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05/11/88

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES FILE DATA

PRIMARY NAME: BRUCE

ALTERNATE NAMES:

OLD DICK
LAWLER MINES

YAVAPAI COUNTY MILS NUMBER: 130B

LOCATION: TOWNSHIP 14 N RANGE 9 W SECTION 20 QUARTER NW
LATITUDE: N 34DEG 32MIN 47SEC LONGITUDE: W 113DEG 13MIN 43SEC
TOPO MAP NAME: BAGDAD - 15 MIN

CURRENT STATUS: PAST PRODUCER

COMMODITY:

ZINC SULFIDE
COPPER SULFIDE
SILVER
GOLD

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BRUCE MINE

THN R9W Sec 17 18
YAVAPAI
Jct. of
19.20

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SOME ASPECTS OF COMBINING HEAVY MEDIA
CONCENTRATION WITH FLOTATION AT A SMALL MILL

BY

A. W. HUNT

CYPRUS MINES CORPORATION, BAGDAD, ARIZONA
AT THE NATIONAL WESTERN MINING CONFERENCE
OF THE COLORADO MINING ASSOCIATION
DENVER, COLORADO FEBRUARY 7, 1964

The Old Dick property was located originally in 1882 and passed through the hands of various owners and leasers without significant production until World War II, when a small tonnage of direct shipping copper ore was mined. Some copper-zinc ore was milled at various custom plants in the late nineteen forties and early fifties. Cyprus Mines Corporation acquired the property in 1955, built the present flotation plant and commenced production in 1957. Production of copper and zinc concentrates has been continuous since, with the exception of a low market shutdown in 1958. The heavy media pre-concentration section was added to the mill in 1961.

The location is 5 miles by dirt road southwest of Bagdad, Arizona, in a mountainous region of low relief with the typical dry desert climate and sparse vegetation of western Arizona. The railhead is on the Santa Fe, at Hillside, Arizona, another twenty-three miles by secondary oiled highway from Bagdad. Altitude is 3,900 feet and annual rainfall averages 14 inches. Temperatures vary from 20° F. to 110° F., with the sub freezing temperatures noted intermittently and only at night during the winter months.

The Old Dick Division mines from two producing shafts, the Old Dick and the Copper Queen, located a half mile apart on similar geologic structures in the schists of the region. The crushing plant, mill and main shops are near the Old Dick shaft, and each shaft is equipped with its own surface installations, including head frame, hoist, compressor house and dry room.

Ores are massive sulfide replacements in pre-Cambrian schists and meta-volcanics of the Yavapai series. Valuable minerals are chalcopyrite and sphalerite, with barely perceptible amounts of silver. Gangue minerals are massive pyrite and accessory pyrrhotite with some arsenopyrite and magnetite noted, along with quartz and altered or silicified schists. Oxidation is not significant. Sulfides make up approximately 60% of the ore as mined and received at the mill; after the pre-concentration step, sulfides comprise 85% to 90% of the flotation feed. Ores from both mines react similarly toward flotation and are mixed in the coarse bin ahead of the crushing plant.

In 1961, due to the squeeze between rising production costs and fixed metal prices, the Old Dick determined to lower unit costs by increasing tonnage. At the mines, this was a relatively straightforward matter of increasing working faces and careful scheduling; sufficient compressed air and hoisting capacity already existed for the expansion.

* The mill, however, presented a different picture, since it was then grinding at its full capacity of 240 tons per day and was scheduled 364 days a year; moreover, while the flotation section was adequate for that tonnage, it had no excess capacity. With a plant availability of 98.0% possible already attained, no substantial gain could be foreseen by any improvements here. In total, any further expansion at the mill indicated a complete second plant in parallel, with its consequent high capital costs.

At this stage, the possibilities of per-concentration to raise mill tonnage were considered, by rejecting a low value waste product and leaving the mill its daily rated 240 tons of enriched material. This appeared attractive in spite of the undeniable fact that values lost in the waste reject would subtract from overall metal recoveries. The process was suggested by the massive, not disseminated character of the ore; waste would necessarily be barren wall rock.

Batch testing with heavy liquids (acetylene tetrabromide) at Old Dick indicated that 20% by weight of the 5/8" X 0 ball mill feed could be rejected at 2.90 specific gravity, losing 5% of the copper and 3% of the zinc in the process;

(OVER)

this included saving all minus 10 mesh material and subjecting only 5/8" X plus 10 mesh to the separation. Cost analysis indicated an economically acceptable process with these figures; daily tonnage would be raised to 300, 240 tons would be ground and floated as before and unit costs would drop. Increases of 19% in cooper and of 21% in zinc metal throughout were indicated after allowing for the extra losses in reject.

The batch testing was confirmed by heavy media pilot plant tests in the Western Machinery Company's San Francisco laboratory. Pilot plant products were subjected to flotation testing in the Old Dick laboratory and no effect on flotation from the heavy media process was noted. On the strength of the tests and cost analyses, a size 1 Wemco Mobil Mill package unit with a drum separator was adapted to fit the Old Dick mill and installed.

Main considerations in the choice of the heavy media pre-concentration over a regular mill expansion were:

1. The process was economically and metallurgically feasible.
2. It had a much lower capital cost.
3. A very short erection time was required.
4. Operating cost would be low in comparison.
5. The process was flexible and could be varied to suit changes in conditions by use of operating controls.
6. The package type plant lent itself to installation in the mill as a unit, eliminating the need for extra attendance. The main disadvantage, the dollar loss of metal in rejects, was nearly offset by the gain in not grinding and not floating this tonnage.

One item that the test work showed to be very important was that in order to effect recovery, all material too fine for efficient gravity separation had to be saved for the mill; none could be discarded.

The location of the heavy media plant, ahead of the ball mill with 5/8" X 0 feed, was dictated by local Old Dick conditions. While another position, say between the primary and secondary crushers with 3" X 0 feed, might possibly be more efficient from a separation standpoint, the difficulties inherent in either storing a 24-hour run of wet screened and filtered material or increasing the crusher labor from one shift to three shift operation were immediately apparent.

Design considerations which have resulted in very satisfactory operation since installation at Old Dick were, mainly:

1. Retention of fines and water recovery:

The feed is wet screened at 10 mesh; fines flow from a hopper to a spiral classifier which separates and drops sands onto the ball mill feed belt carrying sink product, while slimes are pumped to a thickener. Thickened slimes are pumped by a controllable diaphragm pump to the grinding circuit classifier pool and so avoid upsetting the grinding water balances. Overflow water is re-used in the heavy media plant, overcoming the disadvantages of high water requirements in this arid region.

2. Isolation of the plant for emergency or maintenance:

The ball mill was formerly fed from the side by a belt over the scoop box. This same belt was extended to feed the sink float plant, and a plow was installed at the old mill feed drop. Cutting feed off the sink float plant is done by the operator's dropping the plow onto this belt and cutting feed tonnage back to the 240 ton per day rate. In this way, 98.1% availability was held by the flotation section in 1963 without regard to heavy media maintenance.

3. Arrangements for compactness and ease of operating attendance:

The plant was arranged in a rectangle, as shown in the at-

tached sketch, with the ball mill operator stepping through a door at a platform behind his mill onto a platform in the center of the heavy media plant. His by-pass plow is inside the door, his heavy media electrical control panel is just outside it, and the density measuring station is just three steps away. To visualize this more completely, the belt passing over the ball mill drops feed onto the preparation screen, lined up at 90° to the right of the belt. The screen conveys oversize at 90° to the original flow and drops it into the separating drum hopper, again set 90° to the right. The separating drum discharges onto the wash screen in line with it; wash screen sink discharges onto a belt, again 90° to the right, which conveys the sink in to the center of the ball mill feed drum, some six feet below the original feed belt. The operator, then, as he steps onto the platform, has the preparation screen on one side, the drum and wash screen ahead of him and the mill feed sink belt on his other side. The sink belt and sand classifier are just below this platform, giving a walkway over them to the magnetic separator and densifier areas.

4. Design for least interference with production during plant construction.

In the final design, the factor of interference with existing operation was practically eliminated. Foundations and steel structures were arranged to fit into non-vital areas of the existing plant, with the result that the only time lost was during the connection of the main water headers and the adaptation of the ball mill scoop box for the sink belt discharge hopper, both a matter of only a few hours. Changeover to the new plant was done in another two and one half hours when the extra length was added to the feed belt and the drive motor moved to the new head pulley.

5. Stable operation:

Due to the small tonnage, segregation in bins and lack of underground storage, changes in the Old Dick mill feed can be abrupt, from fine to coarse, from high to low head values, and from high pyrite to high quartz. To stabilize the sink float section as much as possible, an overflow was placed on the circulating media sump to the wash sump and a slight excess of water added to the circulating system. Normally, the circulating sump overflows slightly, keeping a constant volume of media in circulation through the separator. If fine wet ore hits the system, the excess water from the ore reports in this overflow and is eliminated through the wash system and densifier; the medium it carries with it is reclaimed and is small in comparison to total medium circulating so that a very slow drop if any is noted in the circulating gravity. On the other hand, if coarse dry ore comes in, the constant circulating volume takes up part or all of the overflow water to hold constant density. The plant actually runs for hours at a time without a density change and will handle excess water from light showers without changing medium density.

*

Metallurgical calculations became much more involved with the plant in operation. The addition of reject to the copper and zinc concentrates and flotation tail makes a fourth product; two of these four are very close in assay -- the reject and flotation tail. The solution regarded at Old Dick as the most practical is to regard the two plants, heavy media and flotation, as separate entities for calculations. Calculated heavy media concentrate then becomes flotation head to apply to the bi-metallic formula. Since both sets of calculations include units, overall recoveries become the simple matter of dividing concentrate units by original feed units.

In practice, total plant feed, regardless of whether or not the heavy media plant is by-passed, is weighed and sampled. Rejects are also weighed and
(OVER)

sampled. Subtraction gives the flotation feed without combining any weights and assays of sink, sand, and slime products.

As an operating check, the grinding classifier overflow is assayed every shift. Theoretically, this equals heavy media concentrate only when there is no by-passed feed direct to the mill. Actually, the monthly average of the classifier overflow is very close to the calculated flotation feed figure each month, although daily variations are noted especially when the sink float plant is down.

Results from the plant have consistently exceeded design figures since the start. The following compares results of the first seven months of 1961 before pre-concentration with the year's average during 1963:

	Flotation Only		With Pre-concentration	
	7 months	1961	Design	Year 1963
Ave. Tons Feed Per Day	243		300	308
% Cu	3.39		3.95	4.17
% Zn	10.5		10.0	10.3
Ave. Tons Rejected Per Day	---		60	72
% Cu	---		1.00	0.71
% Zn	---		1.50	0.72
Ave. Tons Ground Per Day	243		240	236
% Cu	3.39		4.69	5.24
% Zn	10.5		12.1	13.3
% Increase in Metal, Cu	---		18.9	25.6
, Zn	---		21.0	29.1
Heavy Media Recovery, Cu	---		95.0	95.9
Flotation Recovery, Cu	90.0		90.0	89.7
Overall Recovery, Cu	90.0		85.5	86.2
Separating Density	---		2.90	2.83
% Feed Rejected	---		20.0	24.4

Other aspects of the installation, studied by experience since starting, include flotation recovery. Predicted increases in head gave reason to believe that flotation recovery could be improved. Actual practice has followed the batch test work and recovery has remained constant.

Another factor was reagent consumption, not determined exactly in the batch testing. In practice, cyanide and collector consumption have increased with increasing metal throughput. Collector amount apparently follows the amount of metal present. Cyanide, since Old Dick zinc is 40% pre-activated as received at the mill, increases with increasing zinc also.

A third factor was possible metallurgical improvement from the washing action of the pre-concentration. While reason suggests that the thickener underflow will pass on slime, soluble salts, or other deleterious material after buildup in the washing circuit, the possibility of bleeding part of this away was checked. Fine slime carries too much copper to discard and plant tests invoking bleeding off water showed no improvement.

Predicted maintenance costs, based upon studies of gravel plants, have never been attained. Frankly, maintenance is high at this plant. The preparation section, designed to avoid metal loss in fines, sends very effectively de-slimes material to the plant. With only 2% or less minus 10 mesh, this feed is extremely abrasive. Drum lifters lasted 6 months, screen frames a year, woven wire decks 4 days. In the first 5 months of operation, practically all wear areas were replaced with the best present day abrasion resistant materials available.

Maintenance due mainly to abrasion on the plant has been much heavier than expected; deslimed pyrite appears to be particularly abrasive. Regular, planned preventive maintenance and inspection shut-downs have been necessary since the plant started; presently the plant is down each two weeks for two to eight hours for this. The use of rubber linings on the drum, chutes and screen frames, heavy stainless steel bar type screen decks, rubber hoses and fittings in place of pipe, Ni hard fitted pumps and the regular inspections have increased availability of the plant from 83.2% for its first 5 months in 1961 to 92.0% in 1962 and 94.7% in 1963.

A short description of the mill flow sheet follows:

Ore is received into the 300 ton coarse ore bin from both mines, by a 30 inch conveyor belt from the Old Dick headframe and by truck from the Copper Queen shaft.

All ore is crushed to 100 per cent minus $5/8$ inch using a conventional closed crushing circuit, with a Denver 18 x 24 inch jaw crusher set 3 inches feeding a Denver 3 x 6 foot vibrating screen. Undersize goes to the mill bins by an 18 inch x 550 foot belt while oversize is finish crushed in a 3 foot Symons standard and returned to the head of the screen. Crushing rate is approximately 60 tons per hour.

An 18 inch x 20 foot shuttle belt transfers crushed ore to either of two 200 ton cylindrical fine ore bins. Ore is fed from each bin by a 16 inch x 13 foot variable speed conveyor to the main feed belt. The shuttle belt is reversed each 10 minutes during crushing and both bin feeders are used at all times in order to mix ore as much as possible.

An 18 inch x 60 foot belt conveys feed from the bins over a Fairbanks conveyor scale and past the ball mill to the preparation screen of the pre-concentration plant. The 3 x 16 foot Allis-Chalmers prep screen with $3/16$ " Bixby-Zimmer stainless steel grizzly rod decking separates minus 10 mesh fine and washes coarse sizes thoroughly. The plus 10 mesh material is separated into sink and float portions in a 6 x 5 foot Wemco drum separator and drained and washed on a 3 x 12 foot Allis-Chalmers screen divided longitudinally. Float reject is conveyed to a stockpile in an adjacent canyon and sink is conveyed to the ball mill of the concentrator. Specific gravity of separation is 2.83 and the heavy medium used is a water suspension of ground ferrosilicon with some magnetite. Consumption of medium appears to be leveling out at 0.8 pounds per ton of heavy media feed.

The fines separated by the prep screen run by gravity to an 18 inch Wemco spiral classifier; sands fall from this to the sink belt and go on to the ball mill. Classifier overflow with the slime fraction is pumped by a 3 inch Wemco pump to an 8 x 20 foot Wemco thickener. Thickened slimes are pumped by a 2 inch Denver adjustable stroke diaphragm pump to the Dorr classifier pool in the grinding section, while water is returned to the heavy media plant for re-use.

* Undiluted medium drained from the sink and float material is circulated through the drum separator by a 2 inch Wemco sand pump while diluted medium from the washing section is caught in a separate sump and pumped with a 2 inch Wemco to a Stearns permanent magnetic separator for reclamation. Cleaned medium is dewatered in an 18 inch Wemco spiral densifier, dropped through a Dings de magnetizing coil and returned to the circulating sump.

The pre-concentration plant as a whole is a size 1 Wemco Mobil-Mill bought as a package unit, with just sufficient engineering modifications as were required for the special Old Dick duty. These included addition of the spiral classifier and thickener for handling fines and the return water system.

Total feed to the flotation plant grinding section is composed of sink, minus 10 mesh sand, and slimes; this amounts to 240 tons per day. At this stage, as mentioned earlier, the material treated is 80 to 85% sulfides, $5/8$ x 0 in size and has been upgraded to between 4 and 5% copper and 12 to 15% zinc.

The ore is ground to 76% minus 200 mesh in a No. 67 Marcy ball mill in closed circuit with a 5 x 25 foot Dorr duplex rake classifier. Zinc depressors and
(OVER)

and lime are added here. Mill charge is 45% by volume or 13 tons of 3 inch balls; consumption is 1.7 pounds per ton ground. Mill speed is 77% of critical.

Flotation follows more or less conventional lines with zinc depressed by zinc sulfate and cyanide during copper flotation and activated with copper sulfate for the zinc flotation. Copper collector is Cyanamid reagent 404 with auxiliary Z-11, staged, while 404 is used alone for the zinc. Little to no frother is used, with 8 drops per minute of MIBC maximum and none at all is used for days at a time.

Finished copper concentrate is scalped off the first 3 cells of the No. 18 Special Denver copper rougher cells. Rougher concentrate is taken from the remaining 7 cells and is cleaned in two stages in a 4 cell bank of No. 18 Special Denver cells. Cleaned concentrate joins the first finished concentrate and is pumped to the copper thickener. All cleaner tails are combined and reground in a 3 X 4 foot Denver overflow mill, using 1 1/2 inch balls, in closed circuit with a Krebs 4 inch cyclone. Reground cleaner tails are added to No. 6 cell of the rougher bank.

Zinc rougher concentrate is floated in a 10 cell bank of No. 21 Denver cells and cleaned in two stages without further treatment in four No. 18 Special Denver cells. Cleaned concentrate is pumped to the zinc thickener.

Copper rougher tail is thickened to 50% solids between copper and zinc flotation. The water recovered is re-used in the copper section and the thickened pulp is diluted to 34% solids with zinc return water before zinc flotation.

Two inch SRL pumps are used throughout the copper circuit and 1 inch Wilfleys in the zinc section.

As considerable laboratory testing has indicated that indiscriminate use of return water ruins separation, the mill is equipped with separate water systems for the copper and zinc sections. Copper water from the copper rougher tail and copper concentrate thickeners is returned to grinding and the copper section. Zinc return water from the final tail and zinc concentrate thickeners is used in the zinc section. Make-up fresh water is added automatically at the two mill tanks by use of float valves.

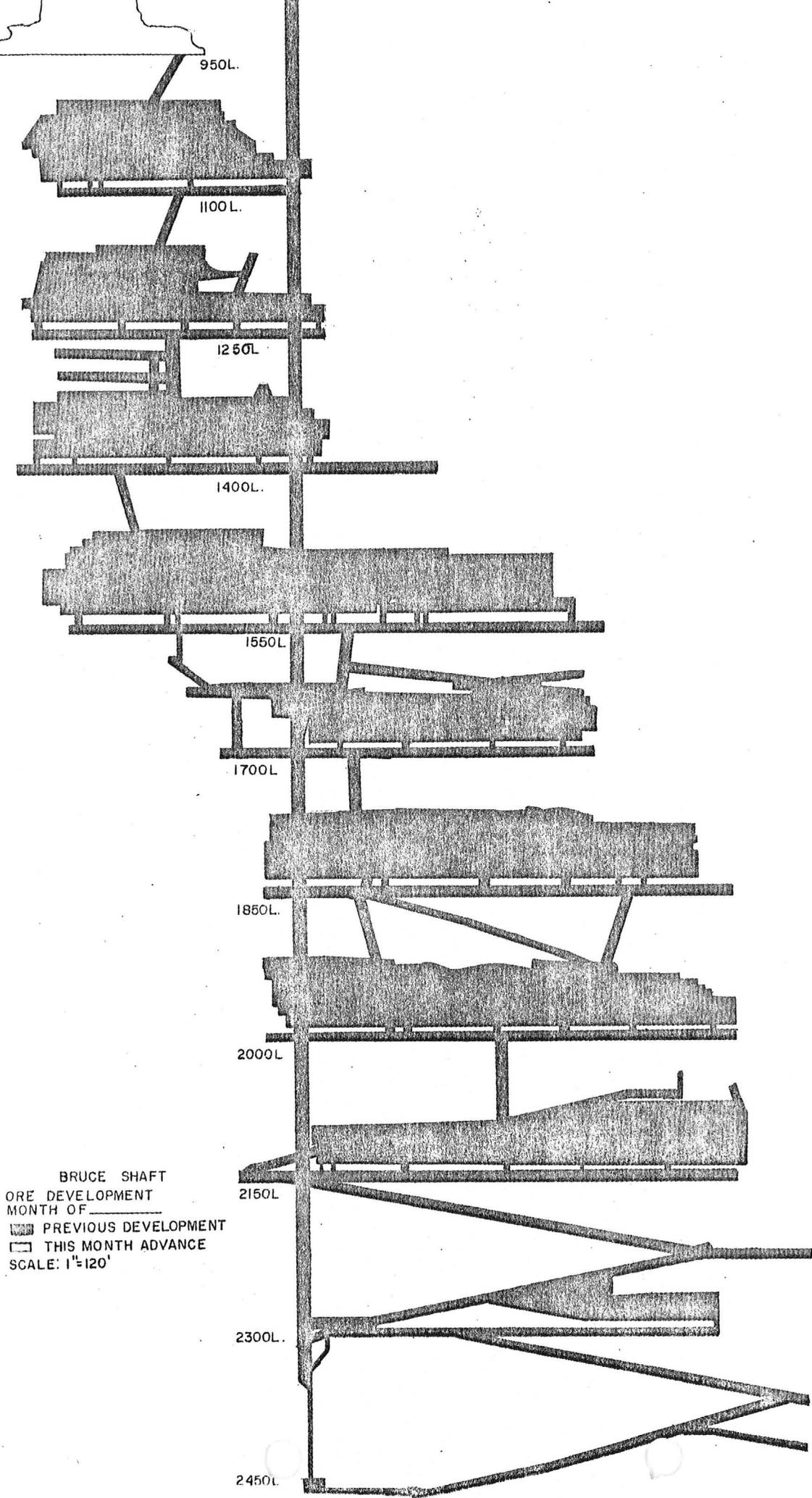
Since water is both scarce and valuable at Old Dick, seepage below the tailing dam is collected and returned to the mill fresh water system. This water has apparently purified itself while seeping through the earth and is acceptable to either circuit. After this system was put in, total fresh water requirements for the operation have been as low as 15 gallons per minute at times, as compared with 350 gallons per minute circulating in the heavy media section or the 150 gallons or more per minute in each flotation section.

Concentrates are filtered on 6 foot Denver filters, two discs on the copper filter and three on the zinc. After falling into their respective bins, concentrates are loaded with a front end loader onto contractor's trucks for shipment 28 miles to the railhead at Hillside, Arizona. Copper goes to the ASARCO stack at Hayden, Arizona and zinc is shipped to Bartlesville, Oklahoma.

The concentrator operates 24 hours a day, 364 days a year. The flotation section operates 98% of this time, with most lost time due to relining the ball mills. The heavy media section loses one scheduled shift each two weeks for maintenance; availability for 1963 was on the order of 94%.

All samples are machine cut and assayed by shifts. An exception to this is the classifier overflow which is hand samples and used as a check on flotation heads. Total mill head is weighed on the conveyor scale and float reject from pre-concentration is weighed from a measured belt section.

Labor requirements are 10 men per day, with two mill operators on each of the three shifts, two crushermen, and reagent and tailing dam men on day shift. Supervision is given by the superintendent.



BRUCE SHAFT
 ORE DEVELOPMENT
 MONTH OF _____
 ▨ PREVIOUS DEVELOPMENT
 ▭ THIS MONTH ADVANCE
 SCALE: 1"=120'

MINING METHODS
AT
CYPRUS MINES CORPORATION
BRUCE MINE DIVISION
BAGDAD, ARIZONA

September 1973

By
R. T. Johnson
J. E. Nelson

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INTRODUCTION

The Bruce Mine Division of Cyprus Mines Corporation operates an underground mine closely adjacent to the Old Dick Mine, which is now inactive. Between 250 and 300 tons of copper-zinc ore are mined daily by cut and fill methods. Mining and milling operations are done on a three-shift basis, seven days a week. Production hoisting is from the Bruce Shaft three shifts per day with Sunday graveyard shift reserved for shaft repairs.

The Bruce Mine is located in Yavapai County 70 miles by road west of Prescott and 3 miles southwest of Bagdad. The railhead, Hillside, on the Santa Fe Railway, is 28 miles east of Bagdad. Elevation of the Bruce shaft collar is 3,848 feet.

HISTORY

Cyprus Mines Corporation purchased the Old Dick Mine in mid-1955, erected a crushing plant, concentrator and other facilities and started production in May, 1957. Production was continuous until late 1966, except for the year 1958 when the property was closed due to low metal prices.

During 1954 an extensive underground diamond drill program was conducted. At that time the Bruce ore body was discovered 250' down strike from the Old Dick.

In late 1966 the Old Dick ore body was exhausted. The following two years were spent sinking a new shaft and driving cross-cuts, drifts, and raises to develop the Bruce ore body.

Production resumed in late 1968 and has been continuous to date with grades in the range of plus 3% copper and 12% zinc.

quartz, calcite and unreplaced remnants of sericite schist occur, but essentially pyrite is the gangue in which the ore minerals occur.

EXPLORATION

Extensive diamond drill programs have been conducted, both on the surface and underground. NX drilling is done on the surface and BX or AX drilling underground. An outside drilling company is used for almost all diamond drilling. The only exception is for short holes, less than 300 feet, where our own CP-55 diamond drill is used.

Since our drill holes deviate considerably in these formations, Tro-Parl surveys are taken every 100 feet for both dip and bearing. On the surface, where the drill holes are NX, these surveys can be taken quite quickly in the following manner:

- (1) The instrument (Figure 1) is put in a brass AX case and attached to 10' or 15' of brass AX rods.
- (2) A BX knob is put on the end of the rods and attached to the driller's wire line.
- (3) The rods, in the hole to be surveyed, are left about 20' off bottom.
- (4) The instrument and brass rods are then lowered and go through the bit until the BX knob stops them.

This leaves the instrument far enough away from the steel rods to get a magnetic bearing. The entire survey, even in deep drill holes, can be completed in less than one hour. The Tro-Parl surveys have been checked by gyro surveys and found to be quite accurate.

A large amount of percussion hole drilling is done in the walls of the drifts and stopes for exploration and to outline known blocks of ore. These are generally horizontal holes that can be drilled with a jackleg using 7/8" hex extension steel.

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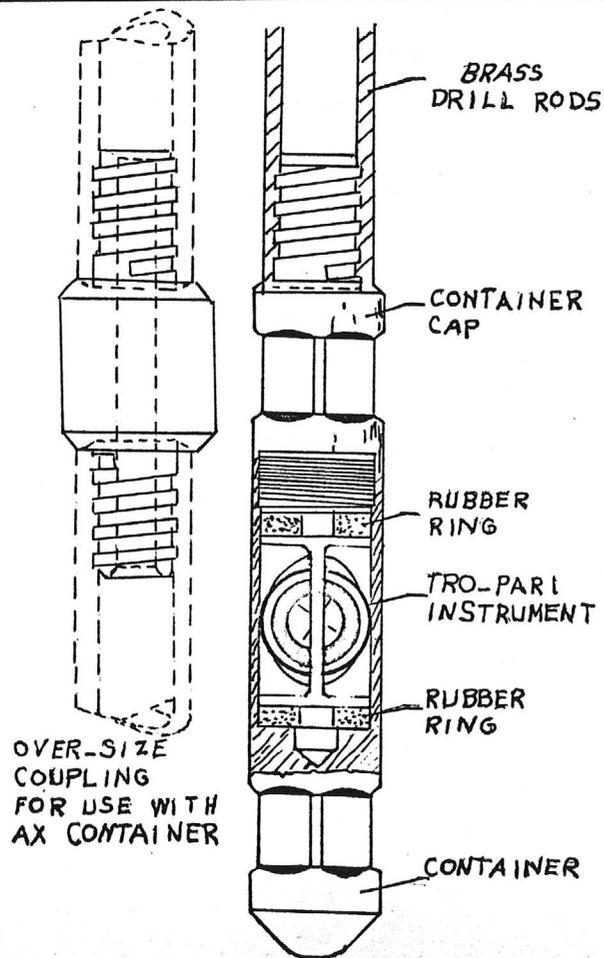
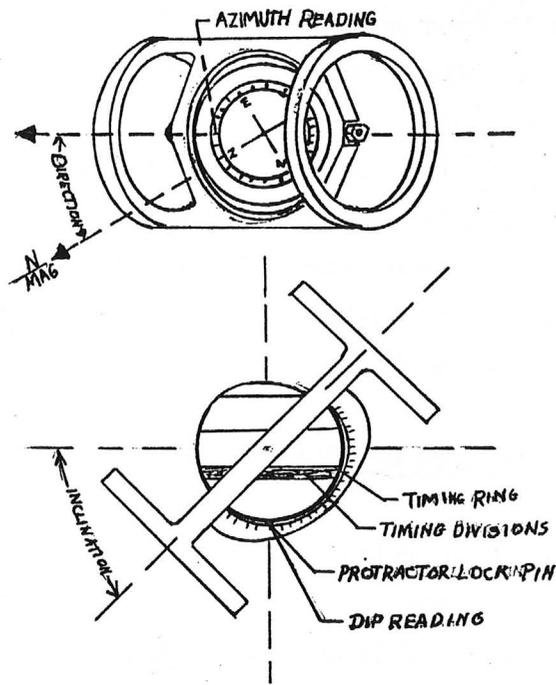
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FIGURE -- I



For longer test holes, up to 70', a heavy longhole drifter is set up using 1" x 36" extension steel. Sludge samples are taken every 5'.

On the surface, in addition to Geochem sampling and geologic mapping, both surface and downhole induced polarization surveys have been made. We are presently drilling an anomaly in an effort to determine the value of these methods when exploring for massive sulphides.

SAMPLING METHODS AND ORE CONTROL

Main drifts are channel sampled every five feet. Records are kept of the grade of ore removed from each cut in the individual stopes. These cuts are surveyed every two weeks. This, along with diamond drill holes and percussion holes, is used for estimating ore reserves. To be conservative, 10 cubic feet per ton of ore in place is the factor used.

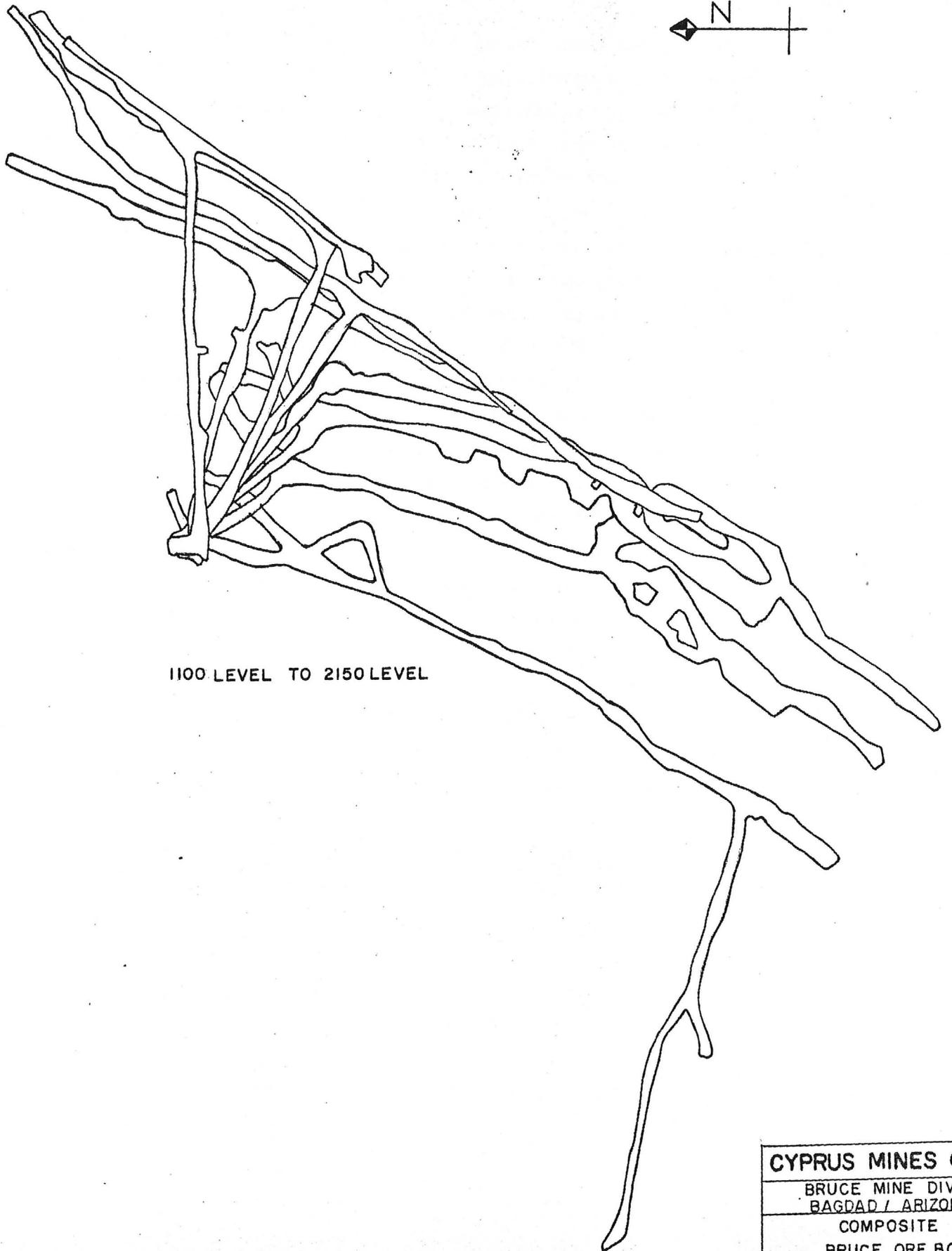
Each skip hoisted is sampled by the skiptender. A daily comparison is made between mine samples and the automatic head sampler at the mill. Tonnages are checked by the mill's weightometer. This, along with some selective mining, enables us to somewhat control the mill feed.

DEVELOPMENT

Main Shaft

Entrance to the mine is through the Bruce Shaft. This is a three-compartment, vertical hanging wall shaft used for both ore and waste haulage. Nine levels, from the 950 to the 2150 spaced 150 feet apart, are serviced by the Bruce Shaft. The 950 level also connects up with the Old Dick Shaft.

Work was started on the main shaft in late 1966. Initially, the shaft was raised from the 950 level 180 feet. Too many problems were encountered, so this method was abandoned.



1100 LEVEL TO 2150 LEVEL

CYPRUS MINES CORP.	
BRUCE MINE DIV. BAGDAD / ARIZONA	
COMPOSITE BRUCE ORE BODY	
SCALE: 1"=100'	
BY: R.A.M.	

Sinking was then started from both the 950 level and the surface. Conventional methods were used below the 950 level during the first phase. (Jackhammers and a Cryderman shaft mucker.) From the surface, a small drill jumbo, using two Gardner-Denver 63 jackhammers mounted on retractable legs, was used. Muck was handled with another Cryderman mucker. The drill jumbo proved to be an excellent piece of equipment, reducing drill-out time approximately 50%. When the two portions of the shaft were connected, there was a horizontal difference of less than 3 inches.

The Bruce Shaft is comprised of three compartments. Two 4' x 4 1/2' compartments are used with two combination skip-cages for both men and ore. The skips have a capacity of 48 cubic feet and are used in a fashion as to counterbalance each other. Skips are loaded from the various shaft pockets by steel measuring cartridges with air operated guillotine-type gates. The shaft hoist is a 250 HP Coeur d'Alene double-drum and has a speed of 1000 feet per minute.

The skips dump through scrolls into two 50-ton capacity bins. From here the ore is loaded and hauled by truck to the crushing plant.

The third compartment, the manway, is 2 1/2' x 4 1/2'. The usual air, water, sand, and pump lines, along with power cables and a ladderway, are carried in this compartment.

Drifts and Cross-Cuts

Main haulage drifts and cross-cuts are driven 6' x 8', using jacklegs, Gardner-Denver 58s and 63s. Mucking is done with Eimco 12B loaders. 24" gage, 35 lb. rail is used throughout the mine. A 2 inch air line, a 1 inch water line, and a 110 volt blasting line is installed at the time the drifts and cross-cuts are driven.

For ventilation, a portable fan is set up by the shaft and 12" diameter Nyprene tubing is carried as the drift advances.

Raising

Initially 4' x 5' "raw" raises are driven from one level to the next. Only pins, stulls, and ladders are put in at this time. 5 foot or 7 foot rounds are drilled with Gardner-Denver RB-53 stopers. A round consists of about 25 holes and is loaded and blasted with 1 1/8" x 8" 40% Amogel stick powder and electric delay detonators.

After the raise has been "holed through" to the next level it is reamed out to 5' x 10', from the top down, with Jackhammers. A manway with offset ladders, timber slide, and a sandfill line is then installed. The completed raise, besides providing service to the stope, serves as a second exit and becomes part of the ventilation system.

STOPING

Preparation

After the drift is run the entire length of the ore body and the ventilation raise is driven up to the next level, stope preparation can begin. Approximately 15 feet from the ventilation raise, a parallel raise is driven 24 feet high. A 9 foot high sub level is then connected between them. This establishes a 16 foot drift pillar and a temporary ore pass. A two-drum slusher is set up and the sub level is driven the entire length of the ore body. As the massive sulphides are quite competent and require no support, the sub level is driven the full width, from foot wall to hanging wall, at the same time. While driving the sub level, a raise is connected to the main drift every 90 feet to reduce the slushing interval. These are later enlarged for one, two, or three compartment crib chutes, framed out of 8" x 8" Douglas fir timber. The inside dimensions of the ore pass compartments are 4' x 4'.

At both ends of the ore body, crib manways 3 1/2' x 3 1/2' inside and timbered out of 3" x 12" Douglas fir are carried up with the stope. These provide access to either end of the stope and are part of the ventilation and second exit system.

After the sub level is silled out, another 9 foot horizontal cut is removed, leaving an opening 18 feet high for the entire length and width of the ore body.

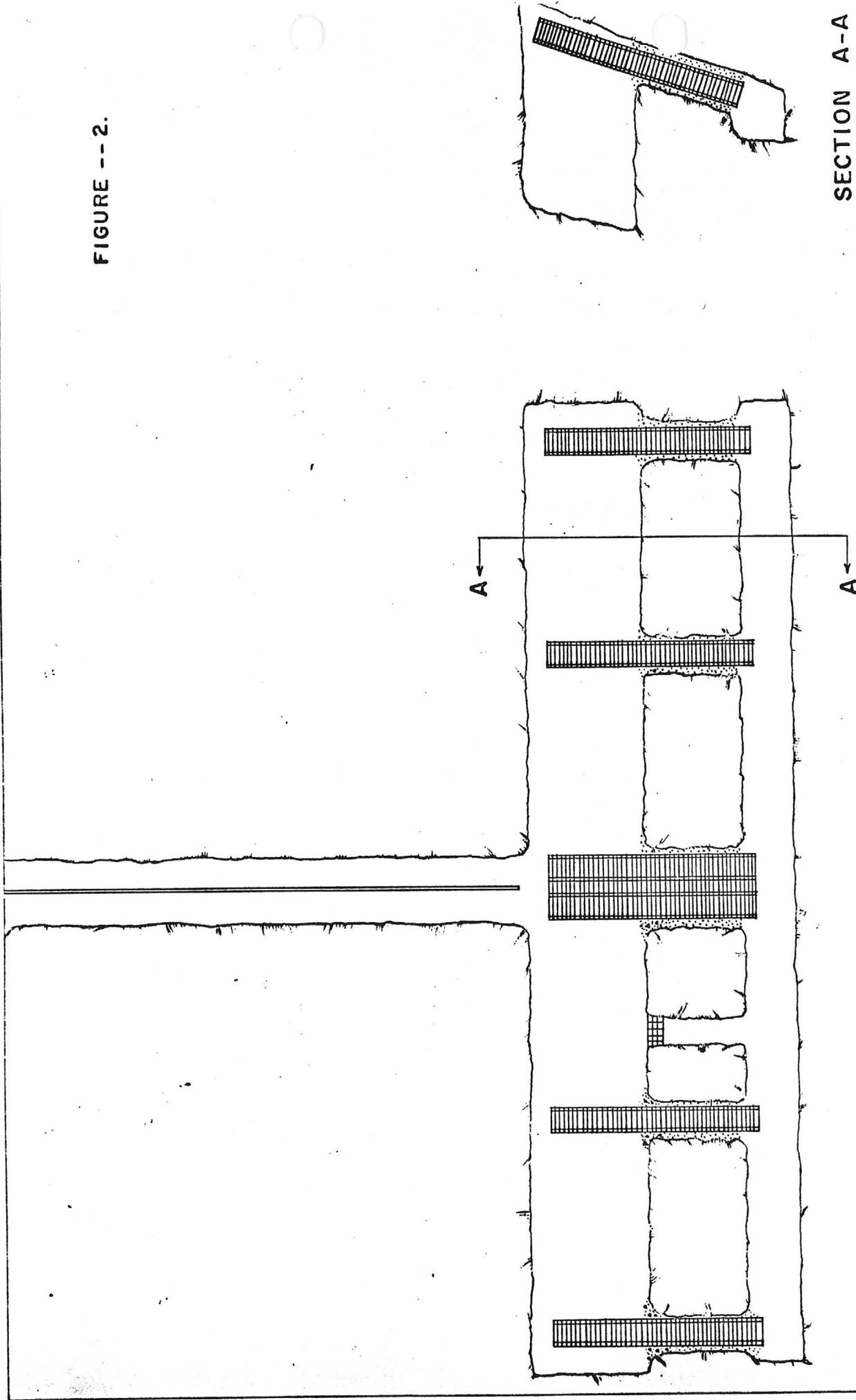
The timbered chutes and manways are then installed. Extreme care must be taken to obtain a tight cement seal around these chutes at the start. Once sealed, the crib is then raised to within 3 or 4 feet from the back of the stope. Two layers of 10 ounce burlap are wrapped around and stapled to the crib. At this point the stope is ready for the initial sandfill pour. (See Figure 2)

Mining

All stoping is of the breasting down method, using Gardner-Denver 58 and 63 model jacklegs. 6 foot rounds are drilled, using integral chisel bit 7/8" hex tungsten carbide drill steel. Drill holes are loaded with AN/FO prills, using one stick of 1" x 8" 60% Amogel powder per hole. Electric detonating caps are used throughout the mine. Better fragmentation is obtained in the stopes by using millisecond delays. Boulders are handled by drilling short plugs and blasting with stick powder or simply "mudcapping" them if not too large.

The usual cycle is to start in the center of the stope and establish a 7 to 12 foot brow. This height is determined according to the firmness of the foot and hanging walls in order to minimize dilution. The cut is then mined to one end of the stope, all muck cleaned out, and equipment moved back to the center. While mining starts toward the other end, a gob fence is built, cribbing is raised and burlapped, and

FIGURE -- 2.



SECTION A-A

TYPICAL STOPE READY FOR SANDFILL

sandfill is started. In this manner the stopes, mainly the larger ones, can be maintained in almost continuous production.

A two-man crew is used in each stope. They will handle all phases including drilling and blasting, slushing, pulling chutes and tramming ore to the shaft pockets. On the upper levels, where the ore is narrow, mining is on a one-shift-per-day basis. In the larger stopes mining is carried on three shifts per day, seven days a week.

Ore Transportation

Two-drum slushers are employed in all stopes at the present time. Where the vein is narrow 10 HP double drum air and electric Joy model FF-211 slushers, pulling a 36"-wide rake, are used. In the wide stopes 25 HP Joy models A2F-211 and B2F-211 electric double-drum slushers, pulling a 48" wide Pacific rake, are used to scrape the muck into the chutes.

During the cross-cutting, drifting, and stope preparation phase, the muck is removed with Elmco 12B loaders, dumping into 40 cubic foot card-rocker-type dump cars. Cars are trammed to the shaft pocket by a 1 1/2 ton battery-operated Mancha motor. After the cribbed chutes are installed, the Elmco 12B loaders are eliminated, except for occasional cleanup work.

An Atlas Copco C.A.V.O. 310E load-haul machine was tested in one of our large stopes for four months to determine if tons-per-manshift could be increased over that obtained using the electric 25 HP slushers. Although the unit performed well, it did not meet our requirements because:

- (1) Tons-per-manshift were not increased;
- (2) With our method of drilling, breasting down, a slusher still had to be used. After a round is blasted, approximately 1/3 of the muck must be scraped off to make room so the next face can be

drilled. Alternative drilling methods were considered; however, they were not deemed desirable.

- (3) Since our sandfill contains no cement, the operators had a tendency, usually unavoidable, to dig too far into the sand, thereby diluting the ore.

In the very near future we will start using three-drum slushers, Ingersoll-Rand 34HP air operated, in the larger stopes. These units are more versatile, since the sheave block does not have to be manually changed for each setup. Tons-per-manshift should be substantially increased.

HYDRAULIC SANDFILL METHODS

General

As previously mentioned the massive sulphides require no support. However, due to gouge faults along and behind both the foot and the hanging walls, cut and fill mining is the only economical way to effectively control dilution.

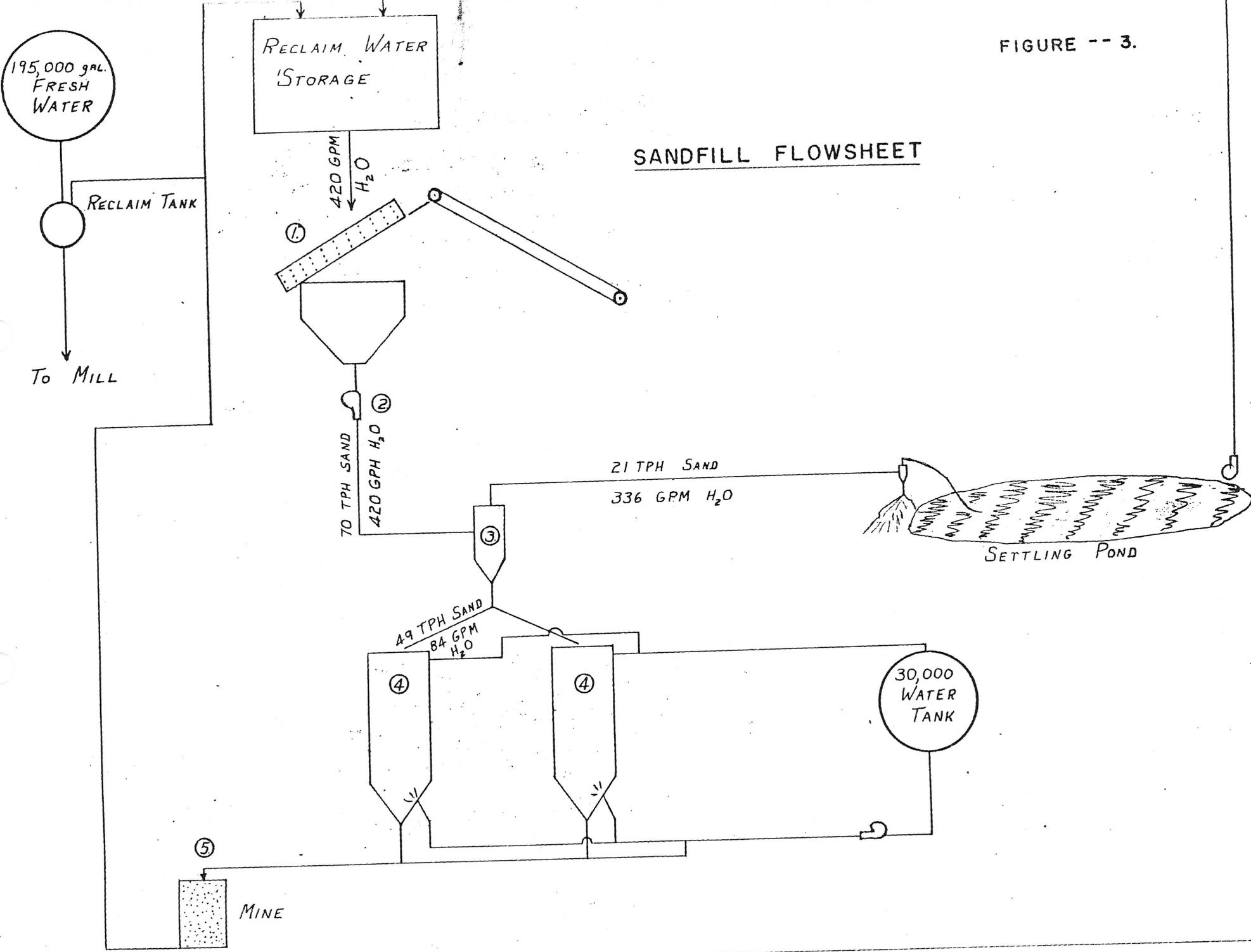
Surface Plant (Figure 3)

Located adjacent to the Bruce Shaft are two 150 ton capacity sand storage tanks and a 30,000 gallon water tank. The sand tanks can be filled by two methods:

- (1) Mill tailings are piped to a 4" cyclone by the sand tanks for de-sliming. Out of 200 tons in 24 hours approximately 100 tons of sand are obtained with the balance going to the tailings pond.
- (2) Our sandplant is located below the berm of the old tailings pond. The tailings are picked up with a payloader and conveyed to the repulper. 420 gallons per minute are required to handle 70 tons of sand per hour. This is then pumped, using a 6 inch, 40 HP Morris

FIGURE -- 3.

SANDFILL FLOWSHEET



Pump, to a 15 inch cyclone above the sand tanks. From this 49 tons per hour of sand and 84 gallons of water per minute goes into the tanks and the remainder flows by gravity to a settling pond.

All overflow water is re-cycled back into the circuit. With both methods we try to obtain sand that is 80% +200 mesh. The rest of the sandfill operation, including placement in the stope, is by gravity flow.

Underground

When a stope is ready to be filled one man on the surface will inject water and air into the base of one sand tank to break the cone and start the flow. A mixture of approximately 70% solids is sent underground through a 2 1/2 inch rubber-lined schedule 40 pipeline.

At the shaft station, on the level above the stope to be filled, the sand line is disconnected and a 5 foot flexible rubber section is installed between the shaft and the drift sand lines.

Rubber-lined pipe is also used throughout the level and down the service raise to the stope. In the stope, 2" inch plastic lines are used to direct the flow to the desired area.

As previously mentioned, all openings around the timbered chutes and manways must be well sealed and the timber burlapped. From past experience we have found that an opening as small as one-half inch can drain tons of sand in a very short period of time.

Water generally percolates through the sand and drains sufficiently so where mining can be resumed within a few days.

In the original plans, cement was going to be added to the tailings to form a hard floor in the stopes. However, due to the oxidation of the old tailings, the desired hardross

could not be obtained. American Cement Corporation did extensive test work on both old (oxidized) and fresh (non-oxidized) tailings. The test work showed that with a 1 to 15 ratio of cement and non-oxidized tailings, a long period of time would still be required for hardening. After much study, it was decided to forego the addition of cement because:

- (1) A large enough supply of fresh tailings was not available, and
- (2) the economics of losing a small amount of ore in the sand, or dilution from it, seemed to outweigh the expense involved with the large amounts of cement that would be required.

VENTILATION

Fresh air is downcast from the collar of the Bruce Shaft to the 2150 level. Air doors on each level keep the airflow in the right direction. On the 950 level, which connects to the Old Dick workings and shaft, a Joy 60 HP Axivane fan is mounted just beyond the raise going down to the next level. With the fan at the #6 blade setting, it pulls 42,500 CFM from the inner workings of the mine and exhausts through the Old Dick mine and shaft.

DEWATERING

The Bruce Mine makes about 30 gallons per minute of water, a large portion of which is due to sandfill operations.

On each level a 2" to 3" hole has been drilled from the bottom of the drainage ditch to the manway compartment of the shaft, breaking through about 20' below the level. These are all connected to a common drain line that empties into a settling sump on the 2150 level. The water is then pumped to a sump on the 950 level. From the 950 level it is pumped outside and enters the reclaim circuit.

POWER AND COMPRESSED AIR

Power is purchased from Arizona Public Service and is delivered over a 69 KV transmission line and is transformed at the mine site. A 4160 volt line is taken down the shaft to the 950 level where it is transformed to 440 volts for distribution throughout the mine.

Compressed air is provided by a 200 HP Ingersoll-Rand XLE electric compressor rated at 1200 CFM and 100 p.s.i. and a 200 HP Worthington electric compressor producing 1200 CFM at 100 p.s.i. Two Ingersoll-Rand Imperial #10 electric compressors, each rated at 600 CFM and 100 p.s.i., are maintained for backup.

CONTRACTS AND BONUSES

All development and stope mining is on an incentive basis. Contract prices vary according to the size and type of opening, ground conditions, etc. Each working place is measured every two weeks by the Engineering Department. Bonuses are calculated by the Mine Superintendent and Accounting Department. Daily wages are always guaranteed.

SAFETY

Safety is always the most important factor in all of our operations. Monthly safety inspections are made throughout the entire property. Periodic meetings are held between the Department Heads and the sub-supervisors. The sub-supervisors also hold informal safety meetings with the other employees. Safety suggestions are encouraged and various contests with cash awards are held during the year in an effort to instill a safety-conscious attitude in all employees.

RUBBER TIRED MINING

Development & Exploration:

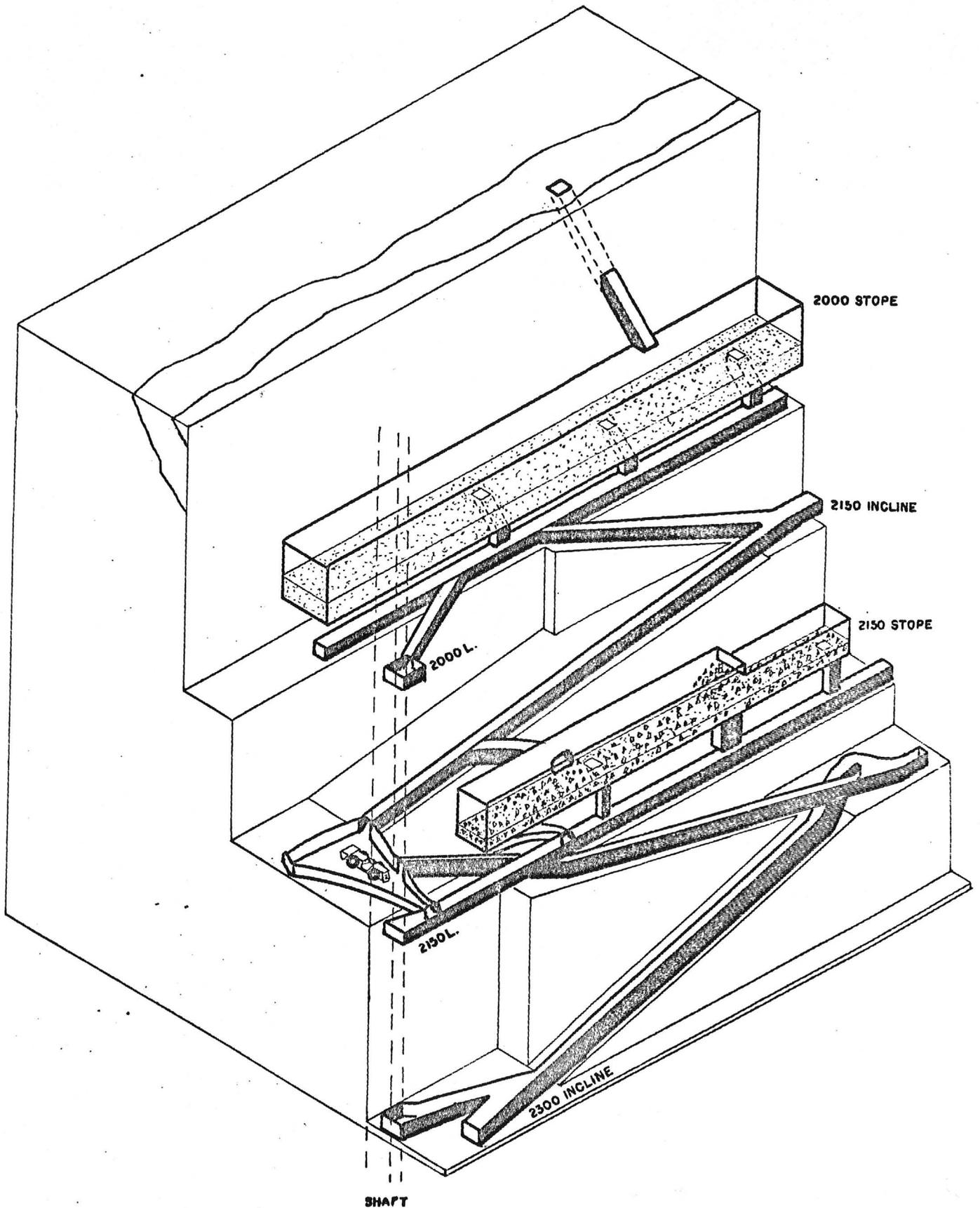
During the past year and a half, the Bruce Mine has been testing, developing and evaluating a system of load-haul-dump mining. (See figure 4)

During the first phase of this test a contractor, (Centennial Development Company) was engaged to drive an incline from the 2150 level to the 2300 level. Centennial was to provide an adequate loader and jumbo to drive this 7' X 8' incline. An Elmco 912B, two cubic yard, 100 BHP loader and a long tom type jumbo were chosen for the job. This type of jumbo uses two Gardner Denver-83 muffled machines. The jumbo was designed for an 8' round as the boom extension is 9'. (See figure 5) This jumbo was designed to be moved by the 912B loader.

The Elmco 912B loader has a two cubic yard capacity, a low profile (72"), and can operate in a 7' wide heading. (See figure 6) Elmco rates the gradability of the 912B at 1 mph loader on a 40% grade. Our experience has shown us that the loader will not muck efficiently on a plus 21% grade. The loader does not have enough traction, tires don't last long and the operators can't get a full bucket. Hauling a load of muck downhill also creates braking problems, as the brake discs tend to heat up and destroy the seals in the brakes.

This loader works extremely well in driving inclines down grade. Our experience has shown us that they muck and tram on inclines up to a 25% grade, after this point the machines are very slow with a full load. Tram time increases very rapidly after a 20% grade. (Tramming uphill) The uphill tram seems to create fewer breakdowns.

The first incline was driven in ore following the footwall contact. It served three purposes, first it provided an excellent look at the mineralization, which diamond drilling does not always provide; second it allowed development work



2000 STOPE

2150 INCLINE

2150 STOPE

2000 L.

2150 L.

2300 INCLINE

SHAFT

BRUCE MINE
 2000 TO 2300 INCLINE
 NOT TO SCALE

FIGURE - - 4

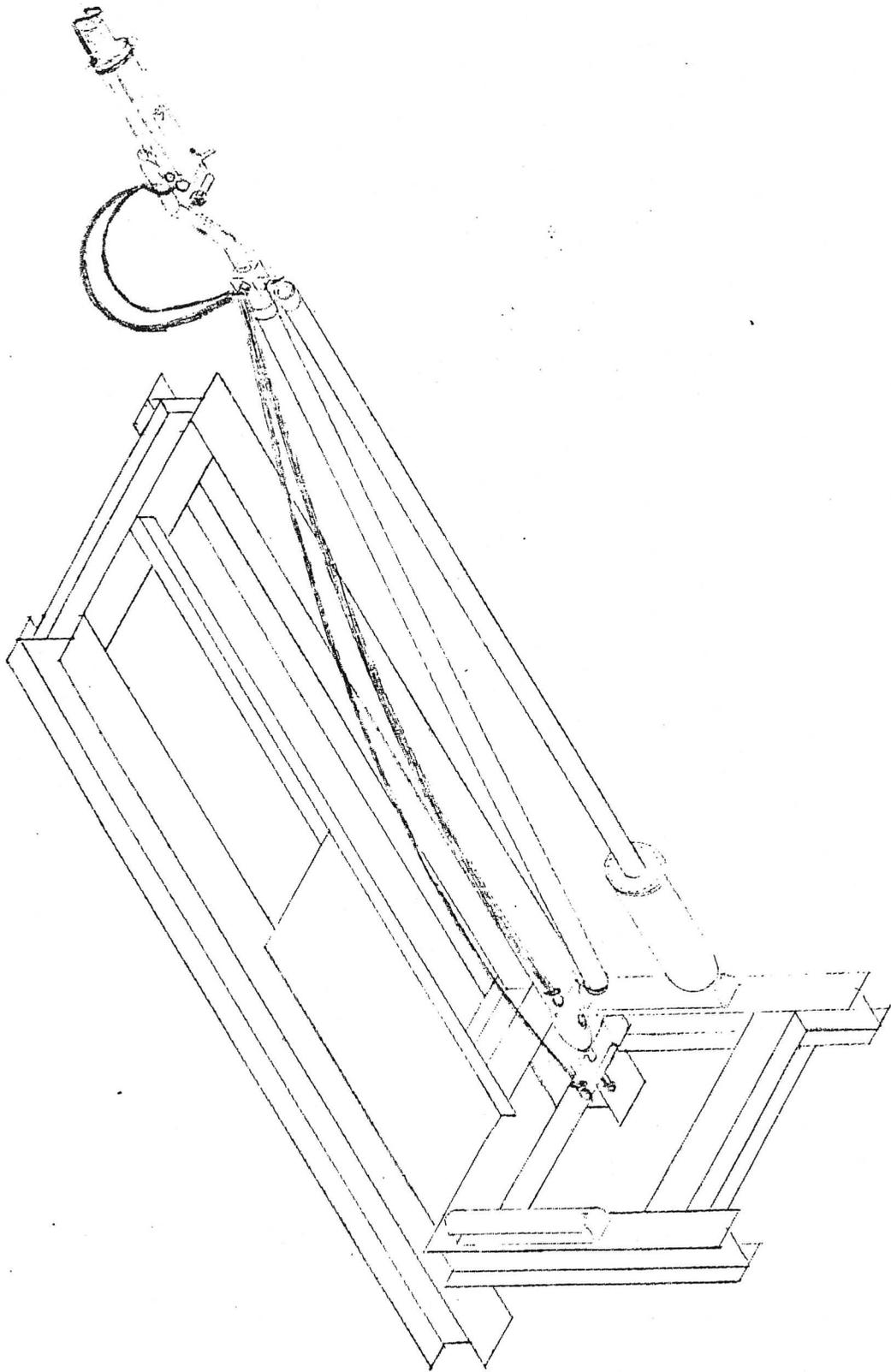


FIGURE-- 5

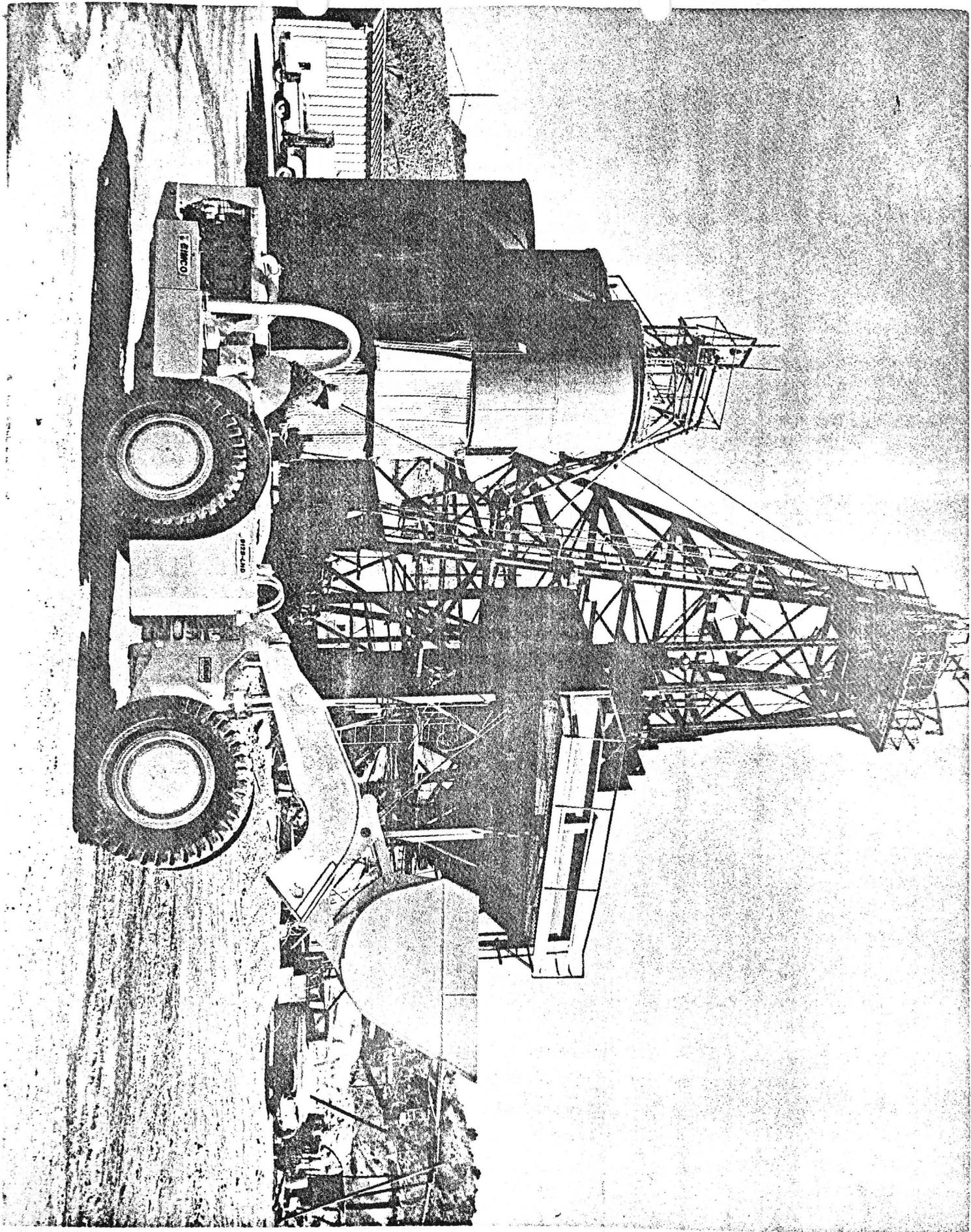


FIGURE - - 6

without creating a waste hoisting problems; third it gave us an excellent outline of where the footwall contact was.

The strike length at the 2150 level of the ore was estimated at 500 feet, and the normal level intervals in the Bruce Mine is 150 feet. With these figures in mind, an incline was driven on a -15% grade from the shaft end (north end) of the ore-body to the south end. At the south end, a switchback was cut and the incline driven back to the north. When the correct level interval was reached a cross-cut was driven to a point directly under the shaft. From this point, a small (4' X 4') raise was driven to connect with the shaft. The raise was then slabbed from the top down and the shaft sets hung. While this shaft work was being done, a 100 foot incline was driven to a point directly under the shaft 20 feet below the 2300 station. A raise was then holed through and this provided skip loading room and a sump that could be mucked out with the LHD machines.

With this proven ore, and the completion of the shaft and ramps, we were ready to start thinking of developing a stope. In developing a stope, the first thing that was done was to take a cut the full width of the ore. This first cut defined the footwall and hanging wall contacts, as well as their competence and the competence of the ore.

A level (7' X 8') was then driven under the stope leaving a 12' pillar. Several drill holes were then drilled from the level to the bottom of the 2300 stope. These holes will provide drainage when the stope is in the sandfill cycle. A raise was connected from the back of the stope to this level. This raise will provide a second way out, ventilation, and additional drainage.

With this done, a section of ramp in the footwall must be driven. Done in this sequence, the waste created by this section of ramp can be used as fill in the first cut. The ramp has to be completed now as you will mine out the existing ramp.

This method of development has proven itself very advantageous to our mine as it eliminated much of the waste that has to be hoisted. It also cuts down on the time that the shaft

would be tied up by conventional shaft sinking methods.

In exploration, this method of sinking inclines in ore is great, the ore mined pays for the incline. It eliminates the need for a long cross-cut and a diamond drilling station (all in waste). The cost of diamond drilling itself is very expensive, also they wander and sometimes will miss the target or can give you a false indication as to the thickness or grade of the ore, but in these large inclines you know what you have.

PRODUCTION:

The use of rubber tired mining equipment in the production stopes requires a footwall ramp. The inclines in ore will be mined out, so this ramp in the footwall will provide access to and from the stopes. This incline is very expensive, but necessary to convert existing stopes to LHD mining.

The final cost of ore mined by the LHD machine has not been determined. In the 2150 stope, the only stope that has completed a full cut, the tons/man shift have increased from 8.36 tons/man shift to 14.14 tons/man shift. Even though the first long section of footwall incline was charged against the stope, and labor charges have risen \$0.63 per hour, the costs show a savings of \$0.55/ton. Besides the increase in tons per man/shift, a savings is being realized by being able to drop timbered chutes and manways. In the past, three manways and four or five chutes had to be maintained per stope, but with the LHD system, only two manways are required, one at each end of the stope.

The LHD machine eliminates the need for a slusher, which requires pin holes (extra drilling), shive blocks and a great deal of cable. This in turn eliminates pulling chutes on the level; i.e. motor, car, track, and chutes.

Using the loader in the stopes allows the use of a drilling jumbo. Drilling with a jumbo allows longer and faster rounds. Larger machines can be handled with ease and there is less machine maintenance due to the machine never being thrown "in the muck". The stuck steel problem is ended with power retraction.

The ramp system also allows easy access to the stopes. In the past, everything had to be lowered on ropes or cables to the stopes. Then once it was in the stope, it had to be carried on employees backs. Each man had to climb ladders to gain access to the stope, which is no easy chore.

The Bruce Mine has three loaders and three drill jumbos. Costs will again drop when the footwall inclines are connected. As things stand now, when a loader or jumbo breaks down, the heading is down. When the ramps are connected this will allow replacement of the broken piece of equipment.

OLD DICK MINE

YAVAPAI

Saw Mr. Sierakoski at the Bruce Mine who said things were about normal after their 3 day strike. GW WR 4/5/72

Mr. Sierakoski was unavailable at the Bruce Mine of Cyprus Mining Corporation. GW WR 5/3/72

Visited with Mr. Sierakoski at the Bruce Mine of Cyprus Mines Corp. He too made some changes in the active mine list. He said they had drilled "a few" holes on the Zannaras claims but said he had no definite information about them as the work was conducted from the Tucson office. The electric power was off at both the Bagdad Copper Corp., and the Bruce Mine. They had a heavy rain and thunderstorm last night. GW WR 6/7/72

Mr. Sierakoski was away from the Bruce mine of Cyprus Mining Corp. GW WR 9/6/72

Visited with Mr. Sierakowski at Cyprus Corporation's Old Dick mine who said they had no major operating problems and were drilling two small geophysical anomalies nearby. GW WR 11/1/72

Mr. Sierakowski of Cyprus' Bruce mine wasn't in. GW WR 12/6/72

Active Mine List - Oct. 1972 0 Empl. 120 (1971 figures 4,900,000 lb Cu, 13,900,000 lb Zinc)

Mr. Sierakowski at the Bruce mine of Cyprus Corp., said they were stockpiling the zinc cons as National Zinc had closed their Bartlesville, Okla. smelter. Cyprus has been trying for the past 6 months to find an outlet for their zinc to no avail. They think perhaps they can sell to the Japanese firm that buys their Anvil mine zinc production but this would entail the additional expense of renting stockpile space at San Pedro plus the sea freight to Japan. It was suggested that there will soon be a surplus of H_2SO_4 , that they could start their own electrolytic plant. Cyprus is still interested in the Zannarapolus property. GW WR 1/3/72

Mr. Sierakowski wasn't available at the Bruce mine of Cyprus Corp. GW WR 2/7/73

Went on to the Bruce mine of Cyprus Mining Company where Mr. Sierokowski said he had about 5000 tons of Zn cons on hand. An ad from the American Metal Market by Philip Bros. stating they would buy Zn cons was given him. He said they had some overtures from Philips Bros. and would probably sell some to them. He also stated that Cyprus still has one drill rig prospecting "to the south". GW - WR 4-6-73

* Mr. Sierakowski wasn't in at the Bruce mine. GW - WR 5-4-73

Saw Mr. Sierakoski at the Bruce Mine of Cyprus Mining Company who said they had sold 500 T of Zn cons. to Bartlesville and had contracted with Philip Bros., New York for 9000 T more. GW WR 6-11-73

BRUCE MINE

YAVAPAI

Went to the Bruce mine of Cyprus Mining Company where it was learned Mr. Sierakowski was home with the flu. GW WR 11/7/73

Stopped at the Bruce Mine of Cyprus Mines Company where Mr. Sierakowski said they were going full blast and had about 3000 tons of Zn cons in the stockpile and that Phillips Bros. were having some difficulty finding smelting facilities in Europe. However, the Bruce is shipping about 500 tons per month to Oklahoma which is about 1/3 of the total produced. He said they weren't drilling on the Zannaras Bros. claims but were holding the option; these claims are south of the mine. GW WR 12/5/73

The Bruce mine division of Cyprus Corp. did considerable examination and some core drilling on 22 claims of the Zannaras brothers. This property adjoins the Bruce mine claims on the south and west. GW AR 73-74

Mr. Rundle, Cyprus Corp., called for information on the Yellow Jacket mine 6 miles west of Wikieup saying the Bruce mine had been contacted regarding milling the high Zn ore. GW WR 12/19/74

OLD DICK MINE

YAVAPAI COUNTY

Visited Bruce mine - interview with Wally Nelson who will retire July 1, 1970. They are doing some mill tests that may change their flowsheet somewhat. FTJ WR 6-19-70

The Bruce mine operated at their regular rate for the year. FTJ Annual Report 6-30-70

Interviewed Joe Sierakoski and Mr. Rundle at the Bruce mine. No vital information received. FTJ WR 10-23-70

Active Mine List - Oct. 1970 - 116 men.

The Bruce Mine near Bagdad produced at their regular rate. FTJ QR 1-13-71

The Bruce Mine was operating at its regular rate. FTJ QR 4-5-71

Called Joe Sierakoski at Bruce Mine - no contact. FTJ WR 6-21-71

Mr. Sierakoski at the Bruce Mine of Cyprus Mines Corp. stated he was glad the Cu strike was finished; they ship their Cu concentrates to A.S. & R. GW WR 9-3-71

Saw Mr. Sierakoski and Stoffers at the Bruce Mine of Cyprus Mines Corporation. Their troubles are rather minor. GW WR 11/5/71

Went to the Bruce Mine, but Mr. Sierakowski was in conference; the fluorspar and annual report were left for him. GW WR 12/1/71

The Bruce mine of the Cyprus Mining Corp., continued to operate thru-out the period. GW QR 9/71

Mr. Sierakoski, not available at the Bruce Mine. GW WR 1/5/72

Mr. Sierakowski was not available at the Bruce Mine. GW WR 2/2/72

*
Went on to the Bruce Mine of Cyprus Mining Company, but Mr. Sierakoski wasn't around. GW WR 3/3/72

Mr. Sierakoski was not available at the Bruce Mine, 6 miles south of Bagdad, was operated throughout the period by Cyprus Mining Corporation. GW QR 2/72

Active Mine List Nov. 1967 - 31 men

Visited Old Dick mine - visit with Wally Nelson and Joe Sierakoski. They have not been sinking the shaft during the past month. Work has been concentrated on the 1700' level, crosscutting, drifting, etc. Sinking is to be resumed this month. A new division of Cyprus is Old Dick Mining and Timber Co., representing a consolidation of Cyprus timber and plywood operations with the Old Dick mine. FTJ WR 1-5-68

Visited with Joe Sierakoski and Wally Nelson at the Old Dick mine. Shaft is at a depth of 1890' with expectations of being finished by end of July. FTJ WR 3-8-68

Active Mine List April 1968 - 41 men

Visit Wally Nelson and Mostyn G. Grant, Gen. Supt. of mine and mill at Old Dick. Shaft sinking, etc. is on schedule. FTJ WR 5-10-68

Visited the Old Dick. Interviewed Joe Sierakoski. Sinking of shaft held in abeyance while development continues on the 2000 foot level. The shaft will be complete in another 150' depth. Mill scheduled to be operating around Sept. 1. FTJ WR 7-12-68

Visited Joe Sierakoski and Wally Nelson at Old Dick. The mill is operating below capacity on stockpiled ore and development ore as a pocket is underway in shaft. Mill started October 15. FTJ WR 10-18-68

Cyprus Mines Corp. has completed sinking of the Bruce shaft to a depth of more than 2000 ft. on the Old Dick zinc-copper mine at Bagdad, Arizona. This new shaft is designed to be deepened to open new levels to expand future ore reserves as mining continues. A concentrator situated on the mine property is now scheduled to produce about 500,000 lbs. of copper and 1,500,000 lbs. of zinc in concentrate per month. Skillings Mining Review Nov. 23, 1968

Road to Old Dick impassable, decided to phone - Wally Nelson said plant nearly to capacity - milling 8,217 tons during January. FTJ WR 2-21-69

Active Mine List April 1969 - 95 men - Joe Sierakoski, Res. Mgr., P.O. Box 457, Bagdad

Interviewed Joe Sierakoski and Wally Nelson at Old Dick. They are now mining and milling up to capacity - 9000 ton per month. FTJ WR 6-20-69

Interviewed Joe Sierakoski and Wally Nelson at the Old Dick mine. FTJ WR 10-24-69

Visited with Joe Sierakoski at the Old Dick mine. Operations normal. FTJ WR 2-20-70

Active Mine List May 1970 - 130 men - J.O. Sierakoski, Res. Mgr.

*

OLD DICK MINE

YAVAPAI COUNTY

Cyprus Mines is continuing to operate mill 1 shift. They are experiencing some difficulty in reaming their pilot hole to 15" and may reduce 12½". The hole is for ventilation in their shaft planning. FTJ WR 3-4-66

Cyprus mine and mill have been operating at a curtailed rate while they sink their new shaft. FTJ QR 7-8-66

Interviewed Wally Nelson and Joe Sierakoski at the Cyprus operation. They were installing a hoist and headframe, preparing to sink the shaft from the surface. Raising for the shaft has been abandoned. The mill has been shut down. FTJ WR 9-9-66

Visited the Old Dick Mine - visit with Wally Nelson and Joe Sierakoski. They have not been sinking the shaft during the past month. Work has been concentrated on the 1700' level, cross-cutting, drifting, etc. Sinking to be resumed this month. A new division of Cyprus is Old Dick Mining and Timber Co., representing a consolidation of Cyprus timber and plywood operations with the Old Dick Mine. FTJ WR 1-5-68

OLD DICK MINE

YAVAPAI COUNTY

Production thru 1962 \$13,395,275 zinc-copper - J.W. Still's figures (corres. file)

FPK note from Ore Bin Oct. 1964 - Production 1962 - 7,800 tons zinc

Visited Old Dick - Copper Queen Mine & Mill. Interviewed Allan Hunt, Mgr. and Joe Sierakoski, Supt. The mill is taking about 7600 tpm, 5100 from the Old Dick and 2500 from the Copper Queen. 115 employees. The present ore bodies are expected to run thru June or July. The work after that will be mostly exploratory. EGW WR 2-19-65

Visited Cyprus Mining Corp. General Mgr., W.J. Rundle. Mill operating 1 shift/day flotation only. Mining from both Old Dick and Queen about 70 to 80 tpd combined. Will continue to mine as long as ore holds out. Present production from the 150' level. Exploration carried on on the 250' level. Cyprus has started a new \$800,000 project. This consists of a new 2200' shaft. This will be located about 1000'+ SW of the Old Dick shaft. At present a diamond drill is putting down a 9" pilot hole to the 950' level. If on line the hole will be reamed to 15" and will be used both as pilot and ventilation. Raising has already started from the 950' and sinking to the 2200' level, from that level, will start when the raise holes through. When raise is finished, pulling pillars from the Old Dick and Queen is planned. The Queen is the higher grade of the two but the ground is quite incompetent and difficult to handle.

Sinking is to be by the company and not contracted out, and expected to be completed in 18 months or 2 years. FTJ WR 1-7-66

Visited Wally Nelson at Old Dick - raising for the new shaft had just begun. FTJ WR 5-6-66

Talked to Joe Sierakoski and Wally Nelson at Old Dick. Headframe and hoist set and shaft down 110'. FTJ WR 11-4-66

Visited Old Dick mine operation of Cyprus Mines Corp. Talked with Joe Sierakoski and Wally Nelson. Both were busy with year end reports, etc. Shaft sinking proceeding satisfactorily. FTJ WR 1-7-67

Visited with Joe Sierakoski and Wally Nelson at Old Dick. Sinking continues at good rate. Shaft is down 600' from surface and raise from the 950' level to connect with shaft is up 250' or 100' from connection. FTJ WR 3-10-67

Interview with Joe Sierakoski who said shaft sinking was proceeding satisfactorily. They were down about 1450 feet. FTJ WR 6-23-67

* Visited Joe Sierakoski and Wally Nelson at the Old Dick. Shaft has been sunk to the 1600. Raise being driven from 1100 to the 950 and crosscutting continues on the 1250 level. FTJ WR 9-8-67

Interview with Joe Sierakoski at the Old Dick. The shaft is 50' below 1700' station, with 450' to go. FTJ WR 11-10-67

The 500-foot vertical shaft at the Copper Queen mine of Cyprus Mines Corp., Bagdad, Arizona, has been completed and stations cut at the 300 and 450-foot levels. The contract crew of Centennial Development Company is now preparing to crosscut to the veins on both levels. The distance is estimated at 100 feet from the shaft at the 300-foot level, and 140 feet on the 450 level. At the corporation's Old Dick mine, production continues at a normal rate, with the zinc-copper ore being mined mainly from the 650 and 800-foot levels. Shaft sinking is in progress at about 860 feet and will be continued to open a new level at 950 feet. Curtis Sundeen is resident manager, directing work at both properties. MINING WORLD Feb. 1961 p. 39

Visited the Old Dick mine and discussed with Curtis Sundeen the production, development, etc. at this property and the nearby Copper Queen Mine (both Cyprus Mining Co. projects). At the Old Dick the shaft has been deepened and a station is being cut out at 950' preparatory to opening a new level at this depth. Ore for the mill is coming principally from the 400' and 650' levels and some from new stopes on the 800' level. At the Copper Queen sinking was stopped at 500'. Levels are opened north from the shaft at 300' and 450'. Exploratory diamond drilling is in progress on the 450' level. 80 men are employed - 6 of whom are working at the Copper Queen. TPL WR 2-20-61

July 26, 1961 - Visited the Old Dick mine of Cyprus Mines Inc. A.A. Friedman is supt. All other staff personnel the same as at the time of the last visit. Daily tonnage milled is normal, 240 tpd and grade of ore about the same. The Company is installing a Wemco Heavy Media plant and expects thereby to discard some 60 tpd as waste. 85 men are employed including a drill crew at the nearby Copper Queen mine, where drilling is in progress on the 450' level. Mill ore is coming principally from the 800' level, of the Old Dick. Drift development and diamond drilling is in progress in ore on the 950' level. TPL WR 7-29-61

Active Mine List Oct. 1963 - 70 men

On June 30, 1963 E. Drexel Spaulding, resident manager of the Pima Mining Co. died suddenly. He had managed the Pima venture since its early development in 1951 and became resident manager in 1955 when plans for an open-pit operation were finalized.

A.A. Friedman will become resident manager for Pima on August 1, 1963. He was assistant resident manager under Spaulding from 1958 until his appointment as resident manager of the Old Dick Mine of Cyprus Mines Corporation at Bagdad, Arizona, in 1961. Prior to his coming to Pima in 1958 he had been resident manager of the Kilembe Mine in Uganda.

Alan W. Hunt will succeed Friedman as resident manager of the Old Dick Mine. He has been mill superintendent there since 1959. Previously he was with the Pima Mining Company and Wah Chang Corporation in charge of various milling operations.

Fermin Palicio will succeed Hunt as mill superintendent at the Old Dick mine. He has been a mill shift boss for the Pima Mining Company since 1958.

*
News Release 7-25-63 Gen. Moore

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JH

RECEIVED
OCT 13 1978
DEPT. MINERAL RESOURCES
PHOENIX, ARIZONA

MEMORANDUM

To: John H. Jett, Director
From: Mike Greedy, Field Engineer
Subject: Cyprus Old Dick and Bruce mines, Yavapai Co., Az.
Date: October 12, 1978

A conversation ^{on Aug 25, 1978,} with Mr. Joe Sierakowski, who was the Mine Manager at the Cyprus Bruce mine, provided the following information:

Production and Average Grades at the Old Dick & Bruce Mines

<u>Mine</u>	<u>Year</u>	<u>Ore Mined</u> (short tons)	<u>Ave. Grade</u>		<u>Recoverable Production</u>	
			<u>Cu(%)</u>	<u>Zn(%)</u>	<u>Cu(lbs)</u>	<u>Zn(lbs)</u>
Old Dick (includes Copper Queen deposit)	1958				3,928,000	20,548,000
"	1959	shut down				
"	1960				5,511,000	13,193,000
"	1961	shut down (?)				
"	1962	"				
"	1963				8,098,000	16,222,000
"	1964				6,516,000	15,983,000
"	1965	83,016	2.89	8.5	4,124,000	19,256,000
"	1966	9,326	3.15	10.2	564,357	1,223,000
Old Dick only	1966	6,233	2.65	6.4		
Copper Queen only	1966	3,093	4.15	17.8		
	1967	sinking new Bruce shaft				
Bruce	1968	19,590	2.66	11.3	893,000	3,293,000
"	1969	103,838	3.45	12.5	6,121,000	18,153,000



Cyprus Bruce Mine file

R

BD

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
100 CALIFORNIA STREET
SAN FRANCISCO, CALIFORNIA 94111

RECEIVED
JAN 24 1977
DEPT. MINERAL RESOURCES
PHOENIX, ARIZONA

NOTICE OF PROPOSED ACTION

by the

U.S. Environmental Protection Agency
Region IX
100 California Street
San Francisco, CA 94111

415/556-3450

on Revocation of a National Pollutant
Discharge Elimination System Permit to
Discharge Pollutants to Waters of the
United States.

January 20, 1977
Public Notice
PN #A-77-9-W(R)

On January 31, 1975, the Regional Administrator,
Region IX, Environmental Protection Agency, issued a National
Pollutant Discharge Elimination System (NPDES) permit to the
following discharger:

Cyprus Bruce Copper & Zinc Company NPDES #AZ0020877
P.O. Box 457
Bagdad, AZ 86321

The Regional Administrator proposes to revoke this permit.
This proposed action is based upon a determination that there is
no discharge to waters of the United States.

Comments, objections, or requests for public hearing
received within thirty (30) days from the date of this notice
will be considered prior to final Agency action. Information
is on file and may be obtained from the U.S. Environmental
Protection Agency (address and telephone number indicated above).

Mine file

Pink - Reading
Alpha - D
✓ Subject - Cyprus Mines Corp.
Copper Report
Copy - GM

April 26, 1977

Mr. Keith E. Dyas
Resident Manager
Cyprus Bruce Copper and Zinc Company
Cyprus Mines Corporation
P. O. Box 457
Bagdad AZ 86321

Dear Mr. Dyas:

The Department of Mineral Resources is compiling data for its annual report on the copper industry, A PROFILE OF ARIZONA'S PRIMARY COPPER INDUSTRY FOR 1976, VOLUME I.

Last year you kindly gave us your production figures for 1975, including tons of ore mined, percentages of copper and zinc in ore, pounds of copper in copper concentrate, pounds of zinc in zinc concentrate and ounces of silver (see attached copy of your letter). We would appreciate receipt of like figures for 1976.

Similar requests are being sent to all Arizona copper producers and a copy of the completed 1976 tabulations will be returned to you.

Thank you very much.

Sincerely,

Glenn A. Miller
Mineral Resources Specialist

GAM:klg

enclosures

OLD DICK MINE:

Employees of the OLD DICK mine of the CYPRUS MINES CORPORATION, Bagdad, Arizona, have received a wage increase ranging from 7 to 10 cents per hour, retroactive to February 1. The Old Dick Mine is an underground zinc-copper mine with an operating crew of approximately 75. Curtis Sundeen is mine superintendent.

Taken from Mining World - April, 1960, p.48

OLD DICK MINE

YAVAPAI COUNTY
EUREKA DIST.

Visited the Old Dick Mine and Mill of Cyprus Mines, Inc. and discussed the current operations with Curtis Sundeen, Supt. The milling rate is about normal at 240 TPD. Grade of mill feed ranges around 14% zinc and 3.5% copper. The ore supply is coming from the 400' and 650' level and some from the 525' level, also from the development heading on the 800' level. On this level the ore shoot was first encountered at 250' south from the shaft and at the time of visit was continuing in the face at 300' from the shaft.

The company recently (Feb. 1) began developing by shaft a mineralized area disclosed by diamond drilling in the Copper Queen property some 2 miles distant from the Old Dick mine. The shaft is being sunk on contract by the Centennial Development Co. of Eureka, Utah with Branch Office at 810 W. Grant Road., Tucson, Arizona. This company has contracted a number of recent shaft jobs in the state at the Orphan Mine, Banner Mining Company's shaft, the Christmas Mine shaft, etc. Harold Spencer is the principal. The foreman on the Copper Queen job is Charles Stubblefield. At the time of this visit the shaft had reached a depth of 300' and a station was being cut at that point. The objective is 500' depth including a sump of 50' below a 450' station cutout. The work is going forward at 2 shifts per day with a total labor force of 7 men (including Stubblefield). A Cryderman mucker is used. The anticipated completion date of the contracted work is about the first of August this year.

TRAVIS P. LANE, WR - 4-30-60

OLD DICK - YAVAPAI COUNTY - EUREKA DIST.

Weekly Report 10-8-59 - Travis P. Lane, Field Engineer

Visited the Old Dick property of ^{US}Cypress Mines Inc. The key plant personnel comprises:

Supt.	Curtis Sundeen
Mine Supt.	Joe Sierckoski
Mill Supt.	Allen Hunt
Office Mgr.	Walter Nelson
Purchasing Agent	Dick Hill
Geologist	John Brown

The current milling rate is 245 TPD. 7546 tons were milled during September with grade of ore: 14.91% Zn - 2.80% Cu. The mill made a 54.30% Zn concentrate and a 25.58% Cu concentrate. Copper concentrates are being stockpiled at the mill pending settlement of the Hayden Smelter strike. Zn concentrates are sent to the smelter at Bartleville, Oklahoma.

Sinking is in progress at 675' depth. Most of the mill ore is coming from between the 525' and 400' levels and some is coming from the area between the 350' and 150' levels. The newly opened 650' level is developing in ore and the dimensions of the ore body so far opened on this level are 40' x 150', with the faces still in ore on each end.

The operating crew numbers as follows:

Mine	28 men
Mill	10 "
Shop	7 "
Surface	3 "
Staff and clerical	9 "
Total	57 men

OLD DICK MINE:

Taken from MINING WORLD-June, 1959 - Page 74

* Cyprus Mines Corporation is operating its Old Dick mine at Bagdad, Arizona on a three-shift basis, milling 230 tons of ore per day. The lower or 650 foot level is being developed as planned, and sinking to open another level is to start shortly. The copper concentrates are sent to the International Smelting and Refining Company at Miami, Arizona; the zinc concentrates to International Minerals and Metals Corporation at Bartlesville, Oklahoma. Curtis Sundeen is resident manager, and Leonard Yount, mill superintendent.

DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA

FIELD ENGINEERS REPORT

Mine Old Dick

Date August 31, 1960

District Eureka, Yavapai County

Engineer Travis P. Lane

Subject: Mine Visit

Visited the Old Dick Mine on August 26, 1960. The production rate was normal. Ore is coming principally from the 650 and 800 ft. levels. Some stoping is being done on the 300 ft. and 400 ft. levels. Shaft sinking is in progress at about 860 ft. and will be continued to open a new level at 950 ft. with sump below.

Active October 1960

*

DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA

FIELD ENGINEERS REPORT

Mine Old Dick Date March 30, 1959
District Eureka, Yavapai County Engineer Travis P. Lane
Subject: Visit of March 13th

Operator: Cypress^{US} Mines Corp.
1206 Pacific Mutual Bldg.
Los Angeles, Calif.

Resident Mgr.: Curtis Sundeen, Bagdad, Arizona
Mill Supt: Leonard Yount
Mine Foreman: Joe Sierkoski
Geologist - Engineer: R. E. Aston
Office Manager: Walton Nelson
Purchasing Agent: Richard Hill
Assayer: Henry Bollwegg

Following a 12 month mill shutdown (during which time development was continued in the mine) the mine resumed production on Jan. 19 and since Jan 19 has operated at 3 shifts per day milling 230 TPD.

The lower or 650' level is being developed and it is planned to begin soon sinking to open another level.

The copper concentrates averaging about 25% Cu are sent to the International Smelting & Refining Co. at Miami, Arizona; and the zinc concentrates averaging about 54% Zn are sent to International Minerals & Metals, Bartlesville, Oklahoma.

Water is obtained from wells in Burro Creek below Bagdad's pump installation and is pumped to this point for transfer in the Bagdad system to the Bagdad mill storage tanks and thence to the Old Dick plant. The plant requires about 50 gpm of new water. If necessary this could be shaved somewhat by recycling additional tailings pond water to the zinc section of the mill.

The current total labor force is 54 men divided as follows:

Mine	20
Mill and crushing	16
Mechanical & surface	9
Engineering	2
Assaying	3
Office	3
Manager	<u>1</u>
Total	54

DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA

FIELD ENGINEERS REPORT

Mine Old Dick

Date Dec. 22, 1958

District Eureka, Yavapai County

Engineer Travis P. Lane

Subject: Visit

The writer accompanied by Frank P. Knight visited the Old Dick mine of the Cypress Corp. on Dec. 18. Mr. Curtis Sundeen, Resident Manager, was present directing rehabilitation of portions of the mill and installation of a hoist to replace the smaller hoist used in the recent operation.

The company suspended operations at the end of 1957 after running their new mill 7 months. They expect to resume during the first week of 1959. Mr. Sundeen reported that a greater extent of ore and somewhat better grade is developed on the bottom or the 650 ft. level -- which was opened this year during the shut-down. The dimensions of the ore body at this horizon are roughly 250' long by 40' wide, and the grade of ore is about 4% Cu and 15% Zinc. The shaft will be deepened and a new level opened as soon as the mine is again in production.

12 men were working in the mill and several others were occupied with the hoist installation which is being done by contractors. He anticipates that the over all crew will consist of 53 men when operating at capacity. 20 of them will be in the mine.

DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA

FIELD ENGINEERS REPORT

Mine OLD DICK Date June 19, 1958
District Eureka (Bagdad) Engineer Travis Lane
Subject: Mine visit

Owner: & Operator: Cyprus Mines Corp., 1206 Pacific Mutual Building, 523 W. 6th Street,
Los Angeles, California

Resident Manager: Curtis Sundeen, Bagdad, Arizona

The property comprises 6 mining claims in the SW $\frac{1}{4}$ of Sec. 8, T. 14 N., R. 9 W. It is approx. 5 miles southwesterly from Bagdad

Cyprus Mining Corporation acquired the property in mid-1955 and after performing extensive development built a copper-zinc flotation plant and auxiliary facilities. They also built 28 houses for company personnel on the outskirts of Bagdad.

The concentrator started up May 5, 1957 and operated until Dec. 31st, 1957 at a rate of slightly more than 200 tpd. The mill was shut down because of a sharp drop in metal prices. During its operation from 60 to 65 men were employed continuously in the mine & mill & on construction work. Official figures were not available but grade of ore appears to have been in the range 4 to 5% Cu and 20 to 25% Zn.

Since the shutdown of the mill, the company has opened a new level in the mine at 650' and is now diamond drilling from this level. Also, a development face is being carried on the 300' level. It is believed that although not fully delimited the ore body on the 650' level will have about the same lateral extent here as on the 525' level immediately above, and slightly higher copper content.

The ore body is a replacement mass or chimney in schist, with continuity of size and grade proven to the floor of the lowest level the mine appears to hold good promise for the future. The management proposes to suspend completely about the middle of July to wait for better metal markets. 9 men were employed on company account at the time of visit and 2 men were drilling on contract.

*

✓
OLD DICK MINE

YAVAPAI COUNTY
Eureka Dist.

✓
CYPRUS MINING CO.
Bagdad, Arizona

✓
200 t/day copper-zinc flotation mill.

Operating.

(Report- MILLS - NORTHERN DIST.) ✓

(Sept. 30, 1957)
("Geology" file)

B.J.SQUIRE
Field Engineer



Information from MINE INSPECTOR'S OFFICE - August 15, 1957

OLD DICK MINE (6 claims) Eureka Dist., YAVAPAI CO. 6-21-57
Bagdad, Ariz.

Owner - CYPRUS MINING CORP., 1206 Pacific Mutual Bldg., Los Angeles
Oper. - OLD DICK MINING CO. " "
Pres. - Henry Mudd " "
Supt - C. R. Gundeen, Box 746, Bagdad, Ariz.

C - Zn 600 tons mo. 49 men.

L.A.S.

*

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
FIELD ENGINEERS REPORT

Mine Old Dick ✓

Date March 23, 1957

District Eureka

Engineer Mark Gemmill

Subject: Present Operations

The property is about 8 miles from Bagdad in a westerly direction and is owned by the Cypress Mining Co. ^{US} Curtis Duneen, Genl. Mgr. Bagdad.

Originally one of the Lawler mines, production from it was started about ten years back, under a lease and option. Royalty paid off the purchase price in two or ~~year~~ years and title to it came to E. R. Dickie. He sold to Hullinger and McFarland. After operating about two years they sold to Dr. Larsen who in turn operated about two years and last year sold to the present owners.

The mine is an exception in that it paid operating profit to each of the owners as well as profit in selling.

The values are in Zinc and copper which are somewhat segregated in the ore zone. The main orebody is chiefly zinc but in certain parts copper predominated. Some of this was shipped direct to copper smelters. Most of the past production was milled at the Hillside Mill.

Since acquiring the mine the Cypress Mining Co. have done considerable development work and it is reported that the mine now has a very substantial amount of developed ore.

A 200 ton flotation mill at the property is now about ready for operation.

*

Properties of the Goodwin Mining Co.
Old Dick Mine
Copper King Mine
Eureka Mining District - Bagdad Area
Yavapai County, Arizona.

The Old Dick and Copper King Mines are a part of the Goodwin Mining Co. holdings in the Bagdad Area. Their location in respect to the Bagdad Copper Mine is shown on the Geological Map of the Bagdad Area (Map 1)

Geology: The rocks of the area of the Goodwin Mining Company properties all belong to the pre-cambrian series. Dr. C. A. Anderson of the United States Geological Survey has classified these into three types: Yavapai Schist, Gabbro Series, and Rhyolite, as shown on Map No. 1. The schist trend in general is N 40 E and the dip steeply to the west. Swarms of rhyolite dikes following closely to the strike of the schist intruded these rocks in pre-cambrian time.

North in the vicinity of Bagdad the pre-cambrian rocks were intruded by quartz-monzonite, which Dr. Anderson believes to be of late cretaceous or early tertiary age.

Locally the older rocks are covered by late lava flows.

Several strong north-south to northwest faults traverse the district. The one of chief concern is the Mountain Spring Fault, which Dr. Anderson believes may be the southward extension of the Hillside Fault, in which case it developed prior to the monzonite intrusion. All the known lead-zinc deposits of the region lie adjacent to this fault and may be related to elements of this fault structure.

(We are indebted to Dr. C. A. Anderson for the data on the general geology of the Bagdad Region. His data is not yet available on the district, but has gone to press and can soon be obtained in the form of an advance bulletin through the Arizona Bureau of Mines.)

Both the Old Dick and Copper King Mines lie in schist or gabbro formation and closely adjacent to rhyolite masses. Mineralization may have a tendency to select certain rock types, but it is doubtful. At the present stage any possible relation of mineral to rock types is not considered of importance.

At the Old Dick the schist appears to change, locally, in both dip and strike. In the canyon south of the mine the schist conforms to the general trend N 40 E but dips steeply east, while north of the mine 600 to 700 feet it again assumes normal strike and dip (N 35 E - dip 80 W). In the mine area the schist swings to as much as N 55 E and at point 3816 strikes almost northerly from where it again gradually assumes its normal course to the north. The gossan zone appears to conform closely to the swing in the strike of the schist and point 3816 is about the northern limit of the gossan. The south limit could not be observed, but the gossan is quite wide at the two gob raises at the surface NE of the New shaft but appeared to be narrowing. At the road it was only a narrow seam 12 inches wide and again at the hole 275 feet south of the shaft. (See Surface Sketch of Old Dick - Map 2.)

Several strong north-south vertical fissures were noted in the gulch south of the mine. These appear to swing easterly with the gossan zone and one or more elements form the footwall of the main orebody. Underground several low angle (40° to 50°) fissures were observed striking parallel to, and dipping easterly into, the vertical footwall fissure. These are believed to be local readjustments within the disturbed area. Ore makes through and along them, but seldom makes more than 15 to 20 feet away from the footwall fissure.

The Old Dick orebody appears to be localized within an area of folds in the schist and influenced by the N-S series of fissures. The area of mineralization is roughly 400 feet long and varying from a few feet to as much as 20 feet in width. It has been explored laterally over the strike length and to a depth of 50 feet below the tunnel level. Experience has proven a yield of approximately 400 tons per vertical foot in depth from the tunnel level.

At least two strands of mineralization have diverged from the main orebody as shown in drill holes on the Underground Maps 3 and 4. The footwall gives little promise for ore but the hanging wall should be explored westerly for a considerable distance. There may be other parallel orebodies in this area. Present drill holes have not penetrated the section far enough in this direction to give much information.

The Copper King structure differs somewhat from the Old Dick. Mineralization follows a strong N 30 E fault zone, which dips flatly, 40 to 50° westerly. The schist in this area appears to dip from 60 to 80° , or much more steeply than the fault. Ore replaces the schist adjacent to the fault, forming a series of irregular steeper dipping ore shoots which as a whole plunge along the same dip as the fault. Here mineralization appears to be localized within a sharp fold in the schist and the ore zone is of short strike length.

The schist varies in strike from N 45 E in the south end of the mine to N 10 W in the north end. Northerly the schist should swing back to normal N 40 E strike and in doing so may form another roll which could make another similar orebody. A gossan outcrop is reported to be exposed 150 feet north of the shaft but time did not permit mapping it.

The Copper King ore production to date has been of excellent grade. Production since 1943 has consisted of ore from pillars and remnants left from earlier mining. There is no experience from which to estimate possible yield, and time did not permit calculating displacement. A rough estimate would be that the yield has approximated about one-half as much per vertical foot as the Old Dick or about 200 tons. (See Plan Map Copper King - Map 5).

Ore Possibilities of the District:

Neither the Old Dick or the Copper King have much developed reserves. 8000 tons is estimated by the owners of the Old Dick and this is being rapidly depleted. The Copper King tonnage is not known, but is much less. It is, however, reasonable to expect that development on these orebodies will prove a tonnage comparable to what the yield per foot has heretofore been. In each of these areas possibilities for other ore shoots exist which were pointed out in the foregoing pages.

* The Copper Queen Property which lies about one-half mile south of the

Old Dick is now being explored by the Goodwin Mining Company. They have drifted about 300 feet on a silicious gossan outcrop which is believed to be earlier mineralization. There is some indication that minor reopening has occurred along this zone near the top of the ridge, which in due time will be cut by the tunnel. They may encounter a small orebody in the area ahead, otherwise the Copper Queen does not appear to offer much promise.

A gossan zone about 2 miles south of the Old Dick has been prospected through a shaft reported to be 300 feet deep, with negative results. Work however has not reached the sulphide zone as far as can be determined from the dump. Structural deformation observed in this vicinity deserves more study, as it is indicated that deeper exploration to the sulphide zone may be justified.

There are numerous other prospects in the district, some of which show lead-zinc mineralization. These deposits in the greater part may be small, but in the aggregate may furnish an important tonnage to a local milling operation. In the past, none of these deposits have developed into sufficient tonnage, or were high enough in grade to stand the truck and freight haul, on top of other costs for treatment and marketing.

Summary: To date, mining in the district has consisted chiefly of digging out ore which was exposed in surface outcrops. Except at the Copper King, little exploration has been done to prove the continuity of ore in depth. Likewise, in the vicinity of the Old Dick and Copper King the mineralized areas have not been explored outside of the present known orebodies to determine if other ore shoots occur.

The tonnage is not indicated to be large in any one area, but ore produced from the district to date has been very good grade. If present grade and volume of ore prove to continue in depth at the Old Dick and Copper King, these two orebodies will make a profitable operation. The first step should be to develop these two orebodies. With a backlog in these, the other possibilities can be explored, which in time may add substantially to the ore reserves.

Too little is known about other prospects in the area to predict the possible tonnage which may be developed in the district as a whole. The region deserves further study, which will undoubtedly point to possibilities for other orebodies.

May, 1949

Edwin A. Stone

GOODWIN MINING COMPANY

Summary of Ore Deliveries to Denn Mill

	Date Last Car Received	Mill Lot Number	Dry Tons Ore	Quoted Price							Net Mill Returns (After Freight Deduction)		Per Ton	Ck. #
				Gold	Silver	Copper	Lead	Zinc	Zinc	Copper	Totals			
Old Dick Claim	1-21-49	11	217.20	.005	.60	3.50	.40	16.60	17.5	23.5	4025.94	18.54	1	
	2- 2-49	20-21	278.71	.008	.54	3.20	.24	22.09	17.5	23.5	6936.84	24.89	2	
	2- 8-49	23	274.38	.006	.55	2.95	.10	19.40	17.5	23.5	5830.83	21.25	3	
	2-14-49	28	276.42	.006	.40	2.20	.20	18.10	17.5	23.5	5326.29	19.27	4	
	2-22-49	35	402.51	.006	.50	2.90	.15	21.80	17.5	23.5	10708.51	26.60	5	
	2-27-49	42	434.77	.005	.55	2.80	.25	18.15	17.5	23.5	8570.31	19.71	6	
	2- 8-49	51	474.39	.004	.42	3.15	.10	16.90	17.5	23.5	8311.44	17.52	7	
	3-12-49	59	274.14	.005	.50	3.08	.10	13.70	17.5	23.5	4166.16	15.20	8	
	3-18-49	67	344.76	.005	.50	2.85	.40	11.45	17.5	23.5	4122.70	11.96	9	
	3-31-49	77	561.51	.005	.40	3.70	.10	16.75	16.0	23.5	9351.36	16.65		
	4- 8-49	94	319.46	.005	.40	3.72	.05	18.70	15.5	23.25	5784.77	18.11		
	4-15-49	104	225.31	.010	.60	3.45	.15	18.80	15.0	21.5	4051.58	17.98		
	4-17-49	109	174.07	.005	.50	3.20	.10	17.50	14.0	21.5	2472.77	14.21		
	4-20-49	118	341.11	.005	.60	4.45	.15	23.80	13.0	21.5	6340.16	18.59		
	4-28-49	125	271.97	.007	.60	4.25	.20	21.10	13.0	20.0	3424.89	12.59		
	Totals & Averages		4870.71	.0056	.50	3.30	.17	18.27			89424.55	18.36		
Copper King Claim	4-16-49	103-112	69.63	.012	1.25	1.66	1.25	22.16	14.0	21.5	996.83	14.32		
	4-20-49	113-121	151.26	.004	1.45	1.45	1.68	25.74	13.5	21.5	2749.89	18.18		
	Totals & Averages		220.89	.007	1.39	1.52	1.54	24.61			3746.72	16.96		
Grand Totals			5091.60	.0057	.54	3.22	.23	18.55			93171.27	18.30		

Bisbee, Ariz.
5-17-49
eg

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
FIELD ENGINEERS REPORT

Mine Bagdad Area

Date Dec. 6, 1952

District

Engineer Mark Gemmill

Subject: Present operations

✓ Old Dick

Production was stopped several months ago when the price of lead and zinc dropped. Since that time development work has continued with a reduced force of men. This work consists of deepening the shaft and running lower levels. No information is available as to the amount of new ore developed but I was informed that the findings are very satisfactory and that the property will be in shape to produce on a large scale when market conditions are right.



OLD DICK

YAVAPAI COUNTY
Eureka Dist.

Learned that Cyprus has resumed full scale
operations at the Old Dick. 50 men employed
and plan additional employment for development
work.

2-2-59 TPL

*

13-4

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
FIELD ENGINEERS REPORT

Mine Old Dick

Date Dec 30th 1947

District Eureka, Yavapai Co.

Engineer A.C. Nebeker

Subject: Report.

Location:

The Old Dick property is located 72 miles west of Prescott, Arizona, in N.E. $\frac{1}{4}$ Sec 8, T.14 N, R 9 W, Eureka Mining District.

Owner: Lawler Estate, and is being work under agreement with the Hillside Mining Co. Mark Gemmill is manager and Harman Swadley Supt.

Roads:

The road to the property is good for auto travel.

Climate:

Ideal for year around operations.

Topography and Geology:

Topography is rough being cut by gullies having steep sides and the geology is made up of granite, schist, which are cut by rhyolite dikes.

Vein:

The vein is a prominent outcrop of ferruginous honey comb quartz with thickness of one foot to 15 feet, having an average strike of N 30 degrees E and it appears that it continues on southwest through the Copper Queen Lode mine.

Ores:

Are mainly zinc with some copper, gold and silver. The zinc ores run from 5% to 30% zinc, and 1% to 6% copper, so given to me by Mr. Swadley. These ores are mined and hauled to the Hillside mill for treatment, mining at this time about 40 tons per day.

Development:

The mine is developed by a shaft 75 feet deep on the croppings, and then crosscut tunnel was run from the gulch cutting the vein about 200 ft in, where mining is going on. The working face show at time of visit a 15 foot face of ore with backs all in ore.

The company plans to drill several diamond drill holes to prove the downward extension of the ore.

Equipment:

The property is equiped with a portable compressor, cars, drills shop and change house. Bunkhouse is not needed as the men stay at Bagdad and drive in to work.

* Timber and water both scarce items.

From present indications it appears that the Dick will become a large producer of ore.

NAME OF MINE: OLD DICK ✓		COUNTY: YAVAPAI	
OPERATOR AND ADDRESS:		DISTRICT: EUREKA	
		METALS: CU	
DATE:		MINE STATUS	
5/1/44	R.R. Belknap, Bagdad, Ariz.	DATE:	Shipping
		5/1/44	
		5/21/44	Idle

OLD DICK MINE

YAVAPAI COUNTY
BAGDAD AREA

About 3 miles southeast from the Copper King, COPPER ZINC
Valerio Rossi, Bagdad, Arizona
Visited by E. A. Stone on May 25, 1945 and again in December 1945.

"Mr. Rossi states there is a ledge of ore developed over a strike length of 300 feet which averages 6 to 7 feet in width. Average grade of this ore according to Mr. Rossi is 15 to 30% Zn, 1% Cu and 18% Fe."

"Zinc occurs along a N 30 E vertical fissure. The vein, in places is 36 inches wide as observed along the lower tunnel. The zinc mineralization is spotted and contains pyrite and quartz with sparse zinc mineralization."

Addendum by G. J. Duff May 21, 1951

This property was brought to the attention of our consulting geologist about a year after the above report, but apparently we didn't have time to re-examine it. Since that time, leasers operated and shipped several thousand tons on which they made considerable money. When they ran out of ore in the bottom of their large stope they relinquished the lease. Within the past few months a new organization took over the property, sunk a shaft well below the bottom of the old stope, and I am informed recently that they have encountered a very good orebody from a cross-cut indicating a continuation of the large stope which made so much money for the former leasers.

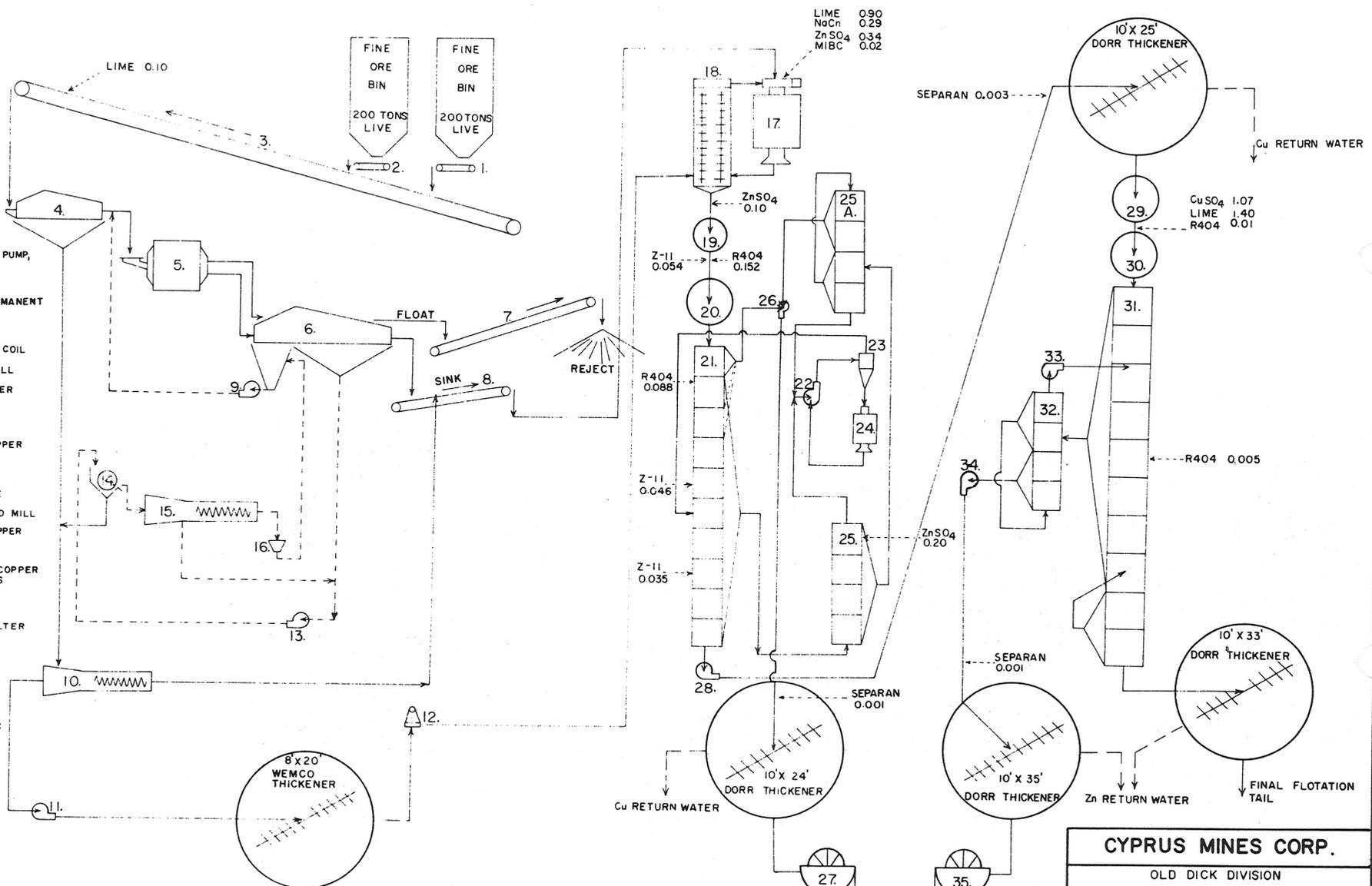
*

LEGEND

HMS

FLOTATION

1. 16" BELT FEEDER
2. 16" BELT FEEDER
3. 18" BELT CONVEYOR
4. 3'x16' A-C LOW HEAD PREP SCREEN
5. 6'x5' WEMCO DRUM SEPARATOR
6. 3'x12' A-C LOW HEAD WASH SCREEN
7. 18" BELT CONVEYOR
8. 18" BELT CONVEYOR
9. 2" WEMCO MEDIA CIRCULATING PUMP
10. 18" WEMCO SPIRAL CLASSIFIER
11. 3" WEMCO SAND PUMP
12. 2" DENVER DIAPHRAGM PUMP, ADJUSTABLE STROKE
13. 3" WEMCO WASH PUMP
14. 24" x 30" STEARNS PERMANENT MAGNETIC SEPARATOR
15. 18" WEMCO DENSIFIER
16. DINGS DEMAGNETIZING COIL
17. No 67 MARCY BALL MILL
18. 5'x25' DORR CLASSIFIER
19. 4'x4' CONDITIONER
20. 5'x5' CONDITIONER
21. No 18 SP DENVER COPPER ROUGHER CELLS
22. 2" SRL PUMP
23. KREBS D4B CYCLONE
24. 3'x4' DENVER REGRIND MILL
25. No 18 SP DENVER COPPER CLEANER CELLS
- 25-A. No 18 SP DENVER COPPER RE-CLEANER CELLS
26. 2" SRL PUMP
27. 6' 2 DISC DENVER FILTER
28. 2" SRL PUMP
29. 6'x6' CONDITIONER
30. 6'x6' CONDITIONER
31. No 21 DENVER ZINC ROUGHER CELLS
32. No 18 SP DENVER ZINC CLEANER CELLS
33. 1" WILFLEY PUMP
34. 1" WILFLEY PUMP
35. 6' 4 DISC DENVER FILTER

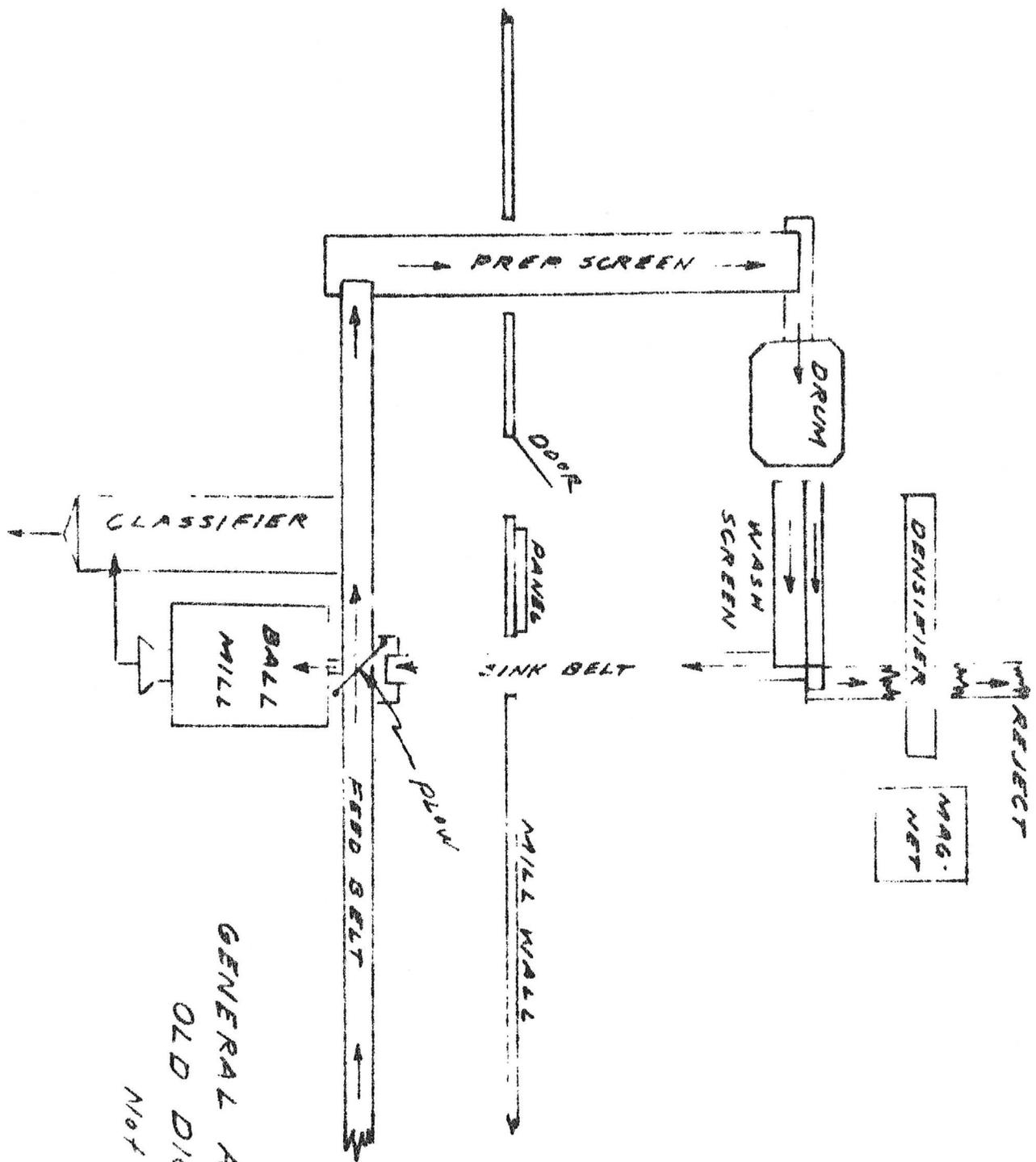


LIME 0.90
NaCN 0.29
ZnSO₄ 0.34
MIBC 0.02

NOTE
ALL REAGENTS IN LB. PER TON
TO FLOTATION

CYPRUS MINES CORP.	
OLD DICK DIVISION BAGDAD, ARIZONA	
1963 MILL FLOW SHEET	
DATE: 1-30-64	DRAWING No
SCALE: NONE	DC - 29
DRAWN BY: <i>[Signature]</i>	PRINTED:

CONCENTRATE BINS



GENERAL ARRANGEMENT
 OLD DICK MMS PLANT
 NOT TO SCALE

*

A. W. HUNT

-7-

FEBRUARY 7, 1964

Power is received from Arizona Public Service Company through a 69 Kilovolt line. This is transformed to 400 volts in a substation at the mine for alllocal use. Fresh water is pumped through a 9 mile system from Boulder Creek below the town of Bagdad.

* * * * *

LEAD-ZINC QUESTIONNAIRE

October _____ 1957.

Do you approve of the Emergency Lead-Zinc Committee's seeking relief for the lead-zinc industry and has it your authorization to speak for you? Yes

What Arizona Mines and Mills in the lead-zinc class do you control?

(1) Old Dick Mine

(2) Copper Queen Mine

Which ones are operating? (1) Old Dick (2) _____

If not operating, when shut down? (1) _____ (2) In Exploration & Development

Number employed, prior to shut-down, in mine, mill or sections thereof producing lead or zinc ores? (1) _____ (2) _____

Number so employed on January 1, 1957? (1) 55 (2) None

Number so employed on October 1, 1957? (1) 50 (2) None

Remarks _____

Cyprus Mines Corporation
Company

By: C. R. Sinden, Pres 1957
Signature

Please fill in NOW, tear off, and mail to:

Arizona Department of Mineral Resources
Mineral Building, Fairgrounds
Phoenix, Arizona

(C) If you could not do this yourself, would a quick drilling program by some government agency (at government expense) be sufficient?

(D) Or would you prefer a loan plan similar to the arrangements during World War II?

no loans, thanks

How about a combination plan in two stages such as follows?

Stage 1: Government engineers review project and, if a little drilling appears to be justified and a preliminary key to the situation, such drilling program to be agreed upon by owner and government engineer, paid for by the government, but let by contract.

Stage 2: If results of drilling (or without drilling) justify underground development and/or production equipment, same to be obtainable via a mortgage loan on property.

Please discuss the above: Give us a stable assured price in line with war economy costs. If metals were subsidized like potatoes, we would have ~~an~~ a comparable glut instead of the present scarcity.

SUGGESTIONS:

In 1949 Copper dropped 5¢ per pound and zinc 8 1/2¢ very suddenly. Fear of a recurrence is deterring expansion of operations at present

DATE

Aug. 10, 1950

SIGNATURE

E. J. Green, Supt.
Goodwin Mining Co.

STATE OF ARIZONA
DEPARTMENT OF MINERAL RESOURCES
MINERAL BUILDING, FAIRGROUNDS
PHOENIX, ARIZONA 85007

July 20, 1976

Mr. Keith E. Dyas,
Resident Manager
Cyprus Bruce Copper & Zinc Company
Cyprus Mines Corporation
P.O. Box 457
Bagdad, Arizona 86321

Dear Mr. Dyas:

Thank you very much for furnishing the Department of Mineral Resources with the 1975 production data for your Arizona mining operations.

Enclosed is a copy of the completed 1974-1975 tabulations for all large Arizona copper producers.

If the Department, or I, can be of assistance to you at any time, please contact us.

Sincerely,

Glenn A. Miller
Mineral Resources Specialist

Enclosure

GAM:jm File: Cyprus Bagdad (Bruce)
Yellow Alpha "C", Copper Report, GAM file

C
O
P
Y

STATE OF ARIZONA
DEPARTMENT OF MINERAL RESOURCES
MINERAL BUILDING, FAIRGROUNDS
PHOENIX, ARIZONA 85007

April 21, 1976

Mr. Keith E. Dyas,
Resident Manager
Cyprus Bruce Copper & Zinc Company
Cyprus Mines Corporation
P.O. Box 457
Bagdad, Arizona 86321

Dear Mr. Dyas:

Last year you kindly gave us your production figures for 1974, including tons of ore, percentages of copper and zinc in ore, pounds of copper in copper concentrate, pounds of zinc in zinc concentrate and ounces of silver, (see attached copy of letter).

We would appreciate receipt of like figures for 1975.

Thank you very much.

Sincerely,

Glenn A. Miller
Mineral Resources Specialist

jm

cc: Pink Reading, Yellow Alpha "C"
Copper Report file, GAM
Cuprus Bruce file

C
O
P
Y

DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA

FIELD ENGINEERS REPORT

Mine To R. I. C. Manning, Director

Date April 27, 1955

District

Engineer Mark Gemmill

Subject: NEWS ITEMS

OLD DICK ✓

It has been reliably reported to me that the Mudd interests, either the Coronado or the Cyprus Companies, have exercised their option and will take over the Old Dick early in May.

BLACK PEARL

Scholz and Cazier have started exploration work for which they were granted a loan, I think the amount is \$125,000. This work will consist of a shaft 150 ft. deep to be sunk near the portal of the present adit, and 400 ft. of drifting from the bottom of the shaft.

BABDAD COPPER

A new 9 yd. P. & H. electric shovel together with a fleet of large Dart trucks have just been put in operation stripping the hill to the northwest of the present pit. This work will uncover an extensive area of known ore.

CASH MINE

Owned and operated by Orr and Dickie is now shipping ore to the Poarch Plant at Humboldt for treatment when the plant is put in operation. The ore carries values in gold, silver, copper, lead and zinc.

TUNGSTONA MINING AND MILLING CO.

The new mill is operating regularly on a three shift basis with a daily capacity of about 260 tons.

MARK GEMMILL

SOME ASPECTS OF COMBINING HEAVY MEDIA
CONCENTRATION WITH FLOTATION AT A SMALL MILL

BY

A. W. HUNT

CYPRUS MINES CORPORATION, BAGDAD, ARIZONA
AT THE NATIONAL WESTERN MINING CONFERENCE
OF THE COLORADO MINING ASSOCIATION
DENVER, COLORADO FEBRUARY 7, 1964

The Old Dick property was located originally in 1882 and passed through the hands of various owners and leasers without significant production until World War II, when a small tonnage of direct shipping copper ore was mined. Some copper-zinc ore was milled at various custom plants in the late nineteen forties and early fifties. Cyprus Mines Corporation acquired the property in 1955, built the present flotation plant and commenced production in 1957. Production of copper and zinc concentrates has been continuous since, with the exception of a low market shut-down in 1958. The heavy media pre-concentration section was added to the mill in 1961.

The location is 5 miles by dirt road southwest of Bagdad, Arizona, in a mountainous region of low relief with the typical dry desert climate and sparse vegetation of western Arizona. The railhead is on the Santa Fe, at Hillside, Arizona, another twenty-three miles by secondary oiled highway from Bagdad. Altitude is 3,900 feet and annual rainfall averages 14 inches. Temperatures vary from 20° F. to 110° F., with the sub freezing temperatures noted intermittently and only at night during the winter months.

The Old Dick Division mines from two producing shafts, the Old Dick and the Copper Queen, located a half mile apart on similar geologic structures in the schists of the region. The crushing plant, mill and main shops are near the Old Dick shaft, and each shaft is equipped with its own surface installations, including head frame, hoist, compressor house and dry room.

Ores are massive sulfide replacements in pre-Cambrian schists and meta-volcanics of the Yavapai series. Valuable minerals are chalcopyrite and sphalerite, with barely perceptible amounts of silver. Gangue minerals are massive pyrite and accessory pyrrhotite with some arsenopyrite and magnetite noted, along with quartz and altered or silicified schists. Oxidation is not significant. Sulfides make up approximately 60% of the ore as mined and received at the mill; after the pre-concentration step, sulfides comprise 85% to 90% of the flotation feed. Ores from both mines react similarly toward flotation and are mixed in the coarse bin ahead of the crushing plant.

In 1961, due to the squeeze between rising production costs and fixed metal prices, the Old Dick determined to lower unit costs by increasing tonnage. At the mines, this was a relatively straightforward matter of increasing working faces and careful scheduling; sufficient compressed air and hoisting capacity already existed for the expansion.

* The mill, however, presented a different picture, since it was then grinding at its full capacity of 240 tons per day and was scheduled 364 days a year; moreover, while the flotation section was adequate for that tonnage, it had no excess capacity. With a plant availability of 98.0% possible already attained, no substantial gain could be foreseen by any improvements here. In total, any further expansion at the mill indicated a complete second plant in parallel, with its consequent high capital costs.

At this stage, the possibilities of per-concentration to raise mill tonnage were considered, by rejecting a low value waste product and leaving the mill

tached sketch, with the ball mill operator stepping through a door at a platform behind his mill onto a platform in the center of the heavy media plant. His by-pass plow is inside the door, his heavy media electrical control panel is just outside it, and the density measuring station is just three steps away. To visualize this more completely, the belt passing over the ball mill drops feed onto the preparation screen, lined up at 90° to the right of the belt. The screen conveys oversize at 90° to the original flow and drops it into the separating drum hopper, again set 90° to the right. The separating drum discharges onto the wash screen in line with it; wash screen sink discharges onto a belt, again 90° to the right, which conveys the sink in to the center of the ball mill feed drum, some six feet below the original feed belt. The operator, then, as he steps onto the platform, has the preparation screen on one side, the drum and wash screen ahead of him and the mill feed sink belt on his other side. The sink belt and sand classifier are just below this platform, giving a walkway over them to the magnetic separator and densifier areas.

4. Design for least interference with production during plant construction.

In the final design, the factor of interference with existing operation was practically eliminated. Foundations and steel structures were arranged to fit into non-vital areas of the existing plant, with the result that the only time lost was during the connection of the main water headers and the adaptation of the ball mill scoop box for the sink belt discharge hopper, both a matter of only a few hours. Changeover to the new plant was done in another two and one half hours when the extra length was added to the feed belt and the drive motor moved to the new head pulley.

5. Stable operation:

Due to the small tonnage, segregation in bins and lack of underground storage, changes in the Old Dick mill feed can be abrupt, from fine to coarse, from high to low head values, and from high pyrite to high quartz. To stabilize the sink float section as much as possible, an overflow was placed on the circulating media sump to the wash sump and a slight excess of water added to the circulating system. Normally, the circulating sump overflows slightly, keeping a constant volume of media in circulation through the separator. If fine wet ore hits the system, the excess water from the ore reports in this overflow and is eliminated through the wash system and densifier; the medium it carries with it is reclaimed and is small in comparison to total medium circulating so that a very slow drop if any is noted in the circulating gravity. On the other hand, if coarse dry ore comes in, the constant circulating volume takes up part or all of the overflow water to hold constant density. The plant actually runs for hours at a time without a density change and will handle excess water from light showers without changing medium density.

* Metallurgical calculations became much more involved with the plant in operation. The addition of reject to the copper and zinc concentrates and flotation tail makes a fourth product; two of these four are very close in assay -- the reject and flotation tail. The solution suggested at Old Dick as the most practical is to

Maintenance due mainly to abrasion on the plant has been much heavier than expected; deslimed pyrite appears to be particularly abrasive. Regular, planned preventive maintenance and inspection shut-downs have been necessary since the plant started; presently the plant is down each two weeks for two to eight hours for this. The use of rubber linings on the drum, chutes and screen frames, heavy stainless steel bar type screen decks, rubber hoses and fittings in place of pipe, Ni hard fitted pumps and the regular inspections have increased availability of the plant from 83.2% for its first 5 months in 1961 to 92.0% in 1962 and 94.7% in 1963.

A short description of the mill flow sheet follows:

Ore is received into the 300 ton coarse ore bin from both mines, by a 30 inch conveyor belt from the Old Dick headframe and by truck from the Copper Queen shaft.

All ore is crushed to 100 per cent minus 5/8 inch using a conventional closed crushing circuit, with a Denver 18 x 24 inch jaw crusher set 3 inches feeding a Denver 3 x 6 foot vibrating screen. Undersize goes to the mill bins by an 18 inch x 550 foot belt while oversize is finish crushed in a 3 foot Symons standard and returned to the head of the screen. Crushing rate is approximately 60 tons per hour.

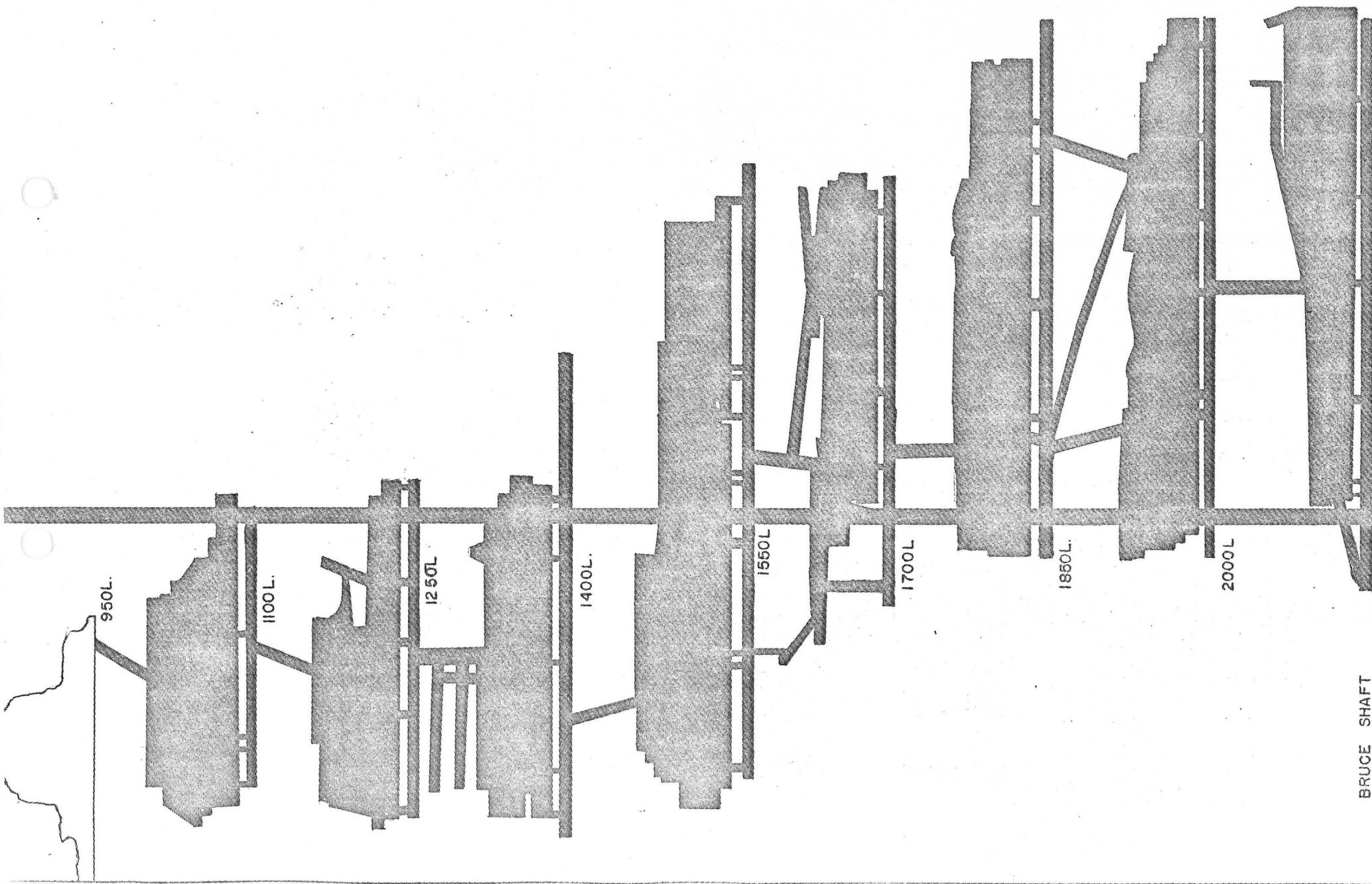
An 18 inch x 20 foot shuttle belt transfers crushed ore to either of two 200 ton cylindrical fine ore bins. Ore is fed from each bin by a 16 inch x 13 foot variable speed conveyor to the main feed belt. The shuttle belt is reversed each 10 minutes during crushing and both bin feeders are used at all times in order to mix ore as much as possible.

An 18 inch x 60 foot belt conveys feed from the bins over a Fairbanks conveyor scale and past the ball mill to the preparation screen of the pre-concentration plant. The 3 x 16 foot Allis-Chalmers prep screen with 3/16" Bixby-Zimmer stainless steel grizzly rod decking separates minus 10 mesh fine and washes coarse sizes thoroughly. The plus 10 mesh material is separated into sink and float portions in a 6 x 5 foot Wemco drum separator and drained and washed on a 3 x 12 foot Allis-Chalmers screen divided longitudinally. Float reject is conveyed to a stockpile in an adjacent canyon and sink is conveyed to the ball mill of the concentrator. Specific gravity of separation is 2.83 and the heavy medium used is a water suspension of ground ferrosilicon with some magnetite. Consumption of medium appears to be leveling out at 0.8 pounds per ton of heavy media feed.

The fines separated by the prep screen run by gravity to an 18 inch Wemco spiral classifier; sands fall from this to the sink belt and go on to the ball mill. Classifier overflow with the slime fraction is pumped by a 3 inch Wemco pump to an 8 x 20 foot Wemco thickener. Thickened slimes are pumped by a 2 inch Denver adjustable stroke diaphragm pump to the Dorr classifier pool in the grinding section, while water is returned to the heavy media plant for re-use.

Undiluted medium drained from the sink and float material is circulated through the drum separator by a 2 inch Wemco sand pump while diluted medium from the washing section is caught in a separate sump and pumped with a 2 inch Wemco to a Stearns permanent magnetic separator for reclamation. Cleaned medium is dewatered in an 18 inch Wemco spiral densifier, dropped through a Dings de magnetizing coil and returned to the circulating sump.

The pre-concentration plant as a whole is a size 1 Wemco Mobil-Mill bought as a package unit, with just sufficient engineering modifications as were required for the special Old Dick duty. These included addition of the spiral classifier and thickener for handling fines and the return water system.



950L.

1100L.

1250L

1400L.

1550L

1700L

1850L.

2000L

BRUCE SHAFT