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D R A F T October 11, 1977.

FIELD NOTES

Morenci, P.D.
October 6, 1977.

Ken Bennett — chief(?) geologist

Morenci pit --- 60,000 tpd

Metcalf-King 35,000 tpd separate mill,

1st Laramide intr. dio por --- 70 my

" (laccolithic) monz por --- 50 my

plus later monz stock ---

Sequence: oldest to youngest

1. older gr por --- 56 my
2. Morenci Bx qtz vein stockwork
3. Metcalf King Bx
4. Candelaria Bx --- specularite (secondary?) 5/my
   main stage mineralization
5. Younger gr por 49 my
6. Volcanics --- from 32 my ---

Primary min ~~is~~ in bx same as surrounding rocks, better cc in King bx due to faulting (?)

Morenci bx --- intrusion type, ign. matrix

Metcalf-King bx collapse and intrusion

Candelaria bx --- explosion --- some rounding, total 16 bx pipes

Alteration preceeded min!!

Pervasive phyllic earlier than bx!!

5 deep holes hit K alteration directly beneath Morenci bx ---

Potassic core developed prior, during and after phyllic ---

Hypogene (potassic alteration) shell --- ±.60% Cu fault wedge (small) exposed by erosion of Chase Creek.

Core (under shell) .15% Cu, .025 moly

Supergene up to 1000' thick ---

King: mature cc blanket up-faulted ~~coincidd?~~

immature blanket formed below, coincident with sudden drop in water table --- minor oxidation in primary sulph between two blankets

mature blanket now undergoing destruction by leaching, may have formed before volc. (32 my.)

Immature blanket formed after 22 my old basin range faulting

Prod: .5 billion tons .97% Cu.

Reserves plus 1 billion tons (.80?) % Cu

Current mill recovery: 76%

J. H. Courtright.

file

Ore Genesis in the Morenci—Metcalf District

J. H. C.

by Jackson M. Langton

Methods of Increasing Gas Penetration Through Sinter Layers

by Werner Wenzel, Heinrich Wilhelm Gudenau, and Johannes Moeljono

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

Tucson, Arizona

MEMORANDUM FOR: J.J. Collins

MORENCI

Enclosed is a copy of a paper given at the recent San Francisco meeting. The longitudinal section on page 26 is of considerable interest in that it shows a "2nd generation" chalcocite blanket extending beneath the low grade primary mineralization exposed in Chase Creek, and ore grade (.60% Cu) primary mineralization beneath the Morenci pit bottom. As depicted, this ore is in the low-pyrite potassic zone underlying the phyllic zone (high pyrite) within which the chalcocite blankets were formed.

The chalcocite under Chase Creek is probably due to lateral migration of solutions, but more important is the disclosure of primary ore at depth which adds to the mounting evidence of vertical zoning in porphyry copper deposits. This theory was partially tested at Silver Bell over 3 years ago with one hole being drilled in each pit to depths of around 1500 feet. A careful review of the results and a further study of alteration patterns should be made to determine if additional, or deeper, drilling is warranted.

J.H. Courtright
J.H. COURTRIGHT

JHC:kre

Encl: as noted

cc: Norman Visnes w/encl.
R.B. Meen w/encl.
W.L. Kurtz w/o encl.

(file under both Morenci and Silver Bell)

SOCIETY OF
MINING ENGINEERS
of
AIME

PREPRINT
NUMBER

72-I-47

ORE GENESIS IN THE MORENCI-METCALF DISTRICT

Jackson M. Langton
Chief Geologist
Phelps Dodge Corporation
Morenci Branch
Morenci, Arizona

This paper is to be presented at the AIME Annual Meeting -
San Francisco, California - February 20-24, 1972.

INTRODUCTION

The Morenci-Metcalf district is located on the southern slope of the White Mountains in Greenlee County, Arizona. Both porphyry copper deposits are four to six miles northwest of Clifton, the county seat, and the new Metcalf mine is situated approximately one mile northeast of the Morenci open pit (Figure 1). Chase Creek, a south-flowing tributary of the San Francisco River, dissects the district and separates the two ore bodies.

More than 1,200 exploration and development drill holes have been completed in the district and the Morenci-Metcalf ore bodies have been delineated on a 400-foot grid. Recently initiated drilling programs have revealed new data about deeper protore and associated hypogene alteration. This information, correlated with surface mapping and petrographic studies, was utilized to propose a plausible geochronologic sequence for this region. The reasoning behind this study has been helpful in locating new ore beneath leached capping indicative of only protore mineralization.

The scope of this paper is to establish a practical solution to a highly theoretical problem of ore genesis and to familiarize the reader with stratigraphic, structural, and mineralogic events responsible for localizing ore in this district. Continued research will possibly alter the proposed time span and relative displacements, but it is doubtful that the order of events will vary significantly. Geochronologic conclusions are therefore presented as general hypotheses and additional geologic mapping,

Metall. Eng., Rocky Mountain Fund Series, New York.

Ramsay, J. G., 1967, Folding and Fracturing of Rocks: McGraw-Hill, Inc., New York, 568 p.

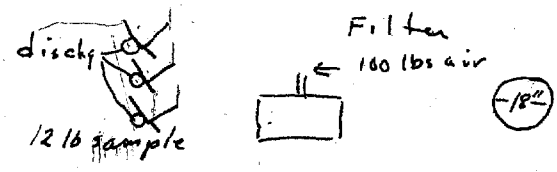
Ratte, J. C., Landis, E. R., and Gaskill, D. L., and Raabe, R. G., 1969, Mineral Resources of the Blue Range Primitive Area, Greenlee County, Arizona, and Catron County, New Mexico: U. S. Geol. Survey Bull. 1261-E, 91 p.

Wilson, E. D., 1962, A Resume of the Geology of Arizona: Arizona Bur. of Mines Bull. 171, 140 p.

Mencci - March 20. 1949

2 28L CD rigs - 2 shifts each
Average 17' per shift. 1200' av depth
Collar 12" - drill to one - reduce to 8"
then 6". Case only when caving
indicated by large fragments in
splitter. Sometimes straight reams
- Underream bits would not stand up.
Use 10' interval - run sand pump
after dart valve bailer.

Splitter combined with dump box
3 Tiers - $1\frac{1}{2}$" - 1" - $\frac{1}{2}$" slots - 12" wide



Filter uses coarse crepe paper on
screens - circular cake sent
in sheet metal boxes to lab
for electric drying -

orenci Geology -

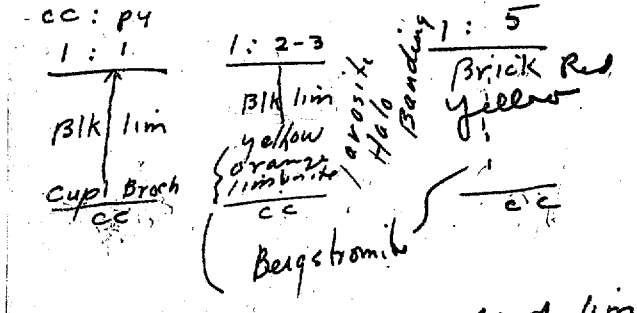
Cu (1.1% grade) as cc replacing or coating py (mill wc. 80-85%)
.06 to .10 m.s.

cc mainly in veinlets —
a few rich stringers or veins
a few discrete grains —

Leached 200 to 400 feet —
ore ± 400 feet thick —

Tonnage 50,000 per day

Leached Outcrops



Dark red or black color of lim due to cupric oxide — No lim (residual) left by copper free pyrite

Morenci

Sperry Rand to Spurn

AMERICAN SMELTING AND REFINING COMPANY
EXPLORATION DEPARTMENT
120 BROADWAY, NEW YORK, N.Y. 10005

J. H. C
APR 28 1969

C. P. POLLOCK
VICE PRESIDENT

April 25, 1969

AIR MAIL

Mr. J. H. Courtright, Supervisor
American Smelting and Refining Company
P. O. Box 5795
Tucson, Arizona

Morenci District - Arizona

Dear Mr. Courtright:

I wish to thank you for your letter of April 22nd enclosing a copy of your memorandum of November 16, 1960, concerning the Morenci District of Arizona.

I am also pleased to have a copy of the April 8, 1967, report by Richard R. Kennedy, on the Banner property, Elsbeth and State Leases. I note there has been some drilling by Quintana in the vicinity of Clifton and northeast of King Mountain but the efforts were not successful.

Very truly yours,

C. P. Pollock

CC-WESaegart

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 22, 1969

Mr. C.P. Pollock, Vice-President
ASARCO - New York Office

Morenci District
Arizona

Dear sir:

Referring to your letter of April 17, please find enclosed my memorandum of November 16, 1960 with sketch map showing outline of the Morenci zone of mineralization plus Banner and Church property. Also attached is subsequent correspondence including a property map of 1967 and reports dated April 8, 1967 on Banner property, Elsbeth and State Leases (Church) by Richard R. Kennedy.

Kennedy quotes Clyde Davis as reporting that sludges gathered from around nearby (near Elsbeth claims) P.D. drill holes averaged .70% Cu. This is a possibility since the eastern edge of the King zone of mineralization includes a portion of the Elsbeth group. For further comment, refer to my letter to John Collins of October 4, 1967 (attached).

Other activity reported includes drilling about 2 miles northeast of King Mountain, and in the vicinity of Clifton. The latter project was designed to test the valley fill for "Exotica" type copper. Both projects were conducted by Quintana and both were reported unsuccessful.

Yours very truly,

J. H. Courtright

J.H.Courtright

JHC:lzb
Encl.

cc: WESaegart

copy for WES 4/23/69 RJB

J. H. C.
APR 2 1969

AMERICAN SMELTING AND REFINING COMPANY
EXPLORATION DEPARTMENT
120 BROADWAY, NEW YORK, N.Y. 10005

C. P. POLLOCK
VICE PRESIDENT

April 17, 1969

AIR MAIL

Mr. J. H. Courtright, Supervisor
American Smelting and Refining Company
P. O. Box 5795
Tucson, Arizona 85703

Morenci and Vicinity - Arizona

Dear Mr. Courtright:

Under date of November 16, 1960, Mr. Richard forwarded to me your memorandum on the ore potential of the Morenci District. This memorandum seems to be missing in our file. Please send me an additional copy for our record.

As I recall, the sketch map accompanying your memorandum showed the Morenci Chief property adjacent to the King ore body, also Banner claims in the vicinity. I would be interested in any activity that you know about at these two adjacent properties.

Very truly yours,

C. P. Pollock

Aa 7B.13.0

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

October 4, 1967

Mr. J. J. Collins, Chief Geologist
ASARCO - N.Y. Office

Joseph Muller Corporation
U.S. Lime and Mining
Morenci Property

Dear Sir:

Following your telephoned request, Mr. S. I. Bowditch met in Silver City with Mr. E. M. Riebold to discuss their holdings in the Morenci district and their clay deposit west of Hot Springs, N.M. The latter will be discussed in a separate letter.

Back in 1960 we did some ground and air reconnaissance over the King Mountain area and determined in a very approximate manner the limits of the zone of alteration-mineralization (see maps and transmitted letter attached dated Nov. 16, 1960).

The property which U.S. Lime and Mining claims to control (Mormon Church and Banner property) is shown on the attached map dated October 1967. As may be seen on this map, only a very small area of the church property lies within the pervasively mineralized zone. It is quite probable, however, that the King ore body could not be completely mined out by open pit without stripping into the church ground and possibly into Banner ground on Markeen Mountain.

U.S. Lime and Mining also controls large tracts of land west of the Morenci pit, but this ground appears to lie well outside of future stripping as well as ore limits.

I believe it is evident that the property offered holds very little ore potential but may be of considerable value to P.D. for stripping room and waste dump space.

Yours very truly,

J. H. Courtright

JHC:lmi
encl.
cc: SIBowditch

April 8, 1967

Mr. Mike Riebold
U.S. Lime and Mining Co.
P. O. Box 231
Silver City, New Mexico

Dear Mr. Riebold:

GEOLOGIC REPORT OF THE ELSBETH AND STATE LEASE MORENCI DISTRICT, ARIZONA

It is the objective of this report to discuss the economic potential of the Elsbeth and State Lease property that is situated in the Morenci, Arizona porphyry copper district, and to make suggested recommendations as to an exploration and development program concerning these properties.

Location

The Elsbeth and State Lease are located in Greenlee County, in southeast Arizona. The Morenci District is about 15 miles west of the Arizona-New Mexico state border.

The properties are located about five miles north-northeast of the town of Clifton, and about 1-1/2 miles northeast of the Morenci Copper Pit owned by the Phelps-Dodge Corporation.

The properties are situated on Markee Mountain at an elevation of 5-6,000 feet in Sections 2, 3, 10 and 11 of Township 4 South, Range 29 East, G.S.R.M. (Refer to the attached location map) The Elsbeth claims situation at an elevation of 6,000 feet are some 2,000 feet above Chase Creek Highway 666.

The Elsbeth group consists of five fractional, lode mining claims (48 acres). The Elsbeth #1-5, the State Lease consists of the Cornell, Princeton, Yale, Columbia, Amherst, Stanford and Tulane claims (67 acres).

Access to the property is gained by driving up Chase Canyon, Highway 666, some five miles northwest of Clifton. From this point access is via dirt roads which were established by Phelps-Dodge for exploration drilling activities. The only other access is by horseback or on foot over a somewhat longer route.

Previous Work

Waldemar Lindgren published a classic study of the district in 1905 as U.S.G.S. Professional Paper 43. B. S. Butler and E. D. Wilson provided a supplementary report published in 1938 by the Arizona Bureau of Mines as Bulletin 145. A. B. Parsons summarized the historical and production data of the district in the porphyry coppers (1933, 19[illegible] 1957). The most recent work to be published is the excellent Geology of the Porphyry Copper Deposits Southwestern North American. Titley and Hicks (1966). Included in this publication is a paper by R. T. Moolick and J. J. Curek titled "The Morenci District". Numerous other geologists have studied and reported on this area.

General Geology

In order that the information may be presented more thoroughly, the following data is presented for the district as a whole, since it also applies equally well to the property under consideration.

Regional Setting. Morenci is in the transitional zone between two major physiographic provinces; the Basin and Range, and the Colorado Plateau. The topography is rugged with moderate to steep relief.

Rock Types. Rocks in the district represent a sequence that ranges from Precambrian to Tertiary.

The Precambrian rocks range from meta-sedimentary pinal schist to quartzite and granite. The Precambrian rocks are overlain by about 1,000 feet of Paleozoic quartzite, limestone and shale. Remnants of Cretaceous sedimentary rocks overlay the Paleozoic sequence, and in turn, are overlain by a Tertiary series of basalts, rhyolites and andesites

The most important sequence of Precambrian intrusive rocks consists of a stock or laccolith and associated dikes of probable Cretaceous age. The stock-like body consists of diorite porphyry, quartz monzonite porphyry and granite porphyry. The monzonite porphyry has the greatest aerial exposure and is the principal ore-bearing rock.

Structure. The Morenci area is one of intricate and abundant regional and local structures. An early sequence of faulting produced a characteristic northeast "grain" to the district. The main Precambrian intrusive, along with the associated dikes and veins all evidence this northeast trend. The exposed laramide intrusive is approximately 10 miles long and from 1 to 4 miles in width. Elongation is in the northeast dimension. In general the sedimentary beds dip southwest, and some large folds with a northwest plunge are reported in the district.

Late Tertiary normal faulting is reported by Moolick (1966) to strike predominantly northwest. The Coronado, San Francisco and Kingbolt faults (Chase Creek) are the most prominent fault features in the area.

The ore body at Morenci is highly fractured, with the fractures generally oriented northeast or northwest.

At least three breccia pipes are known in the area and all show an elongation to the west or northwest. These breccia pipes are apparently closely associated with a late barren hydro-thermal development.

General Mineralization Characteristics

In the Morenci Pit the chalcocite enrichment blanket ranges from 50 to 1,000 feet in thickness and thickens as it dips eastward. According to Moolick, a sericite-quartz alteration is characteristic of the area east of Chase Creek suggesting the possibility of an ore conduit in that area.

Strong weathering, however, has produced a hematite-goethite-jerosite capping that is noted for its absence of copper minerals. However, the primary ore is known to consist largely of pyrite and chalcopyrite.

Elsbeth #1-5

These five fractional lode claims located along the crest of Markee Mountain consists of 48 acres of some of the best situated land in the Morenci District. The area covered by the claims is largely quartz monzonite with a highly indicitive leached capping, sericite and quartz alteration, fault and breccia zones that are unquestionably related to the Morenci Pit structures. The eastern segment of the claims cover an area where Precambrian granite is locally exposed, but field evidence suggests that the older granite is underlain at no great depth by the favorable quartz monzonite.

In the adjacent areas and in road cuts, sulfides are exposed just a few feet below the surface.

State Lease Group

This group os seven lode mining claims consists of approximately 67 acres and are located on the southwest slope of Copper King Mountain and contiguous on the north with the Elsbeth #6.

This area is one of more erratic, but nevertheless, important copper mineralization found along northeast trending fault veins, fractures and quartz monzonite dikes. Fair capping is present and confirms a southeast trend. Banner Mining Company has drilled two holes adjacent to the claim line. The area has potential, but can best be tested by a drilling program.

Mineralization. H. Clyde Davis (1965) indicates that sludge cuttings from diamond drill holes adjacent to the Elsbeth group of claims indicates mineralization over a 1,000 depth that will average 0.70% copper. It is expected that at least the copper, silver and gold values that are obtained from the Morenci Pit will be realized under the Elsbeth claims and elsewhere.

The following table is an indication of the estimated values on the Elsbeth claims #1-5 based on such factors as depth, market price per pound of copper, waste, recovery, etc.

Area = 48 acres or 2,100,000,000 cubic feet per 1,000 feet of depth.
This is equal to 175,000,000 tons of ore per 1,000 feet of depth.

TONNAGE VALUE TABLE*

	Depth 1000 Feet		Depth 2000 Feet		Depth 3000 Feet	
% Cu	lbs. Cu/ less 20% waste	Net Value @ .35¢/lb.	lbs. Cu/ less 20% waste	Net Value @ .35¢/lb.	lbs. Cu/ less 20% waste	Net Value @ .35¢/lb.
2	5,600,000,000	$1,960,000,00	11,200,000,000	$3,920,000,00	16,800,000,000	[illegible],800,000,000
1	2,800,000,000	980,000,00	5,600,000,000	1,960,000,00	8,400,000,000	2,940,000,000
.8	2,240,000,000	784,000,00	4,480,000,000	1,568,000,00	6,720,000,000	3,352,000,000
.6	1,680,000,000	588,000,00	3,360,000,000	1,176,000,00	5,040,000,000	1,764,000,000
.5	1,400,000,000	490,000,00	2,800,000,000	980,000,00	4,200,000,000	1,470,000,000

*Tonnages Calculated as follows:

12 cubic feet = ton

48 acres = 2,100,000,000 cubic feet per 1,000 feet of depth

2,100,000,000 cubic feet = 175,000,000 gross tons of ore per 1,000 feet of depth

Net tons ore = gross tons less 20% for waste

Net pounds copper content = net tons ore x 2,000 $\frac{\text{lbs}}{\text{ton}}$ x % copper

Value of copper = net pounds copper x .35¢/lb.

Recommendations

Both the Elsbeth and State Lease should be drilled and it is so recommended. At least three holes should be drilled on the Elsbeth claims in the saddle of Markee Mountain in the breccia zone related to a northeast fault zone. Total drilling requirement/6,000 feet for vertical holes. The initial holes should be vertical, with supplementary angle holes as required. The angle holes, of which three are recommended, are designed to cut the vein and breccia structures. Total drilling requirement/4,500 feet for angle holes. This would mean a total of approximately 10,500 feet of drilling. Diamond drilling costs are estimated at $12 per foot for a total of $126,000.00.

Assuming that the drilling will yield favorable results, then an underground exploration and development program can be initiated. Due to the land ownership situation, it would be advisable to run a long drift or tunnel, beginning in Hickory Spring Gulch, back to the southwest under the property. A proposed tunnel of this type would be approximately 10,500 feet in length and would cost about $85 per foot to complete (assuming normal mining conditions). Such a tunnel would provide at least 2,500 feet of mining backs. Estimated cost/$900,000.00. Several fault veins could be drifted on as the tunnel advances into the area under the Elsbeth acreage or under State Lease. Once under the properties, large scale block caving techniques could be employed to mine the ore.

Milling

A moderate to large scale mining operation will require milling facilities. Very likely, land is available for purchase and water can be developed to meet needs.

Land acquisition for a mill site requirements will likely cost between $500,000 to $600,000. Mill costs are estimated to be about $2,000 per ton of daily capacity. That is, a mill constructed to handle 20,000 tons per day will cost approximately $40,000,000.

Respectfully submitted,

Dr. Richard R. Kennedy
Consulting Geologist

RRK/bar

aa-78,13.16

BRIGHAM YOUNG UNIVERSITY
PROVO, UTAH
84601

ERNEST L. WILKINSON, PRESIDENT

OFFICE OF UNIVERSITY DEVELOPMENT

April 8, 1967

Mr. Mike Riebold
U.S. Lime & Mining Company
P. O. Box 231
Silver City, New Mexico

Dear Mr. Riebold:

BANNER MINING PROPERTY

Location

The Banner mining property is located directly east of the Elsbeth group #1-5 and northeast north of the State Leased claims. The claims are in Sections 1, 2, 11 and 12 of Township 4 South, Range 29 East. Also in Sections 25, 26, 35 and 36 of Township 3 South, Range 30 East as indicated on the enclosed map.

There are many old minds and workings in the Banner claims area. This is apparent from a aerial view and many of the large structures can be followed for over one half mile in distance.

Geology

These claims are in the Precambrian granite which has a major northeast-southwest trend and has been intruded by later Precambrian dikes of diabase and younger granite. At the time of the Laramite Revolution, the monzonite porphyry intruded this Precambrian series.

There is a small stock or a continuation of the major Morenci monzonite porphyry stock in the north half of Section 35; south of this stock and areas east of the Church Leased claims are large northeast trending monzonite porphyry dikes. It is along these dikes that the high grade mineralization is apparent from the many old workings.

Mineralization

The mineralization mainly follows along the strong porphyry structures indicating that most of the copper oxide minerals of cuprite, secondary chalcocite, asurite, malachite. Many of the old workings went into the old sulphide area exposing your chalcopyrite, primary chalcocite and some bornite.

The surface capping is good along these large quartz monzonite dikes. Many places the porphyry has intruded into large blocks of the Precambrian granite, giving it the favorable type of capping. In the north half of Section 35 and the northeast corner of Section 34 indicates good capping in the patented area of the claims (see map).

Conclusions

(1) At the present time, the Banner Mining Company has a limited drilling program in operation which qualifies their assessment work each year on the hundreds of claims they own.

(2) They have drilled holes adjacent to the State Leased land in Section 2. These holes are in the northeast trend area, and I believe, the laccolith quartz monzonite body is encountered in depth.

(3) It would be wise to continue an exploration drilling program to evaluate quantity and quality of mineralization on the property. It is located very favorable in the northeastern trend of the major ore body. The Phelps-Dodge Corporation has drilled up to the borders of the Banner Mining Company property in many areas and from their pattern of drilling indicated, the extension of this ore body on the northeast side of Chase Creek.

The Banner property could be a help in mining the Church State Lease property and the Elsbeth #1-5. One mode of mining in this area would be driving a tunnel for a mile or one and one-half miles from the San Francisco River area to the Elsbeth #4 claim. The Banner property has many workings on their claims east of Elsbeth #4. These workings indicate a general strike east and northeast. I am certain large structures could be encountered in depth which could be drifted along evaluating the subsurface geology and stock piling ore.

I highly recommend the Banner property and an exploration program to determine its ore potential in depth.

Sincerely,

H. Clyde Davis
Geologist

HCD/bar

Enclosure Under Separate Cover

aa-7B.13.16

April 8, 1967

Mr. Mike Riebold
U.S. Lime and Mining Co.
P. O. Box 231
Silver City, New Mexico

Dear Mr. Riebold:

GEOLOGIC REPORT OF THE ELSBETH AND STATE LEASE MORENCI DISTRICT, ARIZONA

It is the objective of this report to discuss the economic potential of the Elsbeth and State Lease property that is situated in the Morenci, Arizona porphyry copper district, and to make suggested recommendations as to an exploration and development program concerning these properties.

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The Elsbeth group consists of five fractional, lode mining claims (48 acres). The Elsbeth #1-5, the State Lease consists of the Cornell, Princeton, Yale, Columbia, Amherst, Stanford and Tulane claims (67 acres).

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General Geology

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Regional Setting. Morenci is in the transitional zone between two major physiographic provinces; the Basin and Range, and the Colorado Plateau. The topography is rugged with moderate to steep relief.

Rock Types. Rocks in the district represent a sequence that ranges from Precambrian to Tertiary.

The Precambrian rocks range from meta-sedimentary pinal schist to quartzite and granite. The Precambrian rocks are overlain by about 1,000 feet of Paleozoic quartzite, limestone and shale. Remnants of Cretaceous sedimentary rocks overlay the Paleozoic sequence, and in turn, are overlain by a Tertiary series of basalts, rhyolites and andesites

The most important sequence of Precambrian intrusive rocks consists of a stock or laccolith and associated dikes of probable Cretaceous age. The stock-like body consists of diorite porphyry, quartz monzonite porphyry and granite porphyry. The monzonite porphyry has the greatest aerial exposure and is the principal ore-bearing rock.

Structure. The Morenci area is one of intricate and abundant regional and local structures. An early sequence of faulting produced a characteristic northeast "grain" to the district. The main Precambrian intrusive, along with the associated dikes and veins all evidence this northeast trend. The exposed laramide intrusive is approximately 10 miles long and from 1 to 4 miles in width. Elongation is in the northeast dimension. In general the sedimentary beds dip southwest, and some large folds with a northwest plunge are reported in the district.

Late Tertiary normal faulting is reported by Moolick (1966) to strike predominantly northwest. The Coronado, San Francisco and Kingbolt faults (Chase Creek) are the most prominent fault features in the area.

The ore body at Morenci is highly fractured, with the fractures generally oriented northeast or northwest.

At least three breccia pipes are known in the area and all show an elongation to the west or northwest. These breccia pipes are apparently closely associated with a late barren hydro-thermal development.

General Mineralization Characteristics

In the Morenci Pit the chalcocite enrichment blanket ranges from 50 to 1,000 feet in thickness and thickens as it dips eastward. According to Moolick, a sericite-quartz alteration is characteristic of the area east of Chase Creek suggesting the possibility of an ore conduit in that area.

Strong weathering, however, has produced a hematite-goethite-jerosite capping that is noted for its absence of copper minerals. However, the primary ore is known to consist largely of pyrite and chalcopyrite.

Elsbeth #1-5

These five fractional lode claims located along the crest of Markee Mountain consists of 48 acres of some of the best situated land in the Morenci District. The area covered by the claims is largely quartz monzonite with a highly indicitive leached capping, sericite and quartz alteration, fault and breccia zones that are unquestionably related to the Morenci Pit structures. The eastern segment of the claims cover an area where Precambrian granite is locally exposed, but field evidence suggests that the older granite is underlain at no great depth by the favorable quartz monzonite.

In the adjacent areas and in road cuts, sulfides are exposed just a few feet below the surface.

State Lease Group

This group os seven lode mining claims consists of approximately 67 acres and are located on the southwest slope of Copper King Mountain and contiguous on the north with the Elsbeth #6.

This area is one of more erratic, but nevertheless, important copper mineralization found along northeast trending fault veins, fractures and quartz monzonite dikes. Fair capping is present and confirms a southeast trend. Banner Mining Company has drilled two holes adjacent to the claim line. The area has potential, but can best be tested by a drilling program.

Mineralization. H. Clyde Davis (1965) indicates that sludge cuttings from diamond drill holes adjacent to the Elsbeth group of claims indicates mineralization over a 1,000 depth that will average 0.70% copper. It is expected that at least the copper, silver and gold values that are obtained from the Morenci Pit will be realized under the Elsbeth claims and elsewhere.

The following table is an indication of the estimated values on the Elsbeth claims #1-5 based on such factors as depth, market price per pound of copper, waste, recovery, etc.

Area = 48 acres or 2,100,000,000 cubic feet per 1,000 feet of depth.
This is equal to 175,000,000 tons of ore per 1,000 feet of depth.

TONNAGE VALUE TABLE*

	Depth 1000 Feet		Depth 2000 Feet		Depth 3000 Feet	
% Cu	lbs. Cu/ less 20% waste	Net Value @ .35¢/lb.	lbs. Cu/ less 20% waste	Net Value @ .35¢/lb.	lbs. Cu/ less 20% waste	Net Value @ .35¢/lb.
2	5,600,000,000	$1,960,000,000	11,200,000,000	$3,920,000,000	16,800,000,000	[illegible] .880,000,000
1	2,800,000,000	980,000,000	5,600,000,000	1,960,000,000	8,400,000,000	2,940,000,000
.8	2,240,000,000	784,000,000	4,480,000,000	1,568,000,000	6,720,000,000	3,352,000,000
.6	1,680,000,000	588,000,000	3,360,000,000	1,176,000,000	5,040,000,000	1,764,000,000
.5	1,400,000,000	490,000,000	2,800,000,000	980,000,000	4,200,000,000	1,470,000,000

*Tonnages Calculated as follows:

12 cubic feet = ton

48 acres = 2,100,000,000 cubic feet per 1,000 feet of depth

2,100,000,000 cubic feet = 175,000,000 gross tons of ore per 1,000 feet of depth

Net tons ore = gross tons less 20% for waste

Net pounds copper content = net tons ore x 2,000 $\frac{\text{lbs}}{\text{ton}}$ x % copper

Value of copper = net pounds copper x .35¢/lb.

Recommendations

Both the Elsbeth and State Lease should be drilled and it is so recommended. At least three holes should be drilled on the Elsbeth claims in the saddle of Markee Mountain in the breccia zone related to a northeast fault zone. Total drilling requirement/6,000 feet for vertical holes. The initial holes should be vertical, with supplementary angle holes as required. The angle holes, of which three are recommended, are designed to cut the vein and breccia structures. Total drilling requirement/4,500 feet for angle holes. This would mean a total of approximately 10,500 feet of drilling. Diamond drilling costs are estimated at $12 per foot for a total of $126,000.00.

Assuming that the drilling will yield favorable results, then an underground exploration and development program can be initiated. Due to the land ownership situation, it would be advisable to run a long drift or tunnel, beginning in Hickory Spring Gulch, back to the southwest under the property. A proposed tunnel of this type would be approximately 10,500 feet in length and would cost about $85 per foot to complete (assuming normal mining conditions). Such a tunnel would provide at least 2,500 feet of mining backs. Estimated cost/$900,000.00. Several fault veins could be drifted on as the tunnel advances into the area under the Elsbeth acreage or under State Lease. Once under the properties, large scale block caving techniques could be employed to mine the ore.

Milling

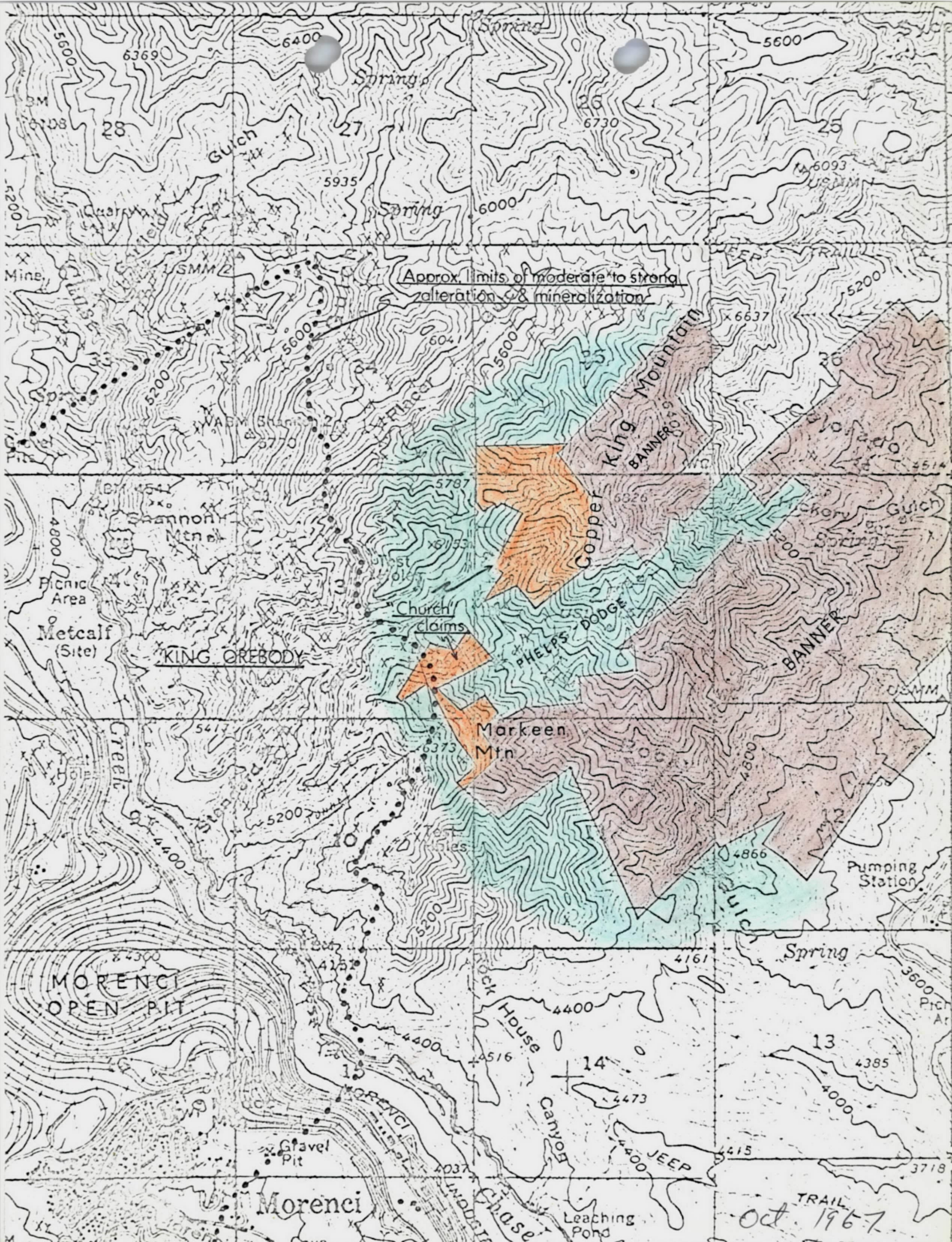
A moderate to large scale mining operation will require milling facilities. Very likely, land is available for purchase and water can be developed to meet needs.

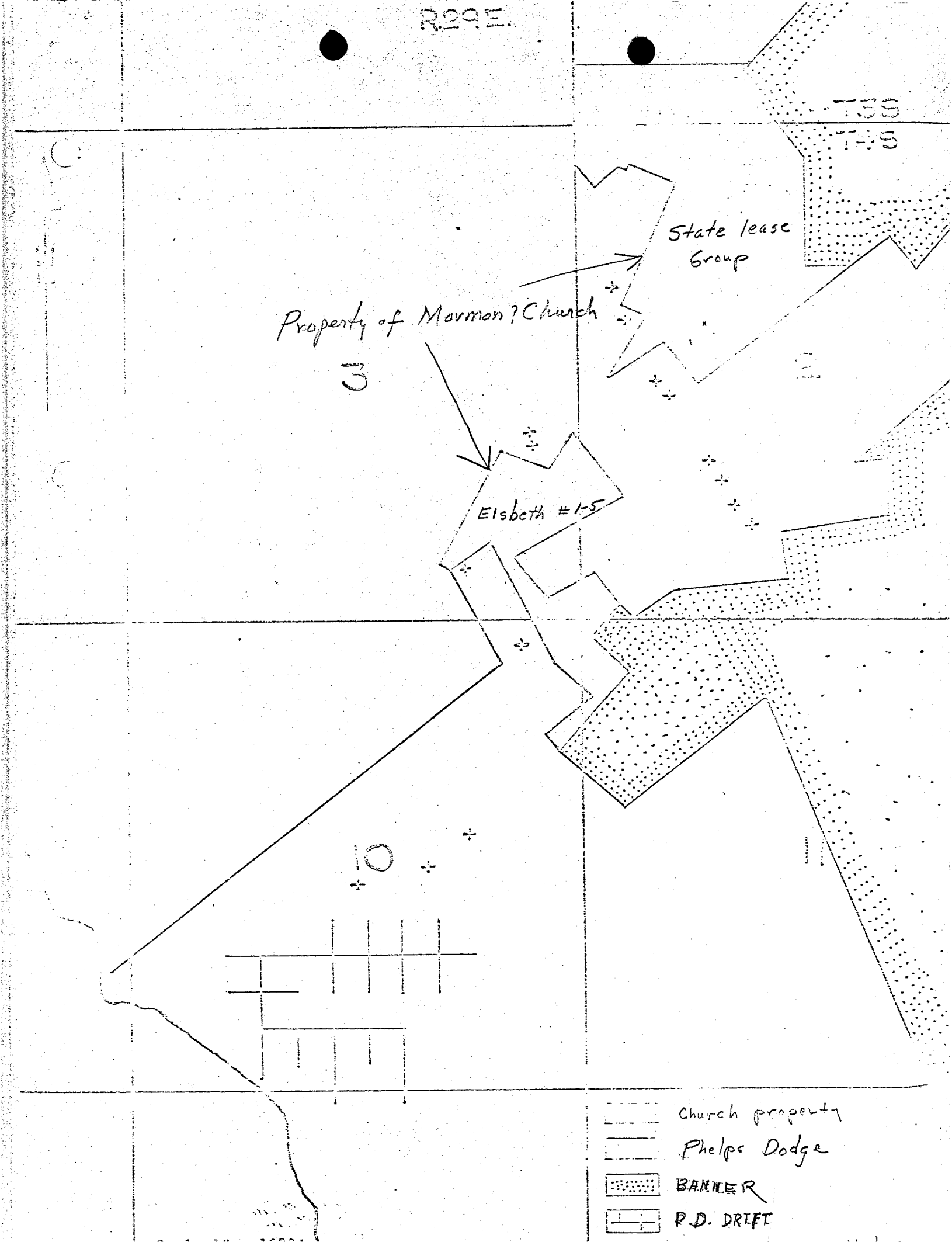
Land acquisition for a mill site requirements will likely cost between $500,000 to $600,000. Mill costs are estimated to be about $2,000 per ton of daily capacity. That is, a mill constructed to handle 20,000 tons per day will cost approximately $40,000,000.

Respectfully submitted,

Dr. Richard R. Kennedy
Consulting Geologist

RRK/bar


Approx. limits of moderate to strong alteration & mineralization
Copper King Mountain
BANNER
Hickory Gulch
Spring
Placer
Shannon Mtn
Picnic Area
Metcalf (Site)
KING OREBODY
"Church" claims
PHELPS DODGE
Markeen Mtn
Pumping Station
MORENCI OPEN PIT
Rock House Canyon
Gravel Pit
Morenci
Chase
Leaching Pond
JEEP TRAIL
Oct. 1967


R29E.
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T4S
State lease
Group
Property of Mormon? Church
3
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Elsbeth #1-5
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11
Church property
Phelps Dodge
BANNER
P.D. DRIFT

L.P.E.
~~J.H.C.~~
S.I.B.
RKK
JRW
SVF
JDS
DBB
JEK
Barry Watson
Sal Anzalone
Robert Gordon
Joy Merz
JHC

PHELPS DODGE CORPORATION

MORENCI BRANCH

MORENCI, ARIZONA

April 27, 1964

Members of Arizona Section, A.I.M.E.
Open Pit Mining Division

Gentlemen:

You are cordially invited to attend the Spring Meeting of the Open Pit Division to be held at Phelps Dodge Corporation's Morenci Branch, Morenci, Arizona, on Monday, May 18, 1964.

Program for the Day

8:30 - 9:30 a.m.	Registration - Safety Meeting Room at the Mine Office and Shop Area
9:30 - 12:00 noon	Technical Session - Safety Meeting Room
12:00 - 1:00 p.m.	Mexican food luncheon, picnic style, to be served on the waste dump area south of the mine shops and railroad service yard.
1:00 - 4:30 p.m.	Tour of the Morenci Mine including the mine repair and servicing facilities and the waste disposal areas.
5:30 - 7:00 p.m.	Cocktails at the Morenci Club
7:00 - 8:30 p.m.	Dinner at the Morenci Club Dr. Sandford S. Cole, President of the Society of Mining Engineers of A.I.M.E., will be the guest speaker.

Private automobiles will be parked in a reserved area of the mine parking lot. Bus transportation will be furnished to the picnic area and for the tour of the open pit.

This meeting is a stag affair.

SIB { ~~[illegible]~~ RKK JRW Bob Gordon } { DBB JDS Joy Merz

JHC { B. Watson ~~JEK~~ Sal Anzalone

Hotel and motel accomodations are quite limited in the Clifton-Morenci vicinity. However, Safford which is less than an hour's drive offers many good accomodations. Those desiring overnight accomodations should make their own reservations. A list of hotels and motels is given below.

Please complete and return the enclosed post card by May 11, 1964.

Very truly yours,

D. H. Orr

D. H. Orr
Chairman, Open Pit Mining Division

Clifton

Hotel Reardon, S. Coronado Blvd.	864-2405
Coronado Lodge Motor Court, 186 S. Coronado Blvd.	864-2132
Trail Motel, 313 S. Coronado Blvd.	864-3602

Morenci

Hotel Morenci, Plaza	865-4151

Safford

Buena Vista Hotel, 322 Main Street		428-2121
Country Manor Motel, E. 5 Street	Hi way 70	428-2451
Tour Rest Motel, 110 5 Street		428-3881
Town House Motor Inn, 211 E. 5 Street	4 doubles 5 singles	428-3474
Desert Breeze Motel, 102 8 Street		428-2230
Western Motel, 1215 Thatcher Blvd.		428-1810

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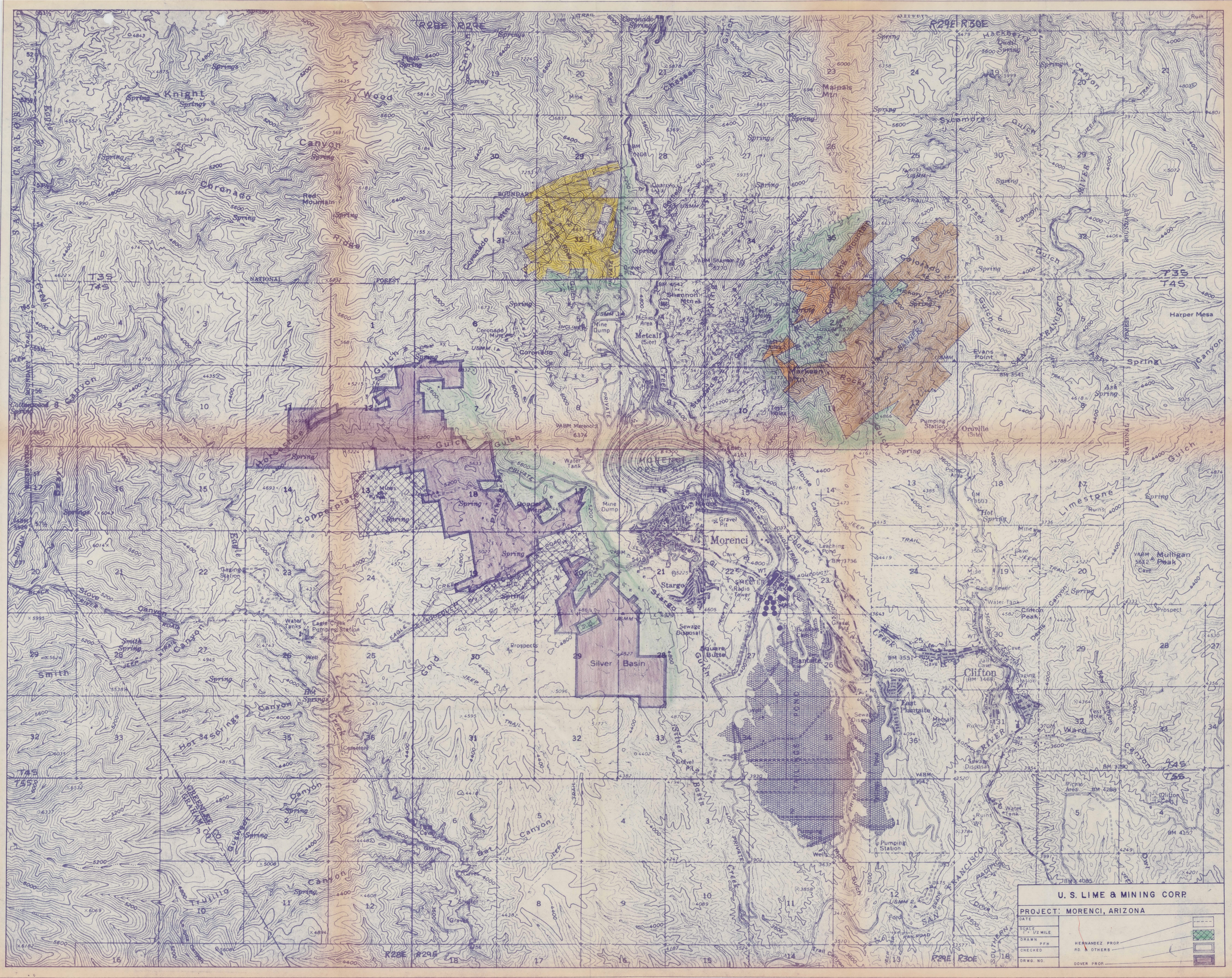
U. S. LIME & MINING CORP.
PROJECT: MORENCI, ARIZONA
DATE
SCALE 1" = 1/2 MILE
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CHECKED
DRWG. NO.
HERNANDEZ PROP.
RD. & OTHERS
DOVER PROP.
Morenci
Clifton
Silver Basin
Stargo
Metcalf (Site)
Coronado Mine
Coronado
Harper Mesa
Evans Point
Oroville (Site)
Malpais Mtn
Knight Springs
Wood Canyon
Coronado Ridge
Red Mountain
Shannon Mtn
Markeen Mtn
Colorado Mtn
Copperplate
Smith Canyon
Hot Springs
Limestone
Mulligan Peak
Clifton Peak
Ward
Square Butte
Eagle Creek Pumping Station
Water Tanks
Gaging Station
Pumping Station
Sewage Disposal
East Plantsite
Plantsite
Smelter
Leaching Pond
Radio Tower
Water Tank
Picnic Area
Hot Springs
Ash Spring
Hackberry Quail Spring
Sycamore Gulch
Dorsey Canyon
Cottonwood Canyon
Bat Canyon
Trujillo Canyon
Bushwhack Canyon
Greenlee Graham Co.
Gold Gulch
Chase Gulch
Rock House Canyon
Coronado Gulch
Copper Gulch
Hickory Gulch
Cedar Gulch
Rocky Gulch
Shannon Gulch
Sutter Basin
Sutter Creek
Aqueduct
Private
Boundary
National Forest
Jeep Trail
Trail
Road
Mine
Mine Dump
Gravel Pit
Test Holes
Spring
Springs
Cemetery
Cave
Ruins
Prospects
Water Tank
Well
Ford
Drive
Southern Pacific Railroad
San Francisco River
Eagle Creek
Stove Canyon
Black River
R28E R29E
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T3S T4S
T4S T5S
T5S T6S

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 15, 1960

PERSONAL/CONFIDENTIAL

D. J. Pope, Assistant to Vice President
American Smelting and Refining Company
120 Broadway
New York 5, New York

MORENCI, ARIZONA

Dear Sir:

In accordance with your letter of December 1, attached is a sketch map showing the approximate position of the Banner claims in the Morenci District.

Due to the ruggedness and inaccessibility of the area, the precise outline of the new Banner claims was not determined. These new claim corners were found nearly at the top and extending down the northerly slope of Copper King Mountain. The outline of the patented Banner claims was taken from a 1943 sketch map by C. R. Amis which has the notation, "Reduced from map made in 1924 by P. D. Co."

One of PD's drill holes is situated a few hundred feet from the top on the west side of Copper King Mountain. This is probably the hole to which Travis refers. However, as viewed from the air, this hole is somewhat outside of PD's drill pattern. Banner's claims merely skim the edge of the zone of alteration, and we are reasonably certain they do not cover any part of the King ore body. A few veins and small patches of alteration containing evidence of a little copper were found on the Banner claims, but these showings are of no consequence.

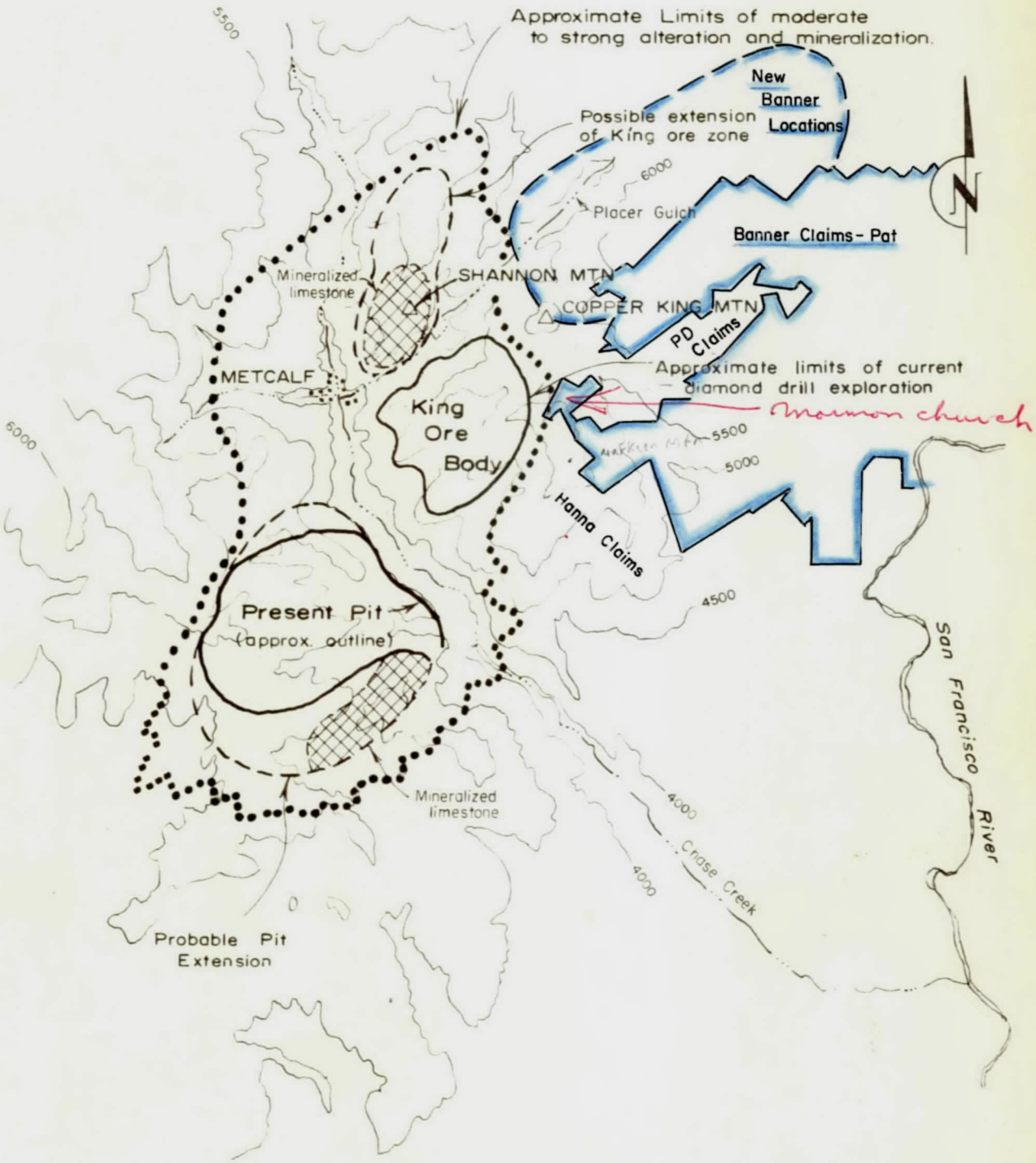
The Hanna claims lie south of the King ore body proper. The King drill pattern may eventually reach the small amount of ore drilled in the Hanna ground; however, to our knowledge, PD still has not acquired the Hanna ground. I believe, though, that Hanna has a man on the PD board.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

Attachment: Sketch Map
KR/ds
cc: TASnedden - Personal/Confidential



MORENCI DISTRICT
ARIZONA

Scale 1 inch = 1 mile

May, 1960

AMERICAN SMELTING AND REFINING COMPANY
MINING DEPARTMENT
120 BROADWAY, NEW YORK 5, N.Y.

D. J. POPE
ASSISTANT TO VICE PRESIDENT

December 1, 1960

K. R.
DEC 5 1960

AIR MAIL - CONFIDENTIAL

Mr. Kenyon Richard, Chief Geologist
American Smelting and Refining Company
813 Valley National Building
Tucson, Arizona

MORENCI, ARIZONA

Dear Ken:

I was very interested in your letter of November 16 regarding the extent of the mineralization at Morenci.

I feel pretty sure that the Phelps Dodge Company has known about the possibilities of the King area for many years. I believe that a part and probably nearly all of this area was held by the Hanna Company for a long time and that P. D. finally benefited by playing patiently a waiting game. Also, the physical difficulties and problems of developing the ore body independently without having access from the use of some of the land held by Phelps Dodge were great and the cost probably prohibitive, not to mention the lack of additional water sources.

Anyway, general information of the nature which you have sent is very interesting. My copy did not arrive, so I will appreciate your sending another copy with the small scale map. On the latter, I will appreciate your sketching in pencil as nearly as you can the approximate location of the Banner Mining Company holdings which lie northerly or northeasterly of P. D.'s. When he was here recently, Mr. Travis mentioned again that Phelps Dodge is drilling right up to the Banner line and he seems quite thoroughly convinced that they are going to have an extension of one of the ore bodies, but from his description I could not tell which.

Very truly yours,

D. J. Pope

DJP:pf
cc: CPPollock
TASnedden-A/M-Confid.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 16, 1960

CONFIDENTIAL

Mr. C. P. Pollock, Exploration Manager
American Smelting and Refining Company
120 Broadway
New York 5, New York

MORENCI, ARIZONA

Dear Sir:

I believe you will find of interest the attached memorandum by Mr. Courtright in which he makes an estimate of the very large ore potential of the district.

The information stems from visits to the district by several of us over the past three years for various reasons: two visits were occasioned by AIME meetings, others were for the purpose of scouting the limits of the mineralized zone. This latter was done with care to avoid recognition by Phelps Dodge personnel; and it was done largely for the purpose of our own edification rather than with any particular expectation of locating exploration possibilities outside of Phelps Dodge property. Incidentally, P. D. claims do cover all mineralization of consequence.

Our curiosity about the area was based on the fact that major exploration possibilities were largely overlooked for many decades. We wondered why. The answer seems partly to be that earlier geologists did not closely examine the higher, more rugged parts of the zone; and partly, that an especial interpretation of the history of enrichment is required.

We have made traverses over parts of the King area and its extension to the north around Shannon Mt. (See Mr. Courtright's map.) There is no question that this all has a major ore potential. Drill access roads are just now being started into the rugged Shannon area.

The distribution of the chalcocite ore bodies, and their apparent relation to the modern topography and to the history of erosion, provides us with information which could be very useful in evaluating other porphyry copper deposits, as Mr. Courtright explains.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
Att: Memorandum
cc: DJPope - w/att.
File Copy routed to:
TASnedden
ACHall
JRCourtright
JEKinnison
ACBlucher
SVonFay

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 14, 1960

FILE MEMORANDUM

MORENCI, ARIZONA

Phelps Dodge has released no information on Morenci ore reserves since the start of open pit mining in 1942, thus "officially" the present reserve would be the published reserve (379,000,000 tons @ 1.02%) minus production to date (250,000,000 tons), or about 125,000,000 @ 1.0% copper. At the current rate of 50,000 tpd, this would last something less than 8 years. This, however, represents but a small part of reserves that actually exist, considering that drill exploration has been conducted in and around the pit almost continuously since the start of operations; and, during the past 3 years the drilling of a large area lying 1 to 2 miles northeast of the pit has been in progress. This latter is known as the "King" area, being situated on the southwest slopes of Copper King Mountain.

During the course of reconnaissance* carried out recently in the vicinity sufficient information was acquired to provide a rough idea of the district's potential. Our observations are summarized on the attached map which shows the present pit outline and probable extensions, and the King ore body with its probable extensions. Also shown are the approximate limits of strong alteration and mineralization which form a northerly trending zone about 2 miles wide and 4 miles long.

As in the case of many porphyry copper districts, early production at Morenci came from selective mining of relatively high grade deposits in garnetized limestone, or tactites. During the course of that mining much "low grade" porphyry was penetrated, leading ultimately to the development of the open pit ore body now being mined. This porphyry ore body consists of a secondary chalcocite blanket, 400' to 500' thick. It is underlain by very lean (.1 to .2% Cu) chalcopyrite mineralization.

Reportedly, the present pit limits on the northwest and on the east represent the ultimate limits, but a major expansion of the pit to the south, beneath the existing Morenci townsite, is planned. Included in this area is a large block of mineralized limestone which contained the high grade deposits mined by underground methods in the early days. Although drill exploration is far from complete, it appears reasonably safe to assume that the Morenci pit will eventually produce twice the total of the original estimate, or about 750,000,000 tons of ore, of which 500,000,000 tons are in reserve. The overall average grade, of course, will be somewhat lower than the 1.0% average of that mined to date. According to P.D.'s annual report for 1959, 14.3 lbs.** of copper was recovered for each ton of ore milled. This indicates a head grade of about .85% Cu. The stripping ratio was 1.8/1, w/o. Currently, the ratio is 2/1.

* By Richard, Kinnison and Courtright
** Presumably, copper produced by leaching is not included.

Drilling in the King area started over three years ago. Currently, four diamond drill rigs are operating two shifts per day. The holes average about 1500 feet in depth. Reportedly, the deposit is comparable to that of the Morenci pit, being a thick chalcocite zone in monzonite porphyry. How it compares in the matters of grade and stripping ratio is unknown.

As may be seen on the attached map, the deposit is situated in a topographically high area on the east slopes of Chase Creek Canyon. Its shape in relation to topography suggests an originally flat, or low dipping thick blanket that has been deeply truncated by Chase Creek Canyon on the southwest and by Placer gulch on the northwest. This condition is also evidenced in the trend of the Morenci pit perimeter along the southwest slopes of Chase Creek Canyon. Chase Creek and its tributaries are believed to represent a cycle of recent and rapid erosion which overtook the relatively slow processes of leaching and enrichment and cut deep into the underlying primary sulphides. This primary mineralization, consisting of disseminated pyrite with very minor chalcopyrite, is well exposed in outcrops in and near the bottom of Chase Creek and in Placer Gulch. On the slopes just above, sulphides are concealed by a thin layer of leached rock, exhibiting the pale yellow-brown tones of limonite derived from pyrite. In contrast, outcrops over the high-lying ore zone show the dark maroon tones of limonite derived from chalcocite. It is hypothesized that the King and Morenci ore bodies are erosional remnants of a pre-existing, very extensive chalcocite blanket -- the accumulation of which involved leaching over a long period of time coincident with the development of a mature erosion surface.

Some leaching but little, if any, enrichment accompanied the recent and rapid erosion cycle. Instead, a great amount of copper was probably removed -- either or both as sulphide erosional debris and by solution and dissipation in circulating ground water. If correct, this concept could have importance in evaluating exploration possibilities in any porphyry copper prospect.

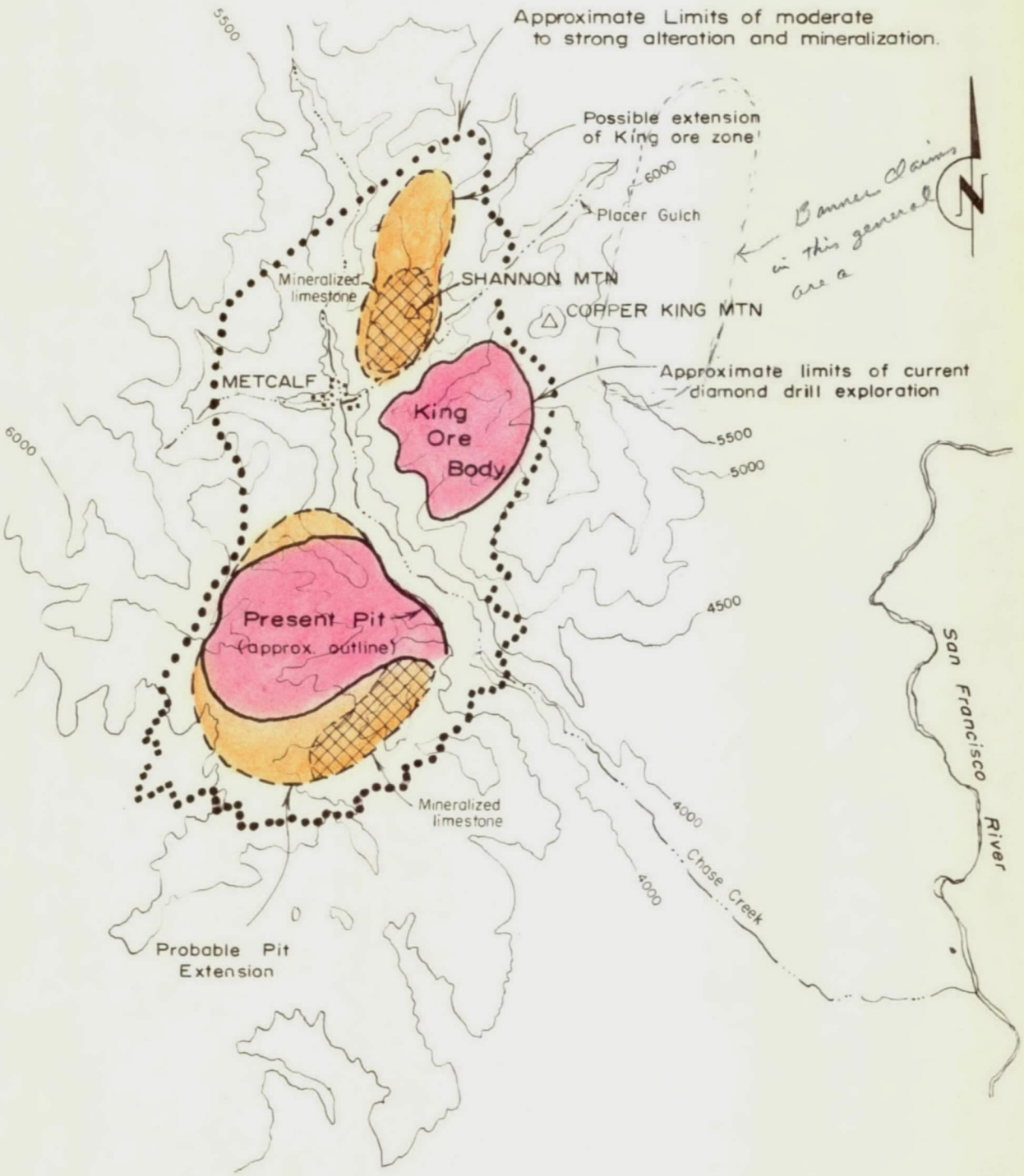
The silicated limestones of Shannon Mountain, across Placer gulch to the north, contained a number of high-grade copper deposits that were mined in the early days. Judging from the character of the outcrops in this vicinity, disseminated copper mineralization is widespread in these tactites. Ore possibilities also exist in the porphyry, granite and quartzite north of Shannon mountain. Again, these possibilities comprise a high-lying erosional remnant of chalcocite.

Considering the size of the drilled area and the possible extension to the north, the ultimate potential is unquestionably large, probably equal to that of the existing pit, say 500,000,000 tons. Thus, the total present ore potential of the district is estimated to be 1,000,000,000 tons. This is sufficient for 60 years operation at the current rate of 50,000 tpd.

It is well known that water supply, rather than ore reserve, limits the daily capacity of Morenci. It is understood that their efforts to increase the water supply involve projects and studies reaching 50 miles or more to the north. It is not known whether this work is intended to safeguard the present production rate, or to permit a higher rate.

J. H. COURTRIGHT

JHC/ds



MORENCI DISTRICT

ARIZONA

Scale 1 inch = 1 mile

May, 1960

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AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 14, 1960

FILE MEMORANDUM

MORENCI, ARIZONA

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As may be seen on the attached map, the deposit is situated in a topographically high area on the east slopes of Chase Creek Canyon. Its shape in relation to topography suggests an originally flat, or low dipping thick blanket that has been deeply truncated by Chase Creek Canyon on the southwest and by Placer gulch on the northwest. This condition is also evidenced in the trend of the Morenci pit perimeter along the southwest slopes of Chase Creek Canyon. Chase Creek and its tributaries are believed to represent a cycle of recent and rapid erosion which overtook the relatively slow processes of leaching and enrichment and cut deep into the underlying primary sulphides. This primary mineralization, consisting of disseminated pyrite with very minor chalcopyrite, is well exposed in outcrops in and near the bottom of Chase Creek and in Placer Gulch. On the slopes just above, sulphides are concealed by a thin layer of leached rock, exhibiting the pale yellow-brown tones of limonite derived from pyrite. In contrast, outcrops over the high-lying ore zone show the dark maroon tones of limonite derived from chalcocite. It is hypothesized that the King and Morenci ore bodies are erosional remnants of a pre-existing, very extensive chalcocite blanket -- the accumulation of which involved leaching over a long period of time coincident with the development of a mature erosion surface.

Some leaching but little, if any, enrichment accompanied the recent and rapid erosion cycle. Instead, a great amount of copper was probably removed -- either or both as sulphide erosional debris and by solution and dissipation in circulating ground water. If correct, this concept could have importance in evaluating exploration possibilities in any porphyry copper prospect.

The silicated limestones of Shannon Mountain, across Placer gulch to the north, contained a number of high-grade copper deposits that were mined in the early days. Judging from the character of the outcrops in this vicinity, disseminated copper mineralization is widespread in these tactites. Ore possibilities also exist in the porphyry, granite and quartzite north of Shannon mountain. Again, these possibilities comprise a high-lying erosional remnant of chalcocite.

Considering the size of the drilled area and the possible extension to the north, the ultimate potential is unquestionably large, probably equal to that of the existing pit, say 500,000,000 tons. Thus, the total present ore potential of the district is estimated to be 1,000,000,000 tons. This is sufficient for 60 years operation at the current rate of 50,000 tpd.

It is well known that water supply, rather than ore reserve, limits the daily capacity of Morenci. It is understood that their efforts to increase the water supply involve projects and studies reaching 50 miles or more to the north. It is not known whether this work is intended to safeguard the present production rate, or to permit a higher rate.

J. H. COURTRIGHT

JHC/ds

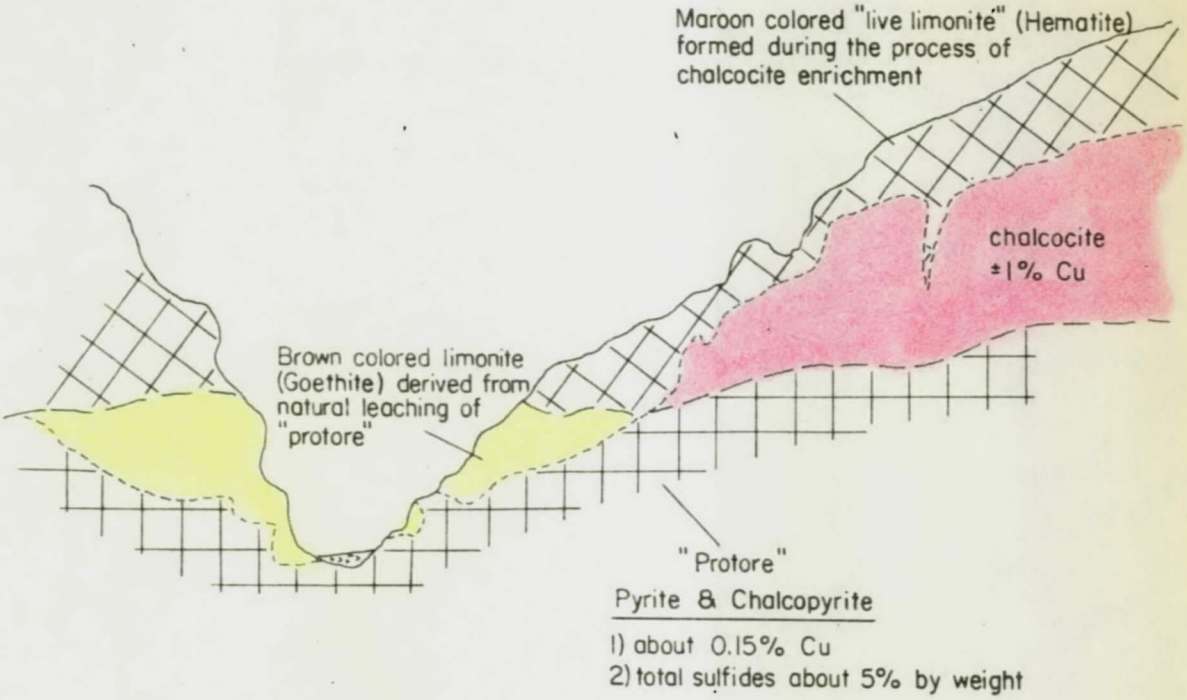
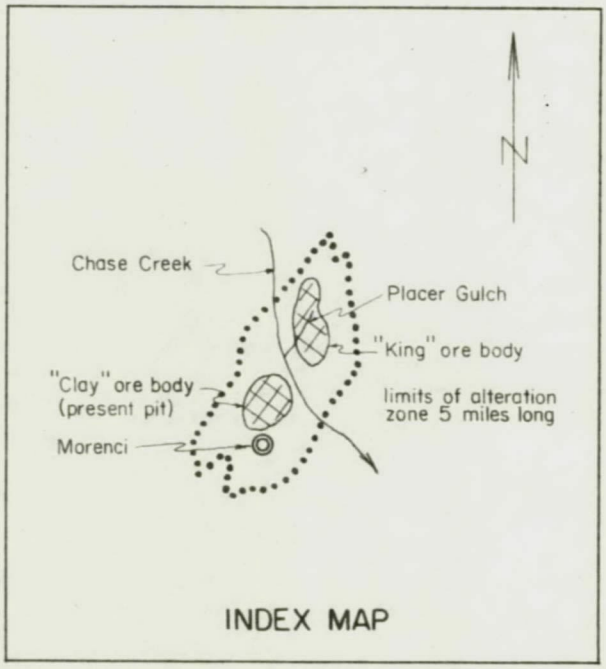


Illustration of late Tertiary- Recent erosion and leaching; partial destruction of an older (Mid Tertiary) chalcocite blanket. Modern erosion and leaching has progressed faster than formation of chalcocite.



DIAGRAMMATIC CROSS SECTION

"KING" ORE BODY

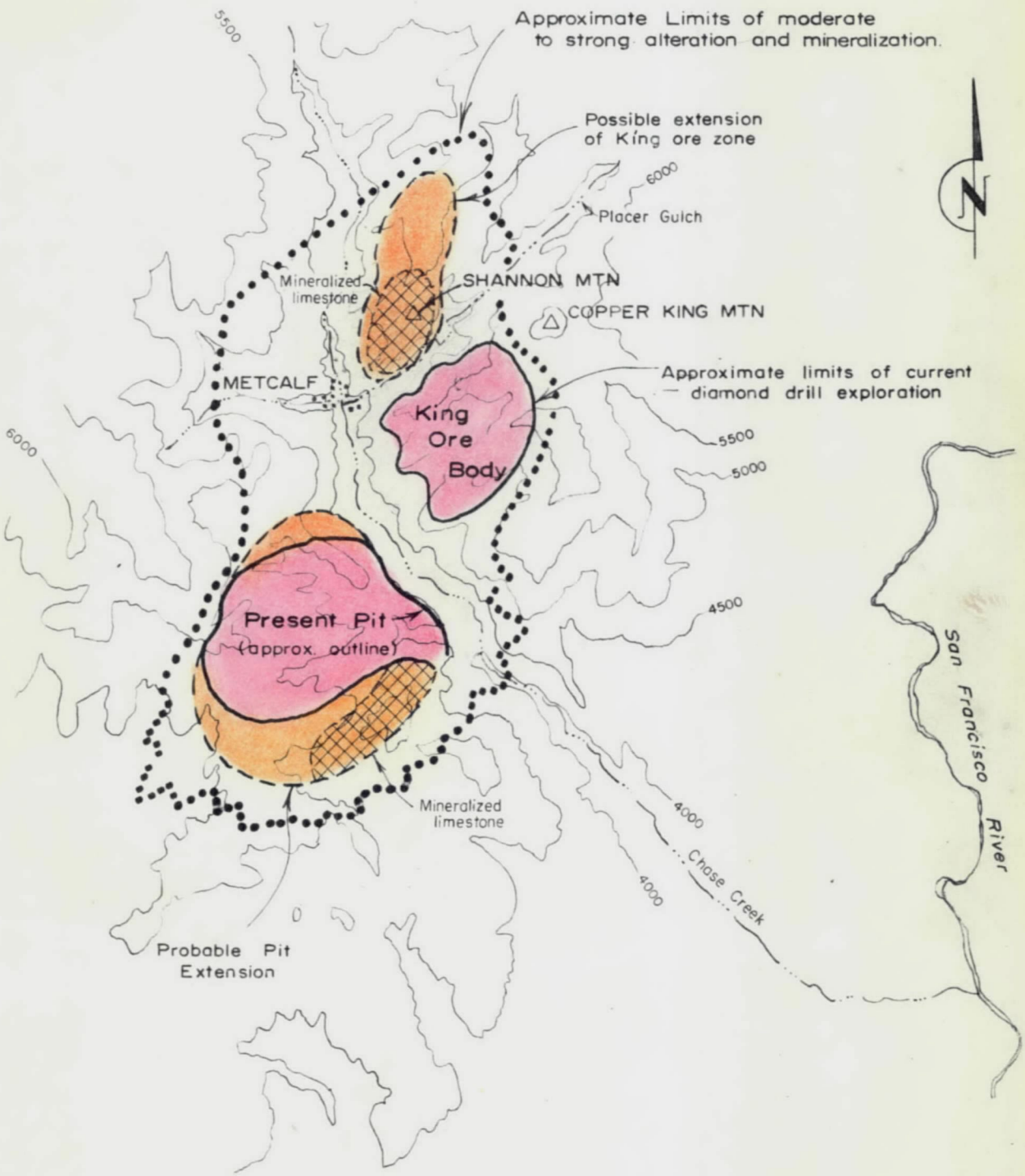
Placer Gulch near Chase Creek
Looking N.E

MORENCI DISTRICT, ARIZONA
not to scale

JEK

1898

JHG

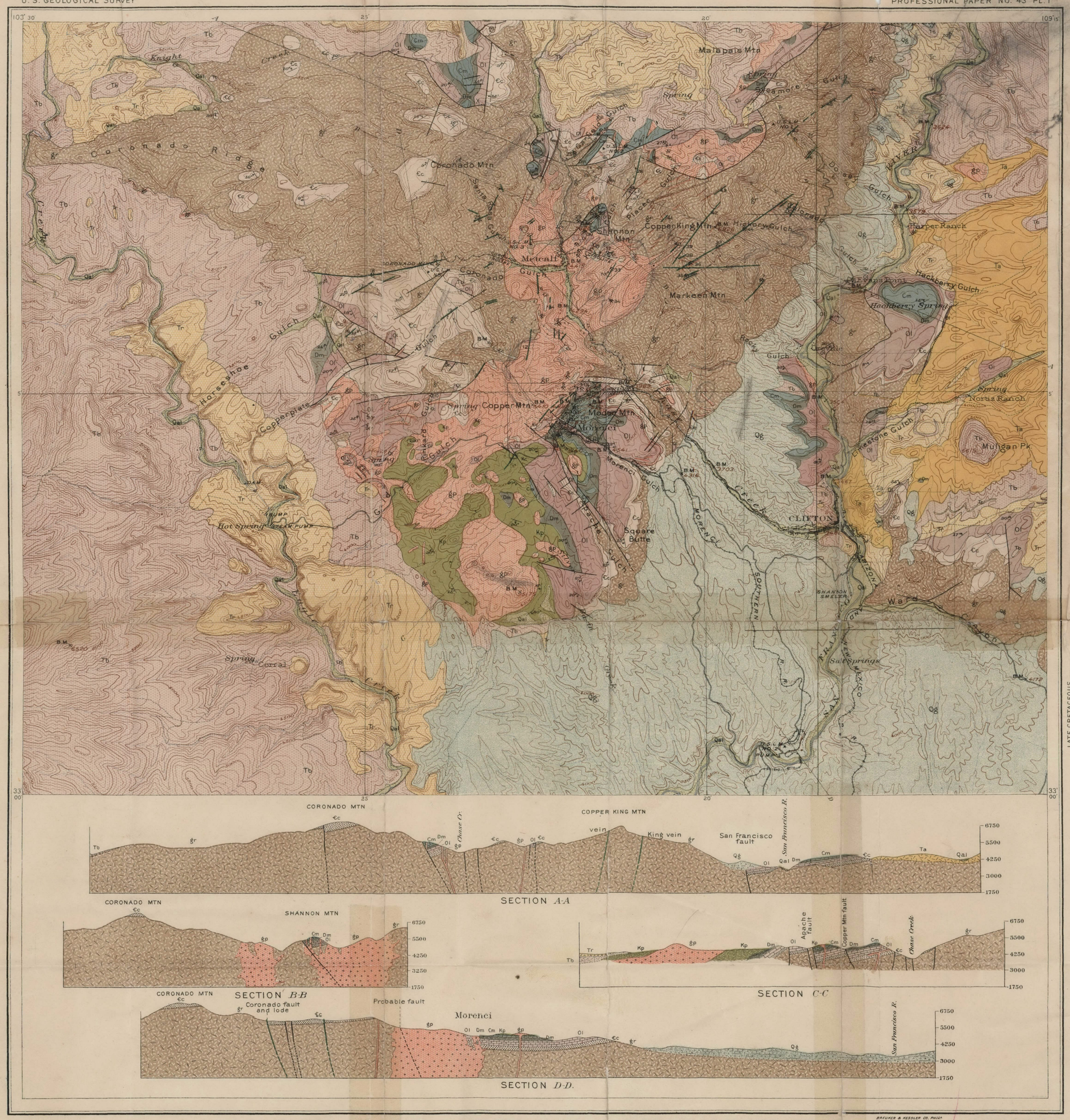


MORENCI DISTRICT

ARIZONA

Scale 1 inch = 1 mile

May, 1960



LEGEND

SEDIMENTARY ROCKS

QUATERNARY

- Qal — Fluviatile sands and gravels
- Qg — Gila conglomerate (detritus, roughly bedded and subangular)

CRETACEOUS

- Kp — Pinkard formation (Sandstones and shales)

CARBONIFEROUS

- Cm — Modoc limestone (heavy-bedded gray limestone, sometimes magnesian in lower part; contains Mississippian fossils)

DEVONIAN ?

- Dm — Morenci formation (black clay shale, sometimes argillaceous limestone in lower part)

ORDOVICIAN

- Ol — Longfellow formation (heavy-bedded brown limestone, shaly and siliceous in lower part; usually cherty and sometimes magnesian)

CAMBRIAN ?

- €c — Coronado quartzite (quartzitic sandstone, brown or red, usually with basal conglomerate)

IGNEOUS ROCKS

TERTIARY

- Tr — Rhyolite
- Tb — Basalt
- Ta — Andesite

LATE CRETACEOUS OR EARLY TERTIARY

- gp — Granite-porphyry, Quartz-monzonite-porphyry, Diorite-porphyry (connected by transitions)

PRE-CAMBRIAN

- gr — Granite
- p, db — Dikes of porphyry and diabase

Mineral veins, chiefly copper: showing strike and dip

Strike and dip of sedimentary strata

Known faults

Concealed faults

Mines, chiefly copper

Prospect pits

Tunnels

MINING PROPERTIES.

Location indicated on the map by numbers.

1. Arizona Central
2. Copper Mountain
3. Humboldt
4. Hormeyer
5. Liverpool
6. Yavapai
7. West Yankie
8. Longfellow
9. Clay
10. Cayuga
11. Producer
12. Fairbanks
13. Copper Queen
14. Mexican
15. Las Terassas
16. Copper Plate
17. Keating
18. Coronado (2 shafts)
19. Las Trajas
20. Emerald
21. Pyramid
22. Ida
23. Miza
24. Stevens Group
25. Brunswick
26. Mammoth
27. Iolanthe
28. Antietam
29. Shannon (2 shafts)
30. Shirley
31. Metcalf Mines
32. Jameson
33. King
34. Standard
35. Markeen
36. Olivette
37. Copper King
38. Virginia
39. Delaware
40. Raton
41. Veiled Prophet
42. Trilby
43. Mansfield
44. Clifton Consolid.
45. Colorado
46. Golden Eagle
47. Black Prince
48. Poland
49. Fischer

E. M. Douglas, Geographer in charge.
Triangulation and topography by Jeremiah Ahern.
Surveyed in 1900-1901.

GEOLOGIC MAP AND SECTIONS OF THE CLIFTON-MORENCI DISTRICT, ARIZONA.

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 miles

1 ½ 0 1 2 3 4 5 kilometers

Contour interval 100 feet.

Datum is mean sea level.

1904.

APPROXIMATE MEAN DECLINATION 1901. 12¾°. TRUE NORTH. MAGNETIC NORTH.

BREUNER & KESSLER CO. PHILA.

J. M. B. W. L.

Geology by W. Lindgren and J. M. Boutwell.
Surveyed in 1902

Plate XVI.—Geologic map of part of the Clifton-Morenci district, showing distribution of principal ore bodies. (Modified from Lindgren.)

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

October 6, 1950

FILE MEMORANDUM

MORENCI
Greenlee County, Ariz.
Exploration and Geology

The Mining Geology Division of the A. I. M. E. held a field meeting at Morenci on September 29th and 30th, 1950. Many of the following news items are common knowledge, but some may be of interest.

Morenci Open Pit, Phelps-Dodge Corporation

Present production rate -	50,000 tons per day at 1.00% Cu
	75,000 tons per day waste
Mined in 1949	20,000,000 tons ore
	35,000,000 tons waste
Bottom level of pit	4500-foot elevation
" of ore	4200-foot elevation
Bench height	50 feet
Ultimate pit slope	1.12 to 1 (42 degrees)
Mill recovery	87%

Total on payroll mining department, 975

The copper in the ore is present essentially as chalcocite. The ore, averaging about 1% copper, carries about .04% non-sulphide copper, .005% MoS_2 and .10% Zn. The primary, or unenriched protore averages about .1% copper, as chalcopyrite. The open pit is almost entirely in monzonite and granite porphyry. The ore, for the most part, is exceptionally friable.

Leaching Operations

Leaching "in place" is being carried on in the caved areas of early underground operations one-half mile south of the pit. Water is sprayed on the surface and collected from the underground workings. Churn drill holes have been put down and blasted in this area to improve the permeability of the ground. At present 25 pounds of copper per 1,000 gallons of water are recovered; formerly the recovery was 125 pounds of copper. The chief difficulty in this type of leaching is the tendency of the solutions to channel in passing through the coarsely broken ground.

Low grade material (both sulphide and oxide) is segregated and dumped below the pit along the southwest slope of Chase Creek Canyon. This material will eventually be leached. Waste capping is dumped north of the pit.

Plans reportedly have been laid to install a 5,000-ton leaching

File Memorandum

plant, similar to the one formerly operated at Ajo. This plant will be supplied by oxidized ore (± 1.0% Cu) occurring just north of the present pit. Much of the copper present is in the form of carbonate. Net sulphuric acid consumption is estimated at 25 pounds per ton of ore.

Leached Outcrops

Extensive detailed studies of capping material have been conducted by Messrs. Reber and Smith. They have found that the color of residual limonites is largely determined by the ratio of chalcocite to pyrite that existed in the rock before it was leached. The richer portions of the ore, carrying from one to two per cent copper, have chalcocite-pyrite ratios of around 1:1. The leached rock lying over this material is gray in color and characteristically contains much black and purplish limonite, while over the leaner ores and protores, with chalcocite-pyrite ratios of 1:5 or more, the rocks are stained brick red to yellow brown and contain relatively small amounts of black limonite. Residual cuprite is considered responsible for the black and dark maroon color of the limonites derived from chalcocite. Specimens were assayed and found to contain one or two tenths oxide copper. In general, the limonites at Morenci closely correspond to those over other porphyry copper deposits of the enriched type.

Exploration

Three exploratory churn drills (Model 26-L) operate one shift per day each. The total footage averages about 1,000 feet per month, or 12 feet per drill per shift. Holes are spaced 200 or 400 feet apart on a grid pattern. Depths range to 1700 feet and average around 1200 feet.

Holes are drilled open (without casing) unless caving is encountered. Oversize rock fragments catching in the splitter are considered evidence of sloughing or caving. Since the water level is near the bottom of the ore body, most of the sampling is done in "dry" holes (samples obtained under water are less apt to be reliable). No information was available on the accuracy of these samples; the churn drill blast hole samples reportedly check within two or three hundredths of the mill heads. (More detail on drilling and sampling procedure at Morenci is contained in my Memo of April 1, 1949).

The exploratory drilling is guided to a large extent by the results of leached capping studies. In some instances several short holes are drilled part way through the capping to gain information on the nature and strength of mineralization. This information is used in selecting locations for deep holes.

Exploration Possibilities

A brief visit was made to a breccia pipe area, just west of Chase Creek, opposite Shannon Hill, and about two miles north of the open pit. Much of the breccia appears to be of post-mineral age (closely resembling the "pebble breccias" of Toquepala), but one area, about 500 feet by 1,000 feet, is composed of typical ore breccia and is well mineralized. There has been no exploratory drilling here for disseminated copper ore, nor in the Shannon Hill and Metcalf areas where "live" limonites are more or less abundant in the leached outcrops.

Of interest is the fact that some 10 million tons of ore were reportedly

File Memorandum

developed by diamond drilling some time ago on the Hanna property, just northeast of the open pit. This ore carries about twice as much primary copper (chalcopyrite) as the open pit ore. Evidently, exploration possibilities are far from being exhausted here, as there are extensive areas of well-mineralized outcrops that have not been tested. The drilling on the Hanna property was done from an old adit, and confined to one relatively small area.

Strong mineralization and alteration extends south and southwesterly from the present pit for half a mile or more, encompassing some of the old high grade mines. It was stated that very likely this entire area would eventually become part of the open pit mine.

In the past, Phelps-Dodge Corporation has been rather conservative with exploratory drilling, confining the work to the immediate fringes of the ore body being mined; however they apparently have reached a stage where a larger and more "venturesome" drilling program must be contemplated. The first step will be the preparation of 400-scale contour maps (from aerial photographs) as a base for mapping mineralization and other geologic features.

Reserves of one per cent ore are probably limited to that sufficient for ten or fifteen years' operation, but when we consider the possibilities in the seven or eight tenths range, an expectancy of over 50 years' life seems a conservative guess.

J. H. Courtright

J. H. COURTRIGHT

JHC:ar

cc: FVRichard
LKWilson

AMERICAN SMELTING AND REFINING COMPANY
Tucson, Arizona

April 1, 1949

MEMORANDUM TO:

Mr. F. V. Michard

MORENCI, ARIZONA
PHELPS DODGE CORPORATION
Churn Drill Exploration

On March 20, 1949, a visit was made to Open Pit operations at Morenci. Here 50,000 tons of 1.0% copper ore are mined daily. The copper occurs as chalcocite associated with pyrite in a rather soft, friable, strongly altered monzonite. A description of prospect drilling practice follows:

Drilling -

Two 23-L churn drills are operated two eight-hour shifts each per day. The holes average 1,200 ft. in length; the average advance per drill shift is 17 feet. Holes are collared and drilled 12 inches in diameter to the ore zone, a distance varying from 200 to 400 feet. The hole is then cased and continued 6 inches in diameter. Holes are drilled open through the ore zone unless caving occurs (indicated by large rock fragments in sludge sample). In such cases the hole is cased and continued 6 inches in diameter. If caving is encountered in the six inch hole, the casing is removed and the hole reamed 8 inches in diameter; after casing the hole is continued, 6 inches in diameter. It was stated that attempts to underream had been unsuccessful.

Sampling -

Sludge is removed from the hole at 10 foot intervals with a dart-valve type bailer. A sand pump is used to clean the hole after the dart-valve bailing is complete. The sludge is passed through a Jones type splitter and subsequently reduced to a mud cake by means of an airpressure filter about 16 inches in diameter. The cake, after drying in the electric ovens at the laboratory, average around 12 lbs. in weight.

In the geologic laboratory, sludge boards are prepared for each drill hole. These are made up of small specimens of the concentrate and rock fragments from each sample arranged to scale on a thin wooden strip. Since one particular rock - a monzonite - is believed to be more favorable as a host for disseminated copper ore, all samples are examined microscopically to determine the rock type, nature of mineralization and degree of alteration. Especial attention is