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P_M_C_NAME (mine, claim & company names)	Sultan Zinc-Lead Mine
COMMODITY If not obvious	Lead Zinc Cadmium Silver

Keep docs at about 250 pages if no oversized maps attached (for every 1 oversized page (>11x17) with text reduce the amount of pages by ~25)

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SEPTEMBER 1947

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
JAMES BOYD, DIRECTOR

REPORT OF INVESTIGATIONS

SULTAN ZINC-LEAD MINE, CLARK COUNTY, NEV.

BY

ROBERT W. GEEHAN

REPORT OF INVESTIGATIONS

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

SULTAN ZINC-LEAD MINE, CLARK COUNTY, NEV.[1]

By Robert W. Geehan[2]

CONTENTS

INTRODUCTION

The Bureau of Mines has been investigating deposits of critical and essential minerals in the United States since 1939. Many of the mines were developed.

A preliminary examination of the Sultan mine was made in January 1945 by the author, who recommended investigation by drifting and crosscutting. The Bureau conducted a project at the mine from April to June 1946. Claims investigated are in sec. 20, T. 25 S., R. 58 E., Mount Diablo base and meridian, in southern Clark County, Nev., about 7 miles southwest of Goodsprings.

The Sultan mine has been an intermittent producer of zinc-lead-silver ore since 1910. During World War II, ore was shipped to the Government stock pile at Jean, Nev., and to the International Smelting & Refining Co.'s smelter near Salt Lake City, Utah. Throughout the past year, ore has been milled and the concentrates have been shipped to the smelter.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Report of Investigations 4119."

2/ Mining engineer, Reno Division, Mining Branch, Bureau of Mines, Department of the Interior.

The drifts, crosscuts, and raises driven by the Bureau totaled 469 feet. The program was designed to locate faulted segments of an ore body exposed underground and to test a favorable area for a continuation of an ore shoot extending from the surface into the upper levels of the mine. Results obtained from the program were both negative and positive. Traces of mineralization were found in the former and an ore body was found in the latter.

ACKNOWLEDGMENTS

In its program of investigation of mineral deposits, the Bureau of Mines has as its primary objective the more effective utilization of our mineral resources to the end that they make the greatest possible contribution to national security and economy. It is the policy of the Bureau to publish the facts developed by these investigations as soon as practicable after the conclusion of a project. The Mining Branch, Lowell B. Moon, chief, conducts preliminary examinations, performs the actual investigation, and prepares the final report. The Metallurgical Branch, Oliver C. Ralston, chief, analyzes samples and performs beneficiation tests.

With respect to this report, special acknowledgment is due A. L. Brokaw and John Reinemund of the United States Geological Survey for geological maps and data, to Roy Jacobson and Ralph Hamilton, operators of the mine, for unusually fine cooperation in all phases of the project, and to Otto Schwartz for assistance in taking samples of mill products. Acknowledgment is also made to A. C. Johnson, chief, Reno Division, Mining Branch, for his aid and direction, and to A. C. Rice, acting supervising engineer, and his staff at the Rare and Precious Metals Experiment Station at Reno for analytical work on the ore.

OWNERSHIP

The property is owned by Mary E. Robbins of Ontario, Calif., and at present is operated by Ralph Hamilton and Roy Jacobson of Goodsprings, Nev., under a lease between Jacobson and the owner.

HISTORY

The original location at the Sultan was made in 1896, but little development was done before 1910, and virtually no ore was produced before 1915. A dry concentrating mill was built in 1916 and operated during World War I. The present operator obtained a lease on the mine in 1943, and sorted ore was shipped to the Government stock pile at Jean, Nev., until it closed in June 1944, at which time shipments were started to the International Smelting & Refining Co.'s smelter near Salt Lake City, Utah.

In 1945, a mill in Sandy Valley was leased, and a large proportion of the mine production has since been concentrated before shipment to the smelter. From June 1944 to the present, the Sultan mine has been the largest producer of zinc-lead ore in the Goodsprings district.

PHYSICAL FEATURES

The Sultan claims are on a spur of the Spring Mountains in an area of high relief. The altitude of the main working level at the mine is 4,000 feet. Desert climatic conditions prevail; summers are hot, and the annual precipitation is slight. Snow is infrequent. Vegetation is sparse and is confined to usual desert growths.

Water used at the mine is hauled by truck from Goodsprings or Sandy Valley. Because of the scarcity of water at the mine, the mill built there in 1916 was a dry concentrating type. An abundant supply of water is available from a well near the present mill in Sandy Valley.

The nearest shipping point and connection with the main Nevada highway system is at Jean, a station on the Union Pacific Railroad. A 7.5-mile paved road extends from Jean to Goodsprings. Access to the mine from Goodsprings is over 6.5 miles of graded and 4.5 miles of desert road, a total of 11 miles.

Transmitted electric power is available from the Southern Nevada Power Co.'s lines 3/4 mile from the mill. Telegraph service is available at Goodsprings, and long-distance telephone service is to be had at Jean. Mine and mill employees live at Goodsprings, where hotel accommodations can normally be obtained.

MINE WORKINGS AND PLANT

Ore produced at the Sultan mine has come from open cuts, from stopes opened by adits, and from stopes developed by a winze off the main adit. The open cuts are now connected to the adits, and recent surface work has been done by glory-hole methods. Workings explore an area 200 by 700 feet with a vertical range of 300 feet.

The main items of mine plant are three small compressors, gasoline engine-powered, an air hoist at the winze station, and sundry rock drills, mine cars, and shop equipment. Near the mine is a sorting plant containing bins, trommel, and sorting belt, with gasoline-engine power. A flotation-gravity mill in Sandy Valley has been leased to treat the Sultan ore. At present, only the gravity section of this mill is in use. Several trucks owned by the mine operators are used for hauling ore and concentrates and to transport the mine crew to and from Goodsprings.

DESCRIPTION OF THE DEPOSIT

Zinc-lead-silver ore occurs as replacements of a brecciated and dolomitized limestone believed to be a part of the Bird Springs formation (Pennsylvanian).[3] This open, porous breccia zone is several hundred feet

3/ Hewett, D. F., Geology and Ore Deposits of the Goodsprings Quadrangle, Nev., U. S. Geol. Survey Prof. Paper 162, 1931, 172 pp.

thick and has a general trend to the northwest. Ore bodies occur as three large, poorly defined shoots trending northeast and plunging to the east. High-angle faults striking northwest cut the breccia zone and appear to cut the ore bodies. Migration of the ore minerals has obscured the original outline of the ore zones and makes it difficult to determine the age of the faults. Some of the major faults may have offset favorable beds and later served as channels for mineralizing solutions. Other faults are almost certainly post-mineral.

Ore minerals now found in the mine are largely carbonates of zinc and lead with some residual nodules of lead sulfide. Much of the zinc appears to be a secondary type redeposited from solutions that leached the primary ore bodies.

CHARACTER OF THE ORE

Type 1, zinc-lead. - Zinc-lead ore occurs in high-grade shoots with a general trend to the northeast and an over-all plunge to the east. The predominant zinc mineral is hydrozincite, with minor amounts of smithsonite and calamine. Lead occurs as galena, cerussite, and anglesite. The gangue minerals are dolomite and calcite, with minor amounts of quartz. Past operators reported that this ore contained 30 to 60 percent lead, 6 to 14 percent zinc, and 10 to 30 ounces of silver per ton. At present there is no large tonnage of ore with this high lead content, although small lenses of nearly pure lead carbonates are found. A recent sample cut in high-grade ore of this type contained 40.9 percent zinc, 11.6 percent lead, and 8.45 ounces of silver per ton. A 50-ton shipment from the same ore body, after hand sorting, contained 32.8 percent zinc, 9.3 percent lead, and 9.0 ounces of silver per ton. Adjacent to the high-grade shoots is a larger tonnage of low-grade ore. Samples cut from this material have contained 7.9 to 9.3 percent zinc, 2.3 to 5.8 percent lead, and 3.0 to 5.6 ounces of silver per ton.

Type 2, zinc ore. - Type 2 ore, found in the open pits and in scattered areas adjacent to the adits, contains very little lead and is composed almost entirely of hydrozincite and limestone-dolomite breccia. The soft, fine-grained hydrozincite occurs mainly as a coating on the breccia fragments; however, in the better-grade ore of this type, the fragments have been replaced by hydrozincite. This ore is believed to represent a precipitation of zinc leached from a type 1 ore body. Mine workings have an assay wall, as the material contains up to 42 percent zinc, 7 percent lead, and 30 ounces of silver per ton. A large tonnage of this ore sent to the Government stock pile at Jean averaged 23.5 percent zinc and 3.9 percent lead. (Silver was not assayed or paid for.) The mine operators have taken advantage of the soft nature of the hydrozincite by installing a trommel to "tumble" the ore. This process tends to rub the zinc mineral off the breccia fragments, which are then discarded as tailings.

MINING METHODS

The Sultan ore bodies have been developed by surface cuts, by adits following ore found on the surface, and by drifts and crosscuts in favorable areas. In the recent past, the glory-hole method has been used for mining some of the ore bodies exposed in the open cuts. The glory holes were connected with and drawn from the adits below. At present, the large block of ore below the main adit is developed by a 120-foot winze and three sublevels off the winze. The original underground stopes were small, irregular workings following the high-grade ore. Recently, large shrinkage stopes have been used in mining the ore. Tramming is done by hand, both on the sublevels and the main adit. This is a major item of expense, as bulk of recent production has required a tram from the winze station to the sorting bins, a distance over 1,000 feet. Wherever possible, waste is sorted from the ore underground and is backfilled in old stopes. Most waste broken in drifts and raises is trammed to surface dumps. All workings are dry.

The efficient shrinkage-stope method of mining now in use was made possible by the success of the sorting plant and mill, which remove much of the waste and make it practical to mine the low-grade ore.

Wall rock in the stopes and country rock in adits is brecciated dolomite and limestone. This material has a tendency to slough off small, angular fragments, particularly when adjacent areas are being blasted down. The breccia is surprisingly competent in stopes and pillars, and many stopes have remained open over a period of 20 years or more with no timber support. Recent development has indicated that the winze is in the heart of the large ore body below the adit level. If mining is to be continued in this area, a new winze or a shaft will soon be necessary, as the present winze pillar is not large enough to protect the winze if additional ground is opened.

METALLURGY

Ore from the Sultan mine is trammed to a sorting plant, where the mine-run material is segregated into shipping ore, mill ore, and waste. Approximately 15 percent of mine-run ore is discarded as waste, 15 percent is sorted and screened to shipping grade, and the remaining 70 percent is sent to the mill. The percentage of ore sorted to each class varies from day to day. Provision is made to bypass the sorting plant direct to shipping bins when mine-run ore is of shipping grade.

The sorting plant is designed to take advantage of the tendency of ore to break to a smaller size than waste. Fines are screened from the mine-run ore and sent to the shipping bins. A trommel is used both as a screen and as a means of knocking and rubbing the soft hydrozincite off coarse fragments, which are then moved over a sorting belt. Ore is hand-sorted from the belt, and waste drops to a storage bin.

The mill in Sandy Valley is a combined flotation-gravity type plant, but only the gravity section is now in use. Zinc-lead concentrates are obtained at jigs, tables, and a slime-settling tank. An unusual feature of this mill is the recovery of zinc concentrates at the tailings end of both tables and jigs. A unique zinc jig is used to scalp off a coarse zinc concentrate that rises to the top of the bed. This material is largely hydrozincite with a "fluffy" texture. Air trapped in the porous mineral gives it a lower specific gravity than the limestone and dolomite gangue. A similar product is recovered at the "tailings" end of the sand table, and at the slime table zinc-bearing slimes are recovered at the "tailing" end and sent to a tank for settling. Figures 1, 2, and 3 show the details of the zinc jig, the arrangement of the tables, and the mill flow sheet.

Analyses of a set of samples cut in the mill on July 11 and 12, 1946, are listed below. These samples show that the mill was making a fair lead recovery but that zinc recovery was poor. Samples cut by the operators show that normal mill heads are somewhat higher in lead and zinc, and that the tailings usually contain less lead, indicating that normal recovery of both lead and zinc is somewhat better than that of July 11.

Sultan mill samples, July 11, 1946, except where noted otherwise

Location	Number	Silver, oz./ton	Lead, percent	Zinc, percent
Mill heads	22	3.05	2.3	8.8
Mill tailings	29	1.55	.5	7.2
Lead jig heads	30	3.45	2.2	7.3
Lead jig tailings	31	1.5	.6	6.6
Lead jig concentrate	32	115.00	62.1	6.8
No. 1 lead jig concentrate1/	1/53	179.90	68.3	3.1
No. 2 lead jig concentrate1/	1/54	64.95	58.8	9.3
Zinc jig heads	33	1.40	.6	6.5
Zinc jig tailings	34	1.40	.4	5.4
Zinc jig top concentrate	35	7.10	2.0	36.6
Zinc jig top concentrate1/	1/52	11.85	4.7	34.4
Zinc jig bottom concentrate	36	15.90	16.0	27.7
Zinc jig bottom concentrate1/	1/51	19.80	22.0	26.3
Coarse table heads	37	3.85	3.0	9.7
Do.	38	2.30	.6	9.5
Coarse table zinc concentrate	39	6.35	2.0	37.2
Coarse table lead concentrate	40	19.40	24.4	10.4
Coarse table cleaned lead concentrate	41	45.65	51.0	7.0
Slime table heads	42	5.30	4.7	14.0
Slime table tailings	43	2.20	.6	10.5
Slime table zinc middlings	44	1.80	.4	11.2
Slime table lead middlings	45	3.90	1.7	12.7
Slime table lead concentrate	46	28.05	38.4	14.8
Slime table zinc concentrate	47	4.75	2.9	23.1
Mill slimes at pump	48	5.15	3.1	23.3
Mill slimes at tank	49	5.10	3.1	22.7
Mill slimes shipped1/	1/50	5.30	3.2	21.6

1/ Indicates July 12, 1946.

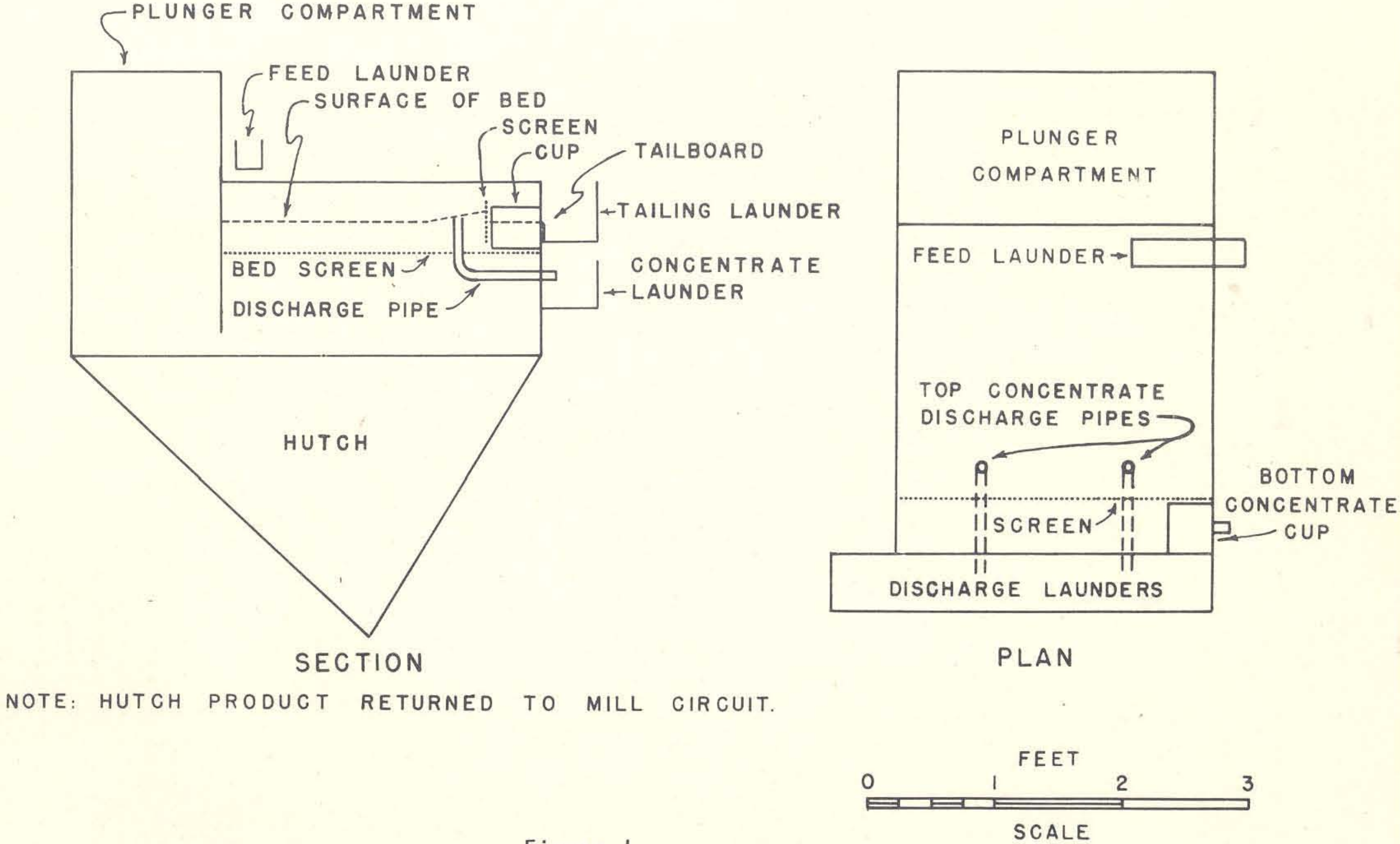


Figure I.

ZINC JIG

SULTAN MINE, GOODSPRINGS, CLARK COUNTY, NEVADA.

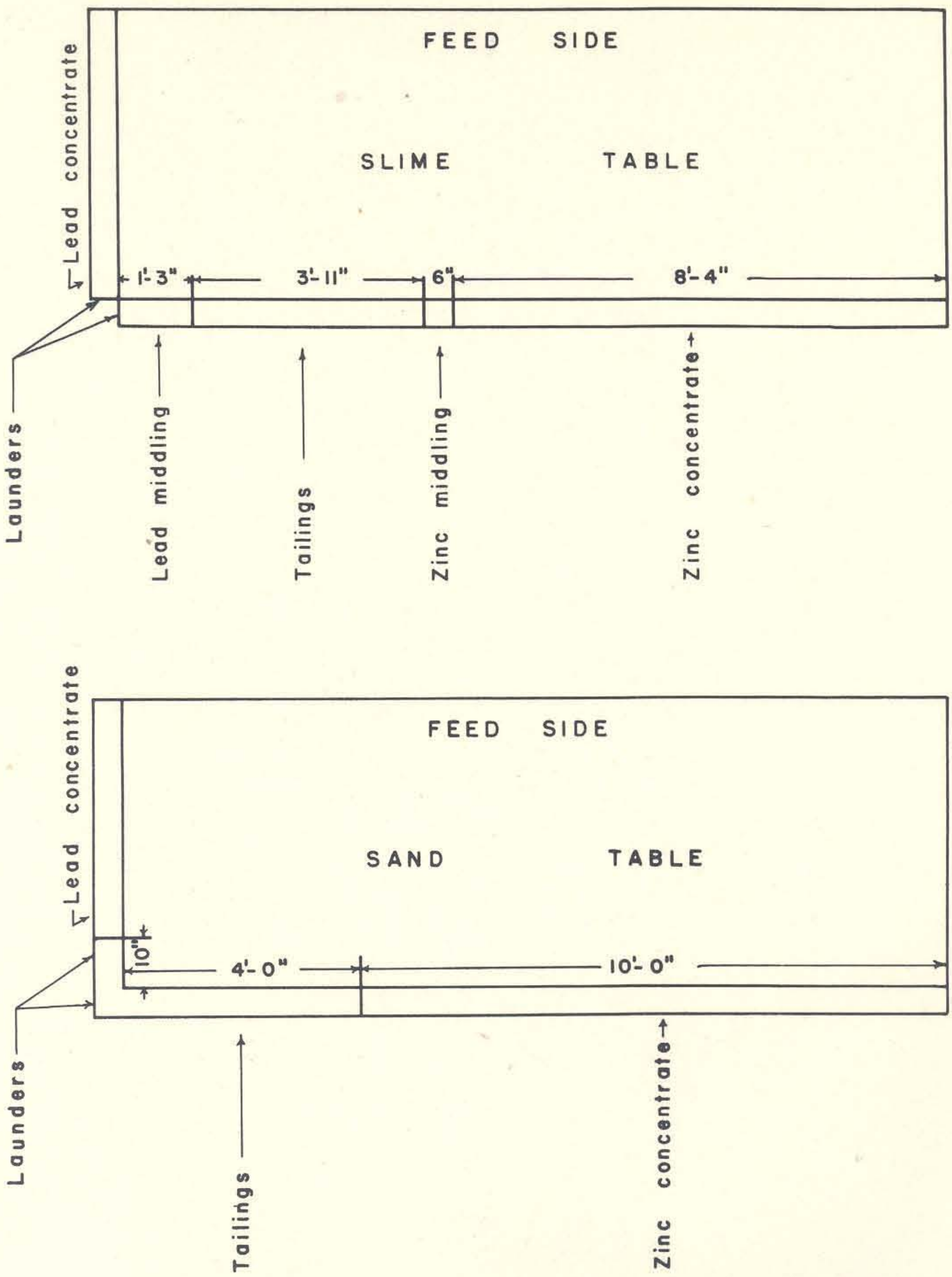


Figure 2.

MILL TABLES

SULTAN MINE, GOODSPRINGS, CLARK COUNTY, NEVADA.

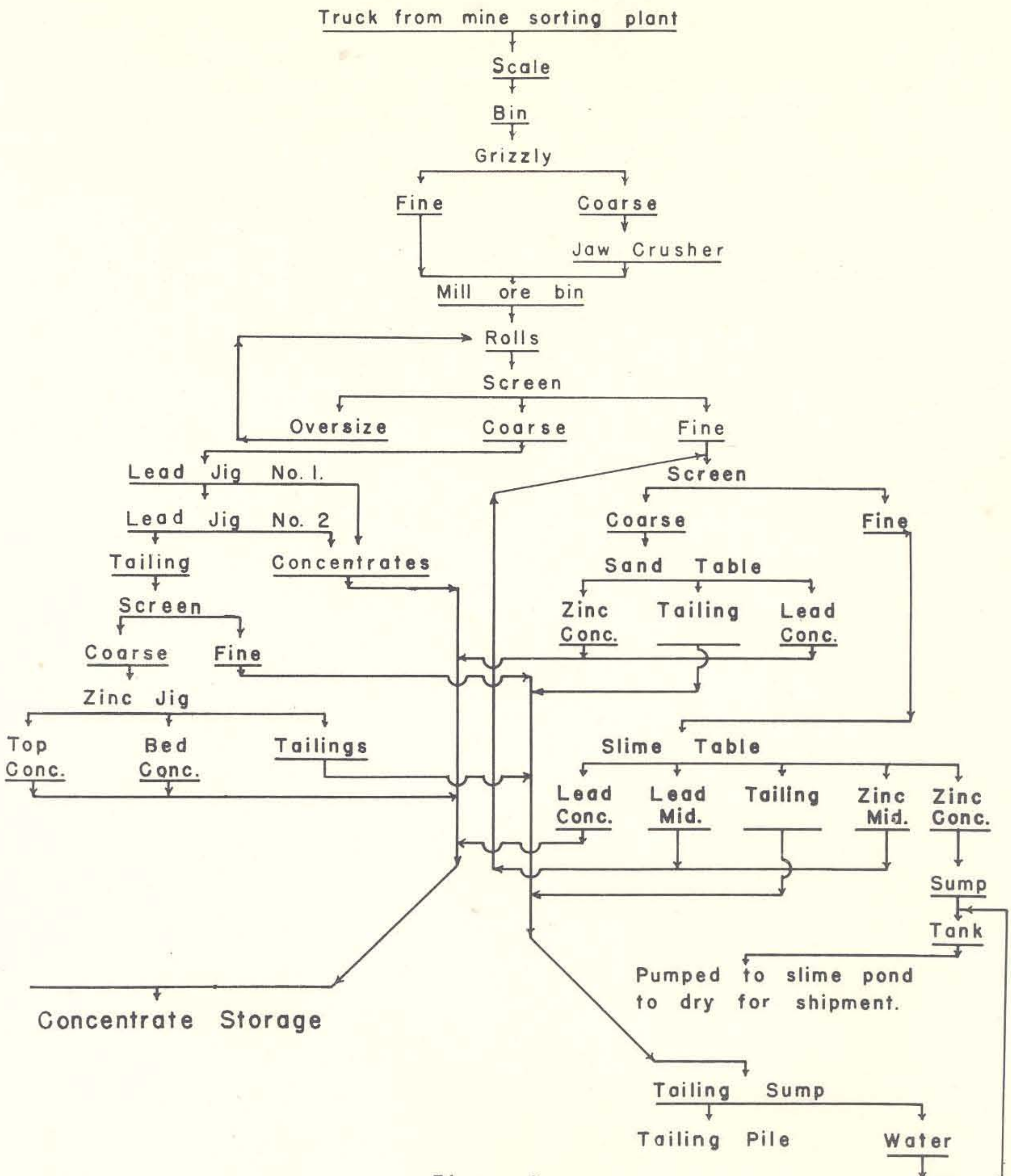
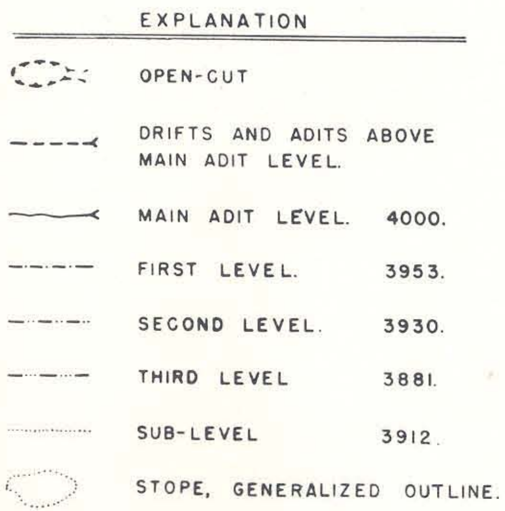
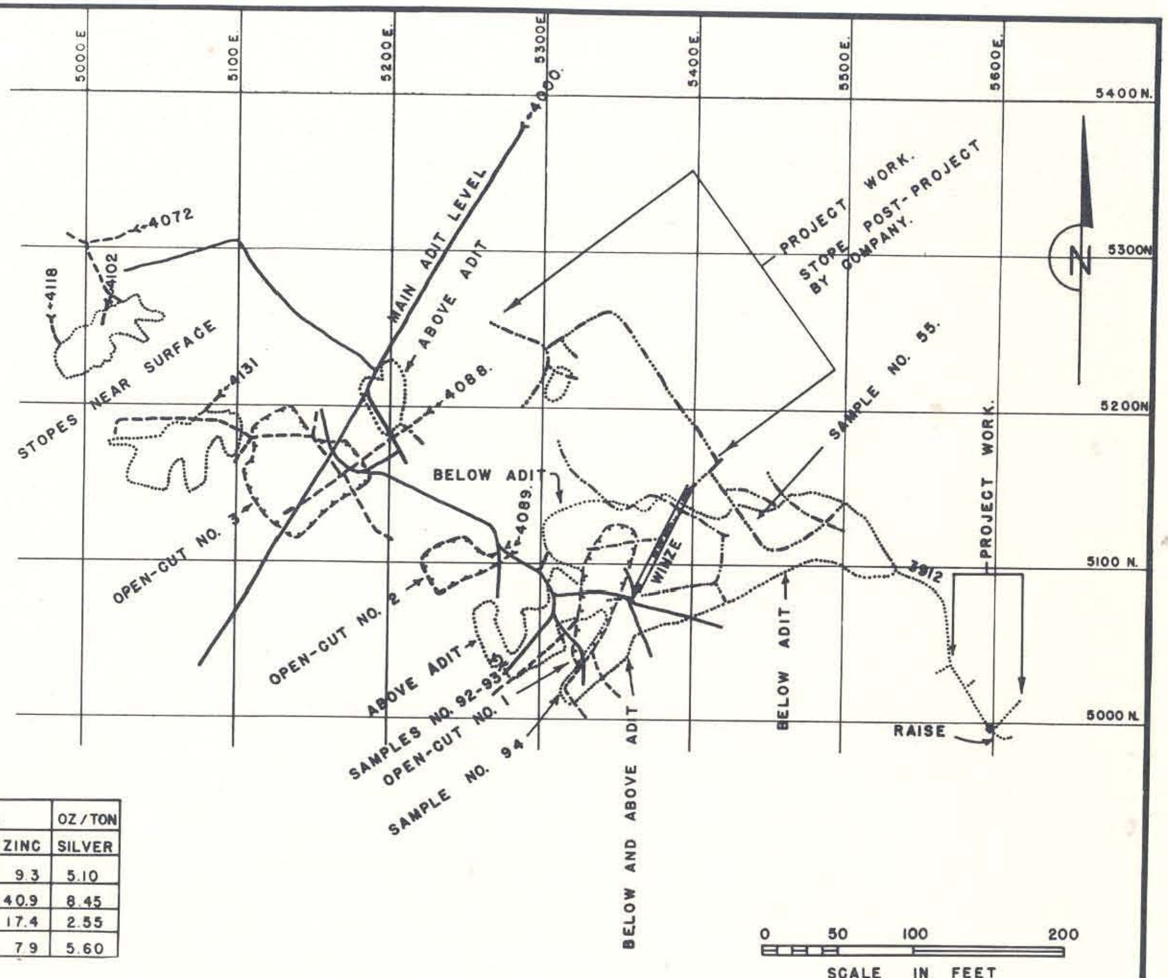


Figure 3.

MILL FLOW SHEET

SULTAN MINE, GOODSPRINGS, CLARK CO. NEVADA.





SAMPLE NUMBER	SAMPLE LENGTH	% LEAD	% ZINC	OZ/TON SILVER
55	CAR SPL	5.8	9.3	5.10
92	5'	11.6	40.9	8.45
93	5'	4.6	17.4	2.55
94	GRAB	5.3	7.9	5.60

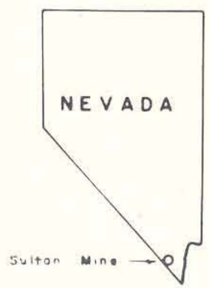
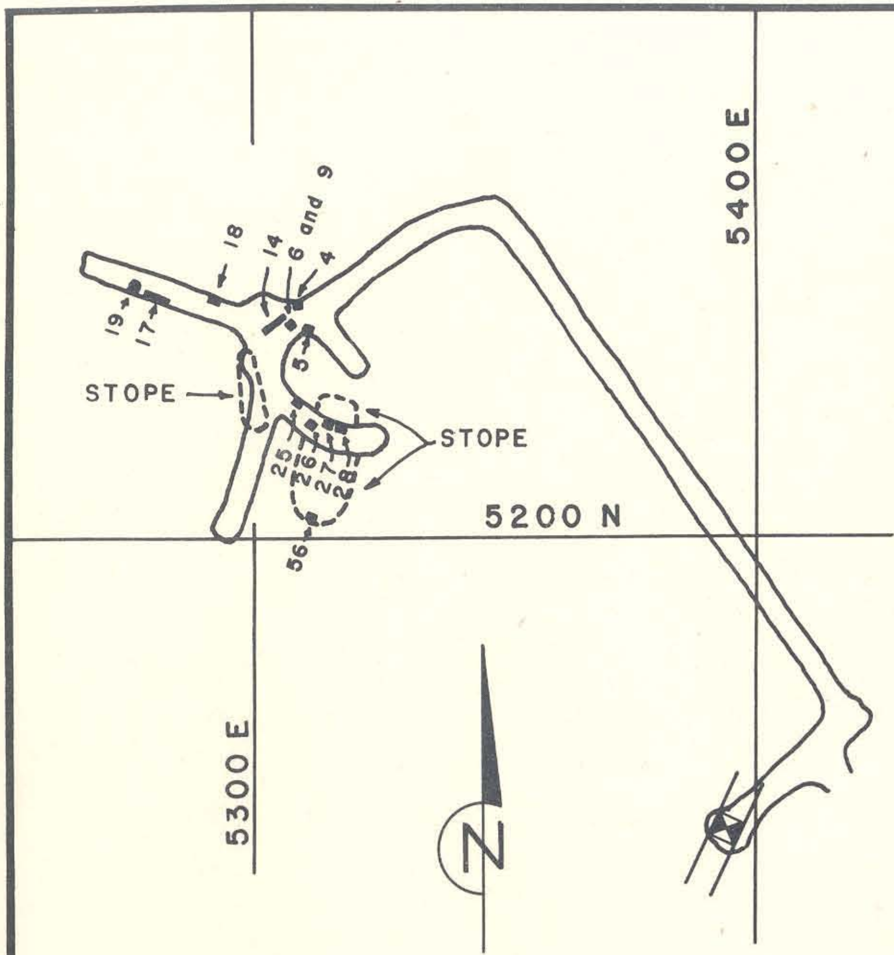


Figure 4.

COMPOSITE MAP.

SULTAN MINE, GOODSPRINGS, CLARK COUNTY, NEVADA.



SAMPLE NUMBER		FROM	TO	SAMPLE LENGTH	% Pb	% Zn	% Cd	Oz/ton Ag
4	V	44		1.2	5.1	33.1	0.005	3.30
5	V	44		1.0	1.7	22.2	—	3.05
6	V	46.5		2.0	0.3	4.4	—	1.00
9	S	45	46	1.0	2.0	10.9	—	1.70
14	H	46	51	5.0	0.2	6.6	—	0.75
17	H	20	23.5	3.5	0.1	15.7	—	3.45
18	H	10.5	12.5	2.0	0.1	25.6	0.02	3.65
19	H	27	28	1.0	0.1	27.8	0.01	5.40
25	V	3		1.2	26.6	2.8	T	13.95
26	V	8.5		2.5	T	22.5	0.02	2.50
27	V	11		1.6	8.8	32.9	0.01	13.15
28[x]	S	12		1.0	0.4	43.4	0.13	27.90
56	V	22		1.6	1.8	27.0	—	6.50

x Spectroscope failed to detect the presence of indium.

H = Horizontal. T = Trace

V = Vertical.

S = Selected.

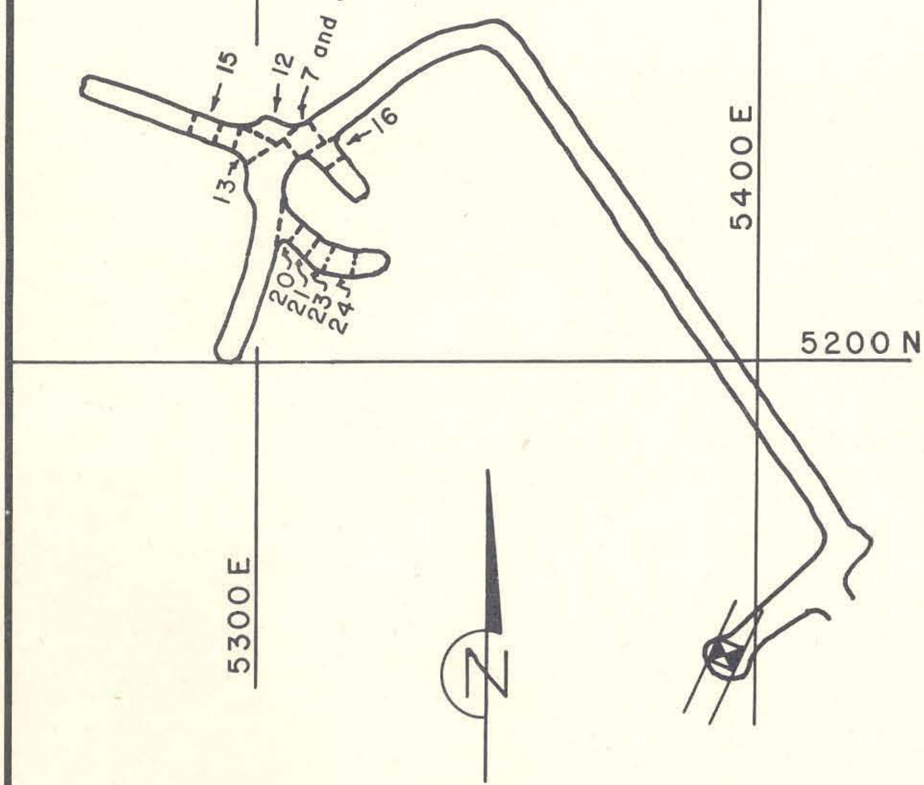
Figure 5.

THIRD LEVEL

ASSAY MAP OF HAND SAMPLES

0 10 20 30 40 50
SCALE IN FEET

SULTAN MINE, GOODSPRINGS, CLARK COUNTY, NEVADA.



SAMPLE NUMBER	FROM	TO	FEET	%		Oz/ton
				Pb.	Zn.	Ag
7 Grab	40	46.5	6.5	0.3	6.7	1.10
8 Car	40	46.5	6.5	0.4	7.3	0.95
12 Car	0	6	6	0.3	14.0	2.05
13 Car	0	6	6	0.1	4.7	0.65
15 Car	10	15	5	0.1	12.7	2.15
16 Car	0	5	5	0.1	3.9	0.30
20 Car	0	4	4	3.1	9.9	5.15
21 Car	4	8.5	4.5	1.7	10.0	3.85
23 Car	8.5	13	4.5	0.3	5.9	1.00
24 Car	13	18	5	0.4	4.1	1.25

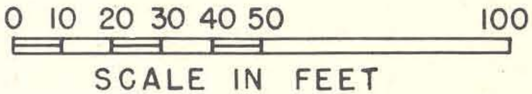


Figure 6.

THIRD LEVEL

ASSAY MAP OF CAR AND GRAB SAMPLES

SULTAN MINE, GOODSPRINGS, CLARK COUNTY, NEVADA.

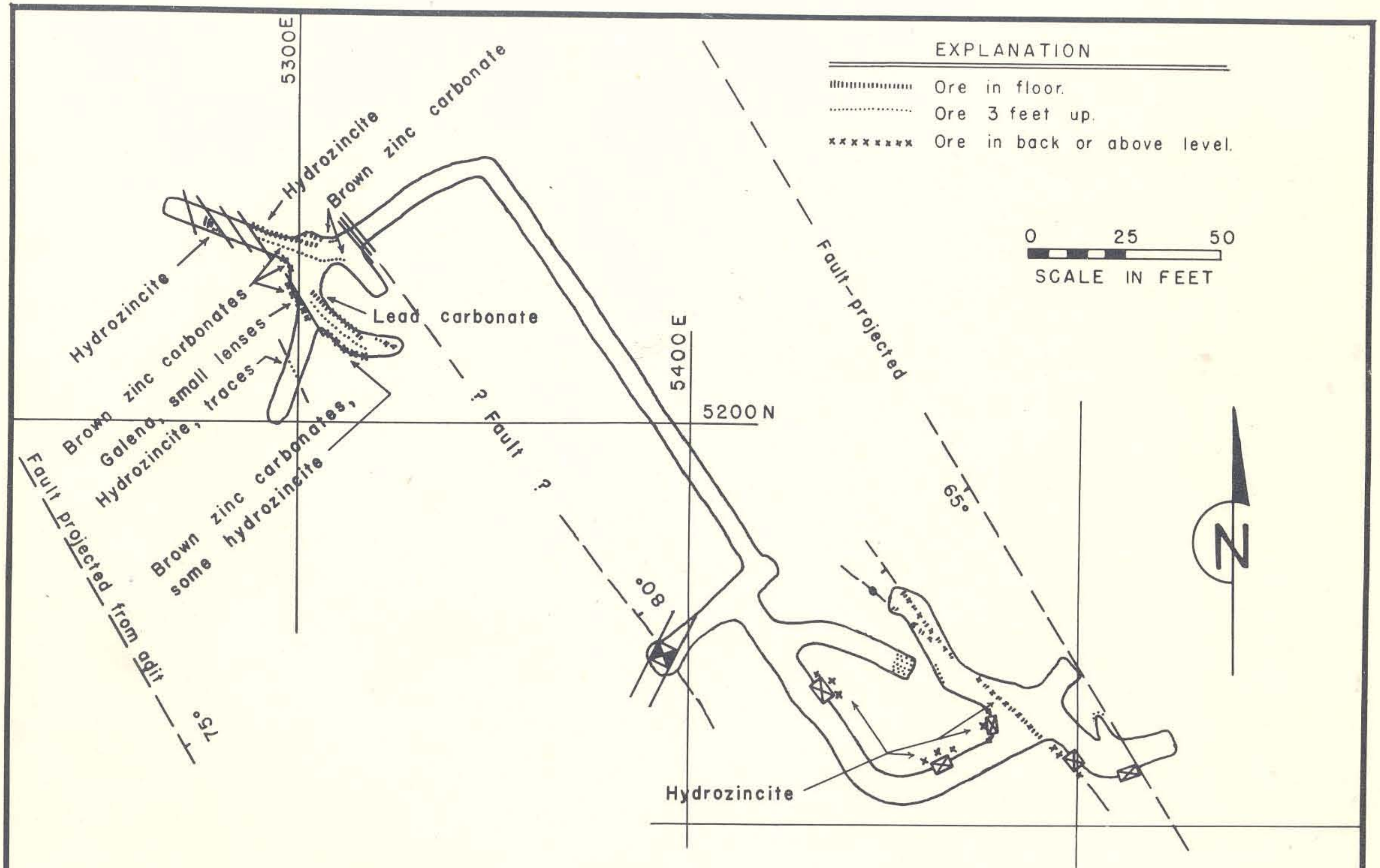
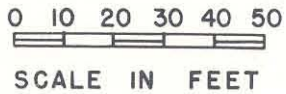
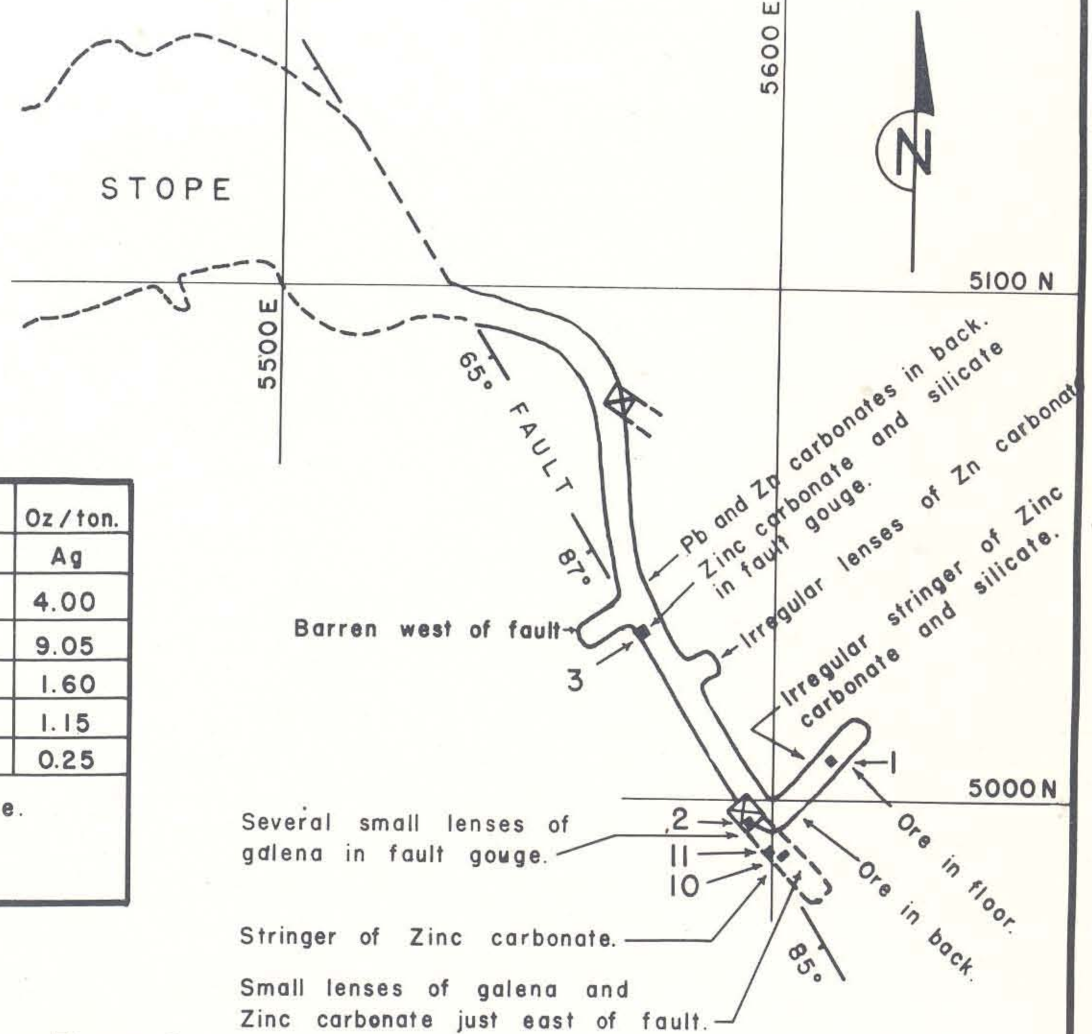


Figure 7.

THIRD LEVEL

SULTAN MINE, GOODSPRINGS, CLARK COUNTY, NEVADA.





SAMPLE NUMBER		FROM	TO	SAMPLE LENGTH	% Pb	% Zn	Oz/ton. Ag
1	V	14		1.5	0.3	19.6	4.00
2	H	14		0.5	3.5	6.7	9.05
3	G	8	9	1.0	T	35.6	1.60
10	H	55		2.0	T	11.9	1.15
11	H	48		0.5	T	3.0	0.25

H Horizontal. T Trace.
V Vertical.
G Grab.

Figure 8.

SUB-LEVEL ABOVE THIRD.

ASSAY MAP OF HAND SAMPLES.

SULTAN MINE, GOODSPRINGS, CLARK COUNTY, NEVADA.

Lead and zinc concentrates are mixed and sent to the International Smelting & Refining Co.'s smelter at Salt Lake City, Utah. All the above samples were cut by hand, as there is no automatic sampling equipment at the mill.

A mill, now dismantled, which treated ore mined in 1916-19, used dry gravity methods of concentration. Tailings from this mill are said to contain 8 to 20 percent zinc.

In 1942-43, the Bureau of Mines made exhaustive tests on ores from the Goodsprings District, including samples from the Sultan. The objective of the ore-dressing studies was to make a lead concentrate for shipment to lead smelters and a zinc concentrate acceptable to the Government stock pile at Jean, Nev., by simple milling methods. The requirements of the stock pile were a ratio of zinc to lead of at least 5 to 1 and a combined percentage of zinc and lead of not less than 17.

On Sultan ores, tabling at 20-mesh recovered a portion of the lead in a salable concentrate but did not remove enough lead from the high-grade ores so that table tailings would meet the 5 to 1 ratio of zinc to lead specified. Flotation tests on ore ground to minus 200-mesh produced a lead concentrate assaying 42.6 percent lead with a recovery of 86.5 percent. Similar tests produced a zinc concentrate containing 20.8 percent zinc with a recovery of 65.8 percent. However, zinc flotation was difficult and required long and numerous conditioning periods and excessive flotation time.

At present, the market for the oxidized type mixed lead-zinc ore and concentrate produced at the Sultan mine is limited to one lead smelter near Salt Lake City where the zinc is recovered in a slag fuming plant.

WORK BY THE BUREAU OF MINES

In January 1945 the mine was examined by an engineer of the Bureau, and recommendations were made for investigation by drifting and crosscutting. A. L. Brokaw and John Reinemund of the United States Geological Survey mapped the geology of the mine area, and their preliminary report and maps were helpful in planning the work. In March 1946 the Bureau solicited bids on a minimum of 175 feet and a maximum of 475 feet of drifting and crosscutting, and in April 1946 a contract was let to Lee Krider of Goodsprings, Nev. The project was designed to test favorable areas for continuations and faulted segments of ore bodies known on the surface and in the mine.

A total of 469 feet of drifts, crosscuts, and raises were advanced under this contract. The location of this work is shown on figure 4; figures 5 to 8 are assay maps showing results of the work. The location of samples cut in the mine area and their analyses are shown on figure 4.

Work in the area northwest of the third-level winze station was designed to locate possible extensions of the ore body known as the "center shoot." A thin high-grade ore shoot was found in this area. Additional work now being done by the company will determine whether this is an isolated ore body with only a small tonnage or a narrow portion of a larger shoot.

Work done southeast of the winze on a sublevel above the third level was designed to locate the offset portion of the "east shoot." Although several small mineralized zones were in this area, nothing was found that indicated the presence of a large ore body. Most of the mineralized material was in the gouge of the fault or within a few feet of the fault.

The contractor began work on April 19, 1946, and completed 469 feet of drifting, crosscutting, and raising on June 17, 1946. No timber was required except staging in the raise. Broken rock was trammed to the third-level winze station, hoisted to the main adit, and trammed to surface dumps. Drifts and crosscuts were driven with a minimum size of 4.5 by 6 feet, but the actual average size of completed workings was 5 by 6.5 feet. Much track cleaning was necessary, because small fragments constantly sloughed off the brecciated dolomite. The total of drifting and crosscutting was 392 feet, and one 77-foot raise was driven.

The contractor's records show the following data:

Man shifts worked	227
Pounds of powder used (No. 3 Atlas gelodyn)	2,125
Feet of fuse used	5,000
Number of caps used	950
Gallons of gasoline used	2,100
Number of mine cars trammed (about 1,800 pound each).	1,267

The following items have been computed from the above data:

Feet advance per man shift	2.0
Mine cars trammed per foot of advance	2.7
Pounds of powder used per foot advanced	4.5
Number of caps used per foot advanced	2.0
Gallons of gasoline used per foot advanced	4.5

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JAN 19 8 00 AM '48
STATE OF NEVADA
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