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Arizona Department of Mines and Mineral Resources Mining Collection

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DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
FIELD ENGINEERS REPORT

Mine BORIANA TUNGSTEN MINE — Date October 6, 1942

District Owens, Mohave Co. — Engineer Elgin B. Holt

Subject: Production Possibility

OWNER: Molybdenum Corp. of America; Mark Hirsch, Pres., 500 5th Avenue, New York City; W. H. Munds, Resident Manager, Yucca, Arizona.

METALS: Tungsten and copper - tungsten predominating.

LOCATION: Property is located on west side of the Hualpai Mountains, Mohave County, Arizona, around 20 miles S.E. of Yucca, and is reached from Kingman, Via Yucca, by a fairly serviceable dirt road, which is maintained by the County.

INTERVIEW: On October 5, 1942, I had an interview in Kingman with Mr. W. H. Munds, Resident Manager of this property, and he gave me the following data concerning the same:

AREA: The Boriana group consists of 16 unpatented mining claims.

VEINS: There are 4 veins, each vein being made up of a series of stringers of tungsten ore from 1" to 15"wide.

DEVELOPMENT WORK: Development work consists mainly of tunnels and raises, aggregating 15,000 feet. There is one inside winze sunk vertically to a depth of 450', at a point 2,900 feet from portal of main tunnel. There are three levels in said winze with 5,000' of lateral work.

MILL, TYPE & CAPACITY: A 200-ton combination gravity and flotation mill is located at property, and produces a product running 70% WO_3, which is shipped to the company's own tungsten reduction and manufacturing works at Washington, Pennsylvania.

1941 PRODUCTION: Ore milled during 1941, per Munds, amounted to 16,000 tons, assaying 1.12% WO_3. Tails assayed 0.12 WO_3. Concentrates produced contained 6,000 units of WO_3.

ORE RESERVES: Mr. Munds stated that no attempt is made to maintain large ore reserves in the mine, due to swelling ground. Therefore, ore is practically mined as fast as developed in order to save maintainence costs of keeping drifts open. However, around from 4 to 6 months supply of ore is kept blocked out ahead of stoping operations, in order to keep the mill operating without closing down.

OPERATING COSTS: Munds also stated that he is not at liberty to give full details regarding operating costs, as such information would have to be secured from Mr. C. Q. Schlereth, consultant for company, Box 258-B, Route #8, Phoenix, Arizona. Or such information might be secured from the company's New York office, as above set forth. However, Munds stated that the company is now paying the regulation scale of wages generally paid Mohave County miners and other worken, which now amounts to an average increase of 22.5% over rate

BORIANA TUNGSTEN MINE

of pay for 1942.

DIFFICULTIES: Mr. Munds further stated that due to the scarcity of skilled workmen during 1942, as well as to the fact that many of his first class men left Boriana in order to take higher paid jobs at nearby defense projects, and which skilled men have been partly replaced by unskilled miners and muckers, which resulted in the new underground employees mixing ore with waste and waste with ore, - that for all these reasons, the production of tungsten, as well as a small amount of copper concentrates, which is produced as a by-product, have fallen at least 50% during 1942 over what the production of these metals amounted to during 1941. He also stated there is now a 25% shortage of mine workers and these mainly consist of a very poor quality, as it takes fully 6 months time to train muckers and miners, in this particular mine, to selectively mine and sort the tungsten ore underground. He also stated that the type of men now employed, or rather available manifest a spirit of indifference in the work they are carrying on.

BORIANA OPERATING AT A LOSS: Munds also stated that operations at Boriana are now being carried on at a loss, as far as the mining and milling of ore are concerned. That if the present pegged price for tungsten could be increased to a figure covering production costs, and no more, that Boriana could go along and probably increase production to around 3,000 units of WO_3 monthly, due to the fact that his company manufactures its own tungsten output. But in such event, he stated there would have to be provisions made to increase labor costs sufficiently to compete with the defense projects mentioned.

Elgin B. Holt

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DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA

OWNERS MINE REPORT

Report by
A. Brodie Campbell

Date June 7, 1942

1. Mine Boriana

2. Mining District & County Yucca District
Mojave County

3. Former name Yucca Tungsten Mining Co.

4. Location 17 miles NE Yucca. Nearly at top of Hualapai Mts.

5. Owner Molybdenum Corp. of America

6. Address (Owner) Yucca, Arizona

7. Operator Molybdenum Corp.

8. Address (Operator) " "

9. President -----

10. Gen. Mgr. Bill Munds

11. Mine Supt.

12. Mill Supt.

13. Principal Metals Wolframite, scheelite, chalcopyrite.

14. Men Employed 100--120

15. Production Rate 40 tons per day. 40 units WO3.

16. Mill: Type & Cap. Combined gravity and flotation. 150 tons/24 hrs.

17. Power: Amt. & Type 500 hp. transmitted elect. Stand by diessel.

18. Operations: Present Develop, mine mill.

19. Operations Planned Same

20. Number Claims, Title, etc. Many but some are held by lease and some by part ownership.

21. Description: Topography & Geography Rugged mountainous country. Elevation, 4,000'. Semi-arid climate Small precipitation.

22. Mine Workings: Amt. & Condition Many thousand feet of drifts, winzes and raises. The older portions are in bad shape. The newer ones require timber. The schist is of the swelling ground nature.

(over)

23. Geology & Mineralization Two prominent quartz veins running parallel with the scistocity in an extensive schist bed in granite. The veins fade out to the SW while still in schist. The veins terminate in a granite stock to the NE. They do not terminate at the contact but penetrate the stock. The veins average about 1' in width. The strike is N 35 E and dip is 80 to 90 to the SE. Mineralization is wolframite, scheelite and chalcopyrite of the quartz.

24. Ore: Positive & Probable, Ore Dumps, Tailings There is no developed ore on this property. The ore is taken out nearly as soon as it is developed. Development is slow because of a step faulted condition of vein structure. The structure continuity on the surface indicates that there is still considerable tonnage left.

24-A Vein Width, Length, Value, etc. The ore body is approximately 1500' long. The veins average 1' in width. The mine is 700' deep and sinking a shaft an additional 200'.

25. Mine, Mill Equipment & Flow Sheet Mine run to bins to conveyor to 10" by 16" jaw, to 8 mesh screen. O'size screen to hi-speed gyratory. U'Size to Classifier. Hi-speed Gy. closed on 8 mesh wet screen. U'size to class. (6 spig.) Class. products to individual tables (7). Table conc. to float section. Midds to ball mill return to circuti via class. Float section; Table conc to ball mill closed on drag class. O'flow to float. Sulphides floated away from WO_3. WO_3 tails thickened filtered and dried. About 60% WO_3.

26. Road Conditions, Route Sulphide conc. filtered and sold.

Take road going NE 2 miles S of Yucca. Road well signed. Go 17 miles NE up canyon to mine. Fair mountain road.

27. Water Supply Good. More than enough water from underground workings.

28. Brief History Started as tungsten producer in 1908. Has produced more or less since that time. Probably the most consistent tungsten producer in state. Has produced between 80,000 and 100,000 units WO_3.

29. Special Problems, Reports Filed Wilson, Tungsten Deposits of Arizona. The special problem here is labor. The property would be on double production if labor was available.

30. Remarks This property is a good example of the need for large capital background for tungsten properties in this state. The Boriana mine does not show on the surface as good as some of the other districts. It has become a successful operation only after considerable capital has been expended.

31. If property for sale: Price, terms and address to negotiate.

32. Signed.....

33. Use additional sheets if necessary.

BORIANA

MOHAVE COUNTY

Mr. Brannum is putting up a mill to handle tailings at Boriana. VBD WR 6/5/75

Went to Boriana where there is no activity and there doesn't appear to have been any recent installation of milling equipment on the mine dump as reported. GW WR 8/27/75

Telephone call from Gary Branum, Hilton Mining Company, P.O. Box 318, Casa Grande, 836-1496. This company has leased the Boriana Mine and wanted to know the ore reserves, etc. GWI WR 4/19/76

GARY BRANUM

Jerry Brannon, Casa Grande, came in to say he and his father have moved their recovery machinery on to the Boriana mill tailing pile. He said they had enlisted the services of a Hecla metallurgist who conducted several bench experiments on the separation of copper sulfide minerals from scheelite and wolframite and had found certain additive chemicals which did the trick. GW WR 4/19/76

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BORIANA MOHAVE COUNTY

Donald McCarthy was in and reported that he and Gerald Weathers were busy in the Hualpai Mountains looking at ground near Antler and Boriana. He was interested in reports of molybdenite and copper in the Boriana. According to Dye and Batherick they had both, along with part of the tungsten ore. LAS WR 3-4-66

Arkla has option on the Boriana mine. Dan Davis doing geology and geochem sampling. FTJ WR 3-8-68

Arkla still has option on the Boriana and some adjoining claims. FTJ WR 9-6-68

Mr. Robinette told me Union Carbide was building drill sites at the old Boriana tungsten mine east of Yucca. GW WR 10/3/73

Union Carbide continues to do exploratory drilling on the old Borianna tungsten property. GW WR 12/6/73

The drilling of the Borianna mine area has been finished by Union Carbide Corp. GW WR 4-4-74

The Union Carbide Corp. drilled several core holes in and near the old Borianna tungsten mine nprtheast of Yucaa. The results were apparently discougaging as the project was abandon after about 3 months. GW AR 73-74

I called on Mrs. Vera Bathrick, one of the owners of the Boriana Mine. Union Carbide has relinquished their option and gave the owners copies of drill logs, maps and reports. She later advised that the department could make copies of all records re-received from Union Carbide. She will mail in the records for copying, but the originals plus one copy must be returned to her. VBD WR 1/7/75

I drove to the Boriana property late in the evening. I made an eyeball estimate of a few 10's of thousand tons of dumps and tailing, some of which Dye and Bathrick reprocessed in the 1950's. There is sufficient tailing and dump to warrant a sampling program with E/MJ quoted prices of tungsten at $95.53 per STU, .65% WO_3. I suggested to Mrs. Bathrick by telephone that she offer the Boriana to Standard Metals Corp. VBD WR 1/8/75

A lease and option to purchase the Boriana mine has been obtained by Gary Branum and Jim Slack. A third unknown is involved. VBD WR 4/10/75

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* Mr. Branum and son have leased the Boriana dump and tailings and will have their new type concentrating tables in operation by July 1st. This table is built in Alabama and is similar in operation to an old Fure Vanner. They expect to put 100 tons of tailings through per day; they assay .25% WO_3, .25%Cu and .5 Oz. Ag per ton. GW WR 5/12/75

BORIANA

MOHAVE

I picked up Clarence Strouse and we drove to the Boriana mine. There is no activity there. A Vanner concentrating belt has been set up on the tailing pond and some material (less than 10 tons) has been treated. I assume the tests were not successful since I found where the concentrator had lost considerable scheelite. VBD WR 9/19/76

CH/Report 11/23/79 - Talked on the phone with Roman Mallock, Mohave County Historian in Kingman. He said that the Boriana Mill which was treating tungsten ore from the Boriana Mine, Sec. 13, T 18 N, R 16 W, has been shut down for four months and may be sold to a company in Butte, Montana. Drove to the mill three miles south of Yucca. It is housed in a fairly new steel building painted a yellowish brown. A house trailer was on the property, but no one was around.

CJH WR 4/3/80: Phone call from Jim Germundson, American Mine Services, 6245 Clermont St, Commerce City, Colorado 80022. Was informed that his company will be reopening the McCracken Mine, Owens Mining District, west of Signal, southern Mohave County, and the Boriana Mill at Yucca.

MG WR 4/2/80: In conversation, learned that Perry Durning's group is attempting to purchase mill equipment (from the Old Boriana mine ?) and to reopen the McCracken lead-silver mine in Mohave County.

KAP WR 2/26/80: Canadian Mines is planning on starting up silver production from the McCracken Mine, Mohave County. They hope to acquire the Boriano Mill. Ore is to be hauled 45 miles from the mine to the mill. The mill will use selective flotation; recovery will be 90 percent. The metallurgical testing and flow sheet design have been done by Mountain States Engineers.

CJH WR 5/14/80: The Boriana Mill is starting up and Fischer-Watt Mining Co.(?) has advertised for a mill man (flotation) and an assayer. They will run the McCracken Mine dumps.

BORIANA

MOHAVE COUNTY

NJN WR 12/25/81: Talked to Jim Vacek "The 49er" about the Boriana Mine, Mohave County. He was interested in contacting the owner to see if he could try and collect scheelite crystals of size and quality suitable for sale to mineral collectors.

Date Printed: 10/29/93

ARIZONA DEPARTMENT OF MINES AND MINERAL RESOURCES

VERBAL INFORMATION SUMMARY

Ken A. Phillips, Chief Engineer Date: October 28, 1993

Information from: **Steve Nolte and Larry Toppenberg**

Company: Desert Wide Properties

Address: 3330 N. Dobson Road # 8
City, State ZIP: Chandler, Arizona 85224
Phone: 602-838-6631

MINE: **Boriana**

ADMMR Mine File: Boriana file
County: **Mohave**
AzMILS Number: **513A**

SUMMARY

Steve Nolte and Larry Toppenberg, brokers with Desert Wide Properties, 3330 N. Dobson Road #8, Chandler, Arizona 85224, phone 602-838-6631, represent a client interested in investing in a mine. They have been approached by Steve Tima, Tima Oil and Minerals of Chandler, to invest in his Boriana Mine's tailings. Tima claims that the Boriana tailings contains large quantities of recoverable tungsten, but that a gravity concentrate from the tailings can only be treated in Japan to recover the tungsten.

Messrs Nolte and Toppenberg are willing to try to get some option time to independently test some of his statements.

Ken A. Phillips, Chief Engineer Date: October 28, 1993

BORIANA MINE

MOHAVE COUNTY
Cedar Valley

DYE & BATHRICK, Kingman, Arizona

Sink-float plant
BORIANNA MINE
Flotation and gravity mill
South-west of Kingman

Tungsten

Not operating - shut Spring 1957.

(Report - MILLS - NORTHERN DISTRICT)
Sept. 30, 1957 (In Geology file)

B.J.SQUIRE
Field Engineer

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Abstracted 6/16/80 JH

Boriana file

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
FIELD ENGINEERS REPORT

Mine GUNSLINGER (McCracken) Date June 3, 1980

District Owens (Mohave County) Engineer Clifford J. Hicks CJH

Subject: Field Visit To Mill

In a joint venture Fischer-Watts (property position and exploration) and Canadian Natural Resources, Ltd. (financing), have let a management contract to American Mine Services of Denver to operate the Gunslinger Mine (formerly the McCracken Mine) and the mill at Yucca (formerly the Boriana Mill).

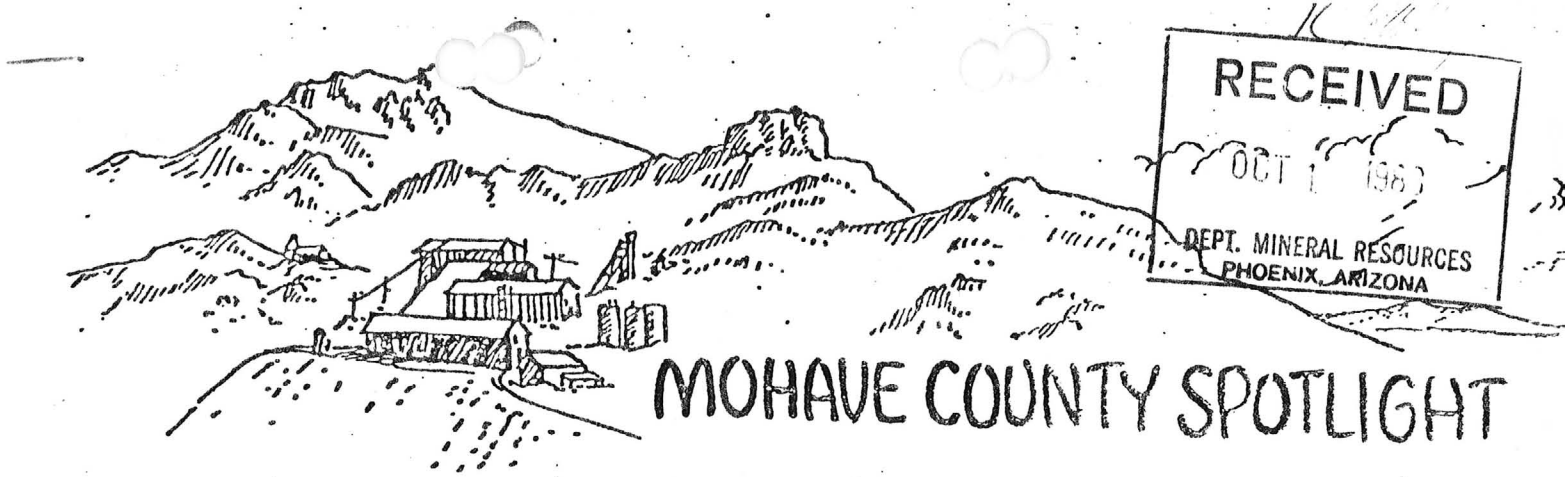
The DMR engineer met with concerned parties in the office trailer at the mill site four miles south of Yucca, Arizona. Present were: M.D. Rowswell, Executive VicePresident, Canadian Natural Resources Ltd., 300 5th Avenue S.W., Calgary, Alberta T2P 3C4 Canada, phone (403) 264-4036; and Perry Durning, Geologist, Fischer-Watts, 114 Tucker, Kingman, Arizona 86401, phone 753-1622 (office), 753-1671 (home). Robert Green is the Project Manager.

Lead-silver ores from the Gunslinger Mine tailings will be truck hauled 45 miles to the mill. There are 25,000 tons of +4.0 oz.Ag/ton tailings at the mine which will eventually be open pitted. Primary and secondary crushing will be done at the mine and tertiary grinding at the mill. The mill is being expanded to handle 400-500 tpd. Heavey equipment is being purchased in Mesa, Arizona.

Hiring will be done locally with a labor force of 38 anticipated. They now need a mill superintendent, a mine superintendent, a mining engineer, a metallurgist, and mill hands experienced in flotation.

Start-up is expected by July 1, 1980.

CJH:mw



MOHAVE COUNTY SPOTLIGHT

Vol. VII October 1983 No. 10

Published by Mohave County Historian, P.O. Box 390, Kingman, Az. 86402

Popularity of Publication

All the publications on the Mohave County history, by Roman Malach, are in many places, and comments about them are published and received by Malach quite often. The prestigious journal, "Arizona and the West", published by the University of Arizona, had a review of the Malach's almost every publication. By request, those publications are on the library shelves of the Princeton University, California University, University of Wyoming, Alaska University, and in other higher learning institutions.

Individuals write comments to Malach about his publications, as this one, dated August 16, 1983, and received from Wesley E. Steiner, director of State Department of Water Resources in Phoenix:

"Thank you for sending me copies of three of your recent publications. I found them fascinating, and will see that they become parts of the Department's library. I would appreciate information on how I might order other of your works."

No Mining At Hackberry

After a report about the reopened Hackberry mine, Malach made a special trip to the mine site and found no sign of any mining operations. The mine appears abandoned after some development work in recent months.

Outdated Book

The "Arizona Place Names" book by Will C. Barnes, revised and enlarged by Byrd H. Granger, was published in 1960, followed by two printings in 1968 and 1970, by the University of Arizona Press, is outdated.

Roman Malach is ready to add 71 new place names to the Mohave County chapter. The incorrect and misleading information in the Mohave County chapter is plentiful. Here are some examples: Boriana mine "is still producing", it was closed years ago. Bonelli constructed a stone house at the Bonelli Crossing on the Colorado River, now under water of Lake Mead. In the book, "but a duplicate of his house exists in Kingman". No such duplicate house ever stood in Kingman. Glenwood was located on the Colorado River near Topock, and not, as the book tells, "12 miles east of McCracken mine". It was Greenwood, which was located in that place. Many other errors could be mentioned, but this one tops them all. "Rabbit Patch. In this area are located the houses of prostitution in Kingman. Reference-Anonymous." That place is occupied by the high school athletic field.

Malach inquired if or when a new and enlarged edition with corrections will be published. No answer.

BORIANA MINE & MILL LIQUIDATION SALE

NO PRIORITIES

Write or Wire, W. D. Lindsay, Yucca, Ariz.
Care Boriana Mine

2—Mine Safety Appliance Co. Battery Charging Units Style No. 9816-250 volt, 2 amp, Control Panel with General Electric Battery Charger and Bulb No. 45x674.

All Portable Miner Lights and Batteries Complete with Rubber-Covered Lead Wire, etc.

1—Panel Switchboard, all wood plank construction 9"x5' fitted with the following:

1—690 amp enclosed terminal line switches.

1—AC Ammeter, 200amps, General Electric Type ARZ No. 1070914.

1—Lot of miscellaneous items.

1—Roots Connerville Rotary Blower 10"x15", S.D. Type R.B. No. 12970. 20 hp G.E. Motor and Switch.

3—Ore Reagent Feeder Bins. 20 Cells, Pipe and Fitting. Clarkson Reagent Feeder No. 234.

1—Roots Connersville Rotary Blower 102x152, S.D. Type R. B. No. 12969. 20 hp G.E. Motor, Starter and Switch.

2—Reagent Feeder Bins, 14 Cells. Pipe, Fittings, etc.

1—6'x6' Redwood Tank with Agitator. 3 hp U. S. Motor.

1—Storage Tank (feeding tank).

2—Cone Storage Feeding Tanks.

1—2'x4" Marcy Rod Mill No. 284, 7½ hp Westinghouse Motor No. 1236 and 1 hp Master Motor No. KD3566. Conveyor and Clarkson Reagent Feeder No. 470.

1—2'x4' Marcy Rod Mill No. 285, 7½ hp Westinghouse Motor No. 636.

9—Assorted Switchboxes, Conduit, Pipe, Etc.

1—1½" Deming Pump with 3 hp Motor.

1—Agitator with 8'x10' Steel Tank. 2 hp U.S. Motor with Suction Pump.

1—Rake Classifier. 2 hp Motor and Dorco Filter.

1—Rotary Dryer, 5 hp Motor, Shafting and Pulleys.

1—Denver Thickener No. 10961 Agitator, 6x8 Steel Tank, 3 hp Allis-Chalmers Motor No. 508D. Denver Lift Pump No. F258, Belt and Pulleys.

1—Dorco Filter and Rotary Dryer No. 48. 2 hp U.S. Motor No. 95812, Shafting, Pulleys and Belt.

1—7x4 Oliver Pump No. 1730, 3 hp G.E. Motor No. 460013.

1—9½x8 Oliver Vacuum Pump No. 10-912, 5 hp U.S. Motor No. 99984.

2—Centrifugal Pumps. 3 hp Westinghouse Motor No. 330929. Tanks, Pulleys

Switch, Throwout Switch, Valves and Pressure Gauge.
1—Throwout Sw
1—Corrugated Iron Building. All Pipe, Electrical Wiring, Conveyor Chute, Crus er Room, Ore Dump Building, Etc.
69—Mine Cars (all) 24x24x42, 18 Gauge, 4-Wheel Roller Bearing 11½" Dia. 2¾ Tire, 17" Wheelbase.
1—6'x20' Redwood Tank.
1—8'x20' Redwood Tank with agitator and 8 hp U.S. Motor No. 97479.
1—3'x7' Galvanized Steel Tank.
1—6'x8' Redwood Tank.
1—5½'x5' Redwood Tank.
1—19½'x9' Redwood Tank.
21—Car Wheels.
1—Lot of Car Parts.
1—11x23 Water Tank.
1—19'x25' Water Tank.
3½ tons Rod Mill Rods.
1 Bldg. 14'x60' (office warehouse).
1—Oil Switch.
7—Ore Bins, Chutes, Doors, Etc.
1—Metal Cabinet.
1—Flotation Table.
1—Rainbow Water Softener 80,000 Gr. Capacity.
1—Sawmill 5 hp Cutoff Saw and 1 7½hp Rip Saw.
1—5 hp Friction Hoist, 300' ⅝" Cable and Incline, Flat Car.
2—Reels ⅝" Cable Lumber I Bram Corr. Galv. Iron, Etc.
Misc. Office Equip., Coolers, Filing Cabs, Filing Safe, Etc.

1 CONTRKTR ASST/OFFICE & D
1 LARGE OLIVER FILTRE & D
2 LARGE THICKNERS
2000' 4" O.D. TUBING 3/16,
50' LENGTHS ETC, ETC.

6-803
(January 1952)

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

Dale No. 194

SUMMARY REPORT OF MINERALS EXAMINATION

State Ariz. County Mohave Mineral Products ~~gold~~ molybdenum copper tungsten

Name of property or deposit Bariana

Date examined 2/13/59 Engineer V. B. Dale Date of this report 4/1/59

Reason for examination Appraisal of tungsten deposits, Reg. III, Acct 3423.

Engineer accompanied by No one Address

Extent of property 28 unpatented lode claims

Owner Dye and Bathrick Mining Co. Address Kingman, Ariz.

Leased or optioned to No one Address

Location of property (be specific) Secs. 12 and 13, R. 15 W. and secs 7, 18, and 19, R. 16 W., T. 18 N. on the west slope of Hualpai ~~Mountains~~ Mountains

Type of deposit and mineralogy (brief description) Quartz veins cut phyllite. Wolframite, scheelite, and chalcopyrite occurs as pockets & masses in quartz in 2 groups of small veins (about 90 feet apart). Ore zones rake about 45° NE.

Known dimensions of the deposits

Length 1,200 ft. Width 10 inches Depth 1,100 ft.

Attitude of the deposit (strike, dip, etc.) Veins and schistosity strike N. 30° to 40° E. and dip from 75° SE to vertical.

Possible extensions; correlation of known showings The ore deposits extend onto the Bell Canyon property to the northeast. Considerable depth extension is reasonably probable.

Mine workings (brief description or attach map or sketch) (indicate whether accessable)

Nine levels at 100-foot intervals and 3 sublevels; flooded to 500-level, and less than 50% accessible above 500-level. See mine maps in Geol. Surv. Bull. No. 940-I.

(over)

Mining and milling equipment on property A complete 400 to 500 tons crushing, screening and concentrating plant less a 400 to 500 ton float-sink unit, and other miscellaneous equipment.

Past production (if any) 118,000 units of WO_3, a few tons of 30% Cu concentrates.

Present rate of production (if any) None

Sampling (describe briefly, or attach sketch) See Geological Survey Bull. 940-I.

Tentative Estimate of Reserves

(Subject to revision when assays are received or after engineering calculations)

Measurable 30,000 dumps tons ~~tungsten ore~~ Grade 1.5 lbs WO_3/ton

Indicated 10,000 tons tungsten ore Grade 1% to 1.5% WO_3

Inferred 44,000 tons tungsten ore Grade 1% WO_3

It is reported that gob in mine contains 0.3% WO_3 - not verified.

Mining method (actual or ~~suggested~~) Cut and fill.

Milling or processing method (actual or ~~suggested~~) Flotation or heavy-media separation.

Processing tests suggested None

Tentative conclusion and decision This mine is the biggest Arizona producer. It is capable of producing more tungsten in the future than it has produced in the past.

To be accompanied by brief letter giving examining engineer's general impression of the deposit, his impression of the owner, and any other confidential information he may care to submit. Refer to any known prior examinations and reports. May be executed in pencil. Should be mailed within 24 hours after examination is completed.

Send original and one copy to Washington Office.

Interior--Duplicating Section, Washington, D. C.

76412

PRODUCTION POSSIBILITY SURVEY

TYPE NO. 1

DEPARTMENT OF MINERAL RESOURCES
STATE OF ARIZONA
FIELD ENGINEERS REPORT

Mine BORIANA TUNGSTEN MINE Date October 6, 1942.

District Owens, Mohave Co. Engineer Elgin B. Holt

Subject:

PRODUCTION POSSIBILITY

OWNER: Molybdenum Corp. of America; Mark Hirsch, Pres., 500 5th Avenue, New York City; W. H. Munds, Resident Manager, Yucca, Ariz.

METALS: Tungsten and copper - tungsten predominating.

LOCATION

Property is located on west side of the Hualpai Mountains, Mohave County, Arizona, around 20 miles ~~S.~~ E. of Yucca, and is reached from Kingman, Via Yucca, by a fairly serviceable dirt road, which is maintained by the county.

INTERVIEW

On October 5, 1942, I had an interview in Kingman with Mr. W. H. Munds, Resident Manager of this property; and he gave me the following data concerning the same:

AREA

The Boriana group consists of 16 unpatented mining claims.

VEINS

There are ~~a series of 4~~ 4 veins, each vein being made up of a series of stringers of tungsten ore from 1" to 15" wide.

DEVELOPMENT WORK

Development work consists mainly of tunnels and raises, aggregating 15,000 feet. There is one inside winze sunk vertically to a depth of 450', at a point 2,900 feet from portal of main tunnel. There are three levels in said winze with 5,000' of lateral work.

MILL, TYPE & CAPACITY

A 200-ton combination gravity and flotation mill is located at property, and produces a product running 70% WO3, which is shipped to the company's own tungsten reduction and manufacturing works at Washington, Pennsylvania.

1941 PRODUCTION

Ore milled during 1941, per Munds, amounted to 16,000 tons, assaying 1.12% WO3. Tails assayed 0.12% WO3. Concentrates produced, during this year, contained 16,000 units of WO3.

1942 PRODUCTION

Ore milled furing this year amounted to 6,000 tons, assaying 1.12% WO3. Tails assayed 0.12% WO3. Concentrates produced contained 6,000 units of WO3.

ORE RESERVES

Mr. Munds stated that no attempt is made to maintain large ore reserves in the mine, due to swelling ground. Therefore, ore is practically mined as fast as developed in order to save maintainence costs of keeping drifts open. However, around from 4 to 6 months supply of ore is kept blocked out ahead of stoping operations, in order to keep the mill operating without closing down.

OPERATING COSTS

Munds also stated that he is not at liberty to give full details regarding operating costs, as such information would have to be secured from Mr. C. Q. SCHLERETH, consultant for company, Box 258-B, Route #8, Phoenix, Arizona. Or such information might be secured from the company's New York office, as above set forth. However, Munds stated that the company is now paying the regulation scale of wages generally paid Mohave County miners and other workmen, which now amounts to an average increase of 22.5% over rate of pay for 1942.

DIFFICULTIES

Mr. Munds further stated that due to the scarcity of skilled workmen during 1942, as well as to the fact that many of his first ~~xx~~ class men left Boriana in order to take higher paid jobs at nearby defense projects, and which skilled men have been partly replaced by unskilled miners and muckers, which resulted in the new underground employees mixing ore with waste and waste with ore, - that for all these reasons, the production of tungsten, as well as a small amount of copper concentrates, which is produced as a by-product, have fallen off at least 50% during 1942 over what the production of these metals amounted to during 1941. He also stated there is now a 25% shortage of mine workers and these mainly consist of a very poor quality, as it takes fully 6 months time to train muckers and miners, in this particular mine, to selectively mine and sort the tungsten ore underground. He also stated that the type of men now employed, or rather available, manifest a spirit of indifference in the work they are carrying on.

BORIANA OPERATING AT A LOSS

Munds also stated that operations at Boriana are now being carried on at a loss, as far as the mining and milling of ore are concerned. That if the present pegged price for tungsten could be increased to a figure covering production costs, and no more, that Boriana could go along and probably increase production to around 3,000 units of WO3 monthly, due to the fact that his company manufactures its own tungsten output. But in such event, he stated there would have to be provisions made to increase labor costs sufficiently to compete with the ~~high~~ defense projects mentioned.

Elgin B. Holt.

A PRELIMINARY REPORT ON THE GEOLOGY OF THE TUNGSTEN DEPOSIT AT BORIANA, ARIZONA

FOR THE

NEVADA-MASSACHUSETTS COMPANY

BY

PAUL F. KERR

SONORA, CALIFORNIA

AUGUST 23rd, 1936

INTRODUCTION

PURPOSE OF INVESTIGATION

The present study is intended to serve as a preliminary survey of the geological conditions at Boriana in order to determine whether the deposit warrants a more thorough investigation from the economic standpoint. An attempt has also been made to make a general estimate of the future to be expected from the observed geological conditions. Evaluation of the mining methods and study of the mining costs is a mining problem and does not come within the scope of this investigation.

It should be kept in mind throughout the entire report that the study is entirely preliminary in character and is devoted to the more general features of the deposit. Three days were devoted to a study of the underground workings and the surface. For the most part the lower levels and the more recent workings in the mine were visited. The time was about evenly divided between the study of the underground workings and the study of the surface.

OWNERSHIP OF THE PROPERTY

The Boriana Mine is owned by the Boriana Mining Company. The Boriana Mining Company has headquarters in Whittier, California and is the outgrowth of the oil well tool manufacturing industry. The company is largely owned by the Sievers family of Whittier, California and Mr. J. P. Sievers of Whittier is Vice President and Executive officer of the Company. The company owns twenty three unpatented claims distributed along the vein system. In addition it owns a one-third interest in a group of prospects to the north. Full ownership of a portion of this ground is also claimed but the title is at present in litigation.

PAST PRODUCTION

Limited mining and some development work were carried on in Boriana during the war. Later the Stoody Company of Whittier took charge of the property and carried on a development program. In 1932 the entire control of the property was taken over the Sievers family. Since that time the Boriana Mining Company has been under their control. The mine superintendent at Boriana is Mr. David Rankin. The mine foreman is Mr. Daniel Parker.

LOCATION

Boriana is located about 18 miles northeasterly from Yucca, Arizona on about the crest of the Hualpai Mountains. The elevation is about 5,000 feet above sea level and the climate is reasonably agreeable. The elevation of Yucca, Arizona is 1800 feet and the climate is usually of the hot desert type. Yucca is a station on the Atchison, Topeka and Santa Fe Railroad and all eastbound trains stop for water at Yucca. Westbound trains stop at Kingman some distance to the north.

GENERAL GEOLOGY

The Boriana region belongs in the Basin Range geological province. This province covers a wide area which extends from the Sierras on the West, to Utah on the East, from Idaho on the north to Arizona on the south and California on the southwest. Throughout this area are numerous more or less isolated mountain chains. Most of these mountain chains have a north-south trend and are separated by flat valleys and basins from five to twenty miles in width. One of the characteristic features of the region is the fault line development along the foothills of many of the ranges. The Hualpai mountains appear to be typical of this province and are similar in many respects to the mountains throughout Nevada.

The Hualpai Mountains in the vicinity of Boriana contain igneous intrusives which enclose schist and slate. The mass of schist and slate at Boriana is several miles in length and in places is one-half mile across. It is either vertical or dips at about 80 degrees to the east. The mass probably represents a large roof pendant supported by surrounding igneous rock.

The slate-schist mass represents an almost unbroken unit extending from the igneous mass on the west to the igneous mass on the east. Faulting has occurred throughout but the displacements are comparatively small and have not disturbed the general attitude of the strata.

Tungsten deposits occur in quartz veins located near the center of the schist and slate area. Four distinct vein systems have been encountered in the workings. All contain ore shoots to a greater or less degree. Exposures of quartz to the east of the vein system now being worked indicate the possibility of other parallel veins. These veins have not as yet been developed. It is probable that they do not carry tungsten at the surface or prospectors would have mined the veins before this since there was a considerable amount of mining activity at Boriana during the war.

Two types of igneous rocks appear to be present in the Boriana area. One is a massive granitic gneiss and the other an intrusive which in the field has tentatively been called a quartz monzonite. The crystallization of the quartz monzonite was apparently followed by extensive high temperature alteration. Alteration has invaded quartz monzonite irregularly and carries a certain amount of tungsten. It is believed that this alteration provided the tungsten which mineralized the vein now being mined at Boriana. Thus two types of ore deposits may be found in the section. First, the quartz veins of the Boriana mine which carry wolframite and scheelite. Second, the alteration zones on the surface which carry scheelite and to a much lesser degree Wolframite.

ROCK TYPES

The metamorphic series consists of slate, schist and metamorphosed sandstone. It has a pronounced slaty cleavage and breaks into blocks or slabs. The schist is micaceous. The slate has a high quartz content and contains some slit. Thin paper-like sheets provide what is called a fissile structure in places. They also form a weak zone which produces heavy ground. This ground swells with moisture and slabs fall into the mine workings. In such areas a large amount of timbering is required. Away from the weak zones the ground stands reasonably well in all of the workings. The inclination of the slate and schist area varies from 80 degrees to vertical and the dip is always east. In places at the surface a false inclination in the opposite direction has been produced by hillside creep. These rocks probably represent an old sedimentary series that has been metamorphosed. There are several rock types somewhat variable in nature. Occasional small limy lenses may be observed and lime streaks are common throughout the workings. Sandy phases are in evidence throughout the eastern part of the schist area.

The quartz veins carrying tungsten ore are confined entirely to the metamorphic series. Whether they extend into the underlying igneous rock has not yet been determined. It seems likely that they may change to alteration zones at the contact.

The granitic gneiss has a striated gneissic structure. Large phenocrysts of orthoclase lie in parallel position throughout the rock. These crystals are about one inch in length and one eighth inch in width. They are surrounded by mica, quartz, and albite. It is considered from field relationships observed that the rock is essentially of igneous origin. Any fault movement between the granitic gneiss and the metamorphic series is slight. In places the contact appears to be somewhat irregular and strongly suggests the type of contact produced by an intrusive mass. It is thought that the structure of the gneiss is due to movement or flowage of the igneous material as it extended along the walls of the metamorphosed pendant. At a distance from the metamorphic mass it might be expected that the structure would disappear to a considerable degree.

QUARTZ MONZONITE

The term quartz monzonite as used in this report is entirely a field name. The rock can hardly be properly classified without microscopic study. The rock mass, however, represents an important field unit of considerable significance in any study of the origin of the Boriana tungsten deposit.

The quartz monzonite forms a rounded stock which apparently truncates a portion of the vein system of the Boriana deposit at the northern end. Whether the veins have been definitely cut off or have been diverted to the east by this intrusive has not been proved. The relationship of the veins to the intrusive as shown on the map, would indicate that definite truncation has taken place. A large mass of the quartz monzonite is exposed on the crest of Robinet Ridge. This mass forms a hard-rock exposure which rises fully 600 feet from the canyon below. Tungsten prospects have been developed both at the base and the top of this exposure and it is reported that other areas of tungsten mineralization lie between.

GREISEN ZONES

Scheelite and some Wolframite are found throughout Greisen zones which penetrate the quartz monozonite. These zones contain considerable areas of Muscovite Mica in coarse flakes. The prospectors refer to this as "Lithia Rock," although it does not resemble the well known Lithium bearing Mica of other localities. These zones appear to represent areas of high temp rature alteration in the quartz monzonite. Tungsten mineralization has accompanied the alteration. Alteration zones vary from a few inches to 15 or 20 feet in width and appear to be irregularly distributed. Boundaries of the alteration zones are in many cases indeterminate on preliminary inspection. A complete examination

of the whole hillside with ultra-violote light, would be necessary to determine the economic possibilities of Robinet Hill as a tungsten deposit. On preliminary investigation it is apparent that such examination would be worthwhile. The title to a portion of the area, however, was under dispute at the time the property was visited, and it was not considered advisable to attempt any elaborate study.

*

QUARTZ VEINS

The most important tungsten deposits now being mined occur within quartz veins which lie in the metamorphic area. These veins strike at an average of about north 30 degrees east and dip to the east at an angle which lies between 80 degrees and vertical. The tungsten minerals are Wolframite and Scheelite. Chalcopyrite and Molybdenite occur along with the ore and both Calcite and Flourite are common in the veins.

The veins vary in size and represent fissure fillings. Four distinct vein systems have been determined in the underground workings. These are generally referred to by number--the vein on the west being known as No. 1, the vein on the east being known as No. 4. Vein No. 2 has produced the most important shoot of ore. Recent development on vein No. 4, however, indicates that this vein may also produce an important ore body.

Although these veins are referred to by number as individuals, they really represent groups of veins which occur within a limited area. These groups seldom contain less than two or three separate and distinct veins. In places as many as ten small veins may make up the group. The group generally covers an area which varies from 3 feet to 6 feet in width and in places may be even ten feet thick. Mining operations are usually based on the total amount of quartz present. It has been found that on the whole the tungsten mineralization varies uniformly with the amount of quartz present. It has been found in mining No. 2 vein that tungsten trioxide is present to the extent of about $2\frac{1}{2}$ per cent throughout the entire vein. Recent developments on No. 4 vein indicate that the tungsten trioxide content is about $3\frac{1}{2}$ per cent.

In mining operations the ore values are considerably affected by dilution due to the Schist which lies between the veins. A cut and fill method of stoping has been employed. In addition the ore is screened and hand sorted in the stopes. All fines from the screening

go directly to the mill. In sorting it is endeavored to remove a large part of the Schist which is broken with the quartz. A chemical method for determining the amount of quartz present in the ore has been developed by Mr. Rankin, the superintendent. The method is based upon the fact that the schist which is associated with the vein contains a small amount of titanium while the vein of quartz is virtually free from titanium. The determination of titanium in the ore feed that goes to the mill gives an index to the amount of schist present. During development work the amount of quartz present in the ore feed usually varies from about 18 per cent to 25 per cent. When the mine is operating in a normal manner and the feed is derived entirely from stoping operation, it is said that the normal quartz feed varies from about 35 per cent to 40 per cent.

On rare occasions single veins containing the entire quartz thickness may be encountered. Ordinarily, however, in mining, two veins from 4 to 10 inches in thickness may be encountered accompanied by several thin stringers. When the total quartz in a stoping width is less than 10 inches the ore is no longer mined. Throughout the ore shoots the ore normally averages from 14 to 20 inches and the veins are remarkably consistent in the total amount of quartz present. The persistence of the vein throughout these areas is also surprising.

The principal ore shoot of the mine has been developed on No. 2 vein. This shoot lies from about 500 feet to 700 feet along the level, and has extended from the surface to the 600 level. Most of the Boriana production has come from this ore shoot. The rake of the ore shoot is decidedly to the north. The distance across the shoot at right angles to the rake is approximately 450 feet. Apparently this shoot is better developed at the lower level than at the surface, and it seems likely that it may continue in depth. It is reported that the ore on No. 4 vein contains higher tungsten values and also contains more copper than the ore on No. 2 vein. No. 1 and No. 3 veins have not been highly

productive. These veins, however, appear to present better showings in the lower levels. It is the contention of the management that in the lower levels No. 1 and No. 3 veins combined will probably produce as much as No. 2. This prediction may be realized although it has by no means been proved.

No. 3 vein is distinguished from the other veins by the presence of a small amount of purple flourite.

The normal distance between No. 1 vein and No. 4 vein is about 140 feet. No. 1, 2, and 3 are usually closely spaced, lying within from 10 to 20 feet of each other. On the 6 level No. 1 and No. 2 veins have been mined together because of their proximity. At the extreme north end of No. 6 level it is difficult to distinguish some of the veins and separate them according to the 1, 2 and 3 classification. In zones of strong mineralization, however, the classification appears to hold very well.

Extensive crosscuts to the east of the vein system have not been attempted. Exposures of quartz at the surface would indicate the desirability of some exploration at depth. On the 3 level the footwall has been crosscut for a considerable distance to the west. The 3 level is also entered by means of a crosscut tunnel. From this tunnel the Sievers crosscut tunnel has penetrated the country rock for approximately 400 feet without encountering any mineralization of consequence. However, no comparable crosscut has been attempted to the east, in spite of the fact that the quartz veins on the surface east of the vein system are much more prominent.

The continuation of the tungsten bearing veins along the strike and also in depth has not yet been thoroughly determined. To the north the veins may be cut off by the intrusive stock. Southward there appears to be no such limitation although they have not been traced and may not continue. The projection of the veins indepth is largely a

matter of opinion. It seems reasonable to believe, however, that a vein system that has proved to be continuous from the surface to the present depth of the workings should continue as far as the base of the metamorphic series. The extension of the veins into the underlying igneous rock is to be doubted. One would expect to find more evidence of quartz veins in the quartz monzonite stock if such were to be the case. The possibility should not be overlooked that the quartz veins may give way to Greisen zones when the igneous contact is encountered at depth. The distance to this contact is hard to predict.

FAULTS

Two types of faults have been observed in the mine workings and it is possible that a third type may also exist. The faults most frequently encountered are steps faults which run almost parallel to the vein system. These dip about 45 degrees to the east and displace the veins from 3 to 10 feet in a reverse manner. There is usually gouge along these faults and the veins are easily picked up on the opposite side in mining operations. The chief disturbing feature is the broken ground which accompanies the faulting. In several places drifts have been driven for considerable distances in such zones. These drifts have required a large amount of timber and in some places it has been impossible to maintain the openings even where timber was used. Several of these faults have been found in the workings and it seems likely that they may be expected at a frequency.

A vertical fault with an east-west strike cuts through No. 2 ore shoot in about the middle. This fault has a displacement in a horizontal direction of from 10 to 20 feet. The north side also has moved upward with respect to the south. The amount of vertical displacement is more or less indeterminate. It seems likely, however, that the movement has somewhat displaced the ore shoot as encountered on No. 2 vein.

Another type of fault may be present, similar in nature to the step faults already described but pre-mineral in origin. In places there appears to be an absence of gouge along the fault plane and the entire rock is firmly cemented. It is possible perhaps that both pre-mineral and post-mineral movements have taken place along the step faults.

No major faults have been observed in the area. The contacts on either side of the slate and schist zones appear to be free from faulting. Although it has been thought in some previous geological work that a parallel fault cut through the schist just west of the tunnel on the third level, the crosscut to the west of this area would indicate that such a fault did not exist. It seems more likely that earlier workers were misled by the hillside creep of the slate which gives a false attitude in surface exposures.

GEOLOGICAL POSSIBILITIES OF FUTURE DEVELOPMENT

If one limits further mining at Boriana to areas of proven ore virtually no future exists. It is even true that the lowest level in the mine is out of ore. On the other hand, it does not seem that these features paint exactly a fair picture of the future to be expected. It seems likely that the lowest level (7 level) was not driven far enough to encounter the ore shoot. The vein system and ore shoots have also shown a continuity which it seems reasonable to project to lower levels. If this principle may be assumed, it seems possible to make some limited predictions concerning the possibilities of future development at Boriana.

The most immediate prediction concerns the newly discovered ore bodies on No. 4 vein. It seems reasonable to predict that this ore body should be available for stoping from the 6 level to the 4A level. Mr. Sievers, in a letter written August 22, estimates a value in place of

$588,000 for the block of ore on No. 4 vein exposed between the 6 level and the 4A level, assuming a vein width of 18 inches and a WO_3 content of 3½%. This estimate may be justified. It should be pointed out, however, that this is merely an estimate of ore in place and yields no clue to the profit to be expected from removal of the ore. For example, the ore as mined at the time the property was visited carried less than 20% quartz as indicated on the assay books. Thus four tons of slate were going through the mill for each ton of quartz. This situation was probably unusual since development ore from the 500 level drift was going through the mill at that time. On the other hand, over a period of months the average amount does not appear to have exceeded 35%. Furthermore, there is a constant loss of ore in the stopes, during sorting and a constant leakage of fines through the cracks between boards on which the ore is broken. Likewise, areas of unusual dilution and small gaps in the ore occur along the step faults. There is also a mill loss of at least 10%.

One should apply these demonstrated factors together with the entire cost of mining, milling, and selling, in determining the profit to be expected from removing the ore on No. 4 vein. In such a computation so many variables are involved that any result is only an estimate. It is probably a safe guess, however, that in spite of the estimated value of the block of ore the ultimate profit to be realized from its removal may be so reduced by the factors outlined above that it might turn out to be disproportionately small for a mining operation. At least this point should be investigated.

It should be pointed out that the ore shoot No. 4 has not yet been completely developed. It is reasonable to believe that it may extend farther to the south and if so the tonnage ultimately reclaimed above the 6 level may be considerably more than estimated.

The continuation of both the vein system and the ore shoot below the 6 level is largely a matter of guess work. It is not unreasonable, however, to assume that two hundred feet more depth may be fully developed below the 6 level. It also seems likely that limited ore shoots on the three veins may be completely recovered. A corresponding ore shoot on No. 4 vein may also continue for two hundred feet more in depth. The present management is inclined to credit ore shoots on No. 1 and No. 3 veins equivalent in value to No. 2 and extending for two more levels. This expectation is probably optimistic in certain respects but is not impossible. The writer would be more inclined to project the No. 2 and No. 4 veins and count upon the parallel ore shoots in No. 1 and No. 2 veins to make up for unforseen losses in the major veins. It must be admitted that such unforseen losses have repeatedly occurred throughout the history of mining operations at Boriana. It would hardly seem fair to expect that they would not again be encountered in future operations. If one is willing to accept the above reasoning, it is logical to expect that the next 200 feet of depth below the 6 level in the Boriana mine may yield in the neighborhood of 1000 tons of concentrates.

It should be kept in mind that the figures given above are merely estimates based upon geological conditions. If the conditions continue as predicted they are apt to be reasonably correct. If conditions change they will doubtless be considerably in error. They are included in this report merely in an attempt to evaluate the geological features in economic terms. They lead to the conclusion that from a geological standpoint there is no reason to expect any lessening in the production of the Boriana mine for the next few years. Also it is not unreasonable to expect that as further knowledge of the deposit is obtained from mining operations, the production may be increased.

No attempt will be made to evaluate the ore producing possibilities of the tungsten bearing zones in the igneous rock. As mining proceeds to lower levels and each successive level is driven farther to the north, the underlying igneous rock will ultimately be encountered.

At that time prospecting along the tungsten bearing zone in the igneous rock will become a normal part of mining operations.

The neglected vein represents a Greisen zone in the granitic gneiss. It contains Wolframite and a small amount of schoelite. Where observed it varies from 6 inches to 10 inches in thickness and is only moderately mineralized, probably containing tungsten values of less than 1 per cent WO_3. This vein has been located in places over a total distance of several thousand feet. It is not easily accessible, however, from the present workings and it is doubtful whether that the values exhibited in the vein warrant economic development.

CONCLUSION

A preliminary survey of the geological conditions at the Boriana Mine indicates thatthe deposit warrants a more thorough investigation from the economic standpoint. The ore shoots appear to be reasonably continuous and justify the expectation that they will continue to lower levels. The tungsten values encountered in the ore shoots are sufficient to justify mining. Just how profitable the undertaking is, however, can only be determined after an economic study by one thoroughly familiar with mining methods and conditions, and particularly costs.

Geological conditions indicate that there is no reason to expect a cessation of mining activity at Boriana at any time in the immediate future. On the other hand it seems more likely that operations will expand. There is no reason to expect the ore deposits to bottom for some time to come. Even when the bottom is reached there is a possibility of future development in the underlying igneous rock.

On the whole, the Boriana deposit is worthy of favorable consideration from the geological standpoint. The tungsten occurs in such a form that it can be easily separated. The vein structure is simple and with reasonable attention to ordinary geological details it should be

easily followed. The ore suffers considerable dilution in stoping, but it is possible that the mine operators could reduce this factor. Faults should cause no serious difficulty in mining.

It is believed that both the surface and underground geology could be further studied to advantage, both from the standpoint of predicting the future of the deposit and from the standpoint of present mining operations. Even on preliminary investigation it appears certain that the Boriana deposit is worth while and should constitute the source of important tungsten production for some time to come.

Respectfully submitted,

PAUL F. KERR

SUMMARY

Property consists of 16 Lode Mining Claims, unpatented.

Titles are believed to be perfect.

A modern and well equipped 150 ton per day mill.

Mine developed upon 5 levels (vertical depth 725 feet); has all necessary equipment for operations above No. 5 level but may need additional air compression when more stopes are prepared for ore extraction, depending upon the number of drills later put in use.

Mine not at present able to produce more than 35 tons of ore per day because of stope limitations.

Eight thousand four hundred thirty six (8,436) tons of Positive ore having a net value after mining and milling of $90,213.60 and six thousand four hundred ninety (6,490) tons of Probable ore having a net value of $61,113.60 or a total of $151,327.20, Possible ore may be placed at $225,000 or more.

Immediate additional preparatory work to increase the stoping facilities is required. Will cost $15,000.

Development work done, 13,562 tons of ore will supply the mill for 9 months at the rate of 50 tons a day.

The monthly production upon the values calculated from the mine sampling should have an average tungsten percentage in the tonnage, (WO3 at $10.00 a unit) of $21.88 a ton, a cost deduction of $7.00 a ton and a net value of $14.88 a ton or $22,000 a month at the mine.

Only a capable mine manager, experience in both mining and milling, should be put in charge, otherwise the above results cannot be obtained.

All costs have been based upon mine output and mill treatment of 50 tons a day.

C
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GRANVILLE MOORE
Consulting Mining Engineer
H. W. Hellman Building
Los Angeles

January 27, 1932

Mr. J. P. Sievers,
Security Investment Company,
Whittier, California

Dear Sir: THE BORIANA MINING COMPANY

In accordance with your instructions, I wish to advise that I have made a careful examination of the real and personal properties of the Boriana Mining Company and have the following to report and submit for your consideration.

Properties

The Boriana Mining Company's properties are situated 18 miles in a northeasterly direction from the town of Yucca, in the Walapai Mining District, Mojave County, Arizona.

The properties consist of fifteen (15) contiguous lode mining claims, and one separated lode mining claim, not patented but title held under the laws of the United States Government by virtue of discovery and location together with annual assessment work which has been performed and recorded for the year ending July 1st, 1932. The names of the recorded lode mining claims are Francis, Francis No. 1, Francis No. 2, Francis No. 6, Francis No. 3, Francis No. 5, Sadie No. 1, Sadie No. 2, Sadie No. 3, Sadie, Sadie No. 5, Sadie No. 6, March Wind, March Wind No. 2, March Wind No. 1 and Helen Ruth. The Water supply is obtained from a well sunk upon the Helen Ruth which claim was taken up for water rights.

All improvements consisting of mill, power house, blacksmith shop, boarding house, assay shop, bunk houses and manager's home are,

resulting in a recrystallization of the original shale particles. The rock is completely crystalline, being composed of a very fine grained interlocking aggregrate of quartz, and cordierite crystals of irregular shape but sharp in outline. Biotite and muscovite are abundant in small orientated flakes which occur scattered uniformly throughout the rock. The rock is obviously rich in alumina, with moderate silica, magnesia and iron, and low in alkalies.

The shale rock, as covered by the lode mining claims of this company, has a width of approximately a half a mile, and is the remnant extension of the greater body of shale which is observable for several miles as the mine is approached from the valley at the South.

The shales, sedimentary rocks, where originally laid down horizontally, or nearly so, but within the area covered by the company's claims due to pressure, heat and torsion from beneath, were raised and arched into nearly a vertical anticlinal fold. Along the strike of this fold, the point of the greatest stress, where the shale dips in one direction easterly and in the other in a westerly direction, the structure was weakened, loosened and distinctly stratified when compared with the remaining massive shale. Within this line or zone of stratification which has a width varying from forty to sixty feet or more, a strike of north thirty degrees east and a dip averaging eighty degrees easterly, were created openings or crevices suitable for the deposition from the highly mineral solutions emanating from below and within which were deposited, among other metals, wolframite, scheelite, chalcopyrite and minute quantities of the precious metals gold and silver.

While this stratified zone, within which the deposits occur, has a general dip to the east, this dip is not constant and regular but upon the contrary it is billowy and variable in different parts of the mine openings as illustrated particularly upon the No. 5 level where the dip is westerly.

Two pronounced post mineral faults have cut and thrown the vein at different elevations but neither of these had any bearing upon the

together with the equipment, located upon the Francis and Francis No. 1 claims with the exception of the pumping plant whichis upon the Helen Ruth.

ACCESSIBILITY

Yucca, a town in Mojave County, Arizona, at an elevation of 1,805 feet above sea level, is situated upon the main line of the A.T. & S. R. RR 350 miles easterly ofLos Angeles and 35 miles south of Kingman (the county seat of Mojave County,) Arizona. There is a good mountain automobile road from Yucca to the mine where the elevation at the No. 5 or main working tunnel is 5,000. The difference in elevation between the railroad station and the mine workings is 3,200 feet.

GEOLOGY

The country rock of hills surrounding the company's lode mining claims which cover a narrow area of shale is granite. The metamorphic rock in immediate contact with the shale is gneiss. Eighty per cent of this coarse grained gneiss, approximately, is composed of new metamorphic minerals, the remaining twenty per cent representing relic minerals antedating the metamorphism. The rock is moderately coarse grained and possesses a pronounced gneissic texture due chiefly to the parallel orientation of the mica flakes, but part at least to a tabular habit of the felspars parallel to the banding and to a stringing out of the quartz grains in the same plane. The quartz and albite tend to form an interlocking granular mosaic. Both minerals are quite clear, show no crystalline outlines, and quite certainly represent products of recrystallization. The micas, biotite and muscovite, are conspicuous and occur as well orientated plates lying in plane of gneissic banding.

The encasing rock within which exist the deposits of quartz, tungsten and copper occur in lenticular veinlets is without question a clay shale recrystallized under influence of dynamic metamorphism, heat and pressure

the mineralization of the veins altho they will have an economic bearing in the mining operations at least inthe area near them where they have shattered and crushed the formations thereby making the ground heavy and difficult to hold in place. The faults are shown upon "Exhibit No. 1". The lower fault is shown on the No. 5 level where it has a strike nearly the same as the vein with a pronounced dip to the west and the upper fault is shown at the top of the upraise on the No. 4 level where it also has a pronounced dip but towards the east.

There are no distinct demarcations separating the stratified rock zone from the massive shale but rather a gradual fading out of the stratifications into the solid mass; therefore, there exists no true walls, either hanging or foot walls which have influenced mineral deposition although invariably the deposition which has occurred has been close to the western limit of the stratifications.

The ore deposition within the veins occurs as lenticular veinlets of which, in many instances, there are several parallel one to another within a few feet of width and separated by bands of shale. It might have been expected that at some favorable place within the vein system these small veins would have joined into one and have made an impressive width but such has not been the case; in instances where they have joined the width of either has not increased.

WATER

Water is obtained from a well drilled upon the Helen Ruth Lode Mining Claim which is located about six thousand feet south of the mine at an elevation of 4,350 feet above sea level. Pumping tests during the dry periods of the year have demonstrated that the capacity of the well can be rated at twenty five gallons a minute or about one hundred and forty five tons per twenty four hours. This quantity with the use of Dorr thickners and the conservation of the water is sufficient for the

mill treatment of one hun'red to one hundred and twenty five tons per day of the character of ore produced from the mine. Sufficient tank storage has been installed to provide for the requirements of the operations. Due to the difference in elevations it is necessary to raise and pump the water from the well to the storage tanks six hundred and fifty feet above.

About one and one half miles north of the mine there is another prospective source of water supply upon three hundred and twenty acres of land held under lease by the company. Small springs exist there which probably can be developed into an important water supply, if it should be required, and at an elevations from which it would flow by gravity to the storage tanks. In addition, the mine itself is making a small quantity of water--about five gallons per minute--from a fault near the entrance of the main working adit at the five thousand foot elevation.

Mill and Mine Equipment

The new millingplant having a rated capacity of treating one hundred and fifty tons of ore in twenty four hours is modern and up-to-date in every respect and all machinery and equipment is in excellent condition. With the exception of the dryer handling the flotation concentrates, which did not give satisfaction, probably no other improvement in the immediate future will be found necessary.

A complete description and map flow sheet of the mill equipment and machinery is contained in your files and, therefore, it would be superfluous to repeat the description in this report.

The mine is well provided with all necessary equipment, machinery and tools for the magnitude of past operations but with any marked increase in production additional compressor capacity will have to be

obtained. The Ingersol-Rand compressor which is now installed is giving 240 cubic feet of air and the Western Enterprise Engine Company is giving approximately 250-275 cubic feet. The practice has been to use this high pressure air for circulation of air in the stopes and drift faces as well as for running the drills. By using electrically driven fans a saving of air for the latter purposes will result.

The property is exceptionally well equipped with all the necessary facilities which go towards an economical mining operation; the power and compressor house is ample in size and equipment, the blacksmith house has all of the modern and necessary machinery and equipment; these together with assay shop, boarding house, bunk houses and superintendent's dwelling leaves little to be desired. Electric light and running water is furnished to all of the buildings which are of good substantial construction.

Development

I have no reliable information as to the exact time mining work was originally started upon the deposits but it was some time during the World War period when tunnel work was first begun probably at the Level No. 1 at an elevation of 5,527 feet above sealevel, and near the summit of the mountain, where the vein outcrops prominently. At this place the vein was split and two adits were driven nearly parallel. A drift of 372 feet long was run to the north on the easterly split of the vein where the ore had an average width of eleven inches. The first 150 feet from the portal was stoped to the surface and it is evident that the ore at the face was found too low grade to be profitable. An adit tunnel was also run on the westerly split of the vein for a distance of 70 feet but no commercial ore was found. This split section of the vein outcrops 10 feet from the main body and joins it at 250 feet from the portal.

At elevation 5,418 feet above sea level the Level No. 2 Cross Tunnel was driven 49 feet to where it cut the vein and from which point a drift northerly was driven 543 feet. The cross cut tunnel was continued beyond the vein, the entire length of the cross being 217 ft; at 193 feet a drift was run northerly for 137 feet on what is called the "Copper Vein" but no ore was found and the work abandoned. Upon the main drift no commercial ore was found for the first 40 feet but from here for 400 feet all ore between this level and No. 1 has been stoped; beyond this point the quartz seams pinch and separate into several, and the face shows no values. Because of the dangerous conditions existing above this level which is caved in several places and the fact that timbering prevents any attempt at systematic sampling no accurate statement can be made of the width of the ore previous mined in this stope but from what can be seen it is evident that the ore width was not to exceed 15 inches.

At elevation 5307 Cross Cut Tunnel Level No. 3 was run 452 feet; at 425 feet from the portal if cut the vein and drifts both north and southwere advanced a total distance of 743 feet, (566 feet northerly and 177 feet southerly). Beginning at the point the northerly drift starts from the cross-cut tunnel all backs of ore above this level have been stoped for a distance of 190 feet on the level to the No. 2 level above. From this point continuing towards the north the backs have been stoped for an additional distance of 180 feet to within a few feet of the No. 2 level; the block of ore remainingstanding in this stope has an average depth of 25 feet and an average thickness of 14 inches which would amount to about 600 tons.

A two compartment winze was sunk from this level, at a point 55 feet southerly from the connection of the cross cut tunnel with the vein, to elevation 5,200 feet above sea level.

The northernmost 340 feet of this drift has no showing of importance and beginning at a point 45 feet south of the winze the ore is irregular as to both widths and values to the south face.

At elevation 5,000 feet above sea level, Level No. 5, the adit started on the vein outcrop and continued through barren ground for 1,554 feet before indications of the ore began to appear. (My sample No. 1 was cut at this point.) 1,420 feet from the portal the first ore shoot of this level was encountered and continued for 150 feet where values ceased; this ore shoot does not appear in the No. 3 level above and values have nearly completely disappeared 90 feet above No. 5 Level so that whatever importance the shoot may continue to have must necessarily be hoped for from beneath this level floor.

The main drift of this 5th level extends from the portal 2,160 to the face; however, 15 feet south of the face a new course, N71°41' E., cross cut was driven 25 feet where it encountered a parallel vein which was first discovered at cross cut to upraise ore shoot No. 16. Beginning at the point where the cross cut, 15 feet south of the face, cut the parallel vein a drift was driven north, but, because it was found impossible to hold open this drift on account of heavy ground, was completely filled so that no examination of it or the stope above it could be made and no statement can here be made regarding the length of the drift, width and importance of the vein. The Company's maps show this drift to have been 174 feet long and that the ground above had been stoped 90' above its level floor for 200 feet in length. It is regretted that this drift was filled because due to its particular position it would have had great importance in ascribing definite value and tonnage to

this important section of the mine if the widths and values of the ore justified it. Due to uncertainty, resultant of this filling, it has a distinct bearing upon the positive tonnage which can be attributed to this ore shoot above this level to the No. 3 level and also to the ore below the No. 5 level. A fault dipping 30° to the west and striking north 36°-45' East (vein strike N. 30°-45' E) is first noticed on this level in the west cross-cut 1,170 feet from the portal, where the vein is thrown 6 feet to the west. The ground along the strike of faulting has been fractured and weakened making it heavy and difficult to hold in drifting and stoping. This accounts for the filling in the northernmost drift.

At elevation 5,200 feet above sea level from the bottom of the winze sunk from No. 3 level, the Number 4 level was driven both northerly and southerly from the winze short distances. The drift to the north where it is not completely sealed by the timbering is badly caved and it was impossible to examine or sample the vein; the length of this drift is not known but is said to be some 90 feet. The drift southerly from the bottom of the winze connecting with three compartment upraise from No. 5 level was run in a faulted section of the vein and no ore in place was found. The distance from the winze to the upraise is 45 feet and it will be necessary, therefore, to rehandle any such ore that may be moved from above this level to the main haulage level below. It is difficult to understand why the upraise from No. 5 level

was not directly connected with the winze. There is a fault showing at the top of the upraise dipping 35° to the east which has broken and weakened the formation of this elevation and undoubtedly it will have an economic influence when this ground is opened up, but at present little can be said of it.

Sampling

Because of uncertainty as to the correctness of the underground maps an independent survey was made of all of the openings, and the new plans, longitudinal and vertical sections are used in completing this report.

The ore occurring in a narrow vein or parallel seams or veinlets within the shale is largely made up of silica, alumina, iron pyrites, arsenical purites, iron oxides, manganese oxides, chalcopyrite, bornite and intruded shale.

The veins exposed in the underground workings were sampled systematically at regular intervals of five or ten feet depending upon the conditions governing the work. All necessary precautions to assure accuracy and certainty of freedom from outside interference in the sampling and in the various checks give me perfect confidence in the trustworthiness of this work.

Because of the manner of the ore deposition, usually in narrow parallel seams separated by bands of shale and the selective method of ore sorting underground which will have to be used, channel samples across the width of the drift or stopes solely included the ore seams and the shale bands were omitted. The metallic values are contained within the quartz and not within the shale. It must

distinctly be kept in mind that the ore widths and values attributed to each individual sample are the totals of the several seams of ore which fell within the scope of the samples as cut and that in making calculations of the tonnage recoverable from the ore reserves due allowance will be made for mining to the necessary widths to recover the ore credited to the scope of the sample and also for the inevitable loss of metallic contents the result of shooting, breaking and handling the ore to the ore shoot from where it goes to the mill.

The accurate chemical determination of the tungsten values within the ore is difficult and only well experienced and capable chemists can be relied upon to do the work. Fortunately a college graduate chemist who had had extensive experience in tungsten determinations was available to do the assaying in connection with this work and his work in turn was frequently checked by Smith Emery Chemical Co., and was found accurate and satisfactory. All samples were also run for copper, and enough were run to determine gold and silver content.

Presented herewithas "Exhibit 1" is a general Plan and Profile, showing all workings except the first seven hundred and thirty five feet of the main lower tunnel (No. 5). This is on a scale of 40 feet to the inch, and on this map are shown all samples of the underground workings with the location and widthof each sample and the percentage of WO3 and copper. "Exhibit No. 2", a reduction of the above map to a scale of 80 feet to the inch for the purpose of binding in this report. "Exhibit No. 3" a general plan of all underground workings which also shows location of mill and other buildings; this map is on a scale of 100 feet to the inch also shows geology. "Exhibit No. 4" a longitudinal section showing all mine workings accessible on a scale of 100 feet to the inch. "Exhibit No. 5" a cross section at "A--A" on a scale of 100 feet to the inch taken at right angles to the veins and across the main working and projected across the shale belt to the gneiss on either side.

Ore Reserves

Upon "Exhibit No. 1" are set forth the blocks of ore in colors; red colored blocks representing the positive ore and the green the probable ore. Because of the heavy specific gravity of the tungsten bearing quartz eleven cubic feet were calculated to the ton of ore in place.

Block	Tons	WO3%	Positive Ore Ore Width	Total WO3 Lbs per ton	WO3 Value $10 per unit.
A	570	2.53	11 inches	50.6	$ 25.30 per ton
B	265	2.53	11 "	50.6	25.30 " "
C	200				
D	400	2.44	17 "	48.8	24.40 " "
E	170	4.58	8 "	91.6	45.80 " "
F	5,500	1.56	16 "	31.2	15.60 " "
G	430	3.32	15 "	66.4	33.20 " "
H	900	2.52	20 "	50.4	25.20 " "
I	410	3.00	17 "	60.	30.00 " "
J	600	4.20	10 "	84.	42.00 " "
K	800	2.84	17 "	56.80	28.40 " "
R	500	2.22	15 "	44.4	22.20 " "
	10,745				

Estimating a loss of 20% in the ore in mining and a mill recovery of 80% of the Wo3 values contained in that ore.

Block	Gross Tons	Net Tons	Gross Val. per ton.	Gross Val. ore in place	20% Mining Loss	20% Milling Loss	Net Val per ton	Net Val. Ore.
A	570	456	$25.30	$ 14,421.	$ 2,884.20	$ 2,307.36	$20.24	$ 9,229.44
B	265	212	25.30	6,704.50	1,340.90	1,072.72	20.24	4,290.88
D	400	320	24.40	9,760	1,952.00	1,561.60	19.52	6,246.40
E	170	136	45.80	7,786	1,557.20	1,245.76	30.64	4,983.04
F	5,500	4,400	15.60	85,800	17,160.00	13,728.00	12.48	54,912.00
G	430	344	33.20	14,276	2,855.20	2,284.16	26.56	9,136.64
H	900	720	25.20	22,680	4,536.00	3,628.80	20.27	14,515.20
I	410	328	30.00	12,300	2,460.00	1,968.00	24.00	7,872.00
J	600	480	42.80	25,680	5,136.00	4,108.80	34.24	16,435.20
R	500	400	22.20	11,100	2,220.00	1,776.00	17.76	7,104.00
	10,545	8,436	22.17	$233,227.50	$46,645.60	$37,316.40	17.69	$149,265.60
Omitted K	800	640	28.40	22,720	4,544.00	3,635.20	22.73	14,540.80

Probable Ore

Block	Tons	WO3#.	Ore Width	Total Lbs WO3 per ton	WO3 value @ $10 per unit
L	966	2.50%	1.75 ft.	50 lbs.	$25.00
M	1,000	2.50	1.25 "	50 "	25.00
N	2,124	1.56	1.5 "	31.20 "	15.60
O	1,772	2.	1.25 "	40. "	20.00
P	1,500	2.	1.50 "	40 "	20.00
Q	750	2.50	1. "	50 "	25.00
	8,012				

Estimating a loss of 20% in the ore in mining and a mill recovery of 80% of the WO3 values contained in the ore.

Block	Gross Tons	Net Tons	Gross Val. per ton	Gross Val. Ore in place	20% Mining Loss	Milling Loss	Net Val. per ton	Net Val. Ore.
L	966	773	$25.00	$24,150.00	$ 4,830.00	$ 3,864.00	$20.00	$ 15,456.00
M	1,600	800	25.00	25,000.00	5,000.00	4,000.00	20.00	16,000.00
N	2,124	1699	15.60	33,134.40	6,626.88	5,301.50	12.48	21,206.01
O	1,772	1418	20.00	35,440.00	7,088.00	5,670.40	16.00	22,681.60
P	1,500	1200	20.00	30,000.00	6,000.00	4,800.00	16.00	19,200.00
Q	750	600	25.00	18,750.00	3,750.00	3,000.00	20.00	12,000.00
	8,112	6490	$20.52	$166,474.40	33,294.88	26,635.90	16.42	$106,543.61

Possible Ore

The vein system north of the existing mine opening is traceable upon the surface outcrops for two thousand feet or more and in places tungsten is visable in narrow seams of quartz but as no work, proving the dimensions of ore shoot or shoots, has been done, it is impossible to attribute any definite possibilities either as to tonnage or values which may exist in this section, although there is a good probability that one or more ore shoots will be encountered by future development.

There is a reasonable possibility that ore will continue beneath the ore shoots "O", "P" and "Q" to considerable depths and therefore credit can be allowed to the downward extensions of the ore shoots as "Possible Ore" for a depth of three hundred feet or more and the calculations would be:

Block "Q" and "P" 240 ft long x 300 ft deep x 1.5 ft wide ÷ 11 =10,000 tons
Block "Q" and 175 ft long x 300 ft deep x 1.0 ft wide ÷ 11 = 5,000 tons

Assuming a tungsten value of 1.5% WO_3 would give 225 tons of WO_3 and this valued at $10.00 a unit would have a gross value in place of $225,000.00

Ore Summary

Positive ore,	10,545 tons	gross value of	$233,227.50	$233,227.50
Probable ore,	8,112 "	" "	166,474.40	166,474.40
Possible ore,	15,000 "	" "		225,000.00
			$399,701.90	$624,701.90

Mining Costs and Methods

The "Cut and Fill" method of mining has been employed in all of the stoping of ore from the mine although in the stopes above the Nos. 1 and 2 levels the "shrinkage method" would have been practicable and more economical as the rock on either side of the vein stands solidly and well. The cut and fillmethod necessitates the cribbing of the ore passages or shoots at frequent intervals through the fillings or waste as the stope is carried upward. These cribbings are usually spaced 20 to 25 feet apart to permit the shovelling of the ore as it is mined and falls upon the waste (or filling floor) into the shoots; the waste acts towards holding the vein walls in place and to prevent caving. This method is avoided when possible because of the cost of the timber construction of the shoots and loss of ore but in the heavy, slippery and difficult conditions existing in the shale walls of this vein, where it is in close proximity to faults, it probably is the best method that can be carried out.

This method of mining will have to, therefore, be continued in all of the lower existing workings at least until firmer and more solid wall formation is encountered as the fault fractures zones are departed from. All of the ore yet to be gained from stopes on No. 5 level as well as the ore

between that level and No. 3 is effected by the two faults before mentioned.

In order to gain the ore with the minimum mining cost especial care must be taken in keeping the widths of the stopes at as near the actual width of the quartz veins as possible and with as little mixture of wall rock as possible; the widths should rarely exceed three and a half feet and usually can be kept well within that width. In many places within the stopes the widths have exceeded ten feet which was unnecessary and expensive. As the quartz ore seams hold quite firmly together, the foreman can insist upon miners first shooting the shale band to the side of the quartz and then bar down the latter, rather than to shoot down the whole mass and increase the mixture of the ore with the waste. It is only by using care in doing this that the loss of ore can be kept down to twenty per cent in accordance with my estimates and this result will depend greatly upon the foreman's ability and watchfulness. Under any circumstances loss of ore underground cannot be avoided because a certain percentage of the shattered small quartz falls and becomes mixed with the waste in such a manner as to be impossible of recovery.

In its present state of development the mine is incapable of producing much more than thirty or thirty five tons of ore a day as the output is limited to the number of men that can work in the stope faces per day. In arriving at this conclusion I have figured two miners working in the faces of "L" stope and two shifts or four men, three faces in "M" stope with six men on the two shifts and two miners in the drift face, or 14 miners total. By drilling four feet holes and actually getting three feet advance in the faces, forty two feet per day will be broken and the table set forth should show the results:

Ore width		Height		Sq. ft.		Length		Cu. Ft.		Cu. Ft. per ton			
1.5 ft.	x	7 ft.	=	10.5 ft	x	42	=	441.	-	12	=	36.75	tons per day Ore
3.5 ft.	x	7 ft.	=	24.5 ft	x	42	=	1029.	-	12	=	85.75	tons per day Waste
5. drift		~~7 ft.~~		35. ft		42		1470		12	=	122.5	tons per day TOTAL

Any ore above 36.75 tons per day of the above value going to the mill will be because either more or less waste is included or a greater width of ore found. In the former case, of course, the values per ton reduce. Probably during the past operation the mill treated more than 36 tons a day at times but from such records that are available I believe that the values of the heads were below seven tenths of one per cent of WO_3 per ton.

In order to increase the "ore output" possibilities of the mine, additional stoping ground must be developed by drifting into such areas of the mine where ore shoots are known to exist and also continuing the No. 5 level north where the possibility of finding a new ore shoot seems favorable. Drifts northwards from the main upraise from No. 5 level canbe quickly and cheaply run at elevations of one and two hundred feet above it which should be productive of additional ore tonnage.

Due to the general narrow widths of the ore, the tonnage of ore per foot of drifting and raising (development) is small and this is, of course, reflected in cost of mining. These costs are also affected by the average daily ore tonnage production of which the mine is capable, as many of the factors entering the cost are no greater for a production of 50 tons a day than those of 36 tons daily.

With the mine prepared for stoping as it is at present I have figured mining and tramming costs, including foreman, engineer, blacksmith, timber framer, fourteen miners, muckers, trammers and jigger, together with their insurance, and also steel, tools, explosives, and timbers, but not including city office overhead expenses at four dollars and fifty five ($4.55) dollars per ton of ore upon a based production of fifty (50) tons of ore per day; wages at today's prevailing scale. This cost cannot be improved to any effective extent upon the mentioned daily tonnage and will be increased when ore is won from levels which in the future will be driven from winzes sunk below the main working level No. 5 as this ore will have to be hoisted by power, and pumping of water may become also a factor.

Basing the tonnage output on 35 tons a day, the estimated output at the present time, the mining costs would be $6.50 a ton. All expenses except explosives remain the same whether 50 or 36 tons per day are produced from the mine.

Milling

The milling plant upon the property was constructed and equipment to treat 150 tons of ore per twenty four day but during its operation was not called upon to treat one half of that tonnage. It was planned for table concentration and flotation separation and is completely and modernly equipped with the exception of an efficient dryer for the concentrates.

The following is the mill flow sheet: After reduction in a roll crusher, the ore is screened and oversize is returned to finishing rolls. The undersize goes to two other screens, from which the oversize is sent to the Deister tables. Undersize, which is minus 40 mesh, from the last screen, goes through a series of Allen cones. Underflow from the cones is put over Deister-Overstrom diagonal deck slime tables. Overflow from the cones goes to a Groch copper-flotation machine. The tailings from this machine goes to the waste dump.

The table concentrate contains about one-third chalcopyrite, one-third pyrite and the remainder tungsten minerals. It is dewatered in an Allen cone and reground to a 200 mesh in a ball mill, operating in closed circuit with a Door classifier. Overflow from this classifier is conditioned with flocation reagents in a Groch conditioner, before flowing to the flotation machines. Concentrates are filtered in an American filter and then through a dryer to the finished material Bin.

The minimum labor for operating this millper shift limits the minimum costs irrespective of the tonnage variations from the low to the maximum

capacity of the mill and it will cost little more to treat 50 tons per shift (the rated capacity of the mill) than any lower quantity; the only difference would be that of power consumption and chemicals. The cost of water pumping and delivery to the mine is, of course, almost entirely chargeable to milling account.

The mill cannot be operated successfully upon an eight hour basis without a foreman, table operator, flotation man, mechanic and one crusher and ore sorter, a total of five men. The labor cost together with power, supplies, insurance, chemicals, water costs, supplies, repairs, laboratory expenses and a proper proration of the surface operation ex enses will amount to $3,000 a month.

Upon a basis of treating 50 t ns of a one shift day the milling costs will amount to $2.00 per ton and any reduction in tonnage will, of course, increase the cost per ton; treating 35 tons per shift would increase the cost to $2.85 per ton.

We have, then from the preceding, upon a 50 ton per day output from the mine to the mill, a mining cost of $4.55 a ton, a milling cost of $2.00 a ton to which must be added .45 cents a ton for management and office expenses, making a total of $7.00.

Positive ore	8,436 tons	$149,265.60	$149,265.60
Probable ore	6,490 tons	106,543.60	106,543.60
Possible ore			225,000.00
Total		$255,809.20	
Mining & Mill cost @ 7.00 x 14,926 tons		= 104,482.00	
Profit		$151,327.20	

Mine Development

It has been pointed out above that additional stopes must be prepared in order to increase the daily output which is now limited to

the two stopes above the No. 5 level. There is an important tonnage between the No. 5 and No. 3 levels beneath "Block F" and north of the three compartment upraise. The drift at elevation 5,200 ft. (level No. 4) should be driven northerly to the extreme north limit of ore shoot below Block F or about 480 ft. from the face of the existing drift on this level. This drift will probably enter the ore within about 100 feet. At the time this drift is started, upraise No. 20 which is now 60 feet above No. 5 level should be carried up to No. 4 elevation and a drift southerly started to meet the drift on this level from the upraise. The completion of this No. 4 drift will give more exact information regarding the limits of the ore-shoot which will have an important bearing upon the drift which will have to run midway between No. 4 and No. 5 levels.

With the information obtained from No. 4 drift, a drift should be run at an elevation 100 feet below it and it probably will be found that this drift should be started from the No. 20 upraise and run both north and south to the limits of the ore-shoot and that this upraise will become the main working raise and man-way for the ore to be recovered from this ore-shoot. The positions for the cribbed ore passages can be determined as the drifts progress but should be spaced at twenty-five intervals and should be constructed three feet square outside measurements of 2" x 6" lumber; this sized shoot is amply large to handle all of the production from the stopes.

The above development should make available 12,000 tons of ore between the No. 3 and No. 5 levels or enough ore to supply the mill with 50 tons a day for 240 days or 8 months.

There are promising surface indications that one or more shoots of ore will be found beyond, and to the north of any of the existing level faces and as the exploration of this area can be more economically accomplished from the main working level (No. 5), I advise that the main

drift of this level be continued and the value of this area be proved. At or near the face of this main drift the course of the working was changed and offset about twenty five feet to the east to follow the ore discovered in or near the foot wall; this offset drift is now filled completely but was represented to have continued 165 feet in ore but with no ore in the face. I understand that the ground above was stoped to a height of 60 feet but that both the stope and the drift had to be abandoned because the mine manager had been unable to hold open the drift. This filled condition can be ignored for the present but remedied later on. Judging from the course given on the old maps, the new drift should join the filled drift near its face and can be continued out in the unexplored area at a moderate cost and with the expectation of encountering commercial ore. Of course, no predictions can be made of quantities or values as only the actual development work will determine these.

Depending upon the results of the development and exploration above outlined, will be the necessity of obtaining ore from depths below the No. 5 level but nevertheless this must be considered at this time for the tonnage which may be reasonably expected from blocks above may not be able to supply the millat the rate of 50 tons daily for more than a year to a year and a half. Any extraction of ore below No. 5 level will have to be hoisted to that level and, of course, there is the possibility that water may be encountered which would have to be raised by pumps, but this last contingency may be considered when and if encountered. A double compartment winze capable of handling the ore as estimated in blocks K, O, and P, large enough in size to go to considerable depth if necessary; a winze 4 ft. x 7 ft. in the clear should be sunk from a point yet to be determined but near the northern limit of the ore sheet upon the No. 5 level. This winze should be sunk to a depth of 120 feet and drifts run from 100 feet in depth to the limits of the ore which would mean a drift

more or less 300 feet in length. As the work of extracting ore progresses the winze can be deepened and new drifts driven at each 100 feet of depth. If the exploration drift work from the face of No. 5 encounters the expected ore, then it may possibly be advisable to continue the drift from the 100 foot level of the proposed winze to the north or, the distance between the ore shoots may be great and another winze sunk in the northern area of the vein may be more practicable. Questions of tramming and air will have much to do in making any decisions regarding the number of winzes required.

Consideration must be given to the ore in and beneath Block J which is below stope L. While the values in the roof of stope L were of negligible importance and no credit has been given for the possibility of finding more ore above, the values found on the No. 5 level justifies the continuance of the ore shoot, which is about 150 feet long to greater depths. Because of the results in the stope above, I have only allowed in my calculations 50 feet of depth for positive ore and 50 feet for probable ore. A small sized double compartment winze sunk to 120 feet in depth from the bottom of No. 3 ore shoot and a drift from the 100 foot depth to the limits of the commercial ore will enable the recovery of these blocks of ore and if necessary the winze can be sunk to greater depths.

For the development work proposed, in driving the two intermediary levels between Nos. 3 and 5 levels, upraise from No. 20 upraise to connect with these levels and to continue No. 5 drift to the north, there is sufficient compressed air available from the present installation and an additional Diesel engine and compressor need not be considered but, for ventilation purposes, electric fans should be installed to reduce the demand for compressed air for that purpose.

Five drills will handle the work outlined. The drills now in use at the mine require from 55 cubic feet for the smallest jack-hammers to

100 cubic feet for the larger sized stope-hammer, and in addition, the drill sharpener requires 80 cubic feet when in use.

Fifteen thousand (15,000) dollars should carry out this proposed work, which would consist of approximately one thousand feet of drifts and two hundred and thirty feet of upraise; the former can be completed for $12.00 a foot and the latter for $9.00 a foot.

I have purposely omitted crediting the copper contents of the ore, which averages one per cent. As I have previously estimated the cost of recovering the ore in the blocks above No. 3 levelin the same manner as the ore blocks below that level although the tonnage in the upper blocks is small and the added expense of placing it in the mill will just about offset the net receipts from the recovered copper concentrates, at present prices of refined copper, when the cost of the necessary preparation of the ore passages is considered as well as the rehandling or tramming of the ore at the three compartment upraise.

No reference herein has been made to capital investment or interest thereon but this will be taken up in a separate letter.

In conclusion, I believe that all material points have been covered in the foregoing report which is respectfully submitted.

Faithfully yours,