting of one patented claim, for sale.

Local estimates of the production vary between $200,000 and $400,000, the values being in copper, zinc and silver. Bismuth ore has been mined but not sold.

Geology.—The country rock is the Magdalena series of alternating thin limestones and calcareous shales. A fault which crosses the claim separates this series from the quartz-bearing monzonite to the east. At the northern end of the claim, the sedi-

[1] Williams, W., Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: U. S. Geol. Surv. Prof. Paper 68, 1910, p. 212.

mentary rocks are overlain by a sill of quartz-monzonite porphyry, and in this region the beds lie almost flat; south of this sill, however, their dip increases, until near the South shaft they dip to the west at 45°.

Certain beds in the series have been almost wholly replaced by andradite, with subordinate diopside and wollastonite. Beds which escaped total replacement by silicates have in certain cases been replaced by quartz, specularite, and sulphides, including chalcopyrite, pyrite, sphalerite and small quantities of galena. Tetradymite is locally fairly abundant. Among the supergene minerals, chalcocite, malachite and azurite, chrysocolla, and calamine have been important. The distribution of silicate beds and ore bodies at the surface is shown on the accompanying map (Plate XIV). There are four principal ore-horizons. The first lies immediately west of the massive garnetite adjacent to the fault, and has been mined from the Roos shaft, where a large body of chalcocite was struck between the 30- and 50-foot levels, and from opencuts to the south, from which malachite, chrysocolla and stubelite (?) were obtained. This body has been followed only about 80 feet down the dip; it appears to pinch on the west side of the stopes opened by the Roos shaft. A second body lies to the west, in the zinc stope. This has been mined for a length of 200 feet, and to a depth on the dip of about 200 feet. The body was four feet thick, and contained down to water level malachite, azurite and calamine. Massive sphalerite ore is said to be exposed in the bottom of the stope. A third zone lies southwest of the Roos shaft, and appears to follow a system of fissures. This has been mined to a depth of only about 20 feet, and consists entirely of limonitic material said to carry high silver values. The fourth, and most important ore zone is that developed from the South shaft. The bulk of the production of the mine has come from stopes on this zone; the minerals are said to have been malachite, azurite and chrysocolla. In addition to the principal orebodies, there are small shoots of oxidized ore in other shafts and excavations. A pit south of the Roos shaft exposes oxidized bismuth ore.

The workings at this mine have shown conclusively that the garnetite beds are poor ore-carriers. The Roos workings expose such beds underground on the 100- and 200-foot levels; scattered sulphides occur, but no payable ore was found on either level. The same is true on the surface.

Although many assays of Memphis ores are available, it is impossible to present figures which would adequately represent the typical ores which have been mined. Two averages may, however, be quoted. The first represents complex sulphide ore taken out during operations on the 180-foot level from the South

shaft, during the years 1911 to 1915: gold, none or traces; silver, 10.8 ounces (55); copper, 6.6 per cent (32); zinc, 12.4 per cent (26); lead, 7.1 per cent (37). For comparison, average figures for the oxidized bismuth ore from an opencut southwest of the Roos shaft may be given: gold, none or traces; silver, 32.5 ounces (3); copper, 6.3 per cent (5); bismuth, 13.65 per cent (3); lead, zinc, not determined. Evidently the bismuth-bearing ores are rich in silver. As the El Paso smelter will not take bismuth ores, there has been no production of this metal, but reserves of it undoubtedly exist in the mine. Shipments from the orebodies which do not contain obvious tetradymite have been penalized by the smelter for bismuth.

Workings.—The South shaft, the original shaft of the property, is said to be 180 feet deep. It communicates with large stopes lying to the south and west, under the alluvium. These workings were considered too dangerous to be examined. There are many shallow shafts, inclines, and opencuts between the South and Roos shafts. The Roos shaft is 200 feet deep, and communicates with levels at 30, 50, 100 and 200 feet. It was sunk below the 50-foot level by the Memphis Corporation, which did some prospecting with a "long-rod" drill, from the north end of the 100-foot level, without, however, any success. The shaft appears to expose only massive garnetites. The 100-foot level extends 70 feet northeast and 50 feet southwest of the shaft; the 200-foot level extends 30 feet southeast and 40 feet northwest. These workings are in good condition. The zinc stope is open at the surface, and accessible almost to water level. A vertical shaft from the surface communicates with the deeper part of the stope.

North of the Memphis property, on the King claim, there is a vertical shaft 200 feet deep, with a drift to the west from the foot. Much pyrite was found, but no payable ore.

Future Possibilities.—At the present time, there is very little ore in sight on this property, zinc-rich ores excepted. It is clear, however, that much unproved ground remains. The eastern member of the Torpedo-Bennett fault zone, although it encloses rich orebodies at the Torpedo mine, has received little attention on the Memphis claim. It is exposed in only one shallow shaft, in which there is a feeble showing of malachite. It could readily be tested by means of a cross-cut from the 200-foot level of the Roos shaft. In view of the known tendency of orebodies in the fault zone to occur below quite barren outcrops, as at the Torpedo and the Stevenson-Bennett, this trial would appear to be worth making in the event of a recovery in the copper market. Apart from the rather remotely possible oxidized ore in the fault, it appears that all payable ore of this character has been

worked out. There remains, however, the possibility that enriched sulphide ores could be found in depth below the 200-foot level, in view of the deep enrichment zone at the Torpedo. The most favorable place to search for such bodies would be near the fault, so that both favorable beds and the fault could be tested.

Under present conditions, it is impossible to recommend further work, since the ores so far produced have been valuable mainly for their copper and zinc.

MERRIMAC MINE
(NE.¼ Sec.30, T.21 S., R.4 E.)

The Merrimac mine, situated 2 miles northeast of Organ, was developed early in the present century. The property consists of one patented claim, owned by Mrs. W. C. Godfrey of El Paso, and the heirs of Mrs. Willhoyt, Cameron, Mississippi. There is said to have been a small production of zinc ore.

The deposit is a replacement of a bed about [illegible] the base of the Lake Valley limestone series: it co[illegible] ite and pyrite with subordinate chalcopyrite and [illegible] their oxidation products, in a gangue containing andra[illegible] replaced by chlorite, and quartz. The developments consist of a stope, inclined northwest at 36°, and a vertical shaft which communicates with the stope at water level, 80 feet below the surface. The incline continues below water level for an unknown distance. The accessible workings are shown on the accompanying map. Reserves of zinc-rich sulphide ore remain in the mine: the oxidized ore, containing limonite, hydrozincite and smithsonite, has mostly been mined out. The size of the ore shoot does not, however, appear to justify the developments which would be necessary if the mine were to become a zinc producer. Zinc ores are not regarded with favor in the Organ district since they cannot be sold to the El Paso smelter. Only a large operation, able to ship ore in quantity to Amarillo or elsewhere, could be made to pay.

IRON MASK AND OPHELIA CLAIMS
(SE.¼ Sec.30, T.21 S., R.4 E.)

The contact between the lower Paleozoic dolomites and the quartz-bearing monzonite is covered by two claims southeast of the Merrimac mine, known respectively as the Iron Mask and Ophelia. The minerals present include: serpentine, phlogopite, penninite, cordierite, spinel, and diopside, replacing the dolomite up to about 25 feet from the contact. Small lenticular bodies of magnetite have been discovered associated with these minerals in the gulch running towards the summit of the ridge below which the Silver Coinage mine is situated. They are not of large enough dimensions to be of commercial value. Apparently later in age than the minerals listed above, there are veinlets with

ABSTRACT

The Organ mining district of Dona Ana County, New Mexico, has been intermittently active since 1849. It has produced between ~~three-quarters of a million and a million pounds~~ 375 and 500 tons of zinc, approximately ~~four and a half million pounds~~ 2250 tons of copper, and some ~~fourteen and a half million pounds~~ 7250 tons of lead. Prior to the most recent campaign of mining and prospecting, begun in 1942, the district had been virtually idle for 22 years. During this interval the largest and formerly the most productive mines have become largely or entirely inaccessible. In May 1943, the only active mine was the Merrimac, producing between 200 and 300 tons of 15 percent zinc ore each month.

Ore deposits occur in and around a composite monzonitic batholith of Tertiary age. The ore bodies form shoots in fissure veins and replacement bodies in limestone or monzonite. The vein deposits may produce siliceous copper ore of low grade, provided there is demand for such at nearby smelters, but no appreciable production of base metals can be expected from them. The replacement deposits have accounted for the bulk of past production and contain by far the larger percentage of reserves.

Replacement bodies in limestone are controlled by lithology and structure. In the areas unaffected by strong pre-mineralization faulting the ore bodies are localized along basal or upper parts of limestone and dolomite formations near their contacts with shale or sandstone. Within the favorable zones ore shoots are most commonly localized along the crests of minor anticlines superimposed on larger folds or on homoclinal structures.

In areas of strong pre-mineralization faulting the replacement bodies are controlled primarily by the shear zones and secondarily by position of favorable beds abutting against the faults.

Inaccessibility of many of the mines and lack of sufficient exploratory work in the accessible places make it impossible to define or evaluate the ore bodies known to exist. Indicated reserves include between 2600 and 3000 tons of 15 percent zinc ore at the Merrimac mine, 17,000 tons of material containing between 1 and 3 percent copper at the Torpedo mine, and between 6,000 and 7,000 tons of 2 percent copper ore (siliceous) at the Sunrise. An additional 1,000 tons of ore containing between 10 and 15 percent zinc is inferred to exist at the Merrimac.

The survey of the district indicated that previous explorations have not tested a number of areas where structural controls of ore bodies seem evident. It is believed that the present small production of a few hundred tons of ore per month is a fraction of the potential production, but for lack of a systematic exploratory program the production is not likely to increase within the near future.

THE TORPEDO MINE

The Torpedo Mine is situated at Organ, New Mexico in the Organ Mountain Mining District fifteen miles northeast of Las Cruces on State Highway No. 3. Las Cruces is the shipping point for the ores of the district. The altitude is 5300 feet and the climate is mild and dry.

The property consists of three patented mining claims, the Torpedo, Little Ben Scot and Papoose comprising 49 acres of patented land.

The ground is situated on the quartz-monzonite and dolomite contact which extends for several miles along the west side of the Organ Mountains in a north and south direction. The dolomite is cut in the Torpedo Mine by several porphyry dikes and many faults. In places the dolomite, shale and limestone are highly brecciated and more or less completely replaced by copper-ore of high grade.

This Brecciated zone which has been partly mined for a distance of 800 feet along the contact and to a depth of 300 ft. has produced over $800,000.00 according to the available smelter returns, and some more of which we have no record. The average copper content of ore shipped was over 12% with some carloads running up to 22%. No ore was mined or shipped running below 5% copper and large bodies of ore of that grade and lower were left in the old workings.

The ore zone above the 300 foot level is about 250 feet wide, over 800 feet long and is considerably leached and completely oxidized. Below the leached zone, at the former permanent water level, a zone of secondary enrichment should be found but at what depth future exploration only will determine. The zone of secondary enrichment will be extensive and rich, if one may judge of it from the large area of crushed and leached ground superimposed which in itself is still a fairly rich copper ore.

On the 300 foot level 5 winzes from 6 to 65 feet in depth were sunk. All were in ore and the 65 foot winze encountered chalcocite running in spots up to 70% copper. A crosscut was started at the bottom of this winze, carried east and west 50 feet and found no walls, all the work being in ore. Inadequate pumping facilities prevented further work in this winze.

Near the north end of the Torpedo claim the ore came to the surface and at that point the first discovery was made. It consisted of Crysocolla, malachite and stubelite, no sulphides showing, and has been mined for a distance of 300 feet along the strike of the contact down to the 300 foot level. This body of ore varied in width from 5 to 35 feet and a peculiar feature is its fading out at the north end into a body of white talc streaked with manganese. The talc continues to the north an unknown distance, a drift on the 200 foot level over 100 feet long failing to find the end of it. Scattered through the talc are hard nodules the center of which s malachite surrounded by chrysocolla which in turn fades out to pure white talc beneath the surface of the nodule, possibly indicating the former existance of an ore body now almost completely leached of its copper.

The mine has been idle for several years and the old workings are badly caved by reason of the rotting of timbers and the broken nature of the ground. On account of the inaccessible condition of most of the old workings a recent lessee of the property started a new shaft in the mon-

zonite to the south of the large stope in the old mine. The shaft is now down 200 feet and a drift running west from the bottom cut 60 feet of sulphide ore running from 1½ to 6% copper, some silver and a trace of gold. It is a very large body of splendid milling ore, probably the same one encountered in the 65 foot winze above referred to. It is now known to have a probable length of 1600 feet or more, a width of 60 feet, unknown depth and will furnish a tonnage for a good size mill for several years.

As ore was found on the 500 foot level in a drift from the No. 3 shaft directly in line to the north with this ore body I believe the probable tonnage can be estimated at 1,800,000 tons in this ore body alone down to, and a little below, the 500 foot level. There are several other richer and possibly larger or bodies in the mine that have been partially worked to water level where the ore still continues downward.

The lessee mentioned above recently obtained the services of parties operating the Radior Geophysical prospecting device which was used on the surface of the Torpedo claim in an effort to locate bodies of sulphide ore. The 60 foot body of sulphide west of the new shaft was accurately located and mapped; another sulphide ore body was indicated beneath the chrysocolla stope at the north end of the Torpedo claim, and a large and highly responsive sulphide body was indicated to begin at the south end of the chrysocolla stopeand to extend to the east several hundred feet. No ore has heretofore been known or expected to exist east of the line of the monzonite contact. Several other sulphide deposits were indicated beneath the old workings.

The record of shipments shows an increase in silver values whenever sulphides were encountered, the silver contents increasing on an average of one ounce per ton for each one per cent of sulphur.

In a prospecting drift from the 500 foot shaft west of the copper ore body a vein of heavy sulphide ore was cut carrying values as follows: gold 0.02, silver 19.96 ounces per ton, copper 13.96 and lead 18.70 percent, which is a fair indication of what may be expected in the sulphide zone below the large oxidized ore bodies.

The water stands at present a few feet above the 300 foot level in the No. 3 shaft. It was lowered to the 500 foot level at one time with a No. 11 Cameron sinking pump with no great difficulty, and as evidence that the water will not be an important item of expense in operating the mine the fact should be noted that it required eight years for the water to rise to its original level after being pumped down.

The writer has known the mine for 34 years—from its first discovery through all the years of its mismanagement—to the present. The recital of its history would be instructive and astonishing but it is not germane to this report.

I believe the mine to be one of the best undeveloped copper-silver prospects in the Southwest and that with sufficient capital and intelligent management it will become one of the great producers and very profitable. Such capital and management it has never had.

Organ, New Mexico.
May 5, 1935

L. B. BENTLEY.

MAP
—OF A PART OF THE—
ORGAN MINING DISTRICT
DONA ANA COUNTY
NEW MEXICO
Scale: 1 inch = 800 feet
12½° N
LEGEND
Magnetic North
Mining Claims
Geology
Organ Townsite
True North
Legal Land Division Grid
U.S. Highway 70
Planimetric Features
PRINCESS
SULTANA
MILTON NO 2
MILTON NO 1
BLACK PRINCE
MILTON NO 3
PRINCESS NO 2
FAULT
EUREKA GROUP
COBRE GRANDE NO 3
COBRE GRANDE NO 2
COBRE GRANDE NO 1
SAN AUGUSTINE
RICARDITE
APEX
COPPER BULLION
OPHELIA
IRON MASK
LITTLE BUCK
TRIANGLE
MERRIMAC
BOB CAT
SAN AUGUSTIN PEAK
U.S. HIGHWAY 70
BIG THREE - GROUP
SUSQUEHANNA
RAVEN
PLUTUS
CRUZ NO 2
CRUZ
BAYLOR PEAK
LEONA
WEDGE
LONDON
SADGER
ECLIPSE
TOUGH NUT
EXCELSIOR MINING CO. - GROUP
EXCELSIOR NO 3
EXCELSIOR NO 2
EXCELSIOR NO 4
HEREFORD
CHIPPEWA
HARD SCRABBLE
HEBA C
MARY C
CHICAGO
APEX
TFC 12-5-27
KALAMAZOO
MICHIGAN
SILVER SET
GIRARD CONSOLIDATED MINING & MILLING CO. GROUP
Cross Fissure N 68°30' W
CAPT. SMITH
MESSADE
HENO NO 2
HENO NO 3
HENO
LADY AGNES
WHITE HOPE
NORTH STAR
HOMESTAKE
RED ELEPHANT
TITANIC
SULTAN
CZAR
SULTANA
HOMESTAKE - GROUP
GIRARD CONSOLIDATED MINING & MILLING CO. GROUP
Faulted to the West 300 ft.
FORD LODE
TFC 11-1-27
SHORT CUT
BLACK DIAMONDS
GIRARD
LONGPOINT
COPPER BAR
Belgium Lode
MEMPHIS
MEMPHIS CORPORATION CO. GROUP
TORPEDO NO 2
TORPEDO NO 3
TORPEDO
BEN SCOTT
POOSE
BLAIR
ORGAN
ORGAN WELL
LAST CHANCE
FASS NO EXT.
STORM KING
ORGAN TOWNSITE
TORPEDO MINING CO. GROUP
FRANKLIN
FRANKLIN NO 2
FASS
FASS NO EXT.
TRINITY
FRANKLIN MINING CO. GROUP
ALBUQUERQUE SPRINGS
COPPER RING
WILD CAT
MINNIE C
EVAD
PORPHYRY
E. STEVENSON
ST AUGUSTIN
McCLELLAN
MAY P
CARBONATE
BENNETT
PATTON
WILDCAT NO 2
OLD LODE
DOROTHY JEAN
PORTLAND
PORTLAND SOUTHWEST MINING & MILLING CO. GROUP
L. C. (Eddie) Edwards