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James Doyle Sell Mining Collection

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TAB

1948-67

Sep 11 5-9 Silver Bell

~~Oxide Body~~

Mining	at 7500 tons	.26
Strip	.636 tons at 28	.18
Milling		.51
Water		.03
General exp		.22
		1.20
Hauling conc		.05
total op.		1.25

Oxide

ore res.	19,800,000
cut off .80% with milling of all material that must be mined to .40	
Grade	.96
Non S	.15
Rec	.75
conc	24%
waste ore — 1.04:1	

El Tino

Res	12,200,000
cut off	.6%
Grade	.78%
Non S	.07% ?
mill recov	.79.3
Conc	38%
Ratio	6.3 to 1
Waste ore	1.52 to 1
Preliminary strip	7,000,000
	.95 to 1

Sept 9 '30 Silver Bell

1. Ore Reserves	32,000,000 tons
2. Grade	0.89% Total copper
3. Recov	76.9%
4. Grade Conc	27.5 cu
5. Ratio	40.3 to 1
6. Rate per day	7000 tons
7. Life	11.8 years
8. Waste	39,200 00 tons
9. Ratio	1.20 to 1
10. Tons prelim strip	15,000 000
11. Operating ratio	.76 to 1
12. Conc tons/day	186

Estimated Analysis Conc.

Au	Ag	Cu	Fe	Insol	S
tr	2.1	27.5	24.7	10.2	30.0

Capital — 12,500 000

Cu price - 16.5 cents — profit $8.12 per ton

at 18.5 — return capital in 11.8 years

24.5 " " 3.9 "

S-1.2

J. H. C.

NOV 20 1967

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

November 15, 1967

MR. WES, BNW, TAB
READ AND RETURN
PREPARE ANSWERS ..... HANDLE .....
FILE ..... INITIALS .....

W.E.S.
NOV 20 1967

Mr. R. B. Meen, Manager
Southwestern Mining Department
American Smelting and Refining Company
P. O. Box 5795
Tucson, Arizona 85703

SILVER BELL UNIT
OXIDE PIT SLIDE ZONE

Dear Sir:

Attached is a memorandum by Robert Edmiston summarizing the information that has been gathered by the geologist on the unstable area located on the southeast corner of Oxide pit perimeter. The most recent observations indicate a failure in this area may be imminent.

This area has been under observation for many years and mining under the potential slide has been controlled. Early this year and prior to the start of the summer rains we completed mining the available ore that might be affected in case of a major failure from the slide zone.

Future expansion of Oxide pit will include this part of the present pit perimeter and this particular fracture zone will be taken down provided it does not fall in on its own accord. We believe present roadways and mining area will not be affected in case of a major slide.

Very truly yours,

Original Signed By
D. R. JAMESON

D. R. JAMESON
Superintendent

DRJ:jca
cc: TASnedden
JHCourtright
WCWaidler
RABarnes
RCEdmiston
NRNuttycombe

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

November 15, 1967

MEMORANDUM TO: Mr. D. R. Jameson, Superintendent

Subject: SPECIAL REPORT ON OXIDE PIT SLIDE ZONE

PURPOSE:

The purpose of this report is to present recent data on the slide zone in Oxide Pit, which is usually summarized in the Quarterly Geologic Report. Measurements are made on this slide zone primarily for mine safety. However, the accumulated data may be useful in interpreting future slope problems.

SUMMARY:

The slide zone in the southeast corner of Oxide Pit has been watched for several years. Measuring gages were installed in early 1966 and show that the amount of movement in the past four months (July-October, 1967) is nearly equal to the movement in the preceeding year. Mining on the 2660 level, below the slide zone was completed in June, 1967 and may be related to the increased rate of movement. On October 3 and 4, 1967, the year's hardest rains further acclerated the movement to a new rate about three times the rate for September, 1967. The fractures continue to open at the higher rate at this time. (The actual rate depending on the point being measured - but averaging 0.01 feet per day.) This represents a more unstable condition than anything previously reported. Small scale ravelling is presently occurring. Until further changes occur this potential slide must be treated as though failure would take place tomorrow.

Description of Potential Slide Zone

The scale of fracturing, its relationship to the southeast pit perimeter, the location of monitoring devices, and the direction movement of two points are all shown on Figure 1.

The main fracturing strikes N20E and appears to dip 80° to the SE, away from the pit. Kingsbury, et.al. mapped a similar shear zone at this location in 1941. This would seem to indicate that the sliding is controlled by a pre-mine shear zone. Where slides have occurred recently the newly formed faces usually are vertical or overhanging. An unusual feature of this zone is a down dropping wedge (Stations 5 and 6, Figure 1). This wedge may be the driving force which caused a failure in September of about 100 tons.

Smaller openings splinter off the main one and move WNW towards the pit perimeter. In September, 1967, when the accompanying map was drawn these fractures could only be traced a short distance. Now they may be traced nearly to the pit perimeter. In general, horizontal movement is large compared to

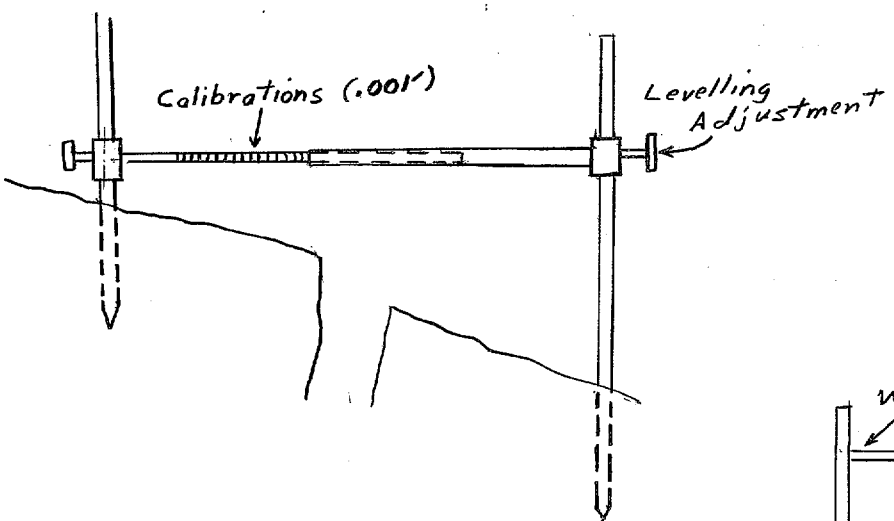
down dropping and no potential failure surface has been recognized dipping into the pit and intersecting the slope.

The entire fracture zone, as it now exists may be mined out in a future extension of Oxide Pit, as shown in Figure 1.

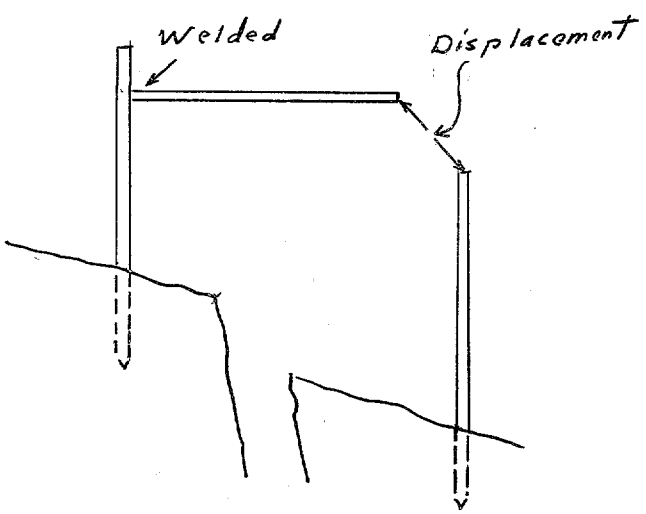
Measuring Methods

Two devices are in use to measure expansion along the fractures. Mr. J. A. Briscoe installed expansion gages at stations 2, 5, 8, 9, and 10 early in 1966. He reported the expansion for three month intervals in the Quarterly Geologic Reports. (The bar at station 9 showed about 0.250 feet of movement up until July, 1967. On November 1, 1967 the same bar showed 0.514 feet of movement.) These expansion bars are read by interpolating between machined groves in the pipe. Accuracy is about ± 0.001 feet.

The author supplemented the above gages with stikes made of concrete reinforcing bar at stations 1, 4, 5, 6, and 7 in mid August. These bars are not as accurate but do give an indication of the direction of movement. Accuracy is ± 0.003; readings are made with a steel tape. Both bars are shown below.



Expansion Bar



Re-Bar Stakes

Only stations 1, 4, 5, 8, and 9 are still usable. Other stations have been struck by falling rock or became unsafe to occupy. A failure at station 2 about October 20, 1967, left one end of the bar hanging in space.

DATA:

The purpose of the monitoring program during this phase of continual movement is to determine the rate of movement and note acceleration and deceleration. Periods of acceleration and deceleration have been shown to precede a rock failure in at least one recorded instance at an open pit, porphyry-copper deposit.

The accompanying graphs have been plotted from the data obtained from stations 1, 2, 5, and 9. Stations 1 and 2 are on the lowest level along which the fracturing can be traced. The measurements on these stations are taken as normal to the failure surface. Station 5 measures the drop of the wedge and the net movement is recorded. Station 9 reads approximately normal to the fracture at the furtherest point from the pit perimeter.

Graph A shows relative displacement vs time while Graph B shows the rate of movement vs time. The slope of the lines connecting adjacent points on Graph B represents the acceleration during that time interval. Steep slopes correspond to high acceleration. A level line means no acceleration; a line sloping down and to the right corresponds to deceleration - a slowing down of movement but not a reversal of movement unless the line crosses the zero displacement ordinate. To examine the correlation between rainfall and movement the rainfall is plotted along the top of the graph with scale on the right.

The graphs show that movement along the zone was relatively uniform during the summer rains. Except for the wedge of rock monitored by station 5, movement averaged .005 feet/day or less, until late September. The small failure mentioned earlier took place between September 19 and 26, 1967. During this period all stations registered a moderate acceleration. Following this, station 2, near the crest, recorded a sharp acceleration.

On October 3 and 4 Silver Bell received it's hardest rain in 1967, (To date). The effect on the readings was immediate and persists at this writing, (November 10, 1967). On the graphs the effects of the rain appear to precede the rain but this is because of the manner in which the graphs are constructed. The graphs show that the wedge accelerated to a rate of movement of over five hundreths of a foot per day. At the same time the fracture at station 1 closed 0.200 feet. The device at station 2 became loose in the rock and the rock on which the pit side of the device was anchored later fell into the pit.

Following the rains the fracture at station 1 re-opened and accelerated to a new rate about twice its previous rate. The wedge decelerated and appeared to level off. It is now accelerating again and moving about three times its previous rate. The movement along the furthest fracture from the pit is of a lesser magnitude but it also is now moving about three times its previous pace.

CONCLUSION AND RECOMMENDATIONS:

Activity along the slide zone in the southeast corner of Oxide Pit is at its highest level in several years. Periods of acceleration and deceleration indicate a very unstable mass of rock. If a large failure should take place the southeast corner of the floor of the pit will be covered with debris. It is improbable that slide material will extend beyond the haul ramp (Figure 1). At this time the area between the pit wall and the haul ramp should be considered hazardous and closed to men and equipment.

A proposed extension of Oxide Pit would remove the mass of rock which is now in motion. When mining is resumed in this area it is important that:

1. An investigation be made of rock discontinuities during mining.

2. The slope angle be changed from 1:1 if necessary.

3. The toe should be completely cleaned up so that movement will not be hidden from view.

R. C. Edmiston

R. C. Edmiston
Geological Engineer

RCE:jca

cc: TASnedden
RBMeen
JHCourtright
WCWaidler
RABarnes
RCEdmiston
NRNuttycombe

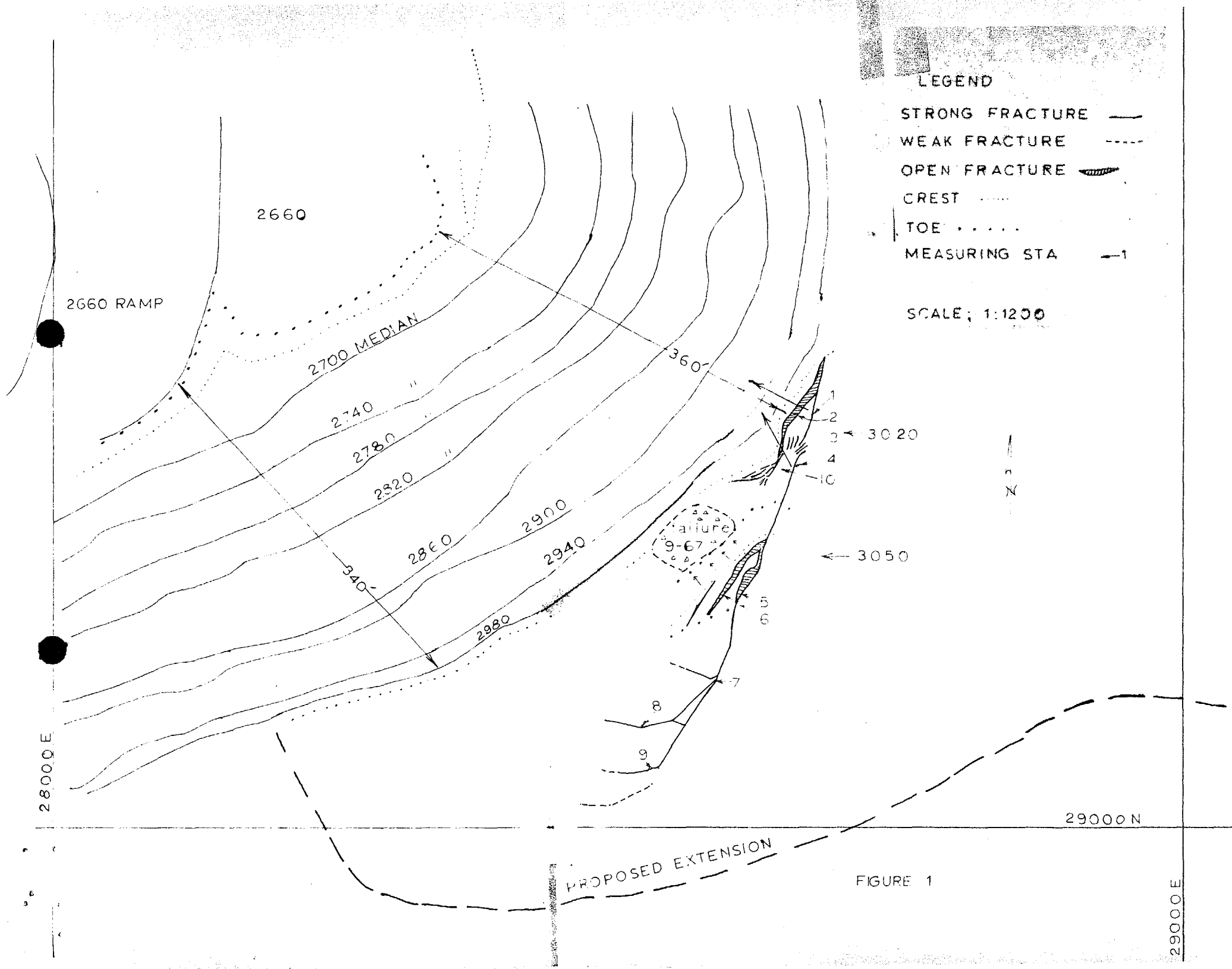
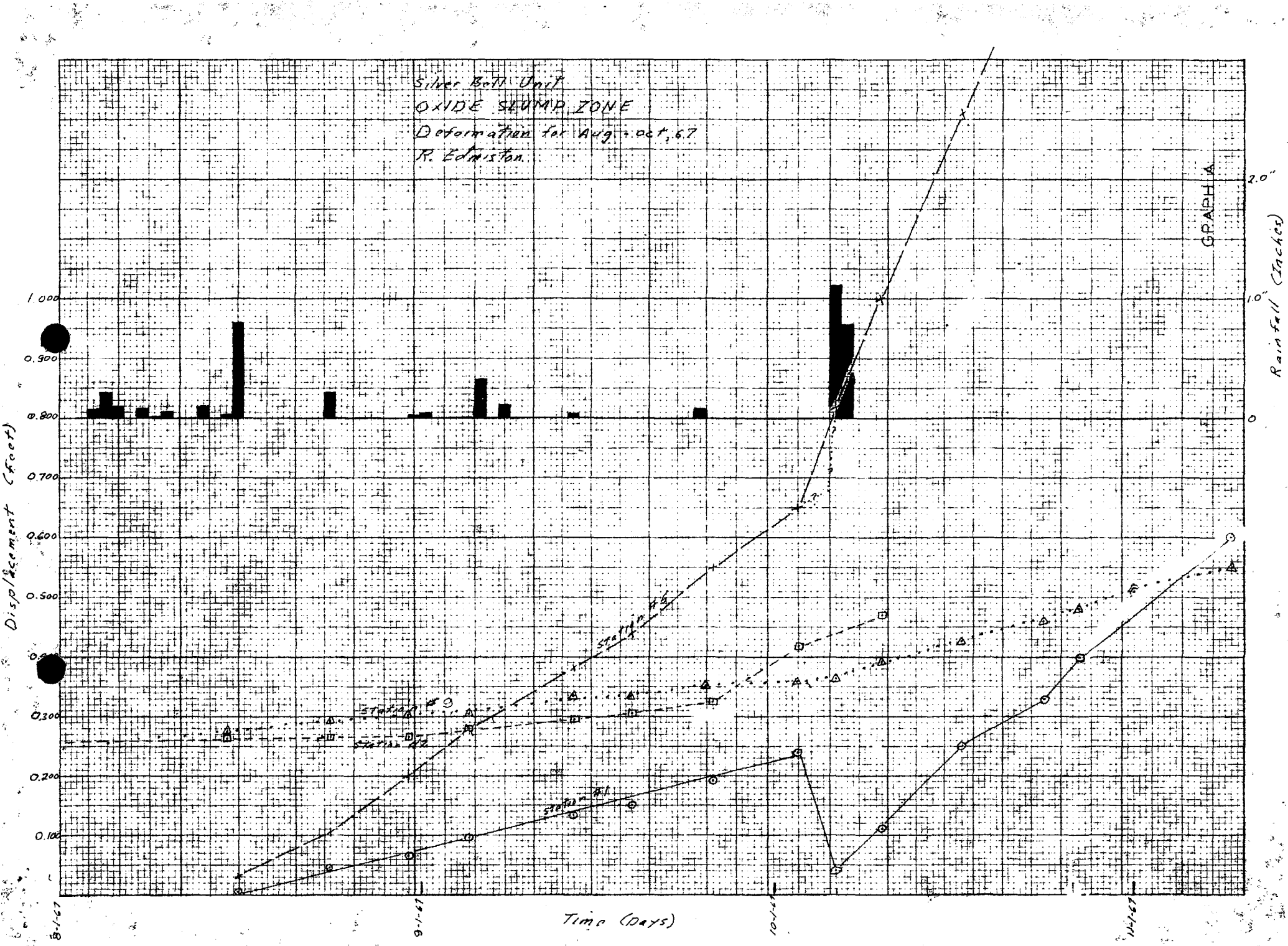
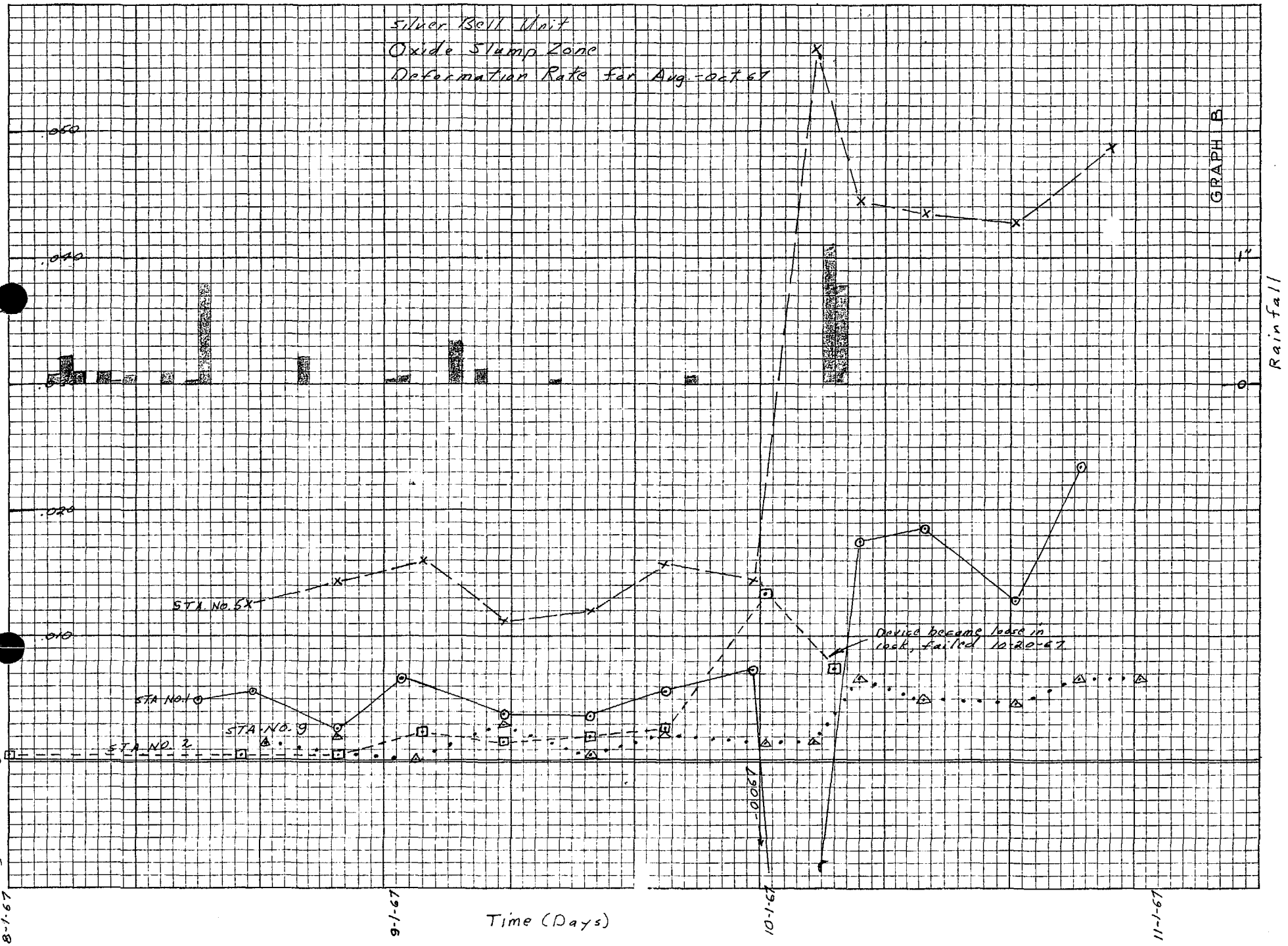

LEGEND
STRONG FRACTURE
WEAK FRACTURE
OPEN FRACTURE
CREST
TOE
MEASURING STA
SCALE; 1:1200
2660
2660 RAMP
2700 MEDIAN
2740
2780
2820
2860
2900
2940
2980
360
340
3020
3050
failure 9-67
1
2
3
4
5
6
7
8
9
10
N
28000E
29000N
29000E
PROPOSED EXTENSION

FIGURE 1


Silver Bell Unit
OXIDE SLUMP ZONE
Deformation for Aug.-Oct., 67
R. Edmiston
GRAPH A
Displacement (Feet)
Rainfall (Inches)
Time (Days)
1.000
0.900
0.800
0.700
0.600
0.500
0.300
0.200
0.100
2.0"
1.0"
0
8-1-67
9-1-67
10-1-67
11-1-67
Station #5
Station #3
Station #2
Station #1



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DIAMOND CORE DRILLING
DIAMOND DRILLING EQUIPMENT
GROUTING
FOUNDATION TESTING
MINING
QUARRYING
SHAFT SINKING
TUNNEL DRIVING
MINE PLANT DESIGN
AND FABRICATION

Boyles Bros.
DRILLING COMPANY
CONTRACTORS-ENGINEERS-GEOLOGISTS

10801 North 21st Avenue
PHOENIX, ARIZONA 85020
Phones: Office 944-1731
Home 948-2009

General Offices and Plant
1624 Pioneer Road P. O. Box 58
SALT LAKE CITY, UTAH 84110
Phone 487-7595

BRANCH OFFICES
PHOENIX
RENO
SPOKANE
DENVER
SACRAMENTO
SANTIAGO, CHILE
LIMA, PERU

J. H. C.

MAY 18 1967

May 9, 1967

MAY 1 1967
SILVER BELL UNIT

American Smelting & Refining & Mining Co.
Silver Bell, Arizona 85270

Gentlemen:

For rotary drilling through dumps the charge will be $5.40 per foot plus cost of mud and chemicals.

Cementing, if necessary, $15.00 per hour plus cost of cement and materials needed for loss circulation.

Standby time at your request $15.00 per hour.

For cleaning out old churn drill holes the charge will be $25.00 per hour plus cost of bits and all materials needed for cleaning of holes.

Thanks for calling on us.

Sincerely yours,

J. E. Roberts
District Manager

JER/tk

Approved by [illegible] May [illegible]

Copies made for: RBMeen
JHCourtright
JABriscoe

S-7.7
142

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
SILVER BELL, ARIZONA

ASARCO

J. H. C.
OCT 10 1966

D. R. JAMESON
SUPERINTENDENT

October 7, 1966

MR. WES, FILE
READ AND RETURN
PREPARE ANSWERS ..... HANDLE .....
FILE ✓ INITIALS

W.E.S.
OCT 12 1966

NOV 16 1966

Mr. J. E. Roberts, District Manager
Boyles Bros. Drilling Company
10801 North 21st Avenue
Phoenix, Arizona 85020

Dear Sir:

This letter will confirm our verbal understanding that the following prices per foot of diamond drilling will be effective September 1, 1966:

Drilling	BXWL	NXWL	NC or Collar Pipe
0 to 500 ft.	$3.10	$4.20	$5.40
500 to 1000 ft.	4.10	5.10	
1000 to 1500 ft.	5.10	5.80	
1500 to 2000 ft.	5.80	6.70	
2000 to 2500 ft.	6.70	7.70	

Also, it was agreed that all other clauses of our present contract with Boyles Bros. Drilling Company, dated June 6, 1960, will remain in force.

Very truly yours,

Original Signed By
D. R. JAMESON

D. R. JAMESON
Superintendent

DRJ/O

cc: RBMeen
JHCourtright

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

October 11, 1966

W.E.S.
OCT 12 1966

MR. WES
READ AND RETURN
PREPARE ANSWERS ___ HANDLE ___
FILE ✓ INITIALS

TO: J. H. COURTRIGHT

FROM: J. E. KINNISON

OXIDE PIT, SILVER BELL
TACTITE

The north wall of the oxide pit is characterized by a narrow band of tactite which contains a high pyrite content but very little copper. This high pyrite zone--nearly massive in places--turns dark brown or black when exposed to the atmosphere after mining. This seemed unusual to me, and as a mineralogical check to determine the cause, I had the surface film of black material analyzed on the visual spectrograph at the Arizona Bureau of Mines. The results indicate a high concentration of manganese, and this is probably the cause of the dark color.

The spectrograph also indicated the presence of zinc and silver. I therefore had two hand specimens of this tactite assayed by Hawley and Hawley, the results of which assay were: Ag 0.12 oz and Zn 2.02%. As these were hand specimens taken principally to check the black surface color, no conclusions regarding the distribution of Zn and Ag may be made. It is worth note that they are present.

John E. Kinnison
JOHN E. KINNISON

JEK:pjc
cc: JABriscoe

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

September 2, 1966

TO: R. B. MEEN

FROM: J. H. COURTRIGHT

SILVER BELL - EAST OXIDE EXPLORATION

Enclosed is Mr. Watson's memorandum on proposed exploration in an area east of the Oxide pit. You, Mr. Snedden, and I discussed this matter briefly the other day.

Back in 1948 we staked a group of claims in this area and carried out a study of the mineralization in outcrops. It was concluded that the possible ore occurrences (as indicated by the results of the Mudd drilling and outcrop studies) were too small and low grade to warrant exploration. The claims were allowed to lapse.

It is now proposed that under the present copper market the area may hold possibilities for at least a modest amount of open pit ore. It is recommended that the claims be relocated (the posting of new notices is already in progress) and that a sufficient number of holes be drilled to cover the required discovery work.

J. H. Courtright
J. H. COURTRIGHT

JHC/kw
Enclosure
cc: KERichard, w/encl.
TASnedden, w/encl.
DRJameson, w/encl.
BNWatson

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

August 30, 1966

J. H. C.
AUG 30 1966

TO: J. H. COURTRIGHT

FROM: B. N. WATSON

SILVER BELL - EAST OXIDE EXPLORATION

In my 1965 report on the Geology of the Area East of Oxide Pit, I stated that the 11 Harvey Mudd churn drill holes put in the area in 1909 showed "only sporadic pockets of good porphyry copper mineralization", that "it is common to come across small isolated areas exhibiting live limonite in the capping", and that the locally interesting capping would overall "condemn the area as a 'longshot' under present economic conditions."

The odds do not seem so long now. In the past year the price of copper has risen, a sizeable west extension to the Oxide pit has been drilled out under what must be considered poor capping, and drilling in North Silver Bell has found areas of marginal mineralization in the weakly altered and generally unfavorable dacite porphyry.

Reference to J. C. Playter's alteration map of the East Oxide area (1948) shows a number of separate localities exhibiting good capping which, if they represent copper "hot spots", might be combined to carry lower grade in-between ground and give an open pit operation. That hot spots do exist is shown by the admittedly unreliable, but indicative, 1909 Mudd holes #7 (80 feet of 0.73% Cu, 75 feet of capping), #11 (125 feet of 0.88% Cu, 90 feet of capping), and #15 (90 feet of 1.35% Cu, 135 feet of capping).

Three other factors favor the East Oxide area: 1) accessibility is good, 2) the haul to the mill is short, and 3) the Mudd holes were evidently placed almost exclusively in monzonite porphyry dikes rather than the very possibly more favorable syenodiorite porphyry bands sandwiched between dikes (see Watson map, 1965). With respect to this last point, both J. Briscoe and myself have noticed in correlating rock types with engineer shot plans of Oxide pit that the syenodiorite is the most favorable host, followed by alaskite, then by monzonite porphyry.

It is now considered advisable to check out the well-defined zone of alteration east of Oxide pit and north of the tailings dams before outside interests take the initiative. The Silver Bell engineering staff is re-papering the old ASARCO Ox group of claims, and resident geologist J. Briscoe plans to start very soon a geochemical study of the area using several across-zone traverses with sample spacings on the order of 150 to 200 feet.

With the accumulation of geochemical data, outcrop mapping, and alteration mapping, Mr. Briscoe in cooperation with the engineers can lay out the required assessment holes where they can do the most good and yet be of most geologic interest.

Barry N. Watson
BARRY N. WATSON

BNW/kw

W.E.S.
AUG 30 1966

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

BWW Aug 30

August 29, 1966

MR. ~~WES~~, ~~BWW~~, ~~SVF~~
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FILE ✓ INITIALS

S. V. F.
AUG 30 1966

MEMORANDUM FOR MR. R. B. MEEN

Silver Bell
Jesuit Claim

This will confirm discussion with you and Mr. Snedden regarding the Jesuit patented claim which has been offered to ASARCO for a cash price of $15,000.

As shown on the attached map, this claim is adjoined on three sides by ASARCO property.

Jesuit Hill is capped by Cambrian quartzite which is underlain by a large sill-like body of dacite porphyry (see geologic map by Owen Evans, 1954). Although it lies within the main zone of alteration, the Jesuit claim covers an area generally weak in mineralization and the chances for ore such as that in the El Tiro deposit are practically nil. However, during the past six months consideration has been given to possible ore occurrences in tactite (garnetized limestone) beneath the dacite sill (James Briscoe memo to D. R. Jameson, 7-11-66), and quite recently it was reported that Duval Corporation encountered mineralized tactite beneath the dacite at a depth of 600 to 700 feet in a hole located just north of Jesuit Hill. It now appears that extensive copper mineralization could occur beneath the dacite anywhere within the zone of alteration providing tactites are present.

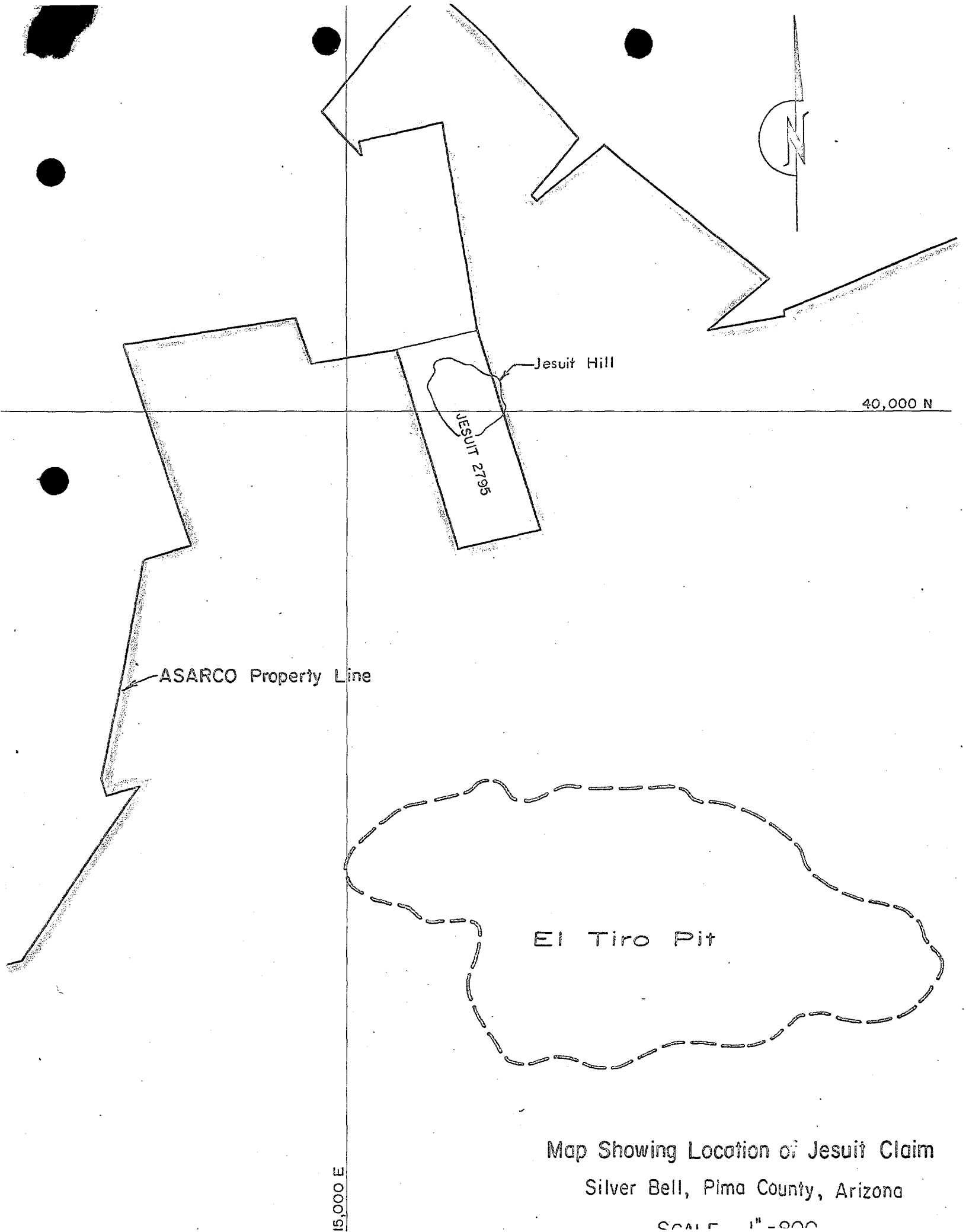
Considering the depth involved, the chances are slim that a deposit of sufficient size and grade to be mineable by open pit could be found. However, at least a limited amount of drilling to test beneath the dacite sill is warranted and four drill sites for this purpose have been selected.

In view of the close spacial relationship that exists between a monzonite stock and the Imperial copper mineralization in tactite, it is probable that ore possibilities are best in the immediate vicinity of the various stocks that intrude the area. The south end of the Jesuit claim overlaps the edge of one of the porphyry stocks.

The exploration possibilities at depth beneath the claim are regarded long shot at best; however, it also has surface value because of its position with respect to ASARCO property. Purchase of the claim at the asking price is recommended.

J. H. Courtright
J. H. Courtright

JHC:bam
Attachment
cc: TASnedden
KERichard
RBMeen, 6 extra



Map Showing Location of Jesuit Claim

Silver Bell, Pima County, Arizona

SCALE 1" = 800

J. H. C.

AUG 2 1966

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

July 13, 1966

PERSONAL/CONFIDENTIAL
Mr. K. E. Richard, Chief Geologist
American Smelting and Refining Company
120 Broadway
New York, New York 10005

file

CORE STORAGE
SILVER BELL UNIT

Dear Sir:

Enclosed is a copy of a memorandum by Jim Briscoe concerning core storage at Silver Bell. This subject has not been discussed in the Tucson Office. It came to my attention from an indirect source after which I asked Mr. Briscoe to send me a copy of his memorandum.

I will discuss this matter with Mr. Snedden, emphasizing our strong conviction that all Silver Bell core should be retained.

Perhaps this situation can be resolved in this office. I will advise you of the outcome.

Very truly yours,

W. E. SAEGART

WES/pjc
Enclosure
cc: JHCourtright

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

July 7, 1966

W.E.S.
JUL 13 1966

MEMORANDUM TO: Mr. D. R. Jameson, Superintendent

Subject: CORE STORAGE FOR RECENT EL TIRO AND OXIDE DRILLING PROJECTS

In response to your request last week that I determine which core from the Imperial area drilling may be discarded, I have gone over the El Tiro drilling maps. Mining in the East Extension has progressed to the 2750 level or 150' to 270 feet below the collar of the diamond drill holes in the area. These holes average five to six hundred feet deep, so only about a third of the rock represented by our core samples has been mined away.

The core from these holes are the only accurate record of the rock mined in this area. The geologic logs prepared as the core was drilled are detailed and accurate. The information contained in them is prepared so that it will be useful indefinitely. If at some time in the future, copper prices and operating costs are such that protore lying under the chalcocite blanket becomes mineable, then these logs and core samples will prove invaluable in computing reserves, and metallurgical testing.

From June of 1960 to the present some 350 diamond drill holes averaging about 500 feet in depth have been drilled. This gives a total of approximately 175,000' of core drilled at an approximate cost (not including the wages of two samplers, a core splitter, a geologist, and the cost of drilling mud, cement, etc.) of $8.00 per foot, or a total investment of $1,400,000 dollars. If a building costing $5,000 were constructed for core storage, core costing $8.00 per foot to drill could be preserved for an indefinite period at a cost of about three cents per foot. If re-examination of core from the present drilling project could make one drill hole in future unnecessary then the total cost of storage would be well spent. For the above reasons I feel that no core presently in storage should be discarded to make room for new core.

The present drilling project in the North Silver Bell area will require approximately 20 holes averaging 250 feet in depth to examine ore horizons known at this time. By conservative estimate 10 to 20 holes averaging 300 feet in depth will be necessary before the Silver Bell drilling program can be considered complete. If favorable results are obtained in either the North Silver Bell area or the North Butte area these figures could easily double. Considering the first estimate, storage will have to be provided for 7,000 to 10,000 feet of core, assay rejects, from the split samples, and metallurgical samples.

James A. Briscoe
Geologist

JAB:jca
cc: RBMeen

Mr. Courtright
S.B. Personal file
J.H.C.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

W.E.S.

March 4, 1966

MAR 7 1966

MR. WES
READ AND RETURN
MAR 4 1966
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FILE ✓ INITIALS ____

MEMORANDUM FOR MR. R. B. MEEN

Silver Bell Unit
BS&K Claims

A little while ago Mr. Courtright told me there was a report that the BS&K Mining Company had re-staked some claims that overlapped our North Silver Bell group of claims, and asked me to investigate. On February 18, I was out at Silver Bell escorting some visiting geologists, and had a chance to talk with Bob Barnes, Jim Briscoe and Chuck Haynes. They reported that some time ago they had come across some new claim corners, with iron caps on iron pipes set in concrete, and the caps were labelled with a survey number. Among these were corners saying "New York" which were not in the same position as we found the New York corners when we were surveying the North Silver Bell claims in 1954.

While Chuck Haynes was showing the visitors around, Bob Barnes and Jim Briscoe took me out in the field, and we found new posts for some corners of the New York, BSK 1, 3, 4 and 5 claims, and location notices for the BSK 1 and 2 claims. These were located on May 20, 1965, and the BSK 2 was amended on June 24, 1965. The Mineral Survey on all corners we saw was M.S. 4630.

We saw no sign of any notice of patent application, but I felt this should be checked further, so, at your request, on February 28 I drove to Phoenix and inquired at the Bureau of Land Management. The survey had been platted, and includes the Nevada, New York, BSK Nos. 1, 3, 4, 5 and 13 claims. The BS&K No. 2 is not included. I ordered two copies of the plat to be sent me, and one accompanies this memorandum, and the other has been sent to Mr. Jameson with his copy of this.

I also found that on February 21, BS&K Mining Company, P.O. Box 5853, Tucson, Arizona 85700, had made application for patent for the above claims, through their attorney Albert H. McKenzie of McKenzie, Scott, Bolze and Weltsch, 222 North Central Avenue, Phoenix 85004. This application has been numbered AR035698. I asked in what newspaper publication had been ordered, and was told that BS&K had had a publishers agreement with a paper in Arizona City, but as this was not an approved newspaper, publication was not ordered, and the matter is still under discussion. The notice required to be posted in the land office had also not yet been posted, so the application had not yet been approved, and the 60 day period in which to adverse had not yet started to run.

I have requested that I be notified when and in what paper publication is ordered. If we decide to proceed further, probably our attorneys, or we as a Company, should also request to be notified.

In the meantime Bob Barnes has been tying in the corners to our surveys, and I have suggested that as we will now have a copy of the official plat he hold off further surveying until he has studied the plat. I have also asked him, after he has seen the plat, to make an effort to locate the posted notice.

Until we have plotted these new claims on our maps we will not know just how much of our ground has been covered, but it is quite apparent that if we wish to preserve our rights in the area we should file an adverse claim in the Bureau of Land Management, and institute suit in court. Fortunately, there is plenty of time in which to do this, but we should nevertheless promptly decide our course of action and begin whatever steps are necessary, which I believe will include a survey of our own by a licensed mineral surveyor, which will show the areas of conflict.

S. I. BOWDITCH

S. I. Bowditch

SIB:bam
Attachment
cc: TASnedden, w/o attach.
DRJameson, w/attach.
JHCourtright, w/o attach. ✓

Silver Bell ORE Est

6-9-65

Oxide Pit 6 mil. (official Reserve)
2 " on 2600 & 2640 levels
5.5 " East extention

El Tiro 21 " (includes current strip area)
12 " "E Extension" (Imperial)
2 " North El Tiro

Measured → 48.5 - or 13 yr life at 10,000 Tpd

plus 8.0 mil "prospective ore (West oxide North El Tiro)

56.5 mil sulphide

probable 15 yr life

@ 10 000 TPd

plus 7.0 mil Imperial oxide ore

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 2, 1965

J. H. C.
APR 2 1965

MEMO TO MESSRS: R. B. [redacted]
D. R. [redacted]
C. W. [redacted]
B. N. [redacted]

OUTCROP GEOCHEMISTRY
SILVER BELL UNIT

Enclosed is an addendum and map (plate 6) which should be attached to your copy of Mr. B. N. Watson's memorandum of December 21, 1964, concerning the subject.

W. E. [redacted]

[redacted]/mw
Encls.
cc: JHCourtright w/o encl.

Please copy for DRT, Silver Bell
OK

J. H. C.

SEP 3 1965

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

August 31, 1965

TO: R. J. LACY

FROM: W. G. FARLEY

Ground Magnetic Survey
Northeast of Imperial Area
Silver Bell, Arizona

Attached is the ground magnetic survey over the plus - 400 gamma anomaly (Map No. 1) partially outlined by the low level helicopter survey of the El Tiro - Imperial area. (See memo by S. Parker Gay - May 11, 1965)

On the ground the magnetic anomaly has a peak amplitude of over 1000 gammas. At one point a change of 100 gammas occurs over a distance of 10 feet and a change of 900 gammas over 100 feet. This steep gradient indicates the source of the magnetic anomaly to be coming from near surface rock. The overall outline of the magnetic anomaly coinsides with the southwest end of the dacite porphyry hill just east of section corner $\frac{33\ 34}{4\ \ 3}$. (Map No. 2) A geological map of this area by Berry Watson (Map No. 3) shows an east-west monzonite porphyry dyke intruding the dacite porphyry at the point of maximum magnetic amplitude.

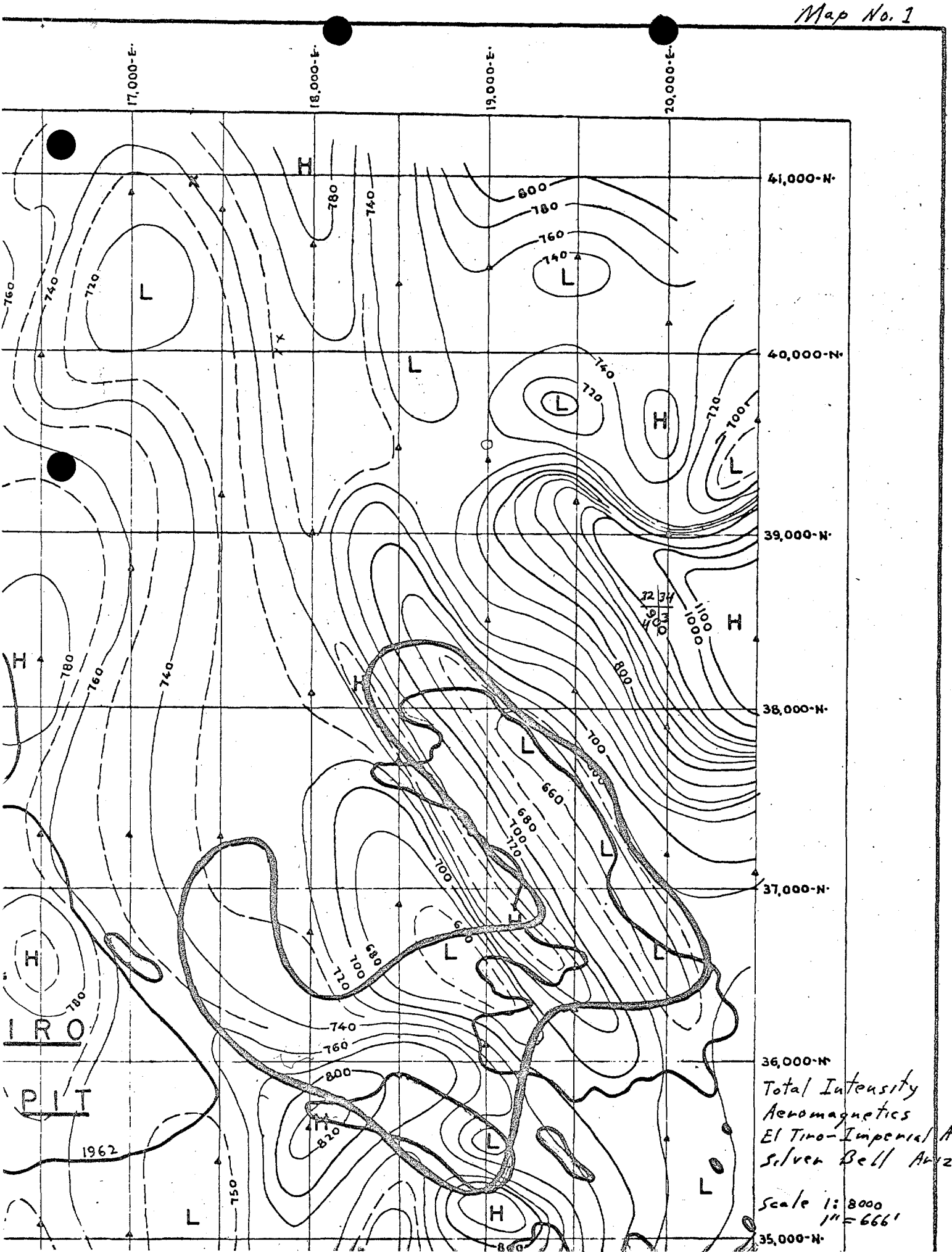
Susceptibility measurements taken on outcrop samples over the anomaly only account for about 1/3 of the total magnetic responce. An attempt was made to find more magnetic surface rock in the field by holding rock samples close to the magnetometer sensing head. The rocks tested appeared to have little effect on the magnetic readings. A possible explanation for the susceptibility measurements not accounting for the total magnetic anomaly is that most of the magnetic response is coming from remanent magnetization. When the rock samples are crushed for susceptibility measurements the rock chips are randomly oriented which cancels out the response from remanent magnetization, and thus gives lower then expected magnetic susceptibility readings.

It is my opinion that the magnetic anomaly is coming from the large block of dacite porphyry which makes up the exposed hill. One-third of the response is coming from induced magnetization and two-thirds from remanent magnetization. The anomaly is of no further interest.

Wayne G. Farley
WAYNE G. FARLEY

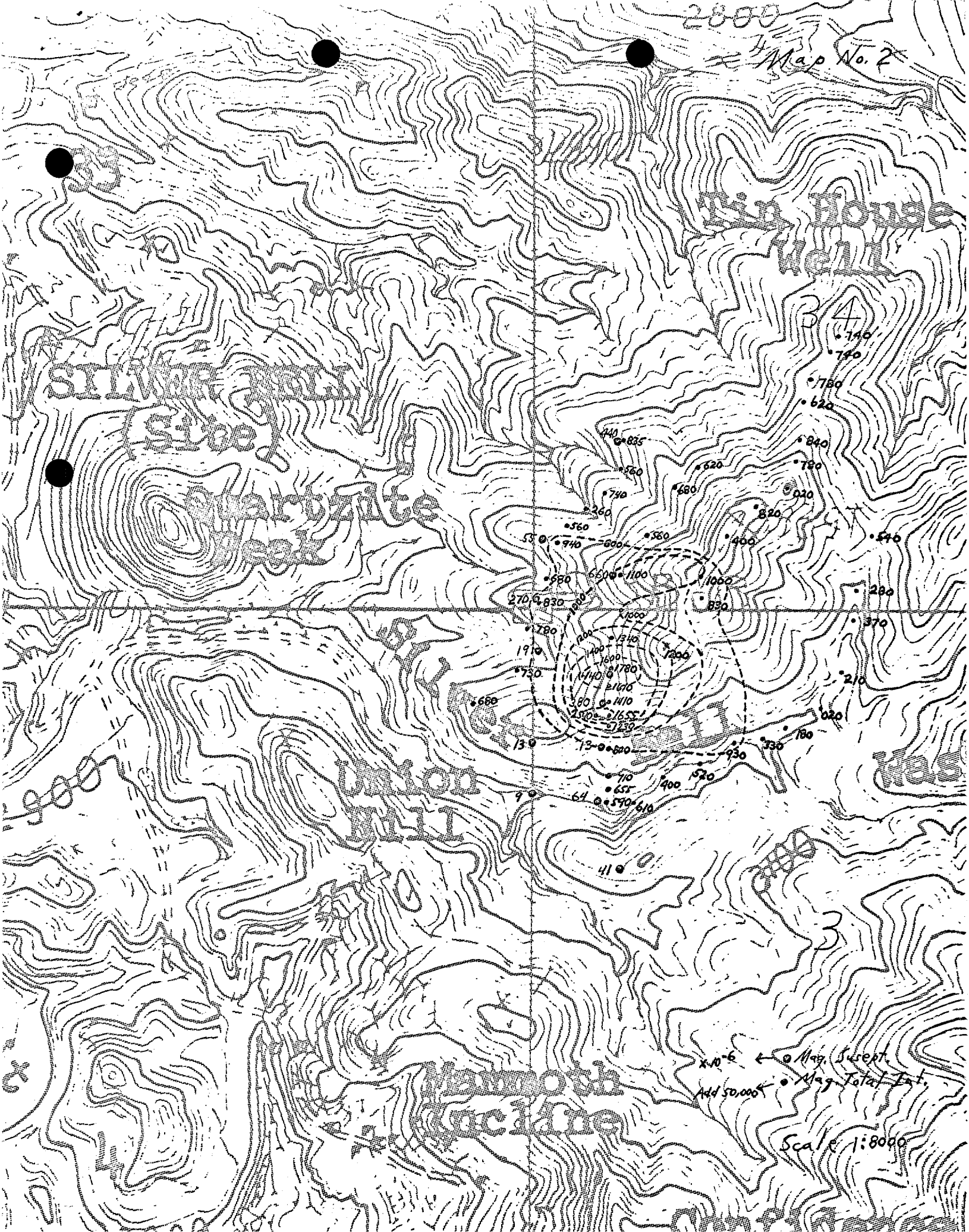
WGF/pjc
Attachments
cc: CPPollock
JHCourtright
WESaegart
SPGay, Jr.

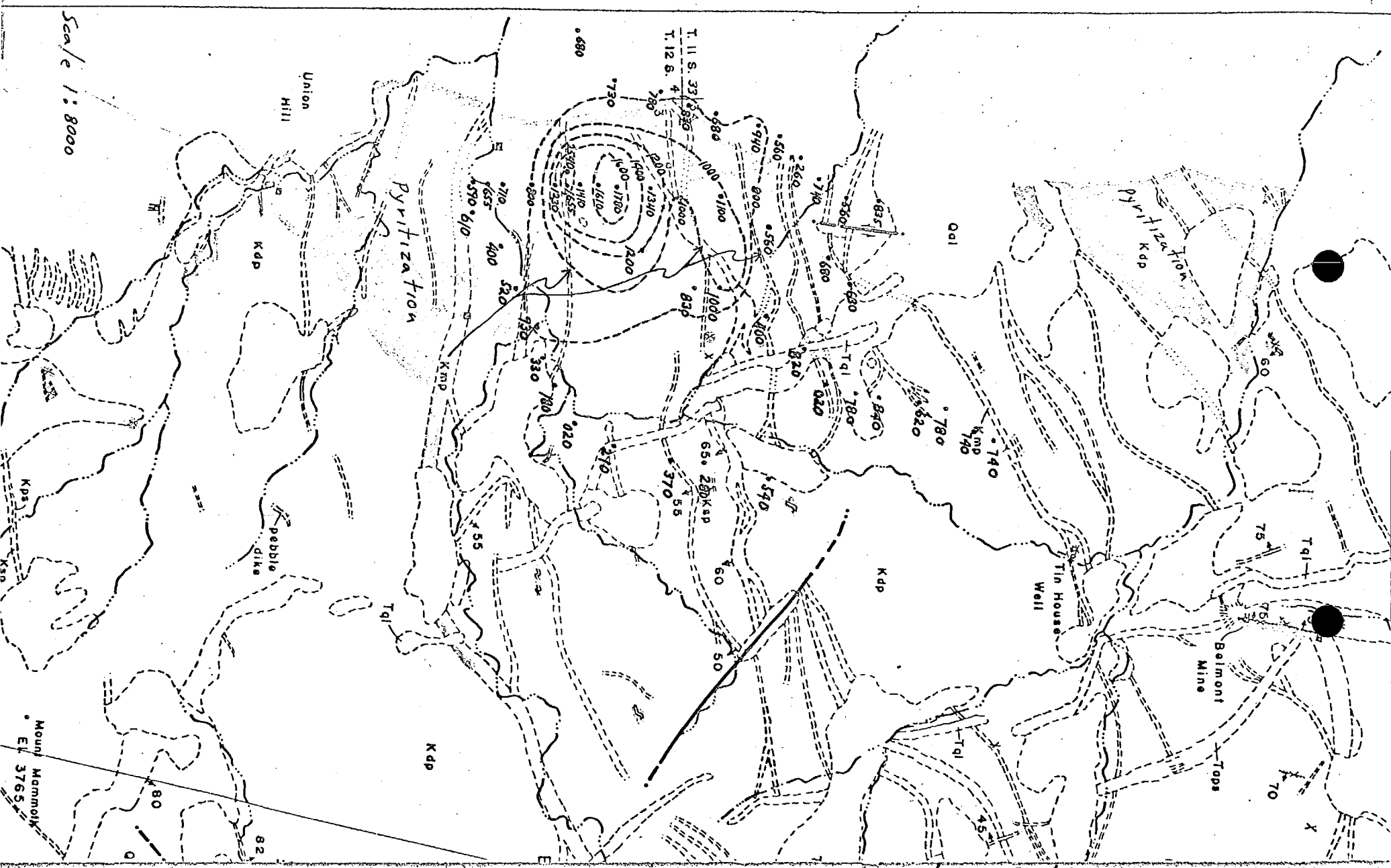
Map No. 1



Total Intensity
Aeromagnetics
El Tiro-Imperial Area
Silver Bell Arizona

Scale 1:8000
1" = 666'


Map No. 2
Silver Bowl
Site
Quartzite
Dacite
Mammoth
Scale 1:8000
x10^-6 ← Mag. Susept.
Add 50,000 ← Mag. Total Int.



Kdp = Dacite porphyry
Kmp = Monzonite porphyry
Tql = Quartz latite porphyry

Add 50,000 for Total Magnetic Field

Map No. 3

Cross filed
S. 10. 11. 2

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 19, 1965

Mr. D. R. Jameson, Superintendent
Silver Bell Unit
American Smelting and Refining Company
Silver Bell, Arizona

Dear Mr. Jameson:

Attached is Mr. Gay's report on the recent airborne magnetic survey of the El Tiro-Imperial area.

Results of this low level hellocopter survey show fair correlation with the Imperial zone of copper mineralization in tactites. Thus, the method may be applicable to the search for copper-bearing tactites elsewhere. Previously run, higher level aeromag failed to show any definite correlation, I understand.

Mr. Gay calls attention to the largest anomaly obtained on the survey, over 400 gammas in magnitude, lying some 1500' northeast of the old Union Mine. I don't believe there has been any drilling on the higher part of this anomaly, but two holes, located high up on the southwest flank of the anomaly, D-161 and D-158, cut 650' and 855' of dacite.

Mr. Watson covered this magnetic high area in his mapping two years ago (PhD. dissertation) and he advises that the outcrops show only dacite porphyry cut by a few narrow monzonite dikes. Since the area is outside the zone of mineralization-alteration, the occurrence of sulphide-bearing tactite (engulfed by dacite) is unlikely.

Magnetite in the dacite may be responsible for the anomaly. I presume samples for magnetic susceptibility tests should be collected to test this possibility. Perhaps Mr. Gay will advise on this.

Yours very truly,

Original signed by
J. H. Courtright

J. H. COURTRIGHT

JHC/jak
Enclosure
cc: KERichard, w/o encl.
RJLacy, " "
WESaegart, " "

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

J. H. C.

February 18, 1965

FEB 19 1965

Mr. Parker S. Gay, Jr.
American Smelting and Refining Company
3422 South 700 West
Salt Lake City, Utah 84119

Silver Bell
Imperial

Dear Parker:

I am enclosing the following information on Silver Bell:

1) 1" = 200' colored geologic map showing drill hole locations
2) 1" = 1000' mineralization map of Silver Bell district. The survey points on this map which are prefixed "F" are Fairchild Aerial Surveys control points.
3) 3 - 1:15,840 contact print aerial photos of El Tiro area,
   Nos. 6700 02A
   6700 03A
   6700 04A
4) Tabulation of magnetite intercepts in Imperial drill holes. The magnetite content is abbreviated as follows:

   tr = trace
   Sp = Sparce
   number = estimated volume % magnetite

5) 1" = 200' uncolored geologic map of Imperial area. The areal extent of this map is not quite the same as that on the map referred to as 1) above. This latter map is enclosed because its reproduction of topographic contours is superior.

The dacite porphyry shown on attachment 1) is generally sill-like, typically intruding the sediments along bedding planes. The extensive outcrops of dp immediately east of El Tiro pit are mostly underlain by sediments. The large outcrop area of dp at the northeast corner of the map is also underlain by sediments.

Quartzite (Cambrian bolsa) is the basal member of the section. It is overlain by the limestones (Paleozoic). The dacite is sill-like and dike-like beneath, within and above all the sediments. Exact relationships are complicated by extensive faulting. The composite mass of bedded rocks, including dp, is tilted NE at $\pm$ 30°.

Monzonite porphyry is the most recent premineral igneous rock. The mp stock in the center of the map (attachment 1)) is assumed to be the source of the mineralization in the sediments which effectively surround it. The mp itself is nearly barren of sulfides and exhibits only weak alteration. The block of sediments which lie west of this monzonite stock may be a down faulted continuation of the same horizons which are exposed east of the stock. This would explain why limestones occur on both sides of the basal quartzite.

Tactite and hornfels were developed in the limestones by metamorphic or hydrothermal processes and are the host rocks for the best $CuFeS_2$ mineralization. Concentrations of magnetite are almost entirely restricted to the tactites.

The amounts of magnetite recorded in the drill logs are not impressive. Aeromagnetic correlation may be impossible as concentrations of importance are small.

You should refer to my letter of March 19, 1956 to Bob Lacy regarding magnetic susceptibilities of rock samples from the Silver Bell district.

Please return the aerial photos to me when you are finished with them.

Very truly yours,

W. E. Saegart

WES:bam
Enclosures
cc: JHCourtright w/o encs.
RJLacy w/o encs.

P. S. Attachment 5) is not enclosed. We are in the process of moving to the new building and the original of 5) is temporarily inaccessible. I will send a print of this map after we are settled in the new building.

W.E.S.

J. H. C.
MAR 17 1965

March 15, 1965

Dr. G. M. Schwartz
Department of Geology
University of Minnesota
Minneapolis, Minnesota 55455

Dear Dr. Schwartz:

I wish to thank you for the two reprints of papers by you which I received today. Your visit and comments here in the office and on the Silver Bell trip were very informative and enjoyable and I wish to extend my thanks for your interest in porphyry copper alteration in general and in the problems we discussed.

Very truly yours,

ORIGINAL SIGNED BY
JOHN E. KINNISON

JOHN E. KINNISON

JEK/jak
cc: JHCourtright

Mr. J. H. Courtright

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

J. H. C.
APR 2 1965

December 21, 1964

MEMORANDUM TO: J. H. Courtright

Subject: EXPLORATION GEOCHEMISTRY - COMPLETION OF OUTCROP SAMPLING FOR TRACE QUANTITIES OF COPPER AND MOLYBDENUM AT SILVER BELL, ARIZONA, AND ANALYSIS OF RESULTS.

This memorandum supplements the reports of Mr. N. P. Whaley on November 20, 1963 and of Mr. B. N. Watson on August 3, 1964 concerning geochemical outcrop sampling at Silver Bell, Arizona. The previous reports describe a definite correlation which had been found to exist between known copper mineralization and anomalous amounts of molybdenum in the overlying near-surface bedrock. Using this correlation as an exploration tool, outcrop sampling had shown that at least one locality - the North Butte-Danube area - had some promise of substantial copper mineralization.

At the request of Mr. William Saegart, a number of additional outcrops were sampled this Fall, and it is now believed that the property has had sufficient investigation by this method for the time being. Sample line No.5 was extended northwesterly from North Butte through the Imperial area to North Silver Bell. Two short north-northeast-trending lines were run across the North Butte-Danube area, and line No. 6 traversed SE-NW across Mt. Expectation just southwest of El Tiro pit. The following illustrations accompany this report: Plate 1, showing traverse lines of outcrop sampling; Plate 2 and 3, geophically illustrating ppm Cu and Mo along line No.5; Plate 4, graphically illustrating ppm Cu and Mo along line No. 6 and along the two North Butte-Danube transverse lines; Plate 5, showing the North Butte-Danube anomaly contoured with 10 ppm moly intervals.

Line No. 5 between North Butte and North Silver Bell exhibits two strong geochemical anomalies in area already known to contain copper mineralization. Samples 31-37 traverse the Imperial area just east of El Tiro pit. No.'s 31,32,34,35,36 and 37 are located in visibly mineralized tactites which give substantial Mo as well as high Cu chemical assays. Sample 33 came from dacite just north of the Mammoth incline and ran high in both Mo and Cu. Sample 36A is from the generally unmineralized monzonite stock between Union Ridge and El Tiro pit, and, while assaying high in Cu, it showed a low 5 ppm Mo - a result in accord with the previous findings of the Silver Bell sampling program. Sample 38 came from weakly mineralized hornfels.

The other line No. 5 anomaly is registered by sample locations 48-51 - dacite outcrops which rim the southeastern perimeter of a small monzonite stock in the North Silver Bell region. Churn drill holes from the year 1955 indicate the presence of a 35 to 100 foot chalcocite blanket averaging about .55 Cu in this dacite immediately adjacent to the stock. Although rock alteration is not strong here, the geochemical sampling discloses unusually high Mo values.

The Mo assays from the remaining line No. 5 outcrop samples are of background proportion with the exceptions of 21,24,39,43 and 45. Sample 21 (120 ppm Mo) fell within a rather strongly altered northeast-trending zone approximately 25 feet wide within alaskite. Strong sericite and liberal amounts of live limonite were seen in the outcrop. The alaskite is weakly altered to the northwest and southeast of this zone and would probably assay only background Mo. Sample 24 (31 ppm Mo) was located

in another, but somewhat more weakly altered, narrow northeast- trending zone. Such zones are common but generally widely-spaced in the interval between Oxide and El Tiro pits.

Sample 39 (70 ppm Mo) was taken from quartzite near the north end of Union Ridge. This anomaly is somewhat of a mystery with dacite the only igneous rock in close proximity.

Sample 43 (130 ppm Mo) and 45 (60 ppm Mo) are from rather weakly altered dacite north of Quartzite Peak. Churn drill holes have shown this general area to contain only sparse copper mineralization. Occasionally a drill hole would deliver moderate copper values, apparently hitting a mineralized fracture zone. The anomalies of sample 43 and 45 may be reflecting the presence of such fracture zones. (Plans have existed for several months to put down 3 exploratory diamond drill holes in the area just north of Quartzite Peak and including sample locality 43. Reasons other than the geochemical information have led to this proposed exploration.)

The North Butte-Danube moly anomaly has been fairly well delineated by 23 outcrop samples. Plate 5 indicates the localities of greatest interest and shows the locations of the three churn drill holes that have been put down in this area.

Some facts pertaining to the North Butte-Danube anomaly should be pointed out. As mentioned by Mr. Saegart in a letter dated September 3, 1964, North Butte straddles one of the aformentioned northeast-trending zones which exhibit strong sericite and liberal amounts of live limonite. This particular zone, however, is of a considerably greater width than similar altered zones to the northwest. The two geochemical samples (5-19 and 5-19B) taken from this zone on North Butte give high moly assays, as might be expected. The other anomalous sample locations in the North Butte-Danube area, however, are in no way connected with such obviously mineralized northeast-trending zones. Sample 5-17A and 5-18 are taken from mineralized tactites but do not show as strong a Mo anomaly as do several of the sample locations in igneous rock.

Churn drill holes 135, 136, and 137 were placed in the area depicted by Plate 5. CDH 135 is outside the major anomaly and shows but very weak mineralization. CDH 136 is located on the flank of a southward-protruding "arm" of the North Butte-Danube anomaly, but also shows only weak mineralization. CDH 137 sits near the edge of the strongly anomalous zone and encountered 25 feet of .4 Cu before entering a late andesite dike which persisted to considerable depth. None of these holes are situated within the heart of the anomaly - CDH 137 offers some encouragement on the "outskirts", while CDH 136 is somewhat disappointing with its poor showing of copper in a moderately anomalous locality.

At present there are plans for at least 3 diamond drill holes in the more favorable portions of the North Butte-Danube anomaly. Some substantial values will probably be encountered, but the overall picture may be one of a patch work sort of mineralization. The moly anomalies at North Butte-Danube are similar in strength to those found over a fair chalcocite blanket in North Silver Bell, but structural similarities are so few as to make a comparison between the two areas seem useless.

Traverse line No. 6 with its low moly assays in but moderately altered rock would seem to offer little hope of finding an appreciable southwest extension of El Tiro pit under Mt. Expectation (although some low grade copper is known to exist under the southwest section of the present pit primeter).

Drilling of the North Butte-Danube anomaly will offer the best critism of geochemical exploration as applied at Silver Bell. Until then, the following observations concerning this sampling can be made:

Continued next page -

1. A definite correlation seems to exist between anomalous moly in near-surface outcrop and known substantial copper mineralization at depth (East Oxide, Portland Ridge, Imperial, North El Tiro and North Silver Bell areas);

2. In igneous rocks a copper anomaly does not necessarily indicate the presence of copper immediately below, although it undoubtedly shows that copper mineralization occurs somewhere in the vicinity;

3. In tactites and hornfels a copper anomaly is usually indicative of a roughly equivalent amount of copper mineralization within these rocks;

4. It would appear to be a general, but by no means a strict, rule that higher moly assays will be associated with more strongly altered rocks in a known copper-molybdenum ore-bearing district;

5. There is a definite suggestion that moly values in monzonite will run considerably lower than in alaskite or dacite of the same degree of alteration and structural favorability on the Silver Bell property (quite possibly some function of chemical composition).

The use of the molybdenum anomaly as an exploration guide to porphyry copper in acid igneous rocks seems to be fairly well established. The use of the moly anomaly as a guide to molybdenum mineralization should not be overlooked, however. Running molybdenum as well as copper assays on the cores to be obtained by diamond drilling from the North Butte-Danube area may provide some very interesting information.

Assistance from Norman Whaley and Charles Haynes in various aspects of the Silver Bell geochemical sampling program has been, to say the least, very helpful.

Barry N. Watson

Barry N. Watson

BNW:jca

cc: RBMeen
JHCourtright (2)
DRJameson
CWHaynes (2)
BNWatson
RE Richard
R.J. Lacy
W.E. SALGART

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
January 20, 1965

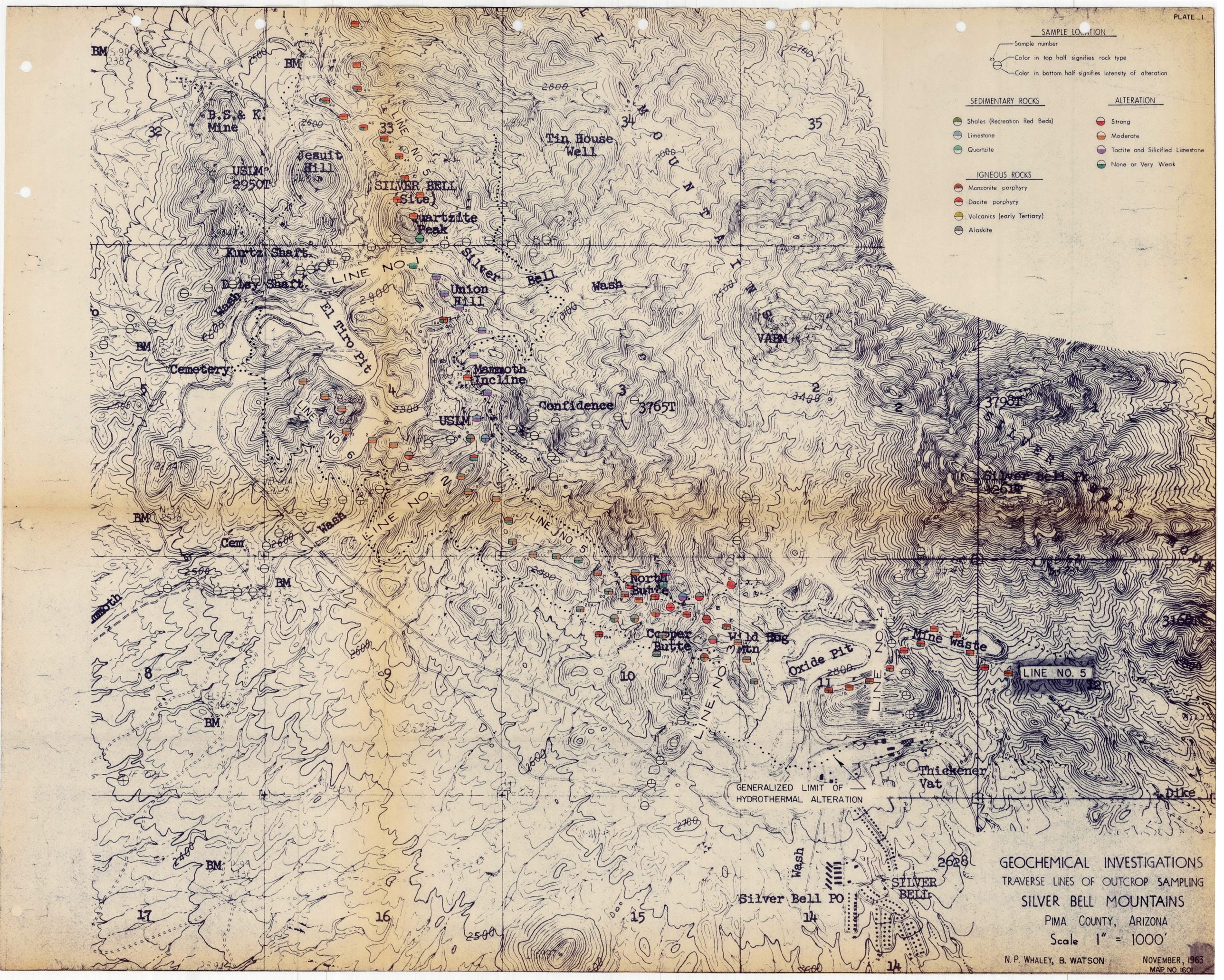
ADDENDUM

Plate 6 has been constructed by Charles Haynes and myself to further illustrate the results of the Silver Bell geochemical exploration described in my memorandum of December 21, 1964. This new map is a molybdenum geochemical overlay for Plate 1 of the memorandum.

It is important to remember that the divisions between background, threshold, moderate and strong p.p.m. moly are somewhat subjective. An attempt was made to establish groupings of samples with p.p.m. moly content in the same general range, then to draw lines between these groupings. No sharp boundaries were found, however, and thus the divisions are in good part arbitrary. The graphs of Plates 2, 3, and 4 were used in making these divisions, and the reader is referred to the absolute p.p.m. values shown on these graphs if he is in doubt about the significance of any particular color grouping shown on Plate 6.

With the p.p.m. Mo groupings used, several important features are readily seen. The major copper mineralization known to exist at North El Tiro and presently being drilled out to the east and southeast of Oxide pit is strongly indicated. Tentative plans for drilling the Danube-North Butte and Wild Hog Mountain areas would seem to be justified, and a need for more extensive exploration in North Silver Bell is suggested. The few samples in the Union Ridge-Mammoth (Imperial) area are of interest, but not truly indicative of what lies below. This area was not thoroughly sampled, however, and the behavior of molybdenum within the metasediments found there is not as well understood as it is in the acid igneous rocks of the district.

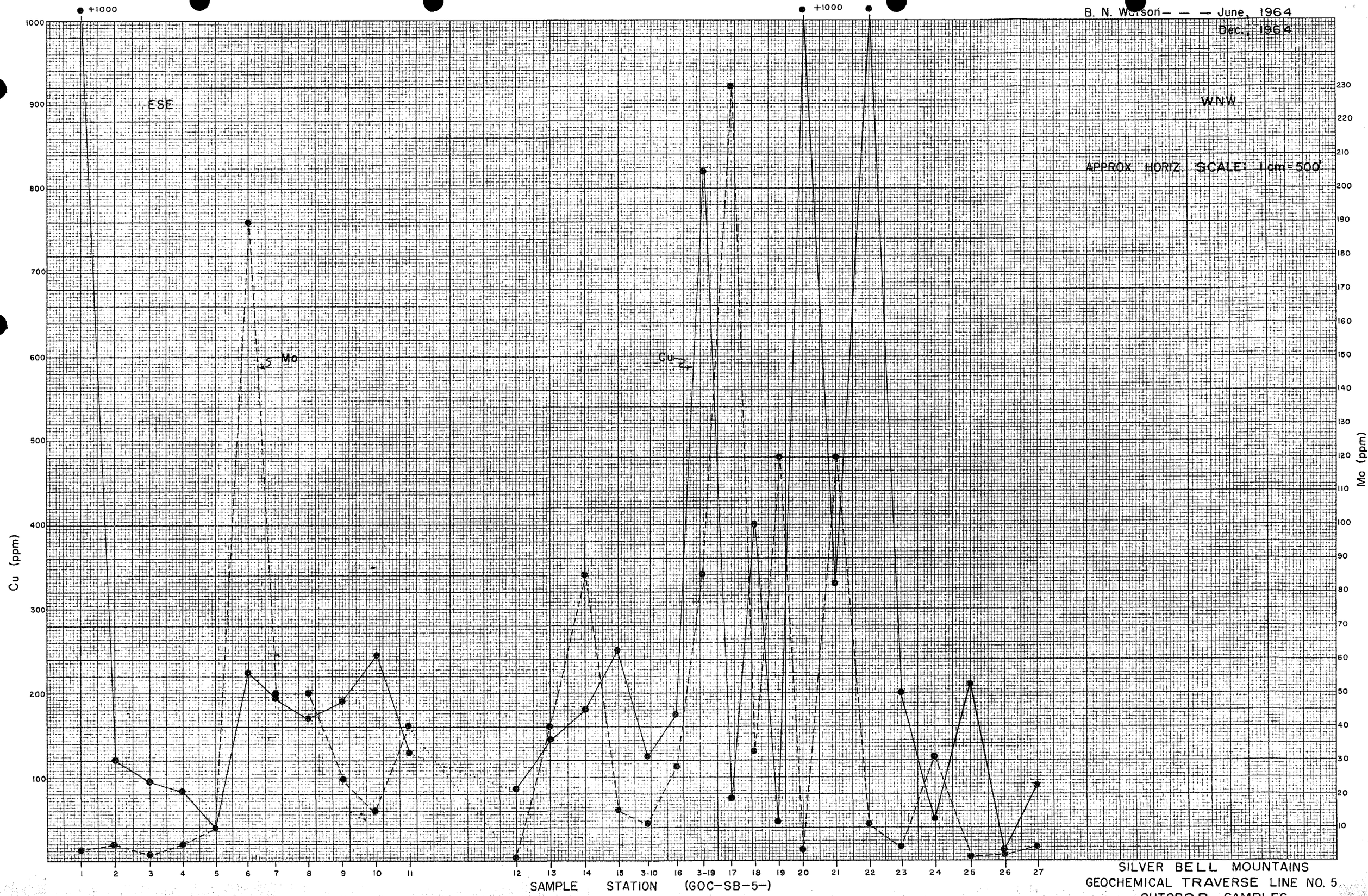
BARRY N. WATSON



GEOCHEMICAL INVESTIGATIONS
TRAVERSE LINES OF OUTCROP SAMPLING
SILVER BELL MOUNTAINS
PIMA COUNTY, ARIZONA
Scale 1" = 1000'

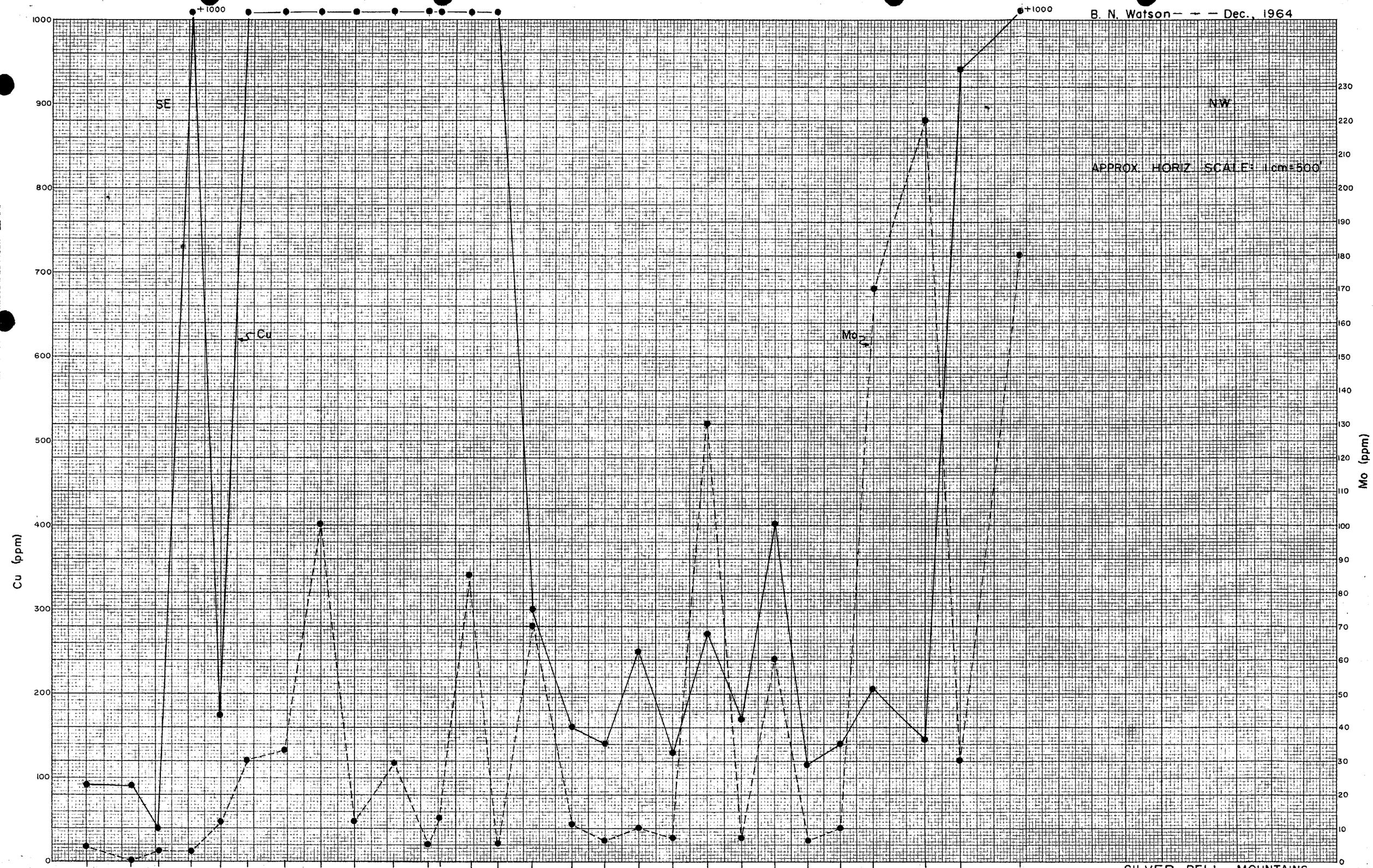
N. P. WHALEY, B. WATSON

NOVEMBER, 1963
MAP NO. 1601



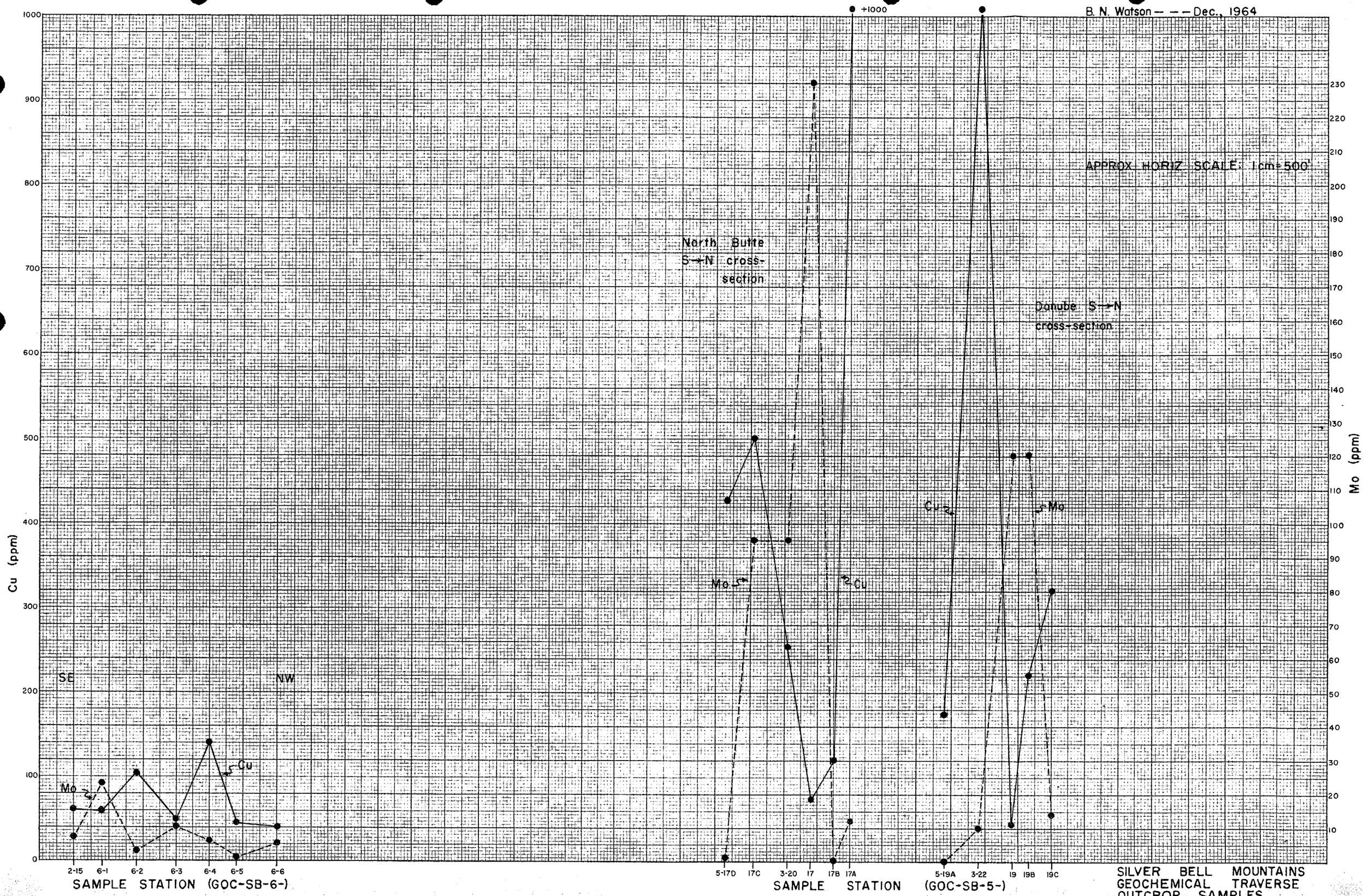
SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE LINE NO. 5
OUTCROP SAMPLES

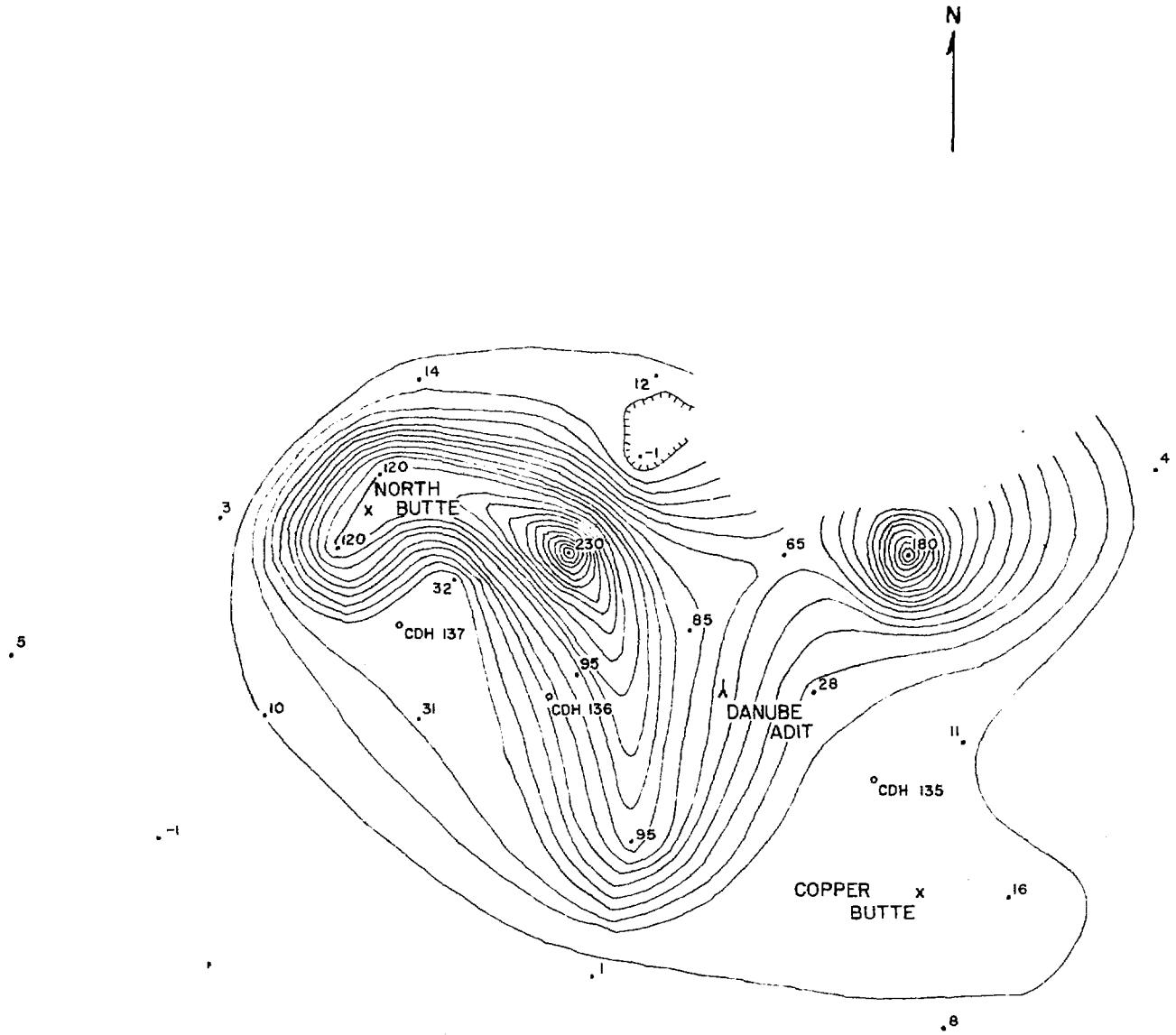
K&E 10 X 10 TO THE CM. 359-14LG KEUFFEL & ESSER CO. MADE IN U.S.A.



SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE LINE NO. 5
OUTCROP SAMPLES

KEUFFEL & ESSER CO. 10 X 10 TO THE CM. 359-14TG


B. N. Watson — — — Dec., 1964
APPROX. HORIZ. SCALE: 1cm=500'
North Butte S→N cross-section
Danube S→N cross-section
+1000
Cu (ppm)
Mo (ppm)
SE
NW
Mo
Cu
SAMPLE STATION (GOC-SB-6-)
2-15 6-1 6-2 6-3 6-4 6-5 6-6
SAMPLE STATION (GOC-SB-5-)
5-17D 17C 3-20 17 17B 17A
5-19A 3-22 19 19B 19C
SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE
OUTCROP SAMPLES

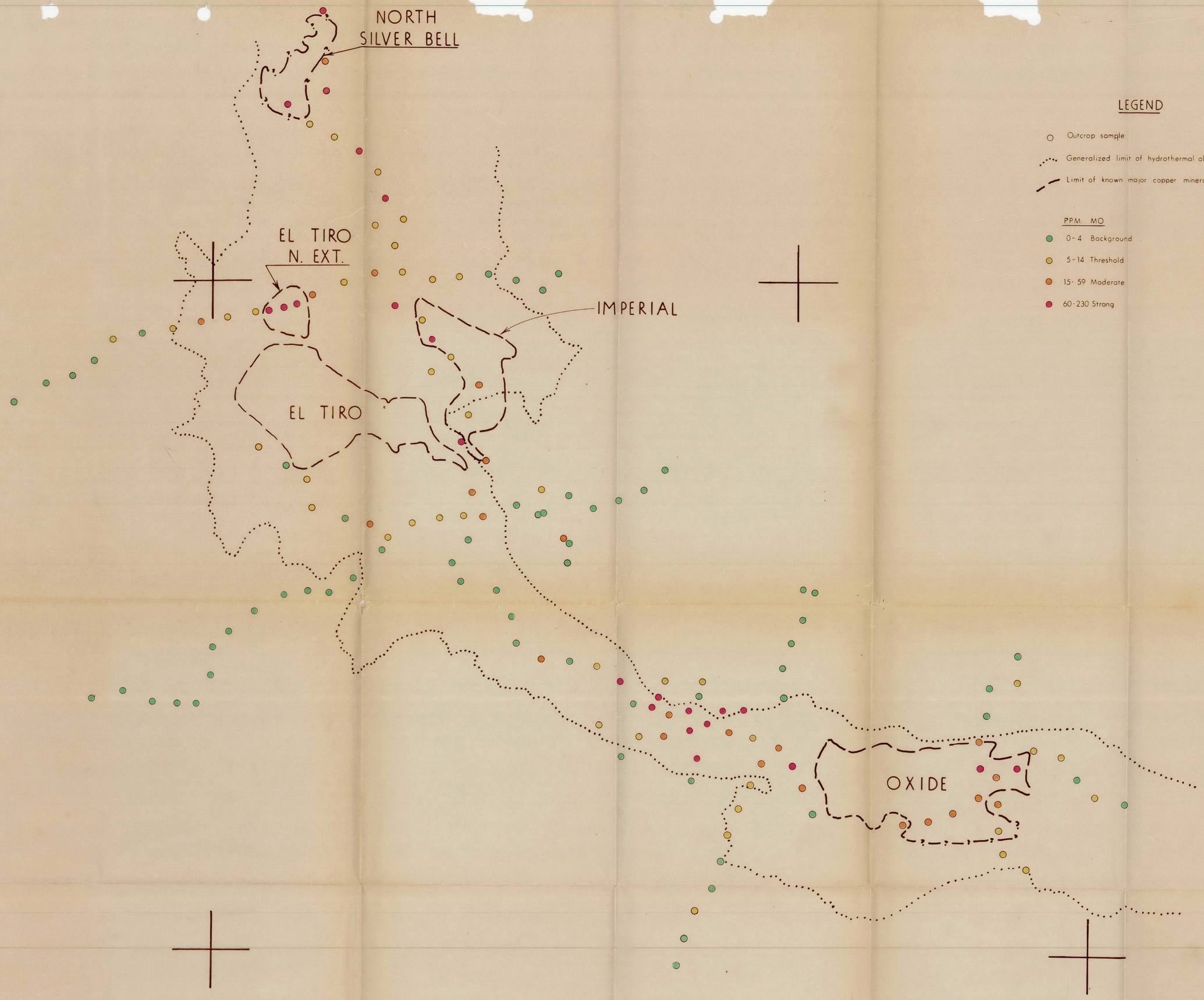


CONTOUR INTERVAL: 10 PPM MO.

·25 GEOCHEMICAL OUTCROP SAMPLE LOCATIONS WITH PARTS PER MILLION MOLYBDENUM

° CDH 123 CHURN DRILL HOLE LOCATION

AMERICAN SMELTING & REFINING CO. SILVER BELL UNIT			
NORTH BUTTE MOLY ANOMALY			
SCALE 1" = 500'	DRAWN BNW	DATE 12/11/64	MAP NO. 1601-A



LEGEND

- Outcrop sample
- Generalized limit of hydrothermal alteration
- Limit of known major copper mineralization to 1-20-65

PPM. MO

- 0-4 Background
- 5-14 Threshold
- 15-59 Moderate
- 60-230 Strong

ASARCO

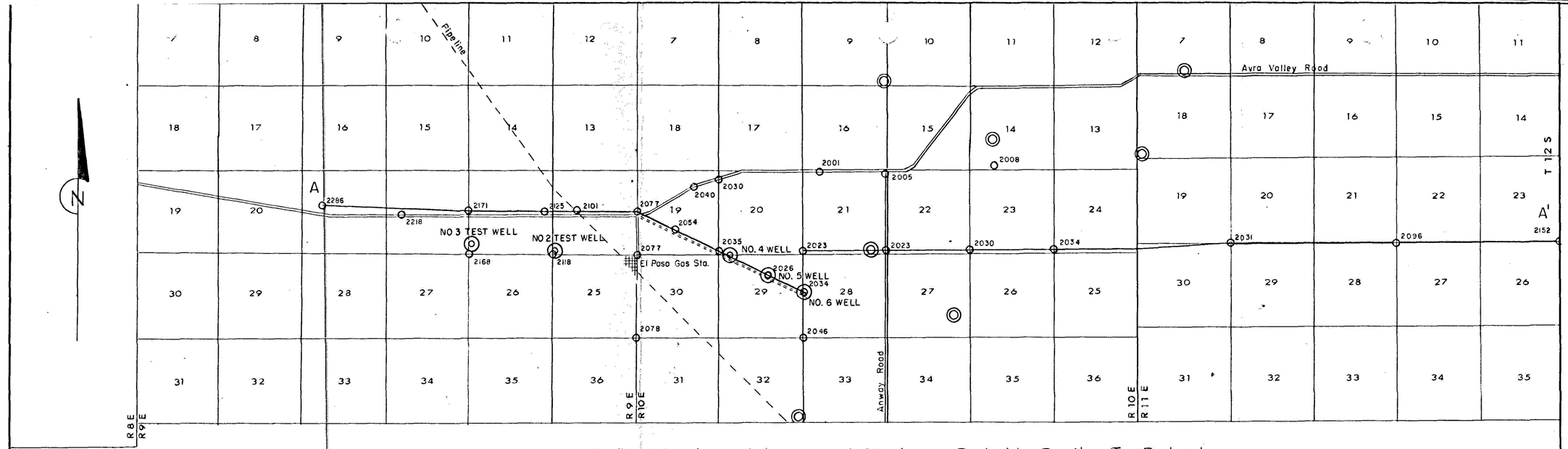
GEOCHEMICAL OVERLAY FOR PLATE 1

MOLYBDENUM IN OUTCROP

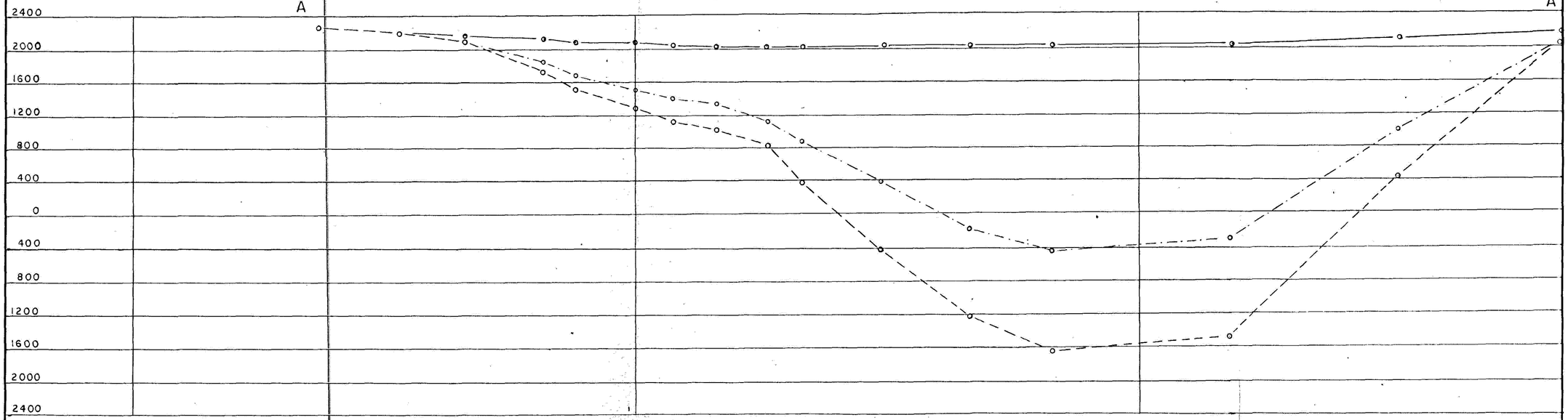
SILVER BELL, ARIZONA

Scale 1" = 1000'

B.N.W. & C.W.H. January, 1964



Profile Showing Minimum and Maximum Probable Depths To Bedrock



PLAN EXPLANATION

- ○ Gravity Station
- ◎ Water Wells

PROFILE EXPLANATION

- ○——○ Surface Elevation
- ○—·—○ Bedrock Minimum Depth
- ○— —○ Bedrock Maximum Depth

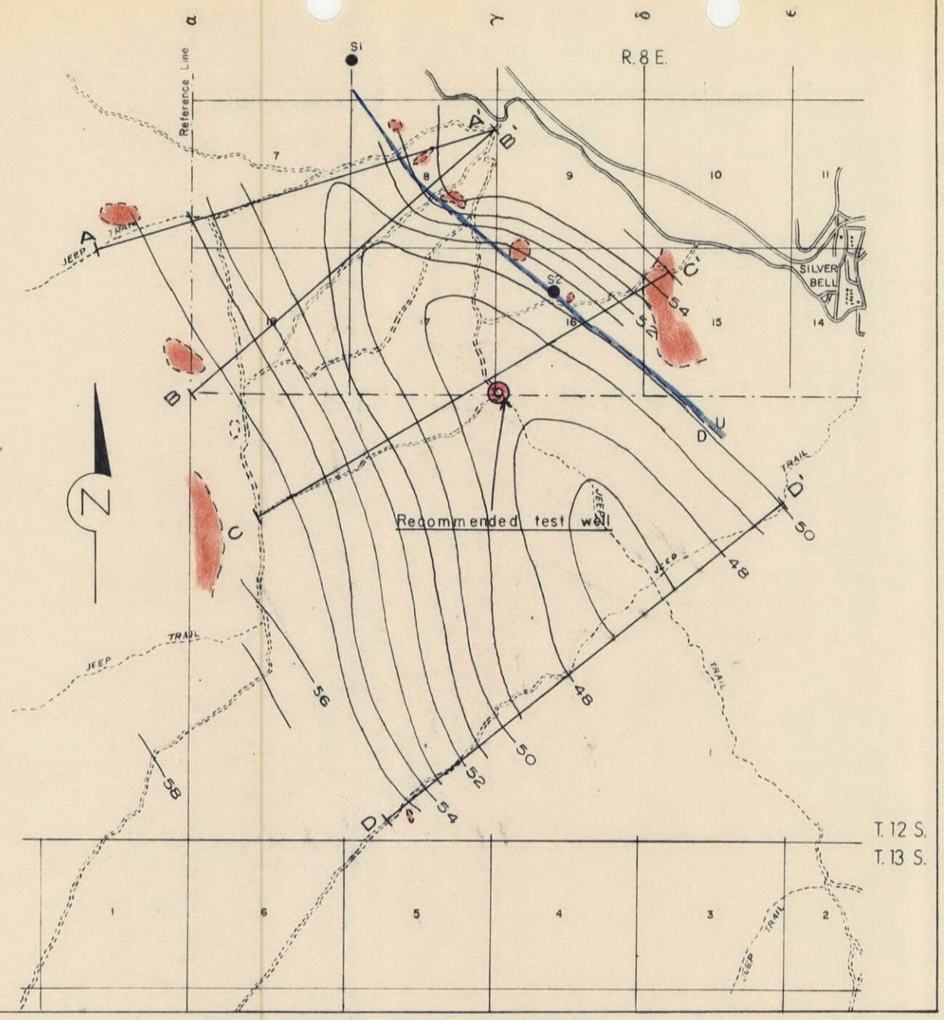
GRAVITY SURVEY

Water Feasibility Study

AVRA VALLEY

SCALE : 1" = 1mile

Oct. 1964 Map No. 1655

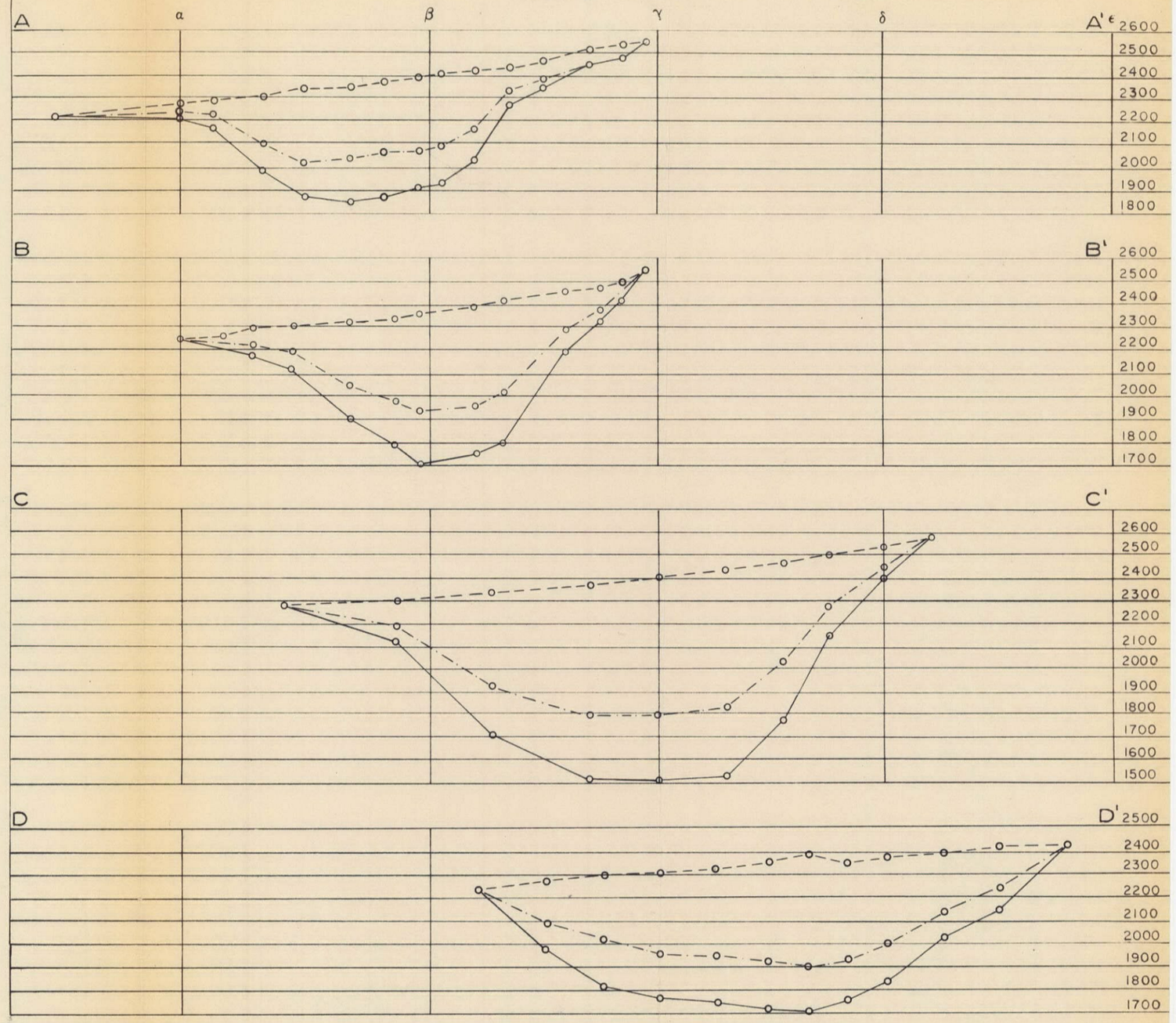


PLAN MAP EXPLANATION

Residual Gravity Contour — Interval 1.0 milligal

- S1 Superior Oil Drill Holes
- Outcrops
- Interpreted Range Front Fault

Profiles Showing Minimum and Maximum Depths To Bedrock
Looking North



PROFILE EXPLANATION

- o- - - -o Surface Elevation
- o— · —o Minimum Depth to Bedrock
- o———o Maximum Depth to Bedrock

GRAVITY SURVEY
Water Feasibility Study

WEST SILVERBELL AREA

SCALE 1" = 1 mile

Oct. 1964 Map No. 1656

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 25, 1964

J. H. C.
DEC 2 1964

J. H. C.
DEC 2 1964
Personal file

MEMORANDUM TO MR. R. B. MEEN

SILVER BELL UNIT
WATER FEASIBILITY STUDIES

During parts of September and October, Mr. D. B. Beck made approximately 86 gravity measurements in Avra Valley and the alluvial flat west of Silver Bell. The gravity stations located in Avra Valley are essentially along an east-west profile which spans the valley (see attached map No. 1655). Four gravity profiles were established in the area west of Silver Bell as shown on attached map No. 1656.

The gravity work was conducted in connection with a water supply study for the Silver Bell Unit. Reference is here made to my memorandum of July 16, 1963 to Kenyon Richard pertaining to a reconnaissance geologic examination of the "Alluvial Flat" area west of Silver Bell. The gravity work was done to obtain estimates of alluvial thicknesses within the two study areas. The gravity method will indicate the distribution of unconsolidated or semi-consolidated valley fill. It does not, however, provide any information on the hydrologic nature of the fill material. Unknowns such as depth to water table, porosity and permeability cannot be resolved from the gravity data.

Avra Valley

The gravity profile across Avra Valley extends, from a point approximately 2 miles east of the tailings dam, easterly to a point about 1 mile north of the Arizona Portland Cement lime quarry on the north end of the Tucson Mountains. ASARCO wells, Nos. 4, 5, and 6, are along the profile.

Gravity values are not shown on the attached map. The two profile curves represent the computed maximum and minimum bedrock elevations across the valley. I have assumed that the specific gravity contrast between gravels and bedrock is within limits of 0.6 and 0.9. That is to say, the volume per unit weight range for the alluvium falls between 16.0 and 18.9 ft^3 /ton relative to 12.3 ft^3 /ton for bedrock. The Mission Unit, incidentally, uses a figure of 16.7 ft^3 /ton for the gravels overlying the Sierrita pediment.

Maximum and minimum bedrock depths were computed using the above density extremes. Computations were made assuming the alluvium could be approximated beneath each gravity station by a flat, infinite slab with horizontal upper (ground surface)and lower (bedrock) surfaces. This method produces only small errors near the center of the valley where dips on the bedrock surface are probably small. Near the edges of the valley, particularly in the vicinity of any range front fault bedrock/alluvium boundaries, the horizontal slab interpretation produces large errors. The computed bedrock profiles, then, are only intended to show the general shape of the valley and the order of magnitude of bedrock depths.

The following table shows the current water table depths along with the total depths of the ASARCO wells compared to the computed range of bedrock depths.

	Current Pumping Level of Water Table(ft)	Total Well Depth(ft)	Computed Depth to Bedrock Minimum(ft)	Maximum(ft)
Well No. 4	309	525	740	1050
Well No. 5	303	495	900	1190
Well No. 6	340	500	1150	1640

(All figures are depths below surface)

Since 1954, the water level in the three ASARCO wells has dropped an average of 7 ft. per year. A modest future increase in this rate could result in a "drying up" of these wells during the life of the Silver Bell operation. In this event, either new wells would have to be drilled or the existing wells would need to be deepened. In either situation, deeper drilling should not be attempted west of well No. 5 because of the risk of intersecting bedrock before reaching the desired hole depth.

The USGS, Groundwater Branch, plans to release the results of a comprehensive study of ground water in Avra Valley sometime in 1965. ASARCO should make use of this information before deciding on alternate hole locations. Production records of deeper wells to the east of ASARCO's wells will probably be included in the groundwater report. The best locations for new wells to provide assured long term water supplies will be east of well No. 6, if the groundwater report indicates good aquifer sands occur below depths of 500 ft.

"Alluvial Flat" West of Silver Bell

The gravity results as plotted on map No. 1656 suggest the existence of a narrow alluvial basin located about 2-1/2 miles SW of the Silver Bell townsite. The axial strike of the interpreted basin is N 38° W. Gravity computations indicate the depth to bedrock in the center of the basin at the north boundary of the Papago I. R. should be between 600 and 900 ft. Along the axis to the NW, the basin becomes progressively shallower. There is insufficient gravity data on the indian reservation to interpret the southeast extent of the basin or changes in thickness in that direction.

Because the basin is narrow, the horizontal slab method of computing bedrock depths is not really valid. Errors near the flanks of the valley are admittedly large. This method was used, however, in the interests of saving time. The resulting computed bedrock maximum and minimum depths are shown in profile on map No. 1656. As in the Avra Valley survey computations, the maximum and minimum bedrock depths are based on specific gravity contrasts of 0.6 and 0.9 respectively.

Mr. Barry Watson has reported the results of two diamond drill holes located along the northwest flank of the basin. These holes are located on ground now controlled by Superior Oil Company. The holes penetrated respectively 25 ft. and 40 ft. of alluvium. The underlying bedrock was logged as units of the Claflin Ranch and Silver Bell formations. These locations are along the interpreted range front fault and each is within a few hundred feet of outcrop. This information is, therefore, of no particular value to the present study.

Owing to the small size of the basin, the chances of developing an adequate water supply are poor. The main advantages of a water source in "Alluvial Flat" are 1) proximity to Silver Bell and 2) the surface elevation here is more than 300 ft. above that in Avra Valley (reduced pumping head). The potential savings in costs and operating expenses are large enough to justify a test well even though the area is not very promising.

I recommend drilling a 4-3/4" rotary hole at the section corner common to sections 16, 17 and the north boundary of the indian reservation. If this hole intersects consolidated rock within 200 or 300 ft. of the surface, the project can be abandoned with very little resulting cost. On the other hand, if the rotary hole penetrates several hundred feet of unconsolidated sand, gravel, clay etc., it can be cased and washed for bailing tests. If bailing tests should be encouraging, a larger hole

could be drilled to permit pump tests.

The drill test in "Alluvial Flat" should be made before deciding on additional capital expenditures for water development in Avra Valley.

W. E. SAEGART

WES/kw
Att.
cc: RBMeem - 2 extra
JHCourtright

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

September 3, 1964

J. H. C.

SEP 16 1964

Mr. R. B. Meen
Building

Cu & Mo in Leached Capping
Silver Bell Unit

Dear Sir:

This is in reference to Barry Watson's memo of August 3 to Mr. J. H. Courtright concerning the subject.

About two weeks ago I made a brief examination of the North Butte-Danube area west of Oxide pit with Messrs. Haynes and Watson. There is spotty evidence in the leached capping of possible ore grade chalcocite occurrences--particularly on North Butte. The appearance of the capping suggests narrow zones of better chalcocite separated by larger areas of low grade mineralization.

This area is essentially untested. Of the two churn drill holes drilled in this area, one entered a post mineral andesitic dike 30' below the base of oxidation.

Previous analyses of capping from the alteration zone indicated that anomalous Mo content was closely associated with the Oxide and El Tiro ore bodies. The high Mo in capping in the North Butte-Danube area should be tested. I think two or three holes are in order and that North Butte should be the primary target.

Very truly yours,

ORIGINAL SIGNED BY
W. E. SAEGART

W. E. SAEGART

WES/jk
cc: JHCourtright
DRJameson
CWHaynes
BNWatson

MR. J. H. COURTRIGHT

S-1.2

RICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

RECEIVED
AUG - 5 1964
W.E.S.
AUG 7 1964
J. H. C.
SEP 16 1964

August 3, 1964

MEMORANDUM TO: Mr. J. H. Courtright

Subject: EXPLORATION GEOCHEMISTRY - ADDITIONAL OUTCROP SAMPLING FOR TRACE QUANTITIES OF COPPER AND MOLYBDENUM, SILVER BELL, ARIZONA.

During the past year Mr. Norman Whaley has conducted geochemical exploratory work in the Silver Bell area which has led to possibly significant findings. There is a strong suggestion in his results that anomalous trace quantities of molybdenum from outcrop may reflect the presence of copper ore bodies. Through personal communication I have learned that the use of molybdenum as a pathfinder element for copper ore has also been strongly suggested in the results of geochemical exploration carried on in the acid rocks at Duval's Esperanza property.

Whether or not this suggested relationship between moly anomaly and copper mineralization is restricted to acid rock environments is yet to be determined. Nevertheless, this relationship appears to exist at Silver Bell and, until proven otherwise, should be viewed as a possible guide to yet undiscovered copper ore on the property.

In this light it was recently decided to expand upon Mr. Whaley's initial work with a two-fold purpose in mind; 1.) to substantiate, if possible, the suggested relationship between moly anomaly and copper ore, and 2.) to use this relationship to delimit targets for exploratory drilling. Two diamond drill rigs are at present at work on the Silver Bell property, and it was deemed desirous to conduct this additional geochemical sampling and analyse the results before the drilling program was completed and the drill rigs moved off the property.

It is felt that the results of the recent sampling are significant. A resume of the work and the results follows herein.

The position of line No. 5 is shown on the accompanying map. This line of rock chip sample locations - trending WNW - follows longitudinally the zone of alteration and thus lies essentially at right angles to the four transverse lines of sampling established by Mr. Whaley. Line No. 5 extends through two areas being drilled at present - the east side of Oxide pit, and the Portland Ridge or south side of Oxide pit - and through areas of proposed drilling to the west and northwest of Oxide pit.

An attempt has been made to follow as closely as possible the sampling procedures set up in the initial study. Analyses were by colormetric methods at the Rocky Mountain Geochemical Laboratory, Prescott, Arizona - as in the original work. Copper and molybdenum in ppm are plotted on the accompanying chart.

The low trace quantities of molybdenum in samples 1 through 5 reflect a rather sudden drop in mineralization some 1,000 feet east of the present eastern perimeter of Oxide pit - a fact confirmed by drilling. Sample 6, showing a strong moly anomaly, was taken from outcrop at the site of diamond drill hole F-17. This

hole carries 48' of .90/.03 copper at a depth of 104'. Sample 7 - anomalous with 50 ppm moly - was collected from outcrop near the site of the recently completed D. D. hole F-34. This hole carries 79' of .98/.02 copper at a depth of 91'. Molybdenum seems to work well as a pathfinder for copper mineralization on the east side of Oxide pit.

Results are not as clear cut on Portland Ridge, but certainly cannot be considered contradictory. Sample 8 - 50 ppm moly - was taken near the old churn drill hole #145 which showed 70' of .58/.04 copper at 55' and 85' of .53/.07 Cu at 170'. Sample 9 - 24 ppm moly - came from the site of D. D. hole F-15. This hole carried 252' of .81/.01 copper at a depth of 139'. Sample 10 - 15 ppm moly - was located mid-way between D. D. holes F-31 and F-33. The latter hole carried 61' of .96/.09 copper at a depth of 192', while the former carried but 36' of .55/.04 copper at a depth of 166'. Sample 11 - 40 ppm moly - was taken some 60' NW of D. D. hole F-29, a hole which showed 51' of .47/.01 copper at a depth of 70' and 150' of .46/.01 copper at a depth of 179'.

Assuming the apparent validity of the relationship between moly anomaly and copper mineralization, it would appear from the chart that chances for ore discovery are dim immediately southwest of Oxide pit but improve greatly northwest of the pit on the eastern shoulder of Wild Hog Mountain. Several proposed drill holes are located in this vicinity and will check out this anomalous area. (These holes were proposed prior to the recent geochemical sampling.)

Of considerable interest are the strong moly anomalies registered by samples GOC-SB-5-16 through 5-19. These anomalies are in agreement with those shown by Mr. Whaley's samples GOC-SB-3-18 through 3-21 from the same general area. Present planning calls for at least three diamond drill holes to check out this ground between North Butte and the old Danube mine to the east. The two sets of geochemical results figured strongly in the decision to drill this area.

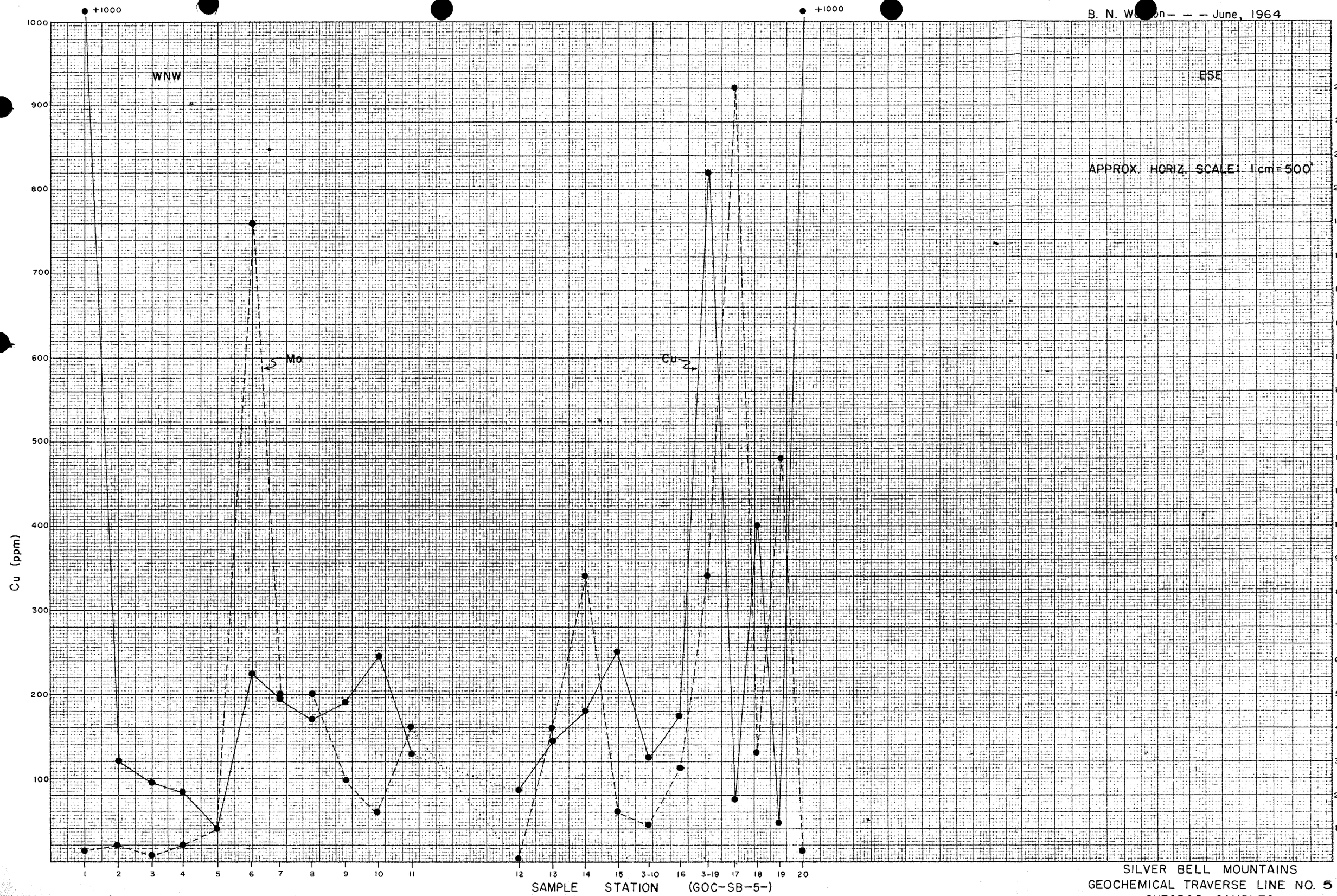
Outcrop sample line No. 5 will be continued to the northwest through the North Silver Bell area this Fall, as requested by Mr. William Saegart.

Barry N. Watson

Barry N. Watson

BNW:jca

cc: RBMeen
JHCourtright
DRJameson
CWHaynes
BNWatson



SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE LINE NO. 5
OUTCROP SAMPLES

SAMPLE LOCATION
Sample number
Color in top half signifies rock type
Color in bottom half signifies intensity of alt
SEDIMENTARY ROCKS
Shales (Recreation Red Beds)
Limestone
Quartzite
IGNEOUS ROCKS
Monzonite porphyry
Dacite porphyry
Volcanics (early Tertiary)
Alaskite
ALTERATIO
Strong
Moderate
Tactite and
None or Ver
B.S.& K. Mine
Jesuit Hill
USLM 2950T
SILVER BELL (Site)
Quartzite Peak
Tin House Well
Kurtz Shaft
Riley Shaft
LINE NO. 1
Silver Bell Wash
Union Hill
El Tiro Pit
Cemetery
Mammoth Incline
Confidence
3765T
USLM
VATM
3798T
Silver Bell Pt
3261P
LINE NO. 2
North Butte
Copper Butte
Wild Hog Mtn
Oxide Pit
Mine Waste
LINE NO. 5
Thickener Vat
GENERALIZED LIMIT OF HYDROTHERMAL ALTERATION
Silver Bell PO
SILVER BELL
2628
GEOCHEMICAL INVEST
TRAVERSE LINES OF OUTCRO
SILVER BELL MOUN
PIMA COUNTY, ARI
Scale 1" = 10
N. P. WHALEY

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 22, 1964

Mr. D. R. Jameson, Superintendent
Silver Bell Unit
American Smelting and Refining Company
Silver Bell, Arizona 85270

SILVER BELL

Dear Mr. Jameson:

Enclosed herewith is a letter from the Nevada Bureau of Mines asking for a pound or two of molybdenite concentrate.

Inasmuch as this is a research project, I believe we should accommodate them if possible. Perhaps Mr. Haynes or Mr. Watson would be able to handle this matter, sending the required information concerning the concentrate along with a sample of molybdenite bearing ore directly to Mr. Schilling.

Yours very truly,

Original signed by
J. H. Courtright
J. H. COURTRIGHT

JHC/jk
Enclosure

J. H. C.
MAY 20 1964

May 20, 1964

Silver Bell

Mr. A. E. Johnson
Rocky Mountain Geochemical Laboratories
233 North Marina Street
Prescott, Arizona

Dear Mr. Johnson:

We are shipping to you today, via Greyhound Bus Lines, 20 rock chip samples for trace element determinations of molybdenum and copper.

A list of these samples is attached and will also be included in the shipment. All samples consist of one container only unlike the past when two containers were shipped for each sample.

When you complete the analyses, please return the reject pulps to us collect, via Greyhound Bus Lines.

Very truly yours,

DAVID B. BECK

DBB/jk
Attachment
cc: JHCourtright

BL Note to JHC: 20 Geochemical rock samples from Silver Bell

GEOCHEMICAL DETERMINATION
Run for Molybdenum and Copper

GOC-SB-5-1
GOC-SB-5-2
GOC-SB-5-3
GOC-SB-5-4
GOC-SB-5-5
GOC-SB-5-6
GOC-SB-5-7
GOC-SB-5-8
GOC-SB-5-9
GOC-SB-5-10
GOC-SB-5-11
GOC-SB-5-12
GOC-SB-5-13
GOC-SB-5-14
GOC-SB-5-15
GOC-SB-5-16
GOC-SB-5-17
GOC-SB-5-18
GOC-SB-5-19
GOC-SB-5-20

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 2, 1964

Mr. K. E. Richard, Chief Geologist
American Smelting and Refining Company
120 Broadway
New York, N. Y. 10005

Dear Sir:

Enclosed is a brief summary of a seminar talk entitled "Development of Mining at Silver Bell" that Barry Watson would like to give before a group of about 25 members, mostly faculty and graduate students at the University of Arizona.

Essentially all of the material he proposes to present has been published and nothing presented will be in printed form, I believe approval should be given. However, Mr. Watson's request has been delayed several weeks and there is insufficient time to get it through the Publications Committee.

I hope you will be able to secure tentative approval and phone or wire me accordingly.

Yours very truly,

Original signed by
J. H. Courtright
J. H. COURTRIGHT

JHC/jk
Enclosure
cc: BNWatson

April 1, 1964

Mr. J. H. Courtright, Chief Geologist
Southwestern Mining Department
American Smelting and Refining Company
813 Valley National Building
Tucson, Arizona 85701

Dear Sir:

In compliance with your request, I am sending a brief summary of a seminar talk on "Development of Mining at Silver Bell" that I am planning to give on Monday, April 6. The seminar group consists of about 25 members---mostly faculty and graduate students of the University of Arizona. If any of the information I plan to present meets with company disapproval, I shall, of course, delete the material.

The talk concerns only the development of the El Tiro and Oxide pits as they presently exist. All reference to the Imperial area---except brief historical summary---has been omitted. Likewise, no pertinent reference will be made to the present exploratory drilling program.

In outline form, the talk will cover the following:

I. Geologic summary of the Silver Bell range and ore zone, from work by Richard and Courtright, and myself.

II. Exploration history at Silver Bell.
   - A. Summary of early mining---1865-1923.
   - B. Roland Blanchard's 1923 report to ASARCO.
     1. Ideas on rock types and structural controls.
     2. Concepts on limonite capping.
     3. Opinions on possible pits in El Tiro and Oxide areas.
   - C. Schmitt, et. al., 1941 report to ASARCO.
     1. Ideas on rock types and structural controls.
     2. Entwistle's summary of Oxide pit possibility.
     3. Kingsbury's summary of El Tiro pit possibility.
   - D. Kerr's report on alteration and mineralization---as published in GSA.
   - E. Pre-1954 statistics on drilling costs and diamond drill core recovery, tonnage originally expected from each pit with expected grades of ore and stripping ratios---all figures approximate.

III. Geophysical and geochemical work. Broad, general statements of applicability of magnetic susceptibilities, resistivity, I.P. and geochemistry to Silver Bell. <u>No charts or graphs</u>.

I have made every attempt to refrain from using any vital information of current interest to the company. I believe my talk can still be of considerable interest, however, and hope that my request to give it meets with your approval.

Yours very truly,

Barry N. Watson

Barry N. Watson
Geologist

RECEIVED
FEB 19 1964

ASARCO

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

J. H. C.
FEB 24 1964

KENYON RICHARD
CHIEF GEOLOGIST

AIRMAIL

February 18, 1964

Mr. J. H. Courtright, Chief Geologist
Southwestern Explor. Dept.
Tucson, Ariz.

Silver Bell - Geochemistry

Dear Sir:

This will acknowledge your letter of February 14 with Mr. Whaley's accompanying report on outcrop sampling at Silver Bell.

The moly anomalies are particularly interesting. As future information is accumulated in other districts which supports these results, it could become a useful exploration technique.

Please commend Mr. Whaley for his carefulness in running these surveys and for his well-written report.

Yours very truly,

Kenyon Richard

KENYON RICHARD

cc: DRJameson
RJLacy
WESaegart
NPWhaley All A/M

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

February 14, 1964

Mr. Kenyon Richard, Chief Geologist
American Smelting and Refining Company
120 Broadway
New York, N. Y. 10005

SILVER BELL
GEOCHEMISTRY

Dear Sir:

This transmits Mr. Whaley's report on the results of a geochemical survey at Silver Bell.

Outcrop samples taken along 4 seperate lines across the zone of mineralization-alteration were analyzed for copper and moly. Graphic plots of the copper and moly values were made for each traverse. These show extreme variation in the copper over both strong and weak sulphide copper mineralization. However, the moly content varies directly with the intensity of the underlying sulphide copper mineralization.

This study indicates that moly determinations may be an aid to leached outcrop interpretation, but additional experimental work is needed to determine the applicability of the method in other areas. (Samples from Nichiquilay were recently shipped to Mr. Lacy for analysis in the Salt Lake laboratory.)

Yours very truly,

Original signed by
J. H. Courtright

J. H. COURTRIGHT

JHC/jk
Enclosure
cc: DR.Jameson
RJLacy
WESaegart
NPWhaley

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 20, 1963

To: J. H. Courtright

From: N. P. Whaley

EXPLORATION GEOCHEMISTRY - INITIAL OUTCROP SAMPLING FOR AN INDICATION OF A PRIMARY DISPERSION PATTERN OF TRACE QUANTITIES OF COPPER AND MOLYBDENUM, SILVER BELL MOUNTAINS, ARIZONA.

Early in September of this year Mr. William Saegart expressed an interest in a limited program of outcrop or rock chip sampling designed to detect an indication of primary dispersion of trace quantities of copper and molybdenum around a porphyry copper ore body, and, if such dispersion existed, to further determine, at least in a preliminary sense, the likelihood of a pattern related to or reflecting intensity of known mineralization.

The Silver Bell Mountains were selected as presenting the best control available for a sampling program and four informal traverse lines were proposed.

A brief description of these traverses and the field procedures in sampling is followed by a section containing my thoughts on the investigation. A location map and some compilation of basic data are attached. Any comments relative to the material are welcomed.

Line locations and orientations were selected with reference to known alteration and mineralization. All lines originated in unaltered and unmineralized rock, traversed the zone of known alteration and mineralization by the shortest possible route tangent to the operating pits and, where possible, terminated in fresh, unmineralized rock beyond.

Two of the lines flank the El Trio Pit -- one on the north and the other on the south. They are subparallel and roughly normal to the regional trend of the alteration and structure. The other two flank the Oxide Pit -- one on the northwest and the other on the east. Although converging to the northeast, they too are essentially normal to the trend of the alteration and structure.

True linear traverses were modified to accomodate topography -- following ridges and summits which roughly paralleled the general bearings of the lines. This not only facilitated sampling by minimizing relief, but probably reduced the likelihood of contamination from secondary dispersion.

A sample interval was arbitrarily established as 500 feet except for those sections immediately adjacent to the pits...where it was reduced to 250 feet if cultural interference such as prospects, structures, and dumps permitted.

Prior to entering the field no definite method was established for determining specific sample locations on the lines. Not only did the limited, reconnaissance

nature of the program preclude surveying techniques, but dependence upon them was not deemed desirable. The most workable approach, developed in the field, was that of laying out a line on U. S. Geological Survey 1:24000 topographic maps, scaling off the intervals for locations, and using topographic control through visual orientation. If necessary, these predetermined locations were altered to correspond to any changes dictated by conditions at the actual sample site.

The sample itself was a composite representing outcrop within a fifteen to twenty foot radius around the so called "sample location." Internal portions of three to five hand specimens were reduced to 5 mm to 15 mm chips with a hammer, mixed, and enough of them used to fill cardboard cans of 126 cc to 146 cc. Small hand specimens were retained and each site was identified by number with yellow paint from a pressurized spray can. Individual samples never represented more than one rock type and every effort was made to avoid sampling fault zones, contacts, narrow dikes, visible ore mineral, or any locally unique feature.

Since no formal grid system existed, traverse lines were numbered 1 through 4. The most northern is Line No. 1 and the most southern is Line No. 4. Sample coding or identification incorporated four factors: 1) abbreviated identification of the type or purpose of the sample, 2) abbreviated identification of the geographical location, 3) traverse or line number and, 4) the sequential number of the sample from the given traverse or line.

As an example:

(GOC - SB - 3 - 10)

Expanded, it would be read as:

(Geochemistry - Silver Bell - Line No. 3 - Sample No. 10)

The four lines were sampled by a two-man team between September 11 and September 26 -- with ten and a half days actually spent in the field. One man did the sampling while the other maintained orientation and a written description of the traverse and samples.

Physical parameters for the lines are as follows:

Line No.	Approx. Length (Ft.)	General Bearing	Elevation Range (Ft.)	Difference in Elev. (Ft.)	No. of Samples
1	10,500	N.78°E.	2460±3310±	850±	23
2	13,850	N.65°E.	2460±3765±	1350±	31
3	7,800	N.20°E.	2645±3240±	595±	17
4	4,600	N. 0°E.	2800±3490±	690±	10
Totals	36,750				81

This represents a collection average of seven to eight samples per day, and a sampling density of one sample per 453 feet of line.

Analyses were by colorimetric methods at the Rocky Mountain Geochemical Laboratories, Prescott, Arizona.

Inferences are made within the bounds imposed by a limited number of samples collected on four widely separated traverse lines. Each line should be regarded as an individual, two dimensional system composed of metal concentration relative to linear location.

All lines display decided geochemical relief apparently related to the known ore bodies. Copper values on some of the lines are extremely erratic, but if the molybdenum is regarded as a pathfinder element and the copper relegated to a supporting role the geochemical landscape exhibits an almost classic profile of regional threshold, local threshold or plateau, and peaked anomalies. In all cases the local molybdenum threshold and anomaly occur within that segment of the traverse proximate to the known ore bodies.

Most promising is the suggestion that the dispersion reflects the more intense mineralization of these known ore bodies rather than a preferential concentration in a specific rock type. While too few samples are involved to draw any conclusions, the distribution curves for Line No. 1 and Line No. 2 also suggest that in these systems the concentration of molybdenum is qualitatively independent of the degree of alteration. These relationships, if established, would be highly favorable factors in an evaluation of the exploration potential of outcrop sampling.

Detailed analysis directed toward establishing the significance of absolute concentration values, their frequency distribution, or the ratios between the thresholds and anomalies would probably be premature at this time. The sample population is limited, the threshold-anomaly ratios highly variable, and little is known of sampling and analytical error.

Of significance at the time is that each of the four traverse line curves reflects molybdenum anomalies which are correlative with the local intensity of known mineralization, and while more work would be required to determine the true import of this implication, the suggested potential for localizing targets in broad zones of alteration is favorable.

While I assume responsibility for identification of rock type and description for the samples, I wish to express gratitude to Charles Haynes of the Silver Bell Unit for many helpful conversations on the petrography of the Silver Bell Mountains.

Norman P. Whaley

NORMAN P. WHALEY

NPW/jk
Attachments

February 12, 1964

ADDENDUM

On January 28 of this year five more outcrop samples, GOC - SB - 3 - 18 through GOC - SB - 3 - 22 inclusive, were collected along a short supplemental traverse in the Copper Butte-North Butte area.

This traverse, which forms an appendage running SWW from the location of sample No. 11 on Line 3, originated in the tactite to the northwest of Copper Butte, crossed the dacite porphyry through a zone of locally strong alteration, and terminated in the moderately altered alaskite southwest of North Butte (Map of November, 1963).

Both rock type and degree of alteration occur as variables.

The copper values were erratic as they were on line 3 and appear to indicate the generally pervasive saturation of oxide copper in this area. Molybdenum values, while fluctuating, remain anomalous but exhibit a tendency to drop off to the west. They could reflect one or a combination of at least three possibilities: a) the proximity of the Oxide ore body, b) the intensity of alteration, or c) the existence of additional primary mineralization at depth.

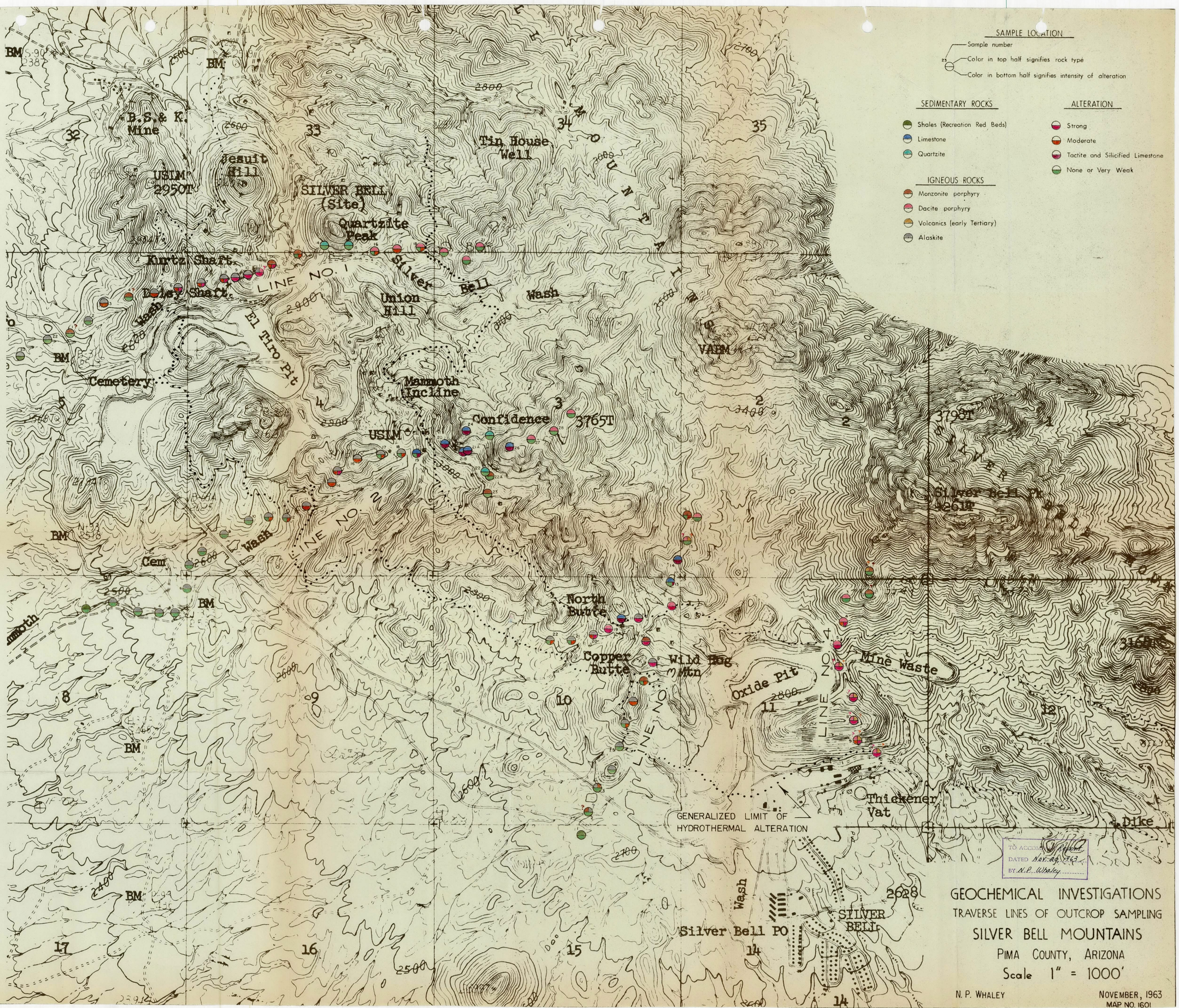
Option (b) would conflict with my original feeling that the geochemical relief for molybdenum was independent of the nature of alteration. At present it would be difficult to either establish or refute a relationship.

Option (c) is the most interesting, and perhaps could be better evaluated if the relationship between alteration and the concentration of molybdenum were better understood.

Norman P. Whaley

NORMAN P. WHALEY

NPW/jk



TO ACCOMPANY Report
DATED Nov. 20, 1963
BY N.P. Whaley

GEOCHEMICAL INVESTIGATIONS

TRAVERSE LINES OF OUTCROP SAMPLING

SILVER BELL MOUNTAINS

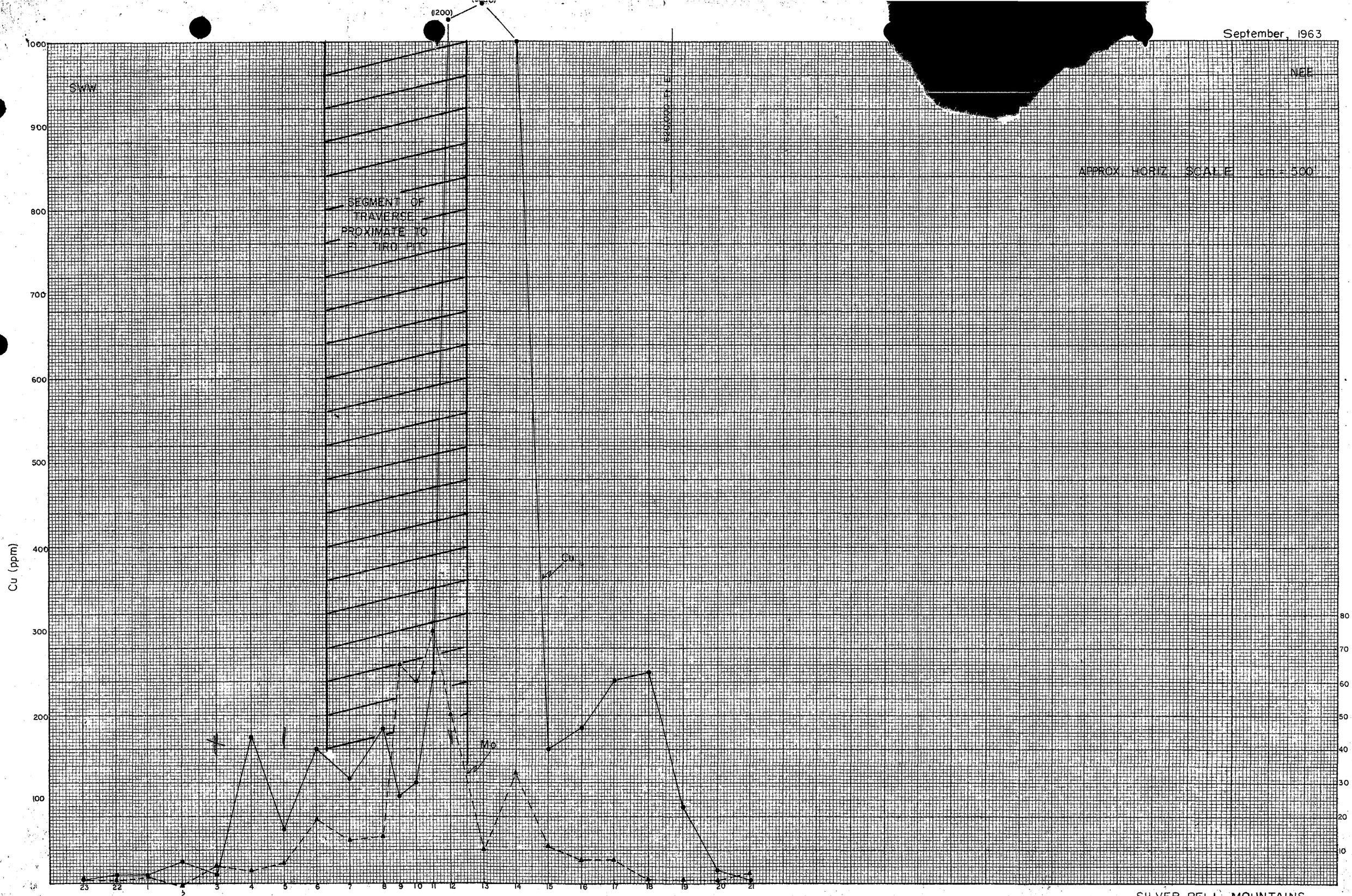
PIMA COUNTY, ARIZONA

Scale 1" = 1000'

N. P. WHALEY

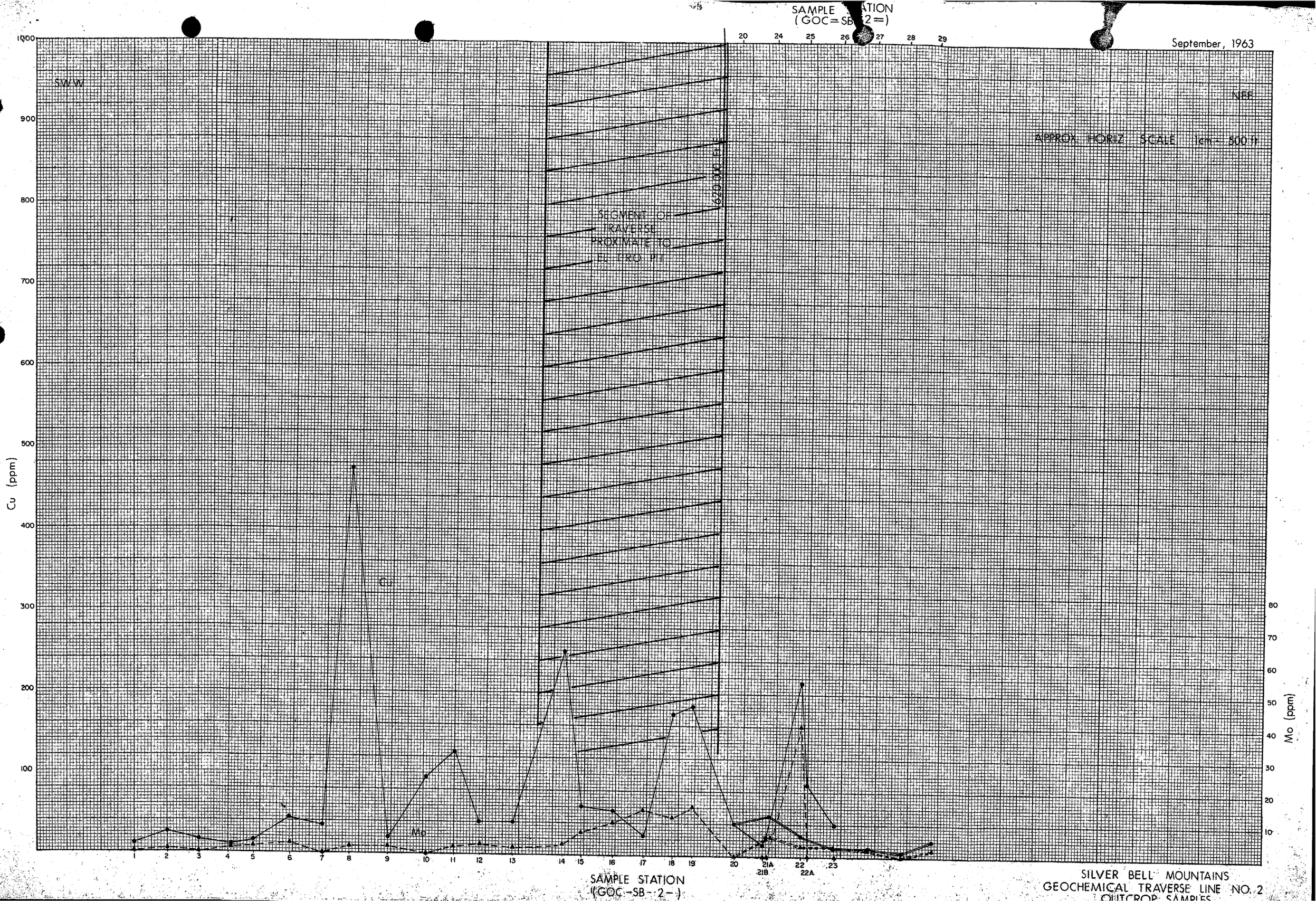
NOVEMBER, 1963

MAP NO. 1601

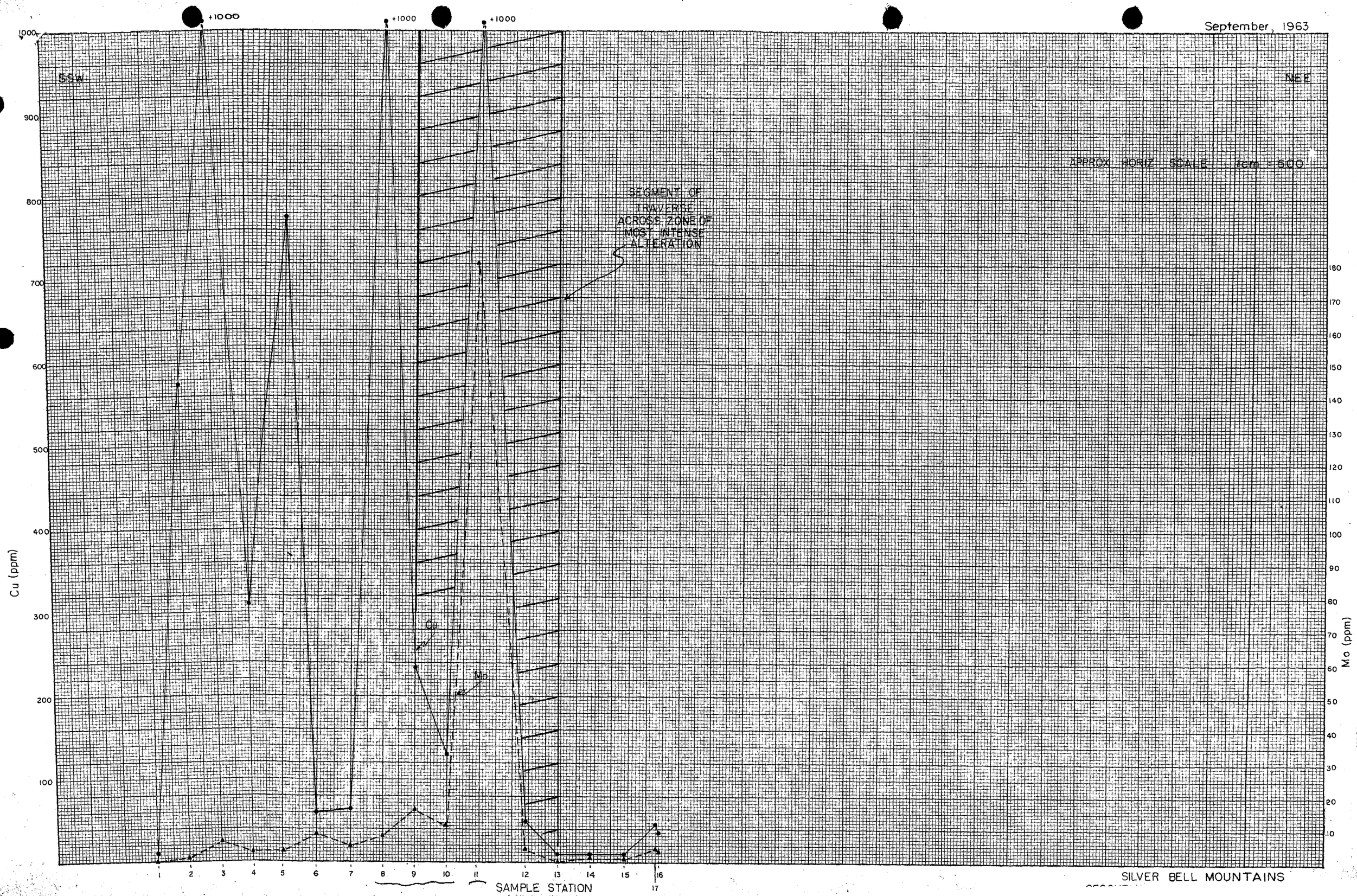


SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE LINE NO. 1
OUTCROP SAMPLES

K&E 10 X 10 TO THE CM. 359-14TG KEUFFEL & ESSER CO. MADE IN U.S.A.

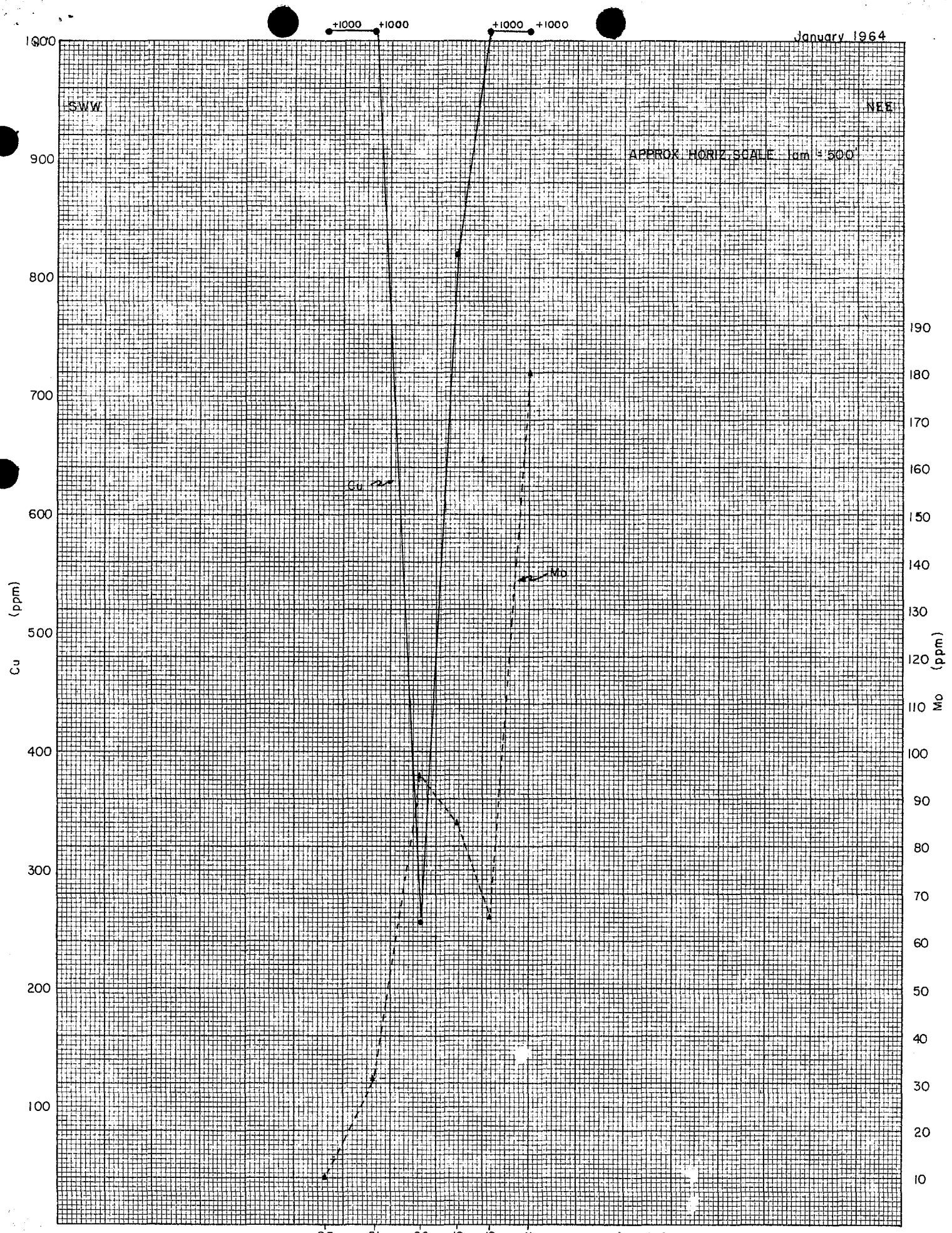

SAMPLE STATION
(GOC=SB-2=)
September, 1963
SWW
NEE
APPROX. HORIZ. SCALE 1cm = 500 ft
SEGMENT OF TRAVERSE PROXIMATE TO EL PASO PIT
Cu
Mo
Cu (ppm)
Mo (ppm)
SAMPLE STATION
(GOC-SB-2-)
SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE LINE NO. 2
OUTCROP SAMPLES

September, 1963



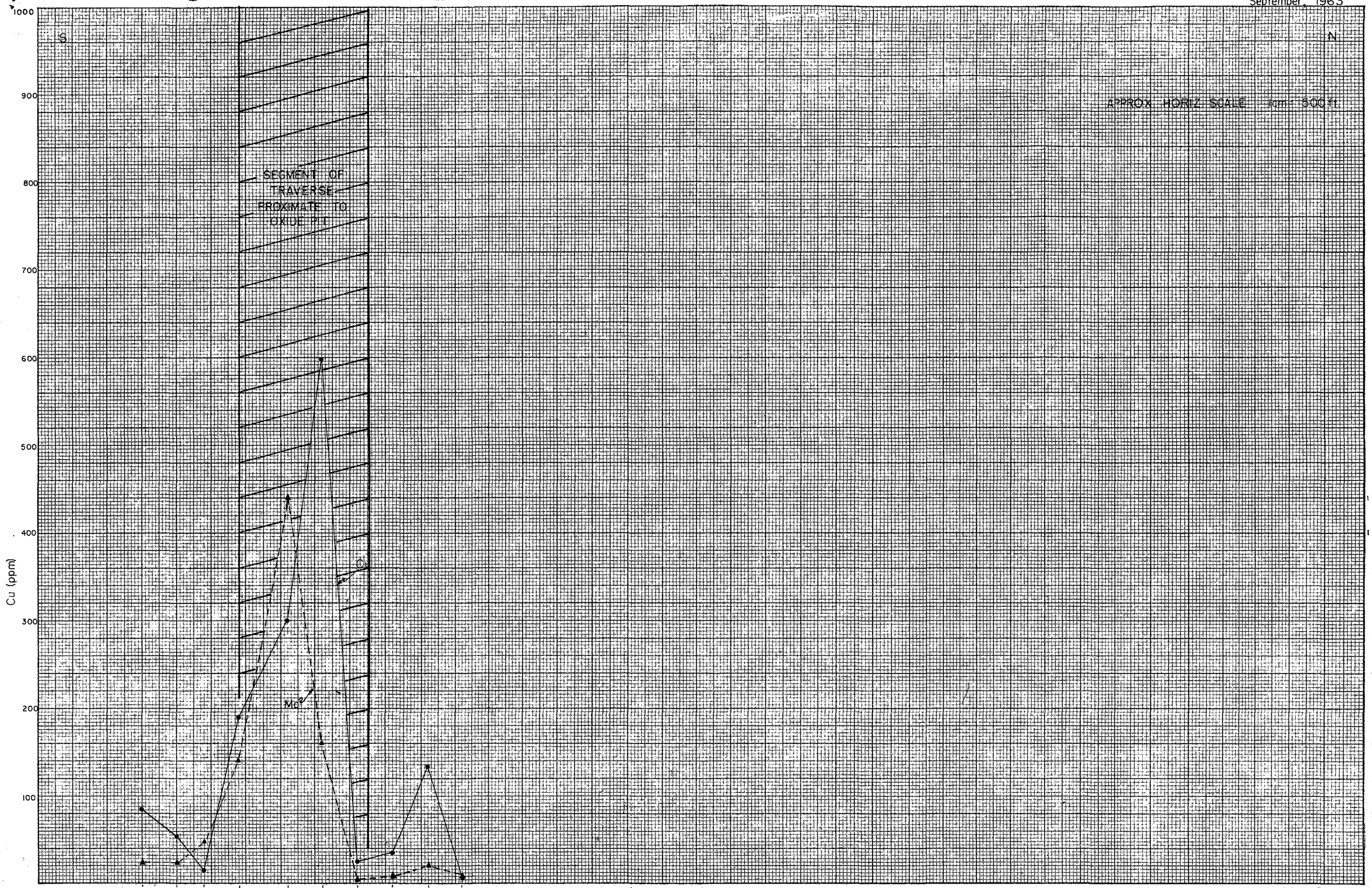
SILVER BELL MOUNTAINS

K&E KEUFFEL & ESSER CO. MADE IN U.S.A. 359-1412 10 X 10 TO THE CM.



SILVER BELL MOUNTAINS
SUPPLEMENT TO GEOCHEMICAL TRAVERSE LINE NO. 3
OUTCROP SAMPLES

September, 1963



SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE LINE NO. 4
OUTCROP SAMPLES

K&E 10 X 10 TO THE CM 359-11G KEUFFEL & ESSER CO. MADE IN U.S.A.

JHC

J. H. C.
JAN 29 1964

January 29, 1964

Mr. A. E. Johnson
Rocky Mountain Geochemical Laboratories
233 North Marina Street
Prescott, Arizona

Silver Bell
Geo chem

Dear Mr. Johnson:

We are shipping to you today, via Greyhound Bus Lines, five (5) rock chip samples for trace element determinations of copper and molybdenum. The samples are identified as follows:

GOC-SB-3-18
GOC-SB-3-19
GOC-SB-3-20
GOC-SB-3-21
GOC-SB-3-22

When you complete the analyses, please return the reject pulps to us collect, via Greyhound Bus Lines.

Very truly yours,

N. P. Whaley

N. P. WHALEY JAK

NPH/jk
cc: JHCourtright
WESaegart

J. H. C.

OCT 21 1963

October 18, 1963

AIR MAIL

Mr. R. J. Lacy, Chief Geophysicist
American Smelting and Refining Company
3422 South 700 West
Salt Lake City 1, Utah

Experimental I.P. Decay Curve Work
North El Tiro, Silver Bell

Dear Mr. Lacy:

I note Mr. Moss feels, on the basis of results obtained from I.P. decay curve experiments at North El Tiro, odds favor the existence of a distinctive curve for copper sulphides. I note also that he plans to conduct additional field tests to resolve the problem with reasonable certainty.

In this connection, I am wondering what results were obtained at Michiquillay in the recent tests made by Mr. Farley. I understood there was some instrument failure but I did not see a report on this work. Did his survey at Michi accomplish anything toward distinguishing between the pyrite zones and chalcopyrite ore.

Very truly yours,

C. P. Pollock

CC-JHCourtright
RBSprague - Lima

J.H.C.
NOV 19 1968

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 20, 1963

To: J. H. Courtright

From: N. P. Whaley

EXPLORATION GEOCHEMISTRY - INITIAL OUTCROP SAMPLING FOR AN INDICATION OF A PRIMARY DISPERSION PATTERN OF TRACE QUANTITIES OF COPPER AND MOLYBDENUM, SILVER BELL MOUNTAINS, ARIZONA.

Early in September of this year Mr. William Saegart expressed an interest in a limited program of outcrop or rock chip sampling designed to detect an indication of primary dispersion of trace quantities of copper and molybdenum around a porphyry copper ore body, and, if such dispersion existed, to further determine, at least in a preliminary sense, the likelihood of a pattern related to or reflecting intensity of known mineralization.

The Silver Bell Mountains were selected as presenting the best control available for a sampling program and four informal traverse lines were proposed.

A brief description of these traverses and the field procedures in sampling is followed by a section containing my thoughts on the investigation. A location map and some compilation of basic data are attached. Any comments relative to the material are welcomed.

Line locations and orientations were selected with reference to known alteration and mineralization. All lines originated in unaltered and unmineralized rock, traversed the zone of known alteration and mineralization by the shortest possible route tangent to the operating pits and, where possible, terminated in fresh, unmineralized rock beyond.

Two of the lines flank the El Trio Pit -- one on the north and the other on the south. They are subparallel and roughly normal to the regional trend of the alteration and structure. The other two flank the Oxide Pit -- one on the northwest and the other on the east. Although converging to the northeast, they too are essentially normal to the trend of the alteration and structure.

True linear traverses were modified to accomodate topography -- following ridges and summits which roughly paralleled the general bearings of the lines. This not only facilitated sampling by minimizing relief, but probably reduced the likelihood of contamination from secondary dispersion.

A sample interval was arbitrarily established as 500 feet except for those sections immediately adjacent to the pits...where it was reduced to 250 feet if cultural interference such as prospects, structures, and dumps permitted.

Prior to entering the field no definite method was established for determining specific sample locations on the lines. Not only did the limited, reconnaissance

nature of the program preclude surveying techniques, but dependence upon them was not deemed desirable. The most workable approach, developed in the field, was that of laying out a line on U. S. Geological Survey 1:24000 topographic maps, scaling off the intervals for locations, and using topographic control through visual orientation. If necessary, these predetermined locations were altered to correspond to any changes dictated by conditions at the actual sample site.

The sample itself was a composite representing outcrop within a fifteen to twenty foot radius around the so called "sample location." Internal portions of three to five hand specimens were reduced to 5 mm to 15 mm chips with a hammer, mixed, and enough of them used to fill cardboard cans of 126 cc to 146 cc. Small hand specimens were retained and each site was identified by number with yellow paint from a pressurized spray can. Individual samples never represented more than one rock type and every effort was made to avoid sampling fault zones, contacts, narrow dikes, visible ore mineral, or any locally unique feature.

Since no formal grid system existed, traverse lines were numbered 1 through 4. The most northern is Line No. 1 and the most southern is Line No. 4. Sample coding or identification incorporated four factors: 1) abbreviated identification of the type or purpose of the sample, 2) abbreviated identification of the geographical location, 3) traverse or line number and, 4) the sequential number of the sample from the given traverse or line.

As an example:

(GOC - SB - 3 - 10)

Expanded, it would be read as:

(Geochemistry - Silver Bell - Line No. 3 - Sample No. 10)

The four lines were sampled by a two-man team between September 11 and September 26 -- with ten and a half days actually spent in the field. One man did the sampling while the other maintained orientation and a written description of the traverse and samples.

Physical parameters for the lines are as follows:

Line No.	Approx. Length (Ft.)	General Bearing	Elevation Range (Ft.)	Difference in Elev. (Ft.)	No. of Samples
1	10,500	N.78°E.	2460±3310±	850±	23
2	13,850	N.65°E.	2460±3765±	1350±	31
3	7,800	N.20°E.	2645±3240±	595±	17
4	4,600	N. 0°E.	2800±3490±	690±	10
Totals	36,750				81

This represents a collection average of seven to eight samples per day, and a sampling density of one sample per 453 feet of line.

Analyses were by colorimetric methods at the Rocky Mountain Geochemical Laboratories, Prescott, Arizona.

Inferences are made within the bounds imposed by a limited number of samples collected on four widely separated traverse lines. Each line should be regarded as an individual, two dimensional system composed of metal concentration relative to linear location.

All lines display decided geochemical relief apparently related to the known ore bodies. Copper values on some of the lines are extremely erratic, but if the molybdenum is regarded as a pathfinder element and the copper relegated to a supporting role the geochemical landscape exhibits an almost classic profile of regional threshold, local threshold or plateau, and peaked anomalies. In all cases the local molybdenum threshold and anomaly occur within that segment of the traverse proximate to the known ore bodies.

Most promising is the suggestion that the dispersion reflects the more intense mineralization of these known ore bodies rather than a preferential concentration in a specific rock type. While too few samples are involved to draw any conclusions, the distribution curves for Line No. 1 and Line No. 2 also suggest that in these systems the concentration of molybdenum is qualitatively independent of the degree of alteration. These relationships, if established, would be highly favorable factors in an evaluation of the exploration potential of outcrop sampling.

Detailed analysis directed toward establishing the significance of absolute concentration values, their frequency distribution, or the ratios between the thresholds and anomalies would probably be premature at this time. The sample population is limited, the threshold-anomaly ratios highly variable, and little is known of sampling and analytical error.

Of significance at the time is that each of the four traverse line curves reflects molybdenum anomalies which are correlative with the local intensity of known mineralization, and while more work would be required to determine the true import of this implication, the suggested potential for localizing targets in broad zones of alteration is favorable.

While I assume responsibility for identification of rock type and description for the samples, I wish to express gratitude to Charles Haynes of the Silver Bell Unit for many helpful conversations on the petrography of the Silver Bell Mountains.

Norman P. Whaley

NORMAN P. WHALEY

NPW/jk
Attachments

February 12, 1964

ADDENDUM

On January 28 of this year five more outcrop samples, GOC - SB - 3 - 18 through GOC - SB - 3 - 22 inclusive, were collected along a short supplemental traverse in the Copper Butte-North Butte area.

This traverse, which forms an appendage running SWW from the location of sample No. 11 on Line 3, originated in the tactite to the northwest of Copper Butte, crossed the dacite porphyry through a zone of locally strong alteration, and terminated in the moderately altered alaskite southwest of North Butte (Map of November, 1963).

Both rock type and degree of alteration occur as variables.

The copper values were erratic as they were on line 3 and appear to indicate the generally pervasive saturation of oxide copper in this area. Molybdenum values, while fluctuating, remain anomalous but exhibit a tendency to drop off to the west. They could reflect one or a combination of at least three possibilities: a) the proximity of the Oxide ore body, b) the intensity of alteration, or c) the existence of additional primary mineralization at depth.

Option (b) would conflict with my original feeling that the geochemical relief for molybdenum was independent of the nature of alteration. At present it would be difficult to either establish or refute a relationship.

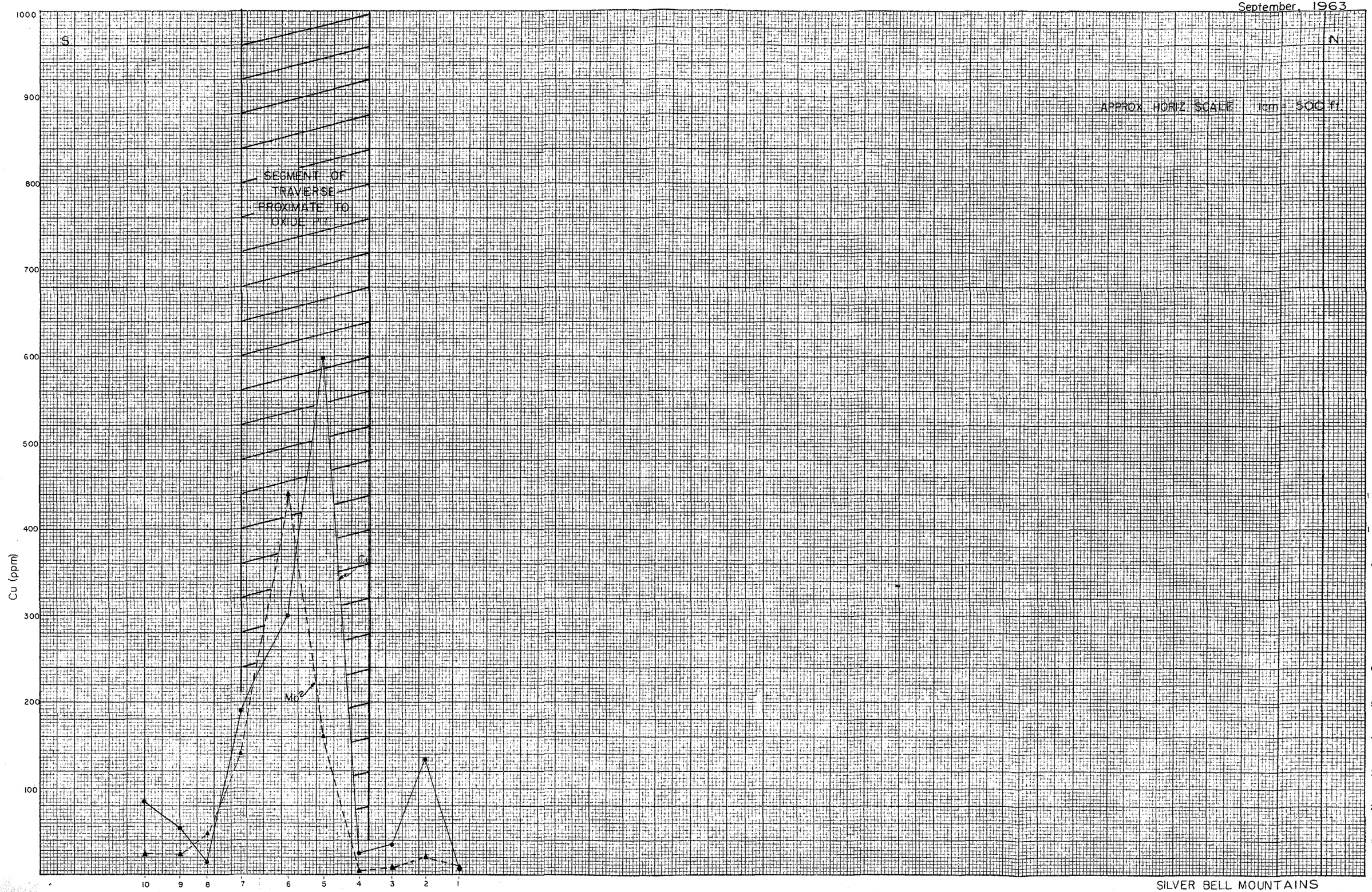
Option (c) is the most interesting, and perhaps could be better evaluated if the relationship between alteration and the concentration of molybdenum were better understood.

Norman P. Whaley

NORMAN P. WHALEY

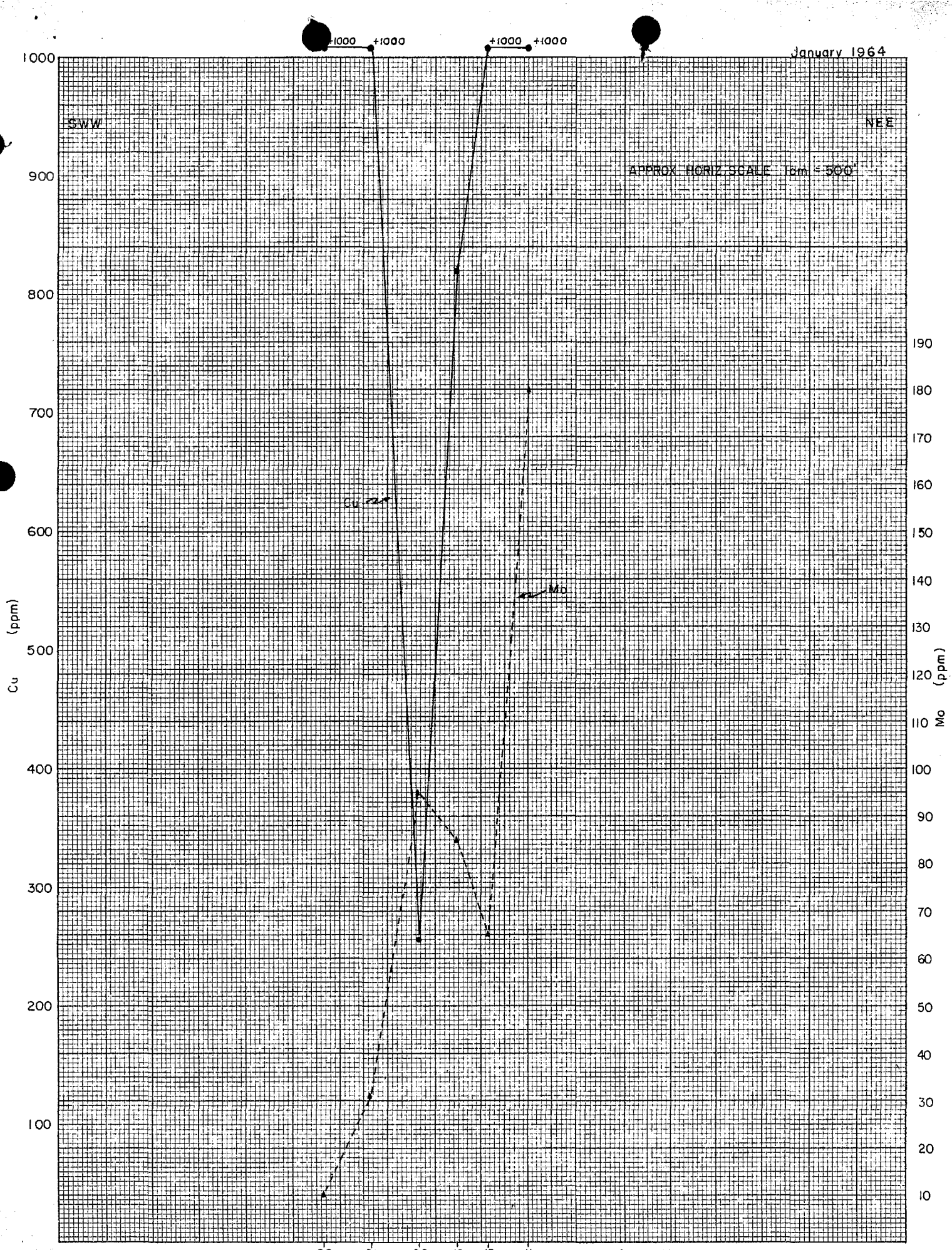
NPW/jk

September, 1963

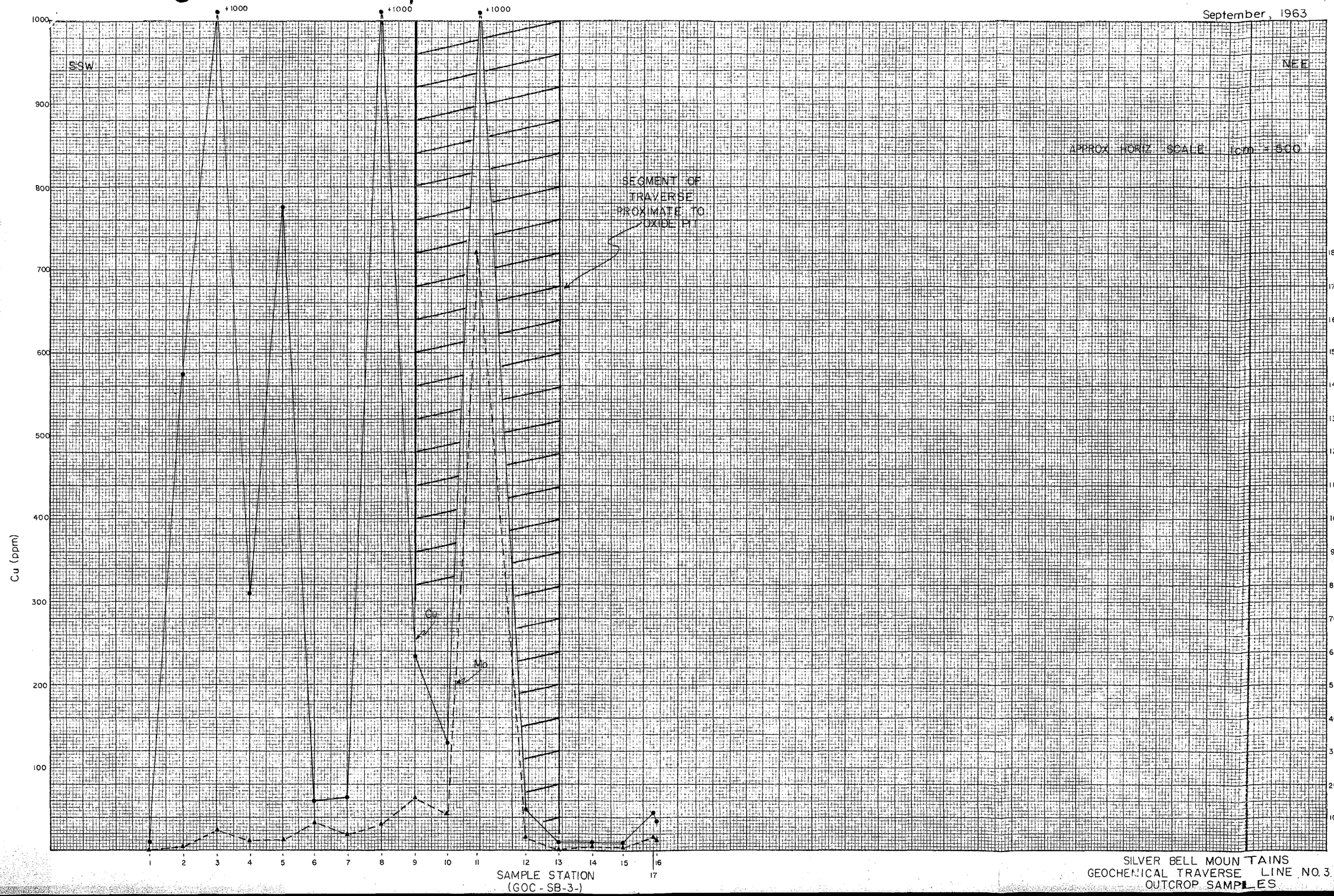


SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE LINE NO. 4
OUTCROP SAMPLES

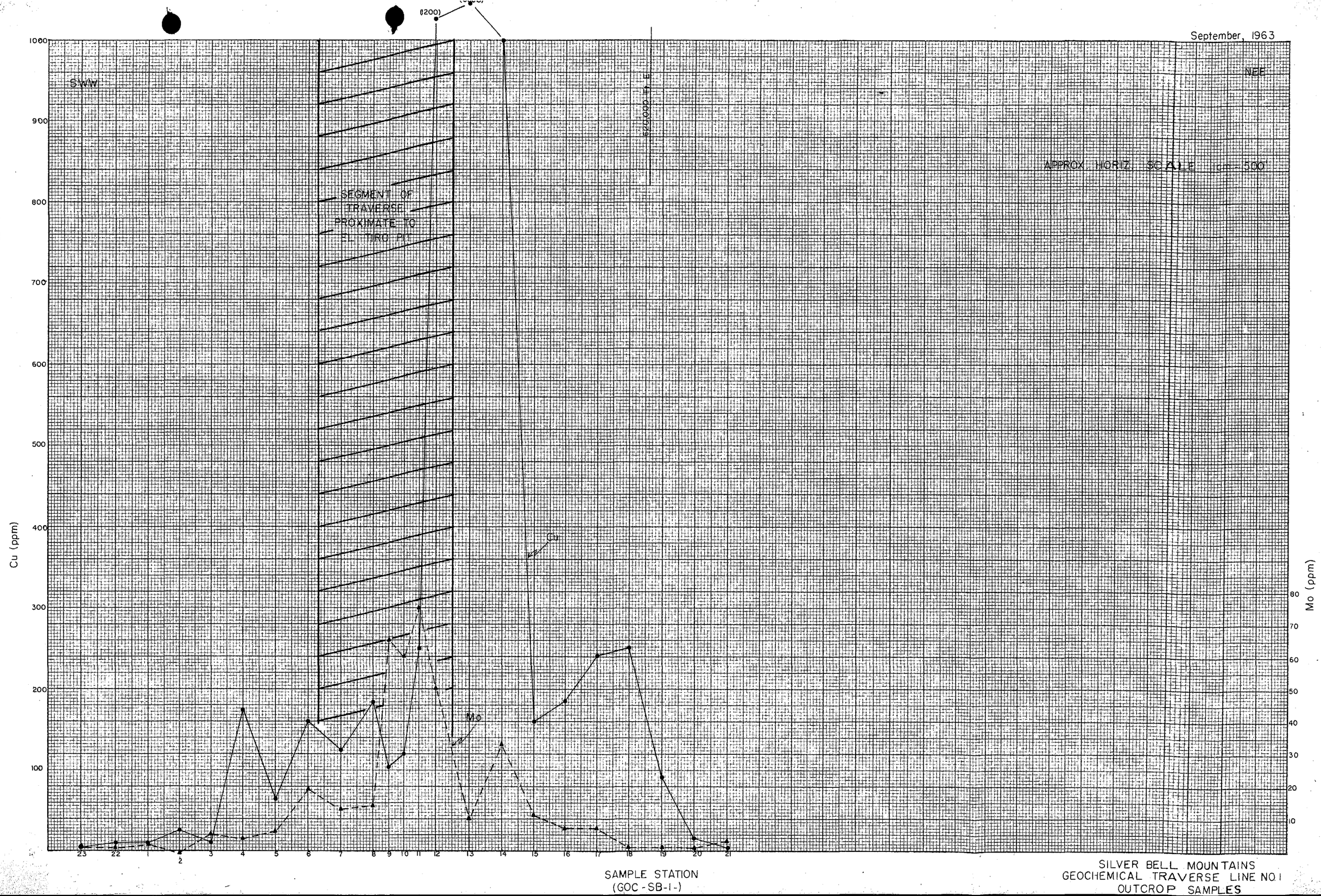
K&E KEUFFEL & ESSER CO. MADE IN U.S.A. 10 X 10 TO THE CM. 359-14G



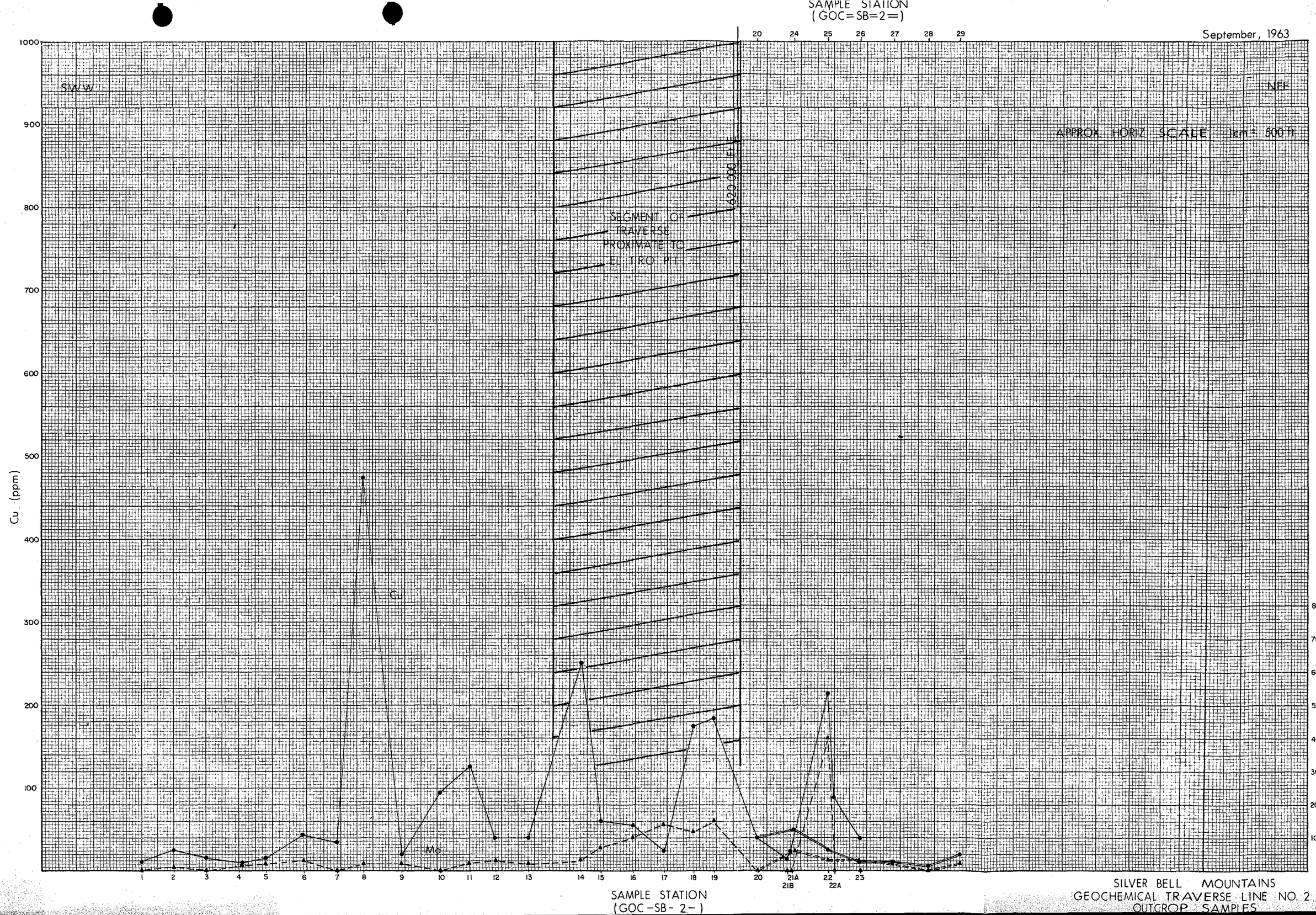
SILVER BELL MOUNTAINS
SUPPLEMENT TO GEOCHEMICAL TRAVERSE LINE NO. 3
OUTCROP SAMPLES



K&E KEUFFEL & ESSER CO. MADE IN U.S.A. 10 X 10 TO THE CM. 359-14R2

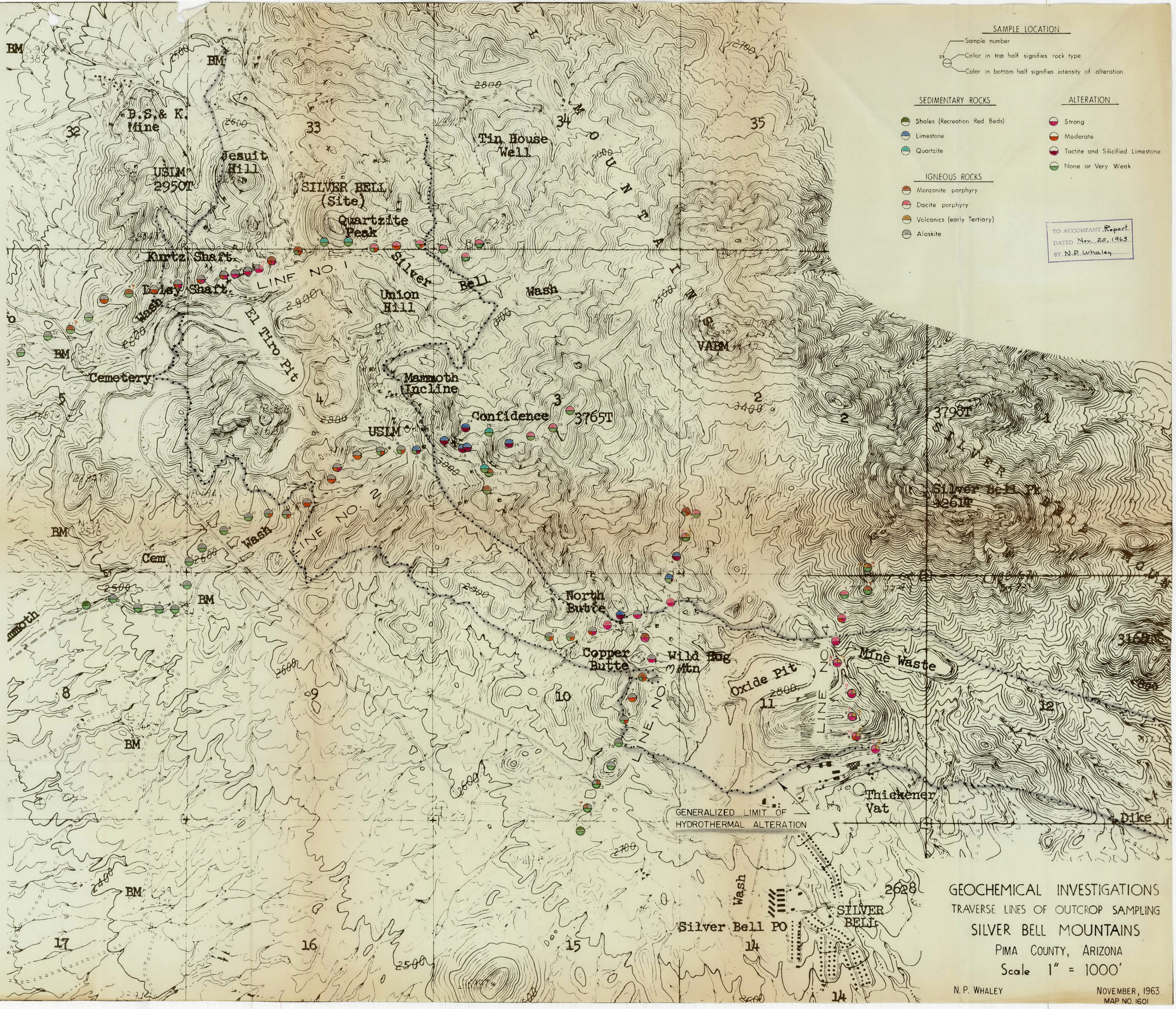


K&E KEUFFEL & ESSER CO. MADE IN U.S.A. 10 X 10 TO THE CM. 359-17G



SILVER BELL MOUNTAINS
GEOCHEMICAL TRAVERSE LINE NO. 2
OUTCROP SAMPLES

K&E 10 X 10 TO THE CM. 359-14LG KEUFFEL & ESSER CO. MADE IN U.S.A.


SAMPLE LOCATION
Sample number
Color in top half signifies rock type
Color in bottom half signifies intensity of alteration
SEDIMENTARY ROCKS
Shales (Recreation Red Beds)
Limestone
Quartzite
IGNEOUS ROCKS
Monzonite porphyry
Dacite porphyry
Volcanics (early Tertiary)
Alaskite
ALTERATION
Strong
Moderate
Tactite and Silicified Limestone
None or Very Weak
TO ACCOMPANY Report
DATED Nov. 20, 1963
BY N.P. Whaley
D.S.& K. Mine
Jesuit Hill
USLM 2950T
SILVER BELL (Site)
Quartzite Peak
Tin House Well
Kurtz Shaft
Loley Shaft
LINE NO. 1
Silver Bell Wash
Union Hill
El Tiro Pit
Cemetery
Mammoth Incline
Confidence
3765T
USLM
VABM
3798T
Silver Bell Pk
3261T
LINE NO. 2
North Butte
Copper Butte
Wild Dog Mtn
Oxide Pit
Mine Waste
LINE NO. 3
Thickener Vat
Dike
GENERALIZED LIMIT OF HYDROTHERMAL ALTERATION
Silver Bell PO
SILVER BELL
2628
GEOCHEMICAL INVESTIGATIONS
TRAVERSE LINES OF OUTCROP SAMPLING
SILVER BELL MOUNTAINS
PIMA COUNTY, ARIZONA
Scale 1" = 1000'
N. P. WHALEY
NOVEMBER, 1963
MAP NO. 1601

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

September 30, 1963

MEMORANDUM TO: Mr. D. R. Jameson, Superintendent

Subject: THE OCCURRENCE OF SPHALERITE IN THE EL TIRO EAST EXTENSION AND EL TIRO IMPERIAL EXTENSION OREBODIES.

INTRODUCTION:

The purpose of this report is to indicate where zinc-bearing copper ore will be encountered during mining, and the significant relationships between sphalerite and chalcopyrite.

The presence of zinc as sphalerite in the El Tiro sedimentary orebodies has been known since the start of the drilling program in June 1960. During core logging the amount of sphalerite was visually estimated, although assays were made of runs showing strong zinc mineralization. Since only selected assays were made of the higher grade zinc intercepts, the zinc content of the ores tended to be concealed. This was due to the dark color of much of the host rock, the dominance of other sulphides, and the disseminated nature of much of the sphalerite.

A recent metallurgical composite sample of the ore grade intercepts in the sulphide zone of the Imperial Extension has demonstrated an average zinc content of 0.72%. Although of value for testing purposes, the composite does not indicate the unequal distribution of zinc.

The zinc content of the East Extension sediments, although less than that of the Imperial area, is still of significant magnitude to merit testing.

The drilling program in the El Tiro area is essentially complete. As a result, generalizations made on the above subject may be considered final, prior to actual mining.

OCCURRENCE:

Significant amounts of sphalerite are found exclusively in the altered sediments, and show no consistent favorability for a specific type of rock alteration. In most cases, high zinc content is accompanied by a high copper content.

Sphalerite is found both as small high grade pods and as small disseminated grains. Although the fine-grained disseminated sphalerite was more easily concealed in the cores, the high grade pods appear to contribute the greater amount of zinc to the orebody.

Within the orebody, the sphalerite is marmotitic (high iron) and is closely associated with chalcopyrite. Minor amounts of galena and pyrite are common. Where the sphalerite is disseminated, it occurs with the chalcopyrite as adjacent mineral grains. In the small high grade pods, the sphalerite-chalcopyrite relationship is more complex, and has two aspects. The greater portion of the chalcopyrite occurs as irregularly shaped grains locked within the sphalerite.

The remaining chalcopyrite (perhaps 10%) occurs as minute blebs in the sphalerite (Figure I). The extremely fine grained nature of the chalcopyrite blebs will make it difficult to separate from the sphalerite.

Cu?

In the barren zones sphalerite is more amber colored (low iron) and commonly occurs with galena and fluorite.

DISTRIBUTION:

The average copper: zinc ratio for the Imperial orebody is 1:1. It can vary to as high as 1:5, indicating the sphalerite is not uniformily distributed. Within the area of disseminated sphalerite is a pronounced higher grade zone where high grade pods are more common. This is shown on the accompanying map. The linear trend of this higher grade zinc zone suggests a semi-regular pattern and may eliminate the possibility of other irregularly scattered high grade zones in the ore.

In the East Extension orebody there is no regular zoning due to the large proportion of igneous rocks which intrude the sediments. The copper: zinc ratio is unknown, although perhaps no higher than 1:0.5. Disseminated and high grade pods of zinc are about evenly distributed.

Mining operations in the East Extension will encounter small amounts of zinc throughout the orebody. In the Imperial area more zinc will be mined, and the zinc content of the ore will vary more widely.

About 20% of the bench intercepts in ore grade copper sulphide contain zinc. Table I lists the ore holes and benches which contain known zinc.

DISCUSSION:

The above information represents what is known about zinc in the sediments and has been derived from diamond drill hole information. Geologic mapping will yield further significant data on zinc distribution as mining progresses. Zinc assays of blast holes in ore grade copper should probably be made. The data of Table I along with information from geologic mapping could be used to determine whether or not zinc assays are necessary. Otherwise, zinc assays of all blast holes in ore grade copper would be needed.

F. T. Graybeal

F. T. Graybeal
Geologist

FTG/jca

Figure I:

Microphotograph showing irregularly shaped light chalcopyrite (cpy) grains locked within gray sphalerite (sl). Also shown are minute blebs and laths of chalcopyrite, which occur throughout the sphalerite (Magnification 175X).

TABLE I: Drill Holes Showing Ore Grade Copper Sulphide Benches and Approximate Percent Zinc*

	East Extension Drill Holes								Imperial Extension Drill Holes											
Bench	D4	D13	D22	D44	D45	D48	D66	D69	D5	D8	D14	D19	D21	D23	D24	D81	D87	D91	D97	D100
2910																				
2870				.1								.1				.2				
2830				.1					.1								.1		.1	
2790																				
2750													.1							
2710	.2						.1			1.0										.1
2670	.1																			
2630																		.1		
2590													.1	.1		.1				
2550		.1			.1						.5									
2510			1.5			.1														
2470																				
2430								.1												
2390															.2					

Imperial Extension Drill Holes (Continued)

Bench	D102	D107	D111	D115	D116	D119	D121	D123	D127	D129	D130	D142	D144	D147	D150	D157
2910		.1														
2870				.2												
2830		.1														
2790									1.0							
2750						.2			.5							.5
2710			.1			.1		1.5		2.5						
2670			.5													
2630			.8		.2							3.4	.1		1.7	
2590							.2					8.0				
2550	.2						.1				.1					
2510					2.0							2.0				
2470																
2430																
2390														1.5		

* Zinc percentages approximated by combining scattered assays with visual estimates.

J. H. C.

SEP 27 1963

September 27, 1963

Mr. A. E. Johnson
Rocky Mountain Geochemical Laboratories
233 North Marina Street
Prescott, Arizona

Dear Mr. Johnson:

We are shipping to you today, via Greyhound Bus Lines, 38 additional rock chip samples for trace element determinations of copper and molybdenum.

A list of these sample numbers is attached. All samples consist of two containers each. These two containers should be combined and the determinations made on the resultant composite.

When you complete the analyses, please return the reject pulps to us collect, via Greyhound Bus Lines.

Very truly yours,

N. P. Whaley

N. P. WHALEY

NPH/jk
Enclosure
cc: JHCourtright w/o Enclosure
WESaegert w/Enclosure

J.H.C.
SEP 18 1963

September 18, 1963

Mr. E. A. Johnson
Rocky Mountain Geochemical Laboratories
233 North Marina Street
Prescott, Arizona

Silver Bell
Geo chem samples

Dear Mr. Johnson:

This will acknowledge receipt of your letter of September 8.

We are shipping to you today, via Greyhound Bus, 43 rock samples. Please make trace element determinations on these for copper and molybdenum.

Attached is a list of sample numbers. You will note that samples GOC-SB-1-13 through GOC-SB-1-18 inclusive are packaged in two containers each (two containers per sample). Each of these pairs should be determined as a single sample.

When you complete the analyses, please return the pulps to us, collect, via Greyhound Bus.

Very truly yours,

ORIGINAL SIGNED BY
W. E. SAEGART

W. E. SAEGART

WES/jk
Enclosure
cc: JHCourtright w/o encl.
NPWhaley w/o encl.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

J. H. C.

SEP 17 1963

16 September 1963

MEMORANDUM TO MR. T. A. SNEDDEN

GROUND WATER STUDY AREA
WEST OF SILVERBELL,
PIMA COUNTY, ARIZONA

As requested in Mr. Pope's letter to you of August 9, I have investigated the ownership of sections 6, 7, 8, 17, and 18 in T 12 S, R 8 E. This is the area recommended for investigation by Mr. Saegart in his letter to Mr. Richard of July 16 in connection with the possible development of water near the El Tiro area. This area is all federal ground with the possible exception of the north-east corner of section 8 where we may all ready have some mining claims located. I do not have the Silverbell property map in front of me while I write this but the boundary on the company claims has been plotted on the field sheet which Mr. Saegart used.

During the course of his examination, Mr. Saegart found evidence of recent mining claims staked in the area of interest. According to the courthouse records, one Lloyd D. Miller has staked 84 claims (Sunrise 1 to 84) in sections 7 and 18, the west part of section 17 and the south-west quarter of section 8. The claims were located July 10, 1962 and recorded July 13, 1962 in Docket 1963 on pages 300 to 383. No assessment affidavit has been filed up to today. No assessment work was necessary until the assessment year beginning September 1, 1962 and ending September 1, 1963.

Paul Zaches located 24 claims (Pau numbers 1 to 24) on April 20, 1961 in section 6 and on April 26, 1961, he located the Pau's numbers 25 to 37, also in section 6. On April 20, 1961, Mr. Zaches also located Zak numbers 1 to 32 in section 17. The description on the location certificates of the Pau and Zak claims is not sufficient to allow these claims to be located on the map with any kind of accuracy but Mr. Saegart noted the location pits of some of these claims and plotted these on his field map. Since these claims were located, no affidavits of labor have been filed for any of them.

It is apparent that the ground covered by the Pau and Zak claims is open for relocation but Mr. Miller still has time in which to file an affidavit for the Sunrise claims. At the time of Mr. Saegart's examination, he saw no evidence of assessment work.

ORIGINAL SIGNED BY
S. I. BOWDITCH

S. I. Bowditch

SIB:bam
cc: JHCourtright
WESaegart

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
August 6, 1963

MEMORANDUM TO MR. J. H. COURTRIGHT:

SILVER BELL UNIT
IMPERIAL AREA
PROPOSED DRILLING

Mr. Von Fay, by memo dated July 31, proposed a number of drill holes "to test the rather large block of ground in the general Mammoth area".

This area was included in an I. P. survey made last year and reported in my memo of June 10, 1963 to Mr. Richard. Significant I. P. response (above 6 m.v./v) was recorded in the general Mammoth area. The untested part of this I. P. anomaly has approximate dimensions of 1000' x 1000'. It is bounded on the east by hole D-26, on the north by holes D-29, D-157, D-159, and D-160, and on the west by holes D-80, D-89 and D-96. Of the 15 holes proposed by Mr. Von Fay, 12 are within the area of significant I. P. response. The anomaly has a maximum of 10.1 m.v./v, located 50' west of the Mammoth incline.

Drilling of the sediments in the Imperial area has demonstrated a pyrite/chalcopyrite ratio of approximately 1:1. Within the sediments, then, the I. P. results are considered a valid qualitative measure of copper sulfide content. The exact degree of correlation will depend on the variability of oxidation depths.

The criteria leading to Mr. Von Fay's recent drilling proposal are independent of geophysical results. The I. P. correlation provides additional justification for the proposed drilling.

W. E. SAEGART

WES/kw
cc: JHCourtright, 4 extra

J. H. C.
JUL 25 1963

May 28, 1963

Silver Bell - West

Dr. L. A. Heindl
U. S. Department of Interior
Geological Survey
Washington 25, D. C.

Dear Leo:

Courtright is now in Peru and he has hidden our photographs on the Chaos area, so I do not know exactly where it is. Approximately, it is 7 miles northwest of the El Tiro pit. I did not intend to "bait" you with my original comment about this Chaos, but I did want you to be intrigued without being completely informed. In this way I had hoped, before receiving the New York assignment, to get you to plan a field trip some day so that we could show it to you. Now I guess I'll have to leave it all up to Courtright.

Your intention not to let the Cat Mountain become another Gila Conglomerate is proper because it is my impression that there are similar rhyolitic ash flows in both overlying and underlying sequences. I think I can distinguish most of these units. However, as you might know, Courtright does not agree with me. In these circumstances, I would agree that your plan to use new local names for these silicic rocks on the reservation is appropriate.

Best regards,

KENYON RICHARD

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 24, 1963

J. H. C.

JUL 25 1963

JUL 25 1963

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

MR. TILES SVF

READ AND RETURN

SILVER BELL UNIT
OXIDE PIT DIAMOND DRILLING

PREPARE ANSWERS ..... HANDLE .....
INITIALS .....

Dear Sir:

Partly because in recent years here in the Southwest chalcocite ore has been found perched under high ridges and hills, re-evaluation of the Portland Ridge area immediately south of the Oxide Pit was undertaken recently. Mr. Haynes has put this material together in a memorandum dated May 14 and transmitted to Mr. Snedden by Mr. Jameson by letter of May 16. Mr. Snedden intends to send you a copy of this memorandum and letter, and I refer to these in the following remarks.

Close around the south edge of the Oxide Pit the intensity of alteration-mineralization drops off markedly, but along the crest of Portland Ridge mineralization improves. This is regarded as being only a moderately good exploration target, but its position at a higher elevation and alongside the Oxide Pit indicates that it should be tested in a preliminary way now. If the first few drill holes shown by Mr. Haynes provide encouraging results, the zone can be drilled out and its mining can be planned well before the present Oxide Pit ore body is gone.

The topography is so steep in places that, if the initial results are encouraging, angled holes may be needed ultimately to define any ore body.

Mr. Courtright and I have reviewed this area in the field recently and have discussed the problem with Messrs. Jameson, Haynes and Greybeal. We agree with Mr. Haynes' recommendations.

Yours very truly,

KENYON RICHARD

KR/kw
cc: DJPope
TASnedden
JNCourtright
DRJameson

H. C.
4 1963

January 22, 1963

Dear Mr. Courtright,

I appreciate very much the aerial photos of the West Silverbell Mountains but after some consideration I am returning them to you. My reasons for doing this are that although I am not being paid to do my thesis by anyone, I am in some respects obligated to another company and feel that I do not want to be under any obligation to the A.S. & R. Company with regard to my thesis findings prior to the availability of my thesis through the University.

I thank you very much for your interest.

Sincerely,

Craig W. Clarke

Craig W. Clarke

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

July 13, 1962

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

EL TIRO-IMPERIAL AREA
EXPLORATION

Dear Sir:

In accordance with our telephone conversation yesterday, attached is a copy of a file memorandum which Mr. Courtright handed me in preliminary form as he left for his vacation a week ago.

Since that time it has been suggested in conversations with Mr. Snedden and Mr. Weiss that the ammonia leach process may be able to handle lower grade ores than Mr. Courtright contemplated with his .8 cutoff. In that case the tonnages of oxide ores in Extension A and B would be larger than shown in Mr. Courtright's tabulation. Also, it seems that the ammonia leach process may not recover the copper silicate. In this circumstance, the proportions of copper carbonates and copper silicates in oxidized ores would be important in mining. That material which consists largely of copper silicate in a lime-free gangue would be selectively placed on a leach dump. That which contains mostly Cu carbonates would be milled. For ore reserve calculation purposes and for selective mining, it may prove difficult, however, to make a very clear distinction between these two ore types.

Mr. Courtright's memorandum and my foregoing comments may be premature in some respects. A great deal of experimental work remains to be done on the ammonia leach process; and as I understand, it merely appears to be promising in a preliminary way. These comments and Mr. Courtright's data are presented to you, then, with the intention only of acquainting you with the general problems and studies that are being undertaken.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/kw
Attach
cc: DJPope)
DRJameson) w/att.
JHCourtright)

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

July 13, 1962

FILE MEMORANDUM

EL TIRO-IMPERIAL AREA
EXPLORATION

The El Tiro-Imperial drilling program, started over two years ago, was designed to explore an area of mineralized sediments extending from the east side of the El Tiro pit into the old Mammoth and Union Mines. While considerable drilling remains to be done, the program has advanced to the stages where a rough estimate of the area's potential can be made.

Ore limits have been fairly well defined adjacent to the El Tiro pit, but they are only partially defined in the Mammoth-Union area farther to the east (El Tiro pit Extensions A and B of Mr. Haynes' memorandum dated 4/10/62). Extension A is structurally complex with a variety of ore types which fall into three general catagories: (1) sulphides (mainly chalcopyrite) in sediments (2) mixed Cu oxides (little or no sulphide) in sediments and (3) oxide (Cu silicate) in igneous rocks. In Extension B, mineralization is more uniform and continuous in a relatively simple structural environment. The ore there consists essentially of two types (1) sulphides (chalcopyrite) in sediments and (2) oxide (mainly Cu carbonate) in limey sediments.

Preliminary estimates by personnel at Silver Bell indicate 7 to 9 million tons of sulphide ore in sediments in Extension A. No other calculations have yet been made; however, a rough approximation of the total open pit potential is as follows:

Extension A	Tons (millions)	Grade % Cu	Cutoff
Sulphide Ore in Sediments	7 - 10	.8	0.4
Oxide Cu - both sedimentary and igneous	4 - 6	1.0 - 1.3	0.8
Extension B			
Sulphide Ore in Sediments	10 - 12	.9 - 1.0	0.4
Oxide (mainly Cu carb.)	2 - 3	1.2 - 1.4	0.8
Total			
Sulphide	17 - 22	0.8 - 0.9	0.4
Oxide	6 - 9	1.1 - 1.3	0.8

File Memorandum
El Tiro-Imperial Area

July 13, 1962

Essentially all of the oxide tonnage listed above would be removed as stripping during open pit mining of the sulphides. Thus, should a successful means of treating this material be found, no mining cost would be involved, theoretically.

Much of the oxides in Extension A is in the form of copper silicate in igneous rock, and thus is amenable to dump leaching. Should the ammonia leach, or some other process, prove applicable to all types of oxide copper, only the lower grade ---- say minus .8% Cu ---- with higher proportions of copper silicate material would be sent to the leach dump. Therefore, specifications for cutoffs of various ore types are needed before current stripping progresses too far.

Although a sufficient tonnage of sulphide ore exists in Extension A for several years operation, evaluation of Extension B should be made at an early date. The latter area, having a better than average grade, might be mined concurrently to an advantage, rather than left to the final period. Accordingly, exploration should be continued until that area is completely drilled out and a full evaluation from the standpoint of both mining and metallurgy can be made.

J. H. COURTRIGHT

JHC/kw
cc: CPPollock
DJPope
DRJameson

El Tiro - ~~I~~ Imperial Ore Guesstimate

Sedimentary Oxide Ore – principally $CuCO_3$ – ~~2,500,000~~ 250,000 tons @ 1.41% Cu
(East) (.80% cutoff)

Igneous oxide and various mixed oxides – 5,500,000 tons @ 1.14
(west – adjacent to El Tiro pit)

8,000,000 @ 1.25

or, say 7,000,000 @ 1.30

Sulphide:

East – 10,000,000 tons .95% Cu
(clean sulphide)

West 10,000,000 tons .80% Cu
(some non sul)

20,000,000 tons .87% Cu

2.57

mercaloyd seeds - 2.82

11.37

12.

17 -	93 -	1.29	- 119.97
19 -	39 -	5.00	- 195.00 ← cut to 2.5%
	100 -	.91	91.00
21. -	119 -	.83	98.77
83 -	20 -	1.03	20.60
	20 -	1.07	21.40
87	73 -	.80	58.40
97	52 -	1.23	63.96
100	123	2.09	257.07
	80	2.03	162.40
102	33	.96	31.68
105	26	1.31	34.06
107	31	.93	28.83
111	111	2.11	234.21

11 | 920 | 880 | 40 | 84. ft

920 | 1417.35 | 1.54
920
4973.5
4600
373.5

150 × 85 × 2.00 × 11 =

85.
30,000
255.

920 | 1302 | 1.41
920
3820
3680
400
4

1417
115
1302

70	16	3.83 - 2.43		
73	69	1.24 - .73		
76	26	1.12 - .92		
	37	2.86 - 2.04		
83	20	1.03 - .18	=	20.60
	20	1.07		21.40
86	115	1.87		215.05
87	73	.80		58.40
89	40	1.16		46.40
				41.04
90	38	1.08		
93	29	1.10		31.90
94	143	1.41		201.63
~~96~~	~~49~~	~~1.19~~		~~58.31~~
97	52	1.23		63.96
~~99~~	~~78~~	~~.84~~		~~65.52~~
100	123	2.09		257.07
	80	2.03		162.40
102	33	.96		31.68
105	26	1.31		34.06
107	31	.93		28.83
111	111	2.11		234.21

18

19 | 1412
133
82

.74 ft per hole

1412 | 1987.20 | 1.41
1412
5752
5648
1040

Imperial — 7-2-62

1 —	40 —	.90	=	36.00
3 —	54 —	1.06	=	57.24
5 —	62 —	.88	=	54.56
9	27 —	.86	=	23.22
12	38 —	.80	=	30.40
~~17~~	~~93~~	~~1.29~~		

221 | 201.42 | 9
221 | 1989
2

221
1624
920
2765

201.42
1868.60
1417.35
3487.37

2765 | 3487.37

3257
920
2337

4057
1417.35 | 1.14
2640
2337
3030
2337
9930
9348

18
5
15
38

221
1624
1412
38 | 3257 | 86
304
217
228

201.42
1868.60
1987.20
4057.22 | 1.25
3257
8002
6514
14880

7
~~85~~ × 150 × 200 = 210000 × 38
~~12~~
210000
380000
76
7,980,000 @ 1.25

3.9	×	1.18	=	4.602
4.6	×	2.78	=	12.788
5.9	×	1.22	=	7.198
5.1	×	.71		3.621
3.0		.77		2.310
4.7		.26		1.222
11.3		.79		8.927
5.9		.86		5.074
9.8		1.23		12.054
54.2				

54.2) 57.796 (1.06
542
3596

Imperial oxides .80 cutoff

17	—	93	—	1.29	— 1.08	=	119.97
							195.00
19	—	39	—	5.00	4.49	=	91.00
		100		.91	.65	=	
							98.77
21	—	119	—	.83	.71	=	
25	—	68	—	.87	.58	—	59.16
27	—	90	—	1.34	.37	cc	120.60
							104.70
31	—	90	—	1.13	.97		
		35	—	2.42	.95		84.70
		146	—	.90	.43		131.14
37		90		1.03	.36	cc	92.70
		52		1.01	.89		52.52
39		51		.94	.42		47.94
41		54		.88	.45		47.52
43		24		.92	.70		22.08
48	—	21		1.54	.41	chungs	32.34
	—	86		1.24	.90		106.64
56		164		1.24	.86	chungs	203.36
58	—	47		1.18	.84		55.46
60	—	97		.95	.65		92.15
55	—	43		1.86	1.52		79.98
	—	41		1.50	1.17		61.50
56	—	164		1.24	.86		203.36
60	—	97		.95	.65		92.15
		112		1.12	.61		125.44
63		52		1.08	.64		56.16
		1624				1624	1868.60

Imperial 6-18-62

D7 —	236	1.12	-	264.32
8 —	100	1.16	-	116.00
19 —	48	.72	-	34.56
	84	1.08	-	90.72
24 —	92	.70	-	64.40
81 —	85	.64		54.40
	201	.79		158.79
83	69	.99		68.39
87	110	1.37		150.70
91	157	.64		100.48
94	46	1.29		59.34
97	28	.90		25.20
	86	1.15		98.90
	55	1.31		72.05
100	101	.70		70.70
102	130	1.30		169.00
	52	.73		37.96
107	135	1.23		166.05
	26	.59		15.34
	31	.93		28.83
	20 | 1872 | 93.6			1846.13

144 av thickness per hole —

13 \| 1872
13
57
52
52

.9

1872 \| 1846.13

± 150' @ 1.00

$\frac{1200 \times 600 \times 150}{10}$ = 10,800,000 tons (means 11 cu ft per ton)

425
320

85000

1275

136000

126

110000

168

13

55

136
18

118

312000
46800

265200

16
5

80

80,00
16

160

8000

17

63

S-1.1

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

J. H. C.
APR 23 1962

April 10, 1962

MR. [illegible]
READ AND R[illegible]
PREPARE AN[illegible] HANDLE
FILE [illegible]

K. R.
APR 11 1962

Mr. T. A. Snedden, Manager
Southwestern Mining Department
American Smelting and Refining Company
813 Valley National Building
Tucson, Arizona

SILVER BELL UNIT
EL TIRO-IMPERIAL DRILLING

Dear Sir:

With reference to Mr. D. J. Pope's letter to you of March 30, 1962, on the El Tiro-Imperial ores, I am enclosing a memorandum by Charles Haynes with a map of the El Tiro-Imperial Area on which are sketched the possible outlines of two extensions, labeled El Tiro Extension A and El Tiro Extension B.

The development program at El Tiro is aimed at sulphide mineralization in sedimentary rocks, exposed and covered, in the area east of the existing El Tiro Pit. In the covered sediments, the non-sulphide content is relatively low, but in the exposed sediments, the non-sulphide is high and generally starts at the surface. The drilling must go through this oxidized zone to test for sulphide, mainly chalcopyrite, mineralization below. To my knowledge there is no well defined area where the oxidized zone would extend through the entire thickness of sediments.

The original recommendations for this area were based on finding sulphide ore but it was also recognized that a considerable tonnage of oxidized material would be developed at the same time. It was anticipated that this area would have a high waste to ore ratio and, if any method could be found to treat the oxidized material, the sulphide ore-body would be more attractive.

Our present drilling program is based on the idea of expanding from previously drilled holes with good intercepts of ore grade sulphides. The hole spotting is closely controlled by our Unit geologists with the advice of Mr. Richard and Mr. Courtright.

Very truly yours,

Original Signed By
D. R. JAMESON

D. R. JAMESON
Superintendent

DRJ/mj

Encls.

cc: DJPope w/encls.
KERichard
NWeiss

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

April 10, 1962

MEMORANDUM TO: Mr. D. R. Jameson, Superintendent

Subject: EL TIRO-IMPERIAL ORES.

The purpose of this memorandum is to show the ore body we are drilling at Silver Bell in the El Tiro-Imperial area and to clarify the sulfide-non-sulfide relationships as they occur in the different rock types. This is done to reply to Mr. Pope's letter to Mr. Snedden of March 30, 1962.

On the accompanying map are shown the El Tiro Extensions, A and B. The perimeters shown are not definite but only show the outlines as we think they will occur, based on the drilling to date. Future drilling and ore reserve calculations will define the areas more accurately.

The targets in the drilling are metamorphosed sediments, and the ore mineral is chalcopyrite. This differs from the El Tiro ore body that is a chalcocite ore lying in igneous rocks. Generally the igneous bodies in the extensions are barren of ore grade material.

The principal difference between the El Tiro Extensions A and B is of a geological nature. In the El Tiro Extension A the sediments are buried beneath a dacite sill. In the El Tiro Extension B the sediments are exposed on surface with a dacite of unknown thickness underlying them. To the northwest of the B area, dacite again occurs on the surface with the sediments extending for an unknown distance and depth beneath it. It should be noted that although two perimeters are shown, it is hoped that they can be joined and mined as one pit.

Another point is that we are drilling for a sulfide (Chalcopyrite) ore body, and the perimeters shown are based on actual sulfide intercepts, or, where not yet drilled, where sulfides are thought to occur. Due to leaching of the near surface rocks oxidation has occurred giving rise to non-sulfide values. Where this has occurred in igneous rocks it has been classified as material which is amenable to acid or heap leaching, mainly in the El Tiro Extension A. In Extension B the non-sulfides occur in surface exposed sediments and are not amenable to acid leaching. This is the material which has been called non-sulfide "ore" and on which a great deal of metallurgical test work has been done. It is not ore since a method has not yet been developed to commercially treat it at a profit. To date most of the drilling has been concentrated in the El Tiro Extension A and, since the sediments lie beneath the igneous rock, not much of the non-sulfide material has been found. However, now we are drilling in the Extension B area

and a substantial tonnage could be developed. The original geologic study showed this area to contain non-sulfides near the surface, but that sulfides occur below. Drilling so far has shown this to be true. Non-sulfides will probably continue to be found, but only in the routine searching for sulfides. We believe no area can be de-limited on the basis of non-sulfides unless it has already been drilled to show that sulfides do not occur beneath them.

Charles W. Haynes,
Resident Geologist

CWH/jca

Imperial Contract – Boyles Bros.

Prices revised Jan 1, 1962

		Hole Size			
		AX	BX	NX	NC
1 rig	0 – 500	$2.60	$2.90	$4.00	$5.00
	500 – 1000	3.60	3.80	4.90	
	1000 – 1500	4.60	4.90	5.60	
2 or 3 rigs		2.60	2.70	3.80	5.00
		3.50	3.70	4.70	
		4.50	4.70	5.40	
4 rigs		2.50	2.60	3.70	4.90
		3.40	3.60	4.60	
		4.40	4.60	5.30	

3.70
2.90
$6.60 ← Imperial

2.50
2.90
5.40 Mission

2.59
3.36
5.40
6.75

Reaming 16.00 per hr
Casing cementing, etc 10.60 per hr

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

September 12, 1961

MEMO FOR MR. T. A. SNEDDEN

EXPLORATION DRILLING
El Tiro-Imperial Area

Mr. Courtright and I spent a day at Silver Bell with Mr. Von Fay reviewing the results of drilling since we left in June. We looked over the sections which Mr. Haynes has been working on, and we went into other problems of the project with Von Fay in some detail. We did not have the opportunity to talk with Mr. Jameson but will do so as early as possible.

Von Fay's resignation is a considerable loss because of his thorough knowledge of all aspects of the program. It was my impression, though, that he did his best to get the important information on paper or convey it to us and to others conversationally.

Haynes has, in general, made good interpretations on the sections. They demonstrate that the deposit is particularly intricate in three respects: (1) The geology is complex from the standpoints both of geometry and character of some of the formations, particularly the breccias. (2) The ore mineralogy and distribution of copper within the various formations is erratic. (3) The metallurgy of various "ore" types is uncertain for one reason that tonnages of several possible metallurgical or commercial "ore" units are not yet defined by drilling.

These points are not new, but I have repeated them here because the problems involved now seem to be more complicated than when we were last in touch with them three months ago.

In addition to plotting current drilling there is a lot of other information still to be compiled on Haynes' sections. It is particularly important that the work on these sections be continued and Haynes should put his full time on this work. In most respects these sections should be considered as experimental working sections. I am sure that as information is gained, we will eventually learn that some of the formations and "ore" units will need to be changed. Von Fay's file memorandum of August 8, 1961, adequately presents the problem of "ore" types and suggests certain cut-off values. Mr. Courtright and I believe this might be simplified somewhat in regard to the data plotted on the sections; but we need to study the matter further, particularly in regard to metallurgy, before making any changes.

I do not believe it would be necessary or feasible to place a man, either from your group or from mine, to function exactly as Von Fay did. Rather, the setup should be as follows:

Memo for T. A. Snedden
Exploration Drilling -
El Tiro-Imperial Area

September 12, 1961

(1) Haynes should work entirely on the sections because of their importance and because it is not the kind of interpretive work which now could be turned over to anyone else. There probably will be occasions, however, when Haynes can use ordinary drafting assistance.

(2) Mr. Rice should continue to function as he has in the past, keeping close track of drilling performance and advising the contractors on such matters as casing, reaming, cementing, mud control, etc. However, as drill holes get deeper, some of these procedures are functions of the relative importance of gaining information at greater depth. In these cases, which we will define more carefully in discussions with Rice, Courtright or I should be contacted before some of these expensive procedures are begun in deeper holes.

(3) Mr. Anzalone has been doing much of the core logging in addition to his open pit mapping and other duties. Von Fay told me that he does this work well. He should continue to do all of the logging in the future. In addition he should telephone Mr. Courtright more-or-less daily and report informally on drilling results such as assays and geology. Also, before telephoning, he should check with Rice on the general drilling performance during each day and convey this information. Either Courtright or I will advise Anzalone as to the sequence of drill holes and as to their final depth. Of course, this will take into account any operating problems of which we are made aware.

Any one of these three men should feel free to contact either Courtright or me directly in regard to any unusual situation. In this connection Courtright or I will plan to keep in touch with the project by visiting Silver Bell frequently. Of course, in case neither of us can be reached, Mr. Jameson should handle any unusual circumstances.

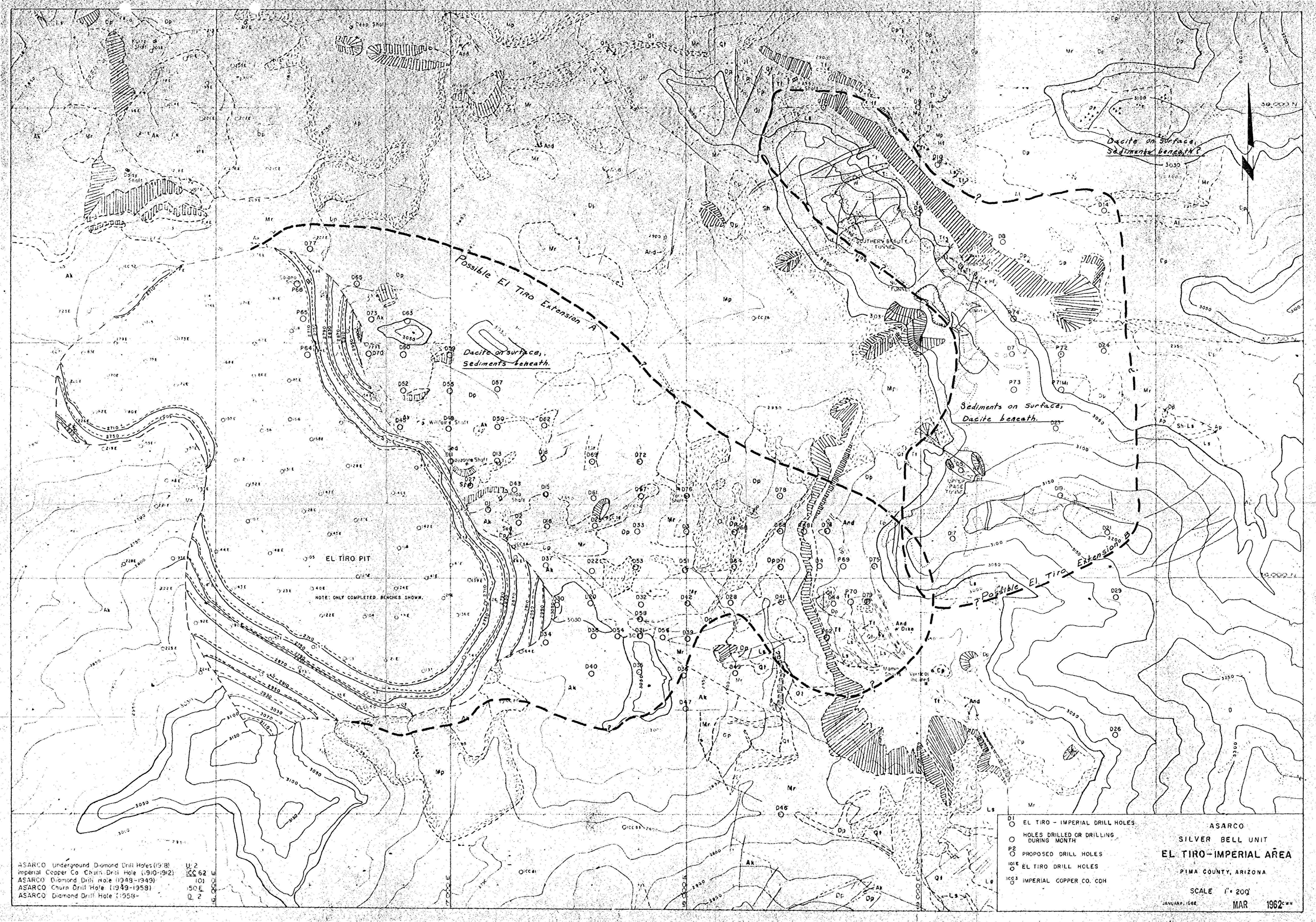
The exploration vehicle which Von Fay has been using should remain at Silver Bell. I am quite sure that it will be needed by Anzalone particularly, and also by the others.

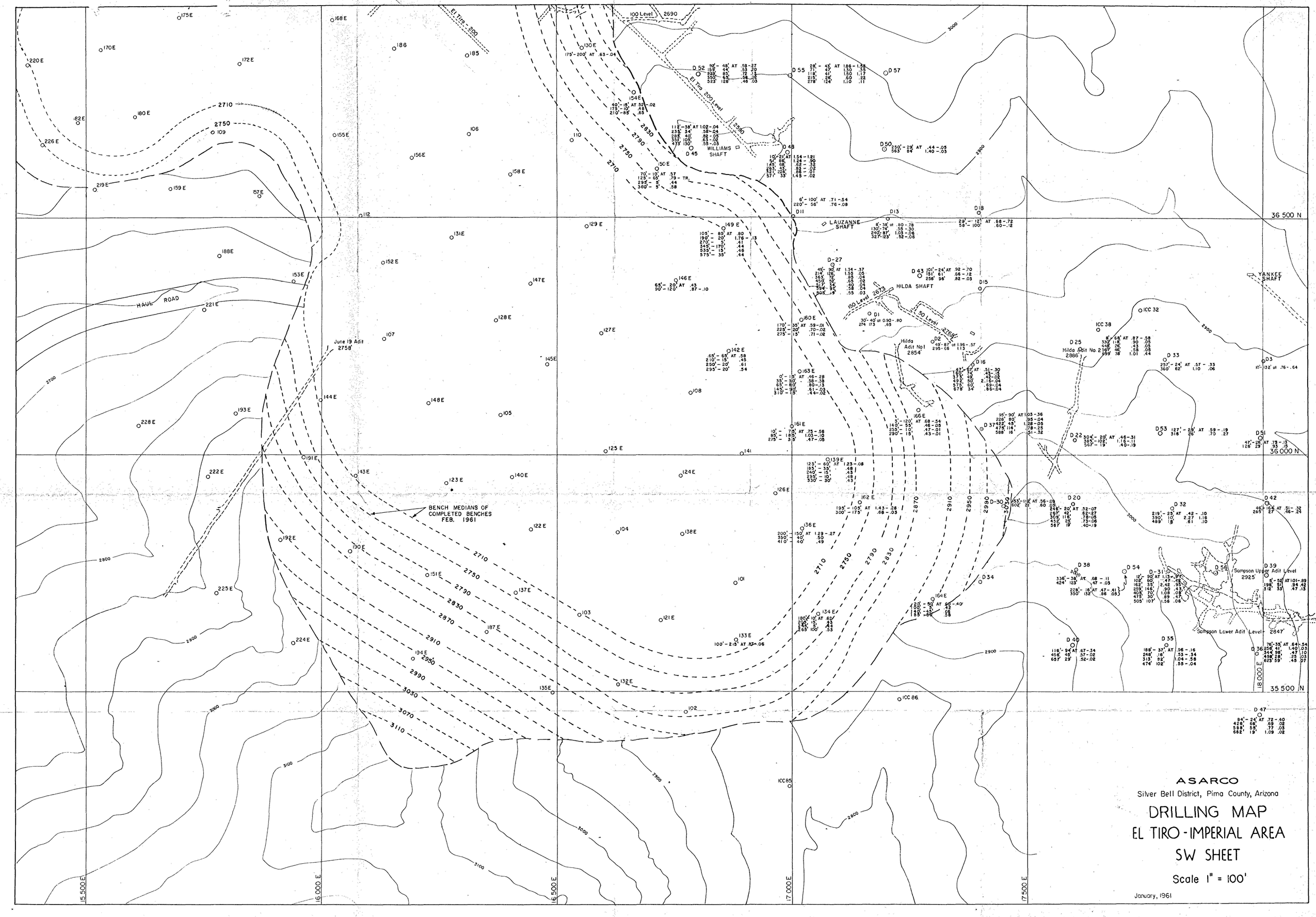
When at Silver Bell, Courtright and I saw the tracing of a drilling map, scale 1" = 100', covering the southwestern drilling area. This map showed ore lenses in all holes except a few of the more recent ones. By his copy of this memo Mr. Jameson is asked to have this tracing brought up to date and send four prints to me. Two of these prints I intend to forward to Mr. Pollock and Mr. Pope.

Original Signed by
K. Richard

KENYON RICHARD

KR/z
cc: CPPollock
DJPope
ACHall
JHCourtright
DRJameson


Possible El Tiro Extension A
Possible El Tiro Extension B
Dacite on surface, Sediments beneath.
Sediments on surface, Dacite beneath.
Dacite on surface, Sediments beneath?
EL TIRO PIT
NOTE: ONLY COMPLETED BENCHES SHOWN.
Deep Shaft
Kurz Shaft
Daisy Shaft
Wilson Shaft
Sonora Shaft
Wallace Shaft
Guazonna Shaft
Hilda Shaft
Tor Shaft
SOUTHERN BRANCH TUNNEL
NORTH TUNNEL
UPPER PACE TUNNEL
Mamin Shaft
Vertical inclined
And Dike
ASARCO Underground Diamond Drill Holes (1918) U 2
Imperial Copper Co Churn Drill Hole (1910-1912) ICC 62
ASARCO Diamond Drill Hole (1948-1949) 101
ASARCO Churn Drill Hole (1949-1958) 150E
ASARCO Diamond Drill Hole (1958- D 2
EL TIRO - IMPERIAL DRILL HOLES
HOLES DRILLED OR DRILLING DURING MONTH
PROPOSED DRILL HOLES
EL TIRO DRILL HOLES
IMPERIAL COPPER CO. CDH
ASARCO
SILVER BELL UNIT
EL TIRO-IMPERIAL AREA
PIMA COUNTY, ARIZONA
SCALE 1" = 200'
JANUARY, 1968
MAR 1962 CWH


ASARCO
Silver Bell District, Pima County, Arizona
DRILLING MAP
EL TIRO - IMPERIAL AREA
SW SHEET
Scale 1" = 100'
January, 1961
BENCH MEDIANS OF COMPLETED BENCHES FEB. 1961
HAUL ROAD
WILLIAMS SHAFT
LAUZANNE SHAFT
HILDA SHAFT
YANKEE SHAFT
100 Level 2690
El Tiro 200
El Tiro 200 Level
150 Level 2673
50 Level 2760
Hilda Adit No1 2854'
Hilda Adit No.2 2886'
June 19 Adit 2758'
Sampson Upper Adit Level 2925'
Sampson Lower Adit Level 2847'
36 500 N
36 000 N
35 500 N
15 500 E
16 000 E
16 500 E
17 000 E
17 500 E
18 000 E

45-113 5213

	Footage Drilled VH	H	M	S	VS	Total	Core Recovered VH	H	M	S	VS	Total
Per Cent Recovery												
All Conventional bits												
	1079.3	3127.8	1899.45	390.45	81.9	6578.9	957.04	2773.36	1441.99	268.49	40.23	5481.11
Percent Core Recovery							88.67	88.67	75.92	68.76	49.1	83.31
All Face Discharge bits												
	1.8	1596.5	299.85	80.11	119.3	660.7	1.72	144.65	274.19	66.45	83.79	555.08
Percent Core Recovery							95.56	90.60	91.44	82.95	70.23	84.01
Overall — All bits												
	1081.1	3287.45	2199.3	470.56	201.2	7239.6	958.76	2918.01	1716.19	334.94	124.02	6036.19
Percent Core Recovery							88.68	88.76	78.03	71.18	61.64	83.38

Combined S and VS

	Drilled	Recovered	
Face Discharge bit	199.43	150.24	85.33%
All Other bits	472.35	308.72	65.36%

45-113 5213

Bit Life

Face Discharge bits	29 bits @ 660.7'	22.78'/bit	Avg Cost/ft/bit $4.77	$108.66/bit 37% loss	
Adjusted	28 bits @ 653.0	23.32'/bit			
All Other bits	145 bits @ 6578.9'	45.37'/bit	Avg Cost/ft/bit $1.80	$81.57/bit 28% dia loss	
Adjusted	120 bits @ 5385.2'	44.88'/bit			
Impregnated bits	8 bits @ 308.8'	38.6'/bit			
Adjusted	5 bits @ 83.4	15.68'/bit			
Bits other than Face Discharge or Impregnated					
	136 bits @ 6270.1	46.10'/bit			
Adjusted	115 bits @ 5301.8	46.1'/bit			
Overall	174 bits @ 7239.6	41.61'/bit			
completion 12/15/60	7261.4				
Total depth all 15 holes	7393.6				
	154.0	132.2 = Rock bit		21.8'	

1.9

D15 →

F.R. # 109 & 110

CHARGE FOR LOSS

CONTRACT A.S.& R. Silver Bell 6-225

DATE	CUT-OUT	NO. & SIZE	TYPE	DESCRIPTION	REMARKS	SETTING	DIAMONDS	FEET /BIT	DIA. LOSS	TOTAL COST	FOOT-AGE	COST /FOOT
1-11-61	56931	1 BxCz	14846	4s		20.00	92.98	33	74%	112.98	33	3.42
"	"	1 "	28619	H		17.00	39.82	63	34%	56.82	63	.90
"	"	2 "	"	B		34.00	38.12	44	18%	72.12	88	.82
"	"	1NxCz	29094	BEH.		21.00	49.58	31	27%	70.58	31	2.28
"	"	1 "	14301	4s		25.00	32.44	40	18%	57.44	40	1.44
"	"	1 "	26555	A-EH		25.00	42.95	37	18%	67.95	37	1.84
"	"	2 "	27946	H		42.00	76.92	72	19%	118.92	145	.82
"	"	7 "	28486	B		119.00	230.98	55	19%	349.98	390	.90
"	"	1NCD	28156	H		35.00	122.94	56	40%	157.94	56	2.82
"	"	5 "	28550	B-		175.00	101.40	35	7%	276.40	178	1.55
"	"	1NCBW	14854	4s	12' Ream	30.00	44.41	—	25%	74.41	—	—
										1415.54	1061	1.34
				Totals -	6707 Ft. @ $2.01							
				$13,480.56								

BOYLES BROS. DRILLING CO.

CONTRACT 6-225 A. S. & R. Silver Bell MONTH Start of Job thru Dec. 31, 96

	COSTS					PER FOOT				
	DEC. THIS MONTH	NOV. LAST MONTH	YEAR TO DATE	~~PRIOR YEARS~~ per ft.	TOTAL COST	THIS MONTH	LAST MONTH	THIS YEAR	PRIOR YEARS	TOTAL COST
LABOR	5043 40	4086 25	20,800 29	$2.54						
SUPPLIES	2080 94	1931 06	8,048 50	.98						
DIAMONDS	4226 50	3777 10	17,545 86	$2.01 2.14						
RENTALS— Company Equipment	1319 00	1162 00	5540 00	.68						
RENTALS—OTHER	30 00	60 00	245 00	.03						
REPAIRS - MAINTENANCE	419 18	334 62	[illegible]	.22						
SERVICES PURCHASED	18 22	11 91	117 64	.01						
TRAVEL, Fat., & Mob.	470 24	335 91	2158 40	.26						
TAXES P.R. and W.Comp	506 30	410 54	2193 74	.27						
GROUP INS. - VAC. PAY	113 56	82 01	463 71	.06						
ALL OTHER	327 62	334 58	1256 49	.15						
TOTAL DIRECT COST	14555 36	12590 99	60166 52	7.34						
ADMINISTRATION	1311 28	1076 63	4765 14	.58						
TOTAL EXPENSE	15866 64	13667 62	64931 66	7.92						
CONTRACT INCOME	13036 03	12527 51	58381 36	7.12						
PROFIT OR LOSS	(2830 61)	(1140 11)	(6550 30)	.80						
FOOTAGE	1975	1765	8197							
DR. SHIFTS	114	77	417							

192
417 | 8199
417
4029
3153
876

Christensen Diamond Products Company

DIAMOND BITS & CORE BARRELS

MAIL: P. O. BOX 387

1937 SOUTH SECOND WEST STREET — TELEPHONE HUNTER 4-5231 — SALT LAKE CITY 10, UTAH — U. S. A.

CABLE ADDRESS: CHRISDIACO

January 4, 1961

Mr. J. E. Roberts
Boyles Bros. Drilling Co.
1016 East Minnezona Avenue
Phoenix, Arizona

Dear Joe,

I thought it best to drop you a line and bring you up to date on the cost of drilling with the face discharge bits used at A.S. & R. Silver Bell #6-225.

NO.	SIZE	TYPE	DESCRIPTION	AVG. FTG.	COST PER FT.
1	NCD	28156	H-Mat, 6 Ports, H-25, Step Crown	10	$ 13.84
3	NX C2	27468	H-Mat, 6 Ports, H-25, Step Crown	23	5.85
2	NX C2	26438	H-Mat, 6 Ports, A-15, Step Crown	25	5.47
12	NX C2	28886	H-Mat, 6 Ports, H-25, W-Crown	28	5.05
1	NX C2	28933	EH-Mat, 6 Ports, H-25, Step Crown	8	11.95
3	BX C2	28981	H-Mat, 6 Ports, H-25, W-Crown	5	11.29
2	BX C2	14930	H-Mat, 6 Ports, A-15, Step Crown	69	1.40

Overall Cost Per Ft. $ 4.77

When the above bits are deducted from the contract totals the cost per foot lowers from $ 2.14 to $ 1.80. This figure is still high and it includes some 312 feet of ream at a cost of $ 1104.41.

If you have any questions on the above information do not hesitate to drop me a line. I will be sending you some contract close-outs very shortly so you will be able to make your files complete.

Sincerely

CHRISTENSEN DIAMOND PRODUCTS CO.

Jack C. Norris

JCN/lj
CC: Mr. Paul Park

CHARGE FOR LOSS

CONTRACT A S + R Silver Bell 6-225

DATE	CUT-OUT	NO. & SIZE	TYPE	DESCRIPTION	REMARKS	SETTING	DIAMONDS	FEET /BIT	DIA. LOSS	TOTAL COST	FOOT-AGE	COST /FOOT
11-7-60	56188	5BXC2	28619	/ A		85.00	466.51	13	68%	551.51	66	8.36
"	"	5NXC2	28486	✓ B		105.00	87.30	36	10%	192.30	184	1.05
"	"	1 "	"	/ B		21.00	126.78	21	74%	147.78	21	7.04
"	"	3 "	"	/ H		63.00	156.95	107	26%	219.95	321	.69
11-60	56339	2AXC2	27084	A		27.00	94.20	17	55%	121.20	34	3.56
"	"	2BXC2	28981	✓ H		34.00	77.07	6	34%	111.07	13	8.54
"	"	1 "	"	/ H		[illegible]	63.72	[illegible]	[illegible]	80.92	4	20.23
"	"	11NXC2	28486	/ B		231.00	563.53	31	19%	[illegible]	945	1.72
"	"	1 "	"	✓ B		21.00	45.27	25	64%	66.27	45	3.67
		41 Bits				448.00	6071.31			10,519.31	[illegible]	2.379
12-22-60	56723	4BXC2	28619	✓ B		68.00	107.50	44	26%	175.50	175	1.00
"	"	13 "	28486	/ B		221.00	540.65	73	24%	761.65	957	.80
"	"	3NXC2	"	/ B		63.00	253.65	31	49%	316.65	94	3.37
"	"	2NCBW	14854	/ H 47'	REAMING	60.00	[illegible]	—	41%	204.14	—	—
"	"	1NXCS	28536	/ B		25.00	62.77	59	51%	87.77	59	1.49
						2885.00	9180.02			12,065.02	5646	2.136

CHARGE FOR LOSS

CONTRACT A S & R SILVER BELL 6-225 272.00 - 1981.70 2253.70 - 1548 - 1.228

DATE	CUT-OUT	NO. & SIZE	TYPE	DESCRIPTION	REMARKS	SETTING	DIAMONDS	FEET /BIT	DIA. LOSS	TOTAL COST	FOOT-AGE	COST /FOOT
[illegible]	55028	1 NXC2	28628	1 H		25.00	41.34	90	19%	66.34	90	.74
"	"	1 "	26076	1 H		25.00	87.73	67	51%	112.73	67	1.68
"	"	1 "	28486	1 B		21.00	138.44	57	79%	159.44	57	2.80
"	"	1 "	26983	1 A		21.00	161.02	21	69%	182.02	21	8.67
"	"	1 "	26555	1 A		25.00	43.64	42	18%	68.64	42	1.63
"	"	2 NCD	28623	1 H		70.00	137.85	64	18%	207.85	133	1.56
[illegible]	55059	1 NXC2	28486	1 B		21.00	74.58	82	43%	95.58	82	1.17
"	"	1 "	26983	1 H		21.00	33.00	64	16%	54.00	64	.85
"	"	1 "	"	1 A		21.00	37.[illegible]	60	16%	58.[illegible]	60	.97
8-15-61	55280	1 "	[illegible]	1 B		21.00	33.[illegible]	27	19%	54.17	27	2.01
"	"	2 "	"	1 H		157.00	326.11	55	24%	483.11	388	1.25
"	"	1 "	26496	1 A		21.00	55.92	24	27%	76.92	24	3.[illegible]
"	"	1 "	"	1 H		21.00	[illegible]	27	[illegible]	102.23	27	3.79
"	"	1 NCD	28623	1 H		55.00	72.31	47	18%	127.31	47	2.28
"	"	2 "	28550	1 A		70.00	69.97	39	23%	139.97	79	1.77
"	"	1 "	28152	1 H		35.00	103.42	10	33%	138.42	10	13.84
8-16-61	55279	2 NXC2	28486	1 H		42.00	100.48	54	25%	142.48	108	1.32
"	"	3 "	"	1 B		63.00	76.72	30	15%	139.72	92	1.52
"	"	1 "	"	1 B		21.00	60.27	64	36%	81.27	64	1.27
"	"	1 "	26555	1 A		21.00	64.07	24	27%	85.07	24	3.54
"	"	1 "	28628	1 H		25.00	72.37	42	33%	97.37	42	2.32
8-25-61	55355	1 "	27468	1 H		21.00	68.14	58	32%	89.14	58	1.54
"	"	1 "	26555	1 A		25.00	43.85	28	18%	68.85	28	2.46
"	"	1 "	28486	1 H		21.00	17.36	52	8%	38.36	52	.74
"	"	1 "	"	1 H		21.00	50.24	40	25%	71.24	40	1.78
						860.00	2161.29			3021.29		1.[illegible]

CHARGE FOR LOSS

CONTRACT A.S.&R. SILVER BELL 6-225 1411.00 - 4716.00 6127.00 - 2758 - 2.221

DATE	CUT-OUT	NO. & SIZE	TYPE	DESCRIPTION	REMARKS	SETTING	DIAMONDS	FEET /BIT	DIA. LOSS	TOTAL COST	FOOT-AGE	COST /FOOT
			(36 Bits, 48' Avg. 28% Loss)									
9-13-60	55464	1BXC2	14930	A		17.00	60.59	93	24%	77.59	93	.83
"	"	1NXC2	26555	A		25.00	57.82	42	24%	82.82	42	1.97
"	"	1 "	28886	H		21.00	63.28	78	34%	84.28	78	1.08
"	"	1 "	28486	H		21.00	34.08	55	17%	55.08	55	1.00
"	"	1 "	"	H		21.00	120.83	24	63%	141.83	24	5.91
9-22-60	55769	4BXC2	27150			68.00	75.78	34	16%	143.78	137	1.05
"	"	1 "	"	H		17.00	35.70	38	32%	52.70	38	1.39
"	"	3 "	"	H		51.00	297.71	30	88%	348.71	92	3.79
"	"	1NXC2	28886	H		21.00	104.10	7	57%	125.10	7	17.87
"	"	5 "		H		105.00	182.15	34	97%	287.15	122	8.09
"	"	1 "	26096	H		25.00	99.17	10	53%	124.17	10	12.42
"	55488	1BXC2	14930	H		17.00	98.39	45	48%	115.39	45	2.56
"	"	1NXC2	28486	H		21.00	31.62	113	16%	52.62	113	.47
"	"	1 "	"	H		21.00	65.56	32	34%	86.56	32	2.71
"	"	2NXC2Pilot	27468	H		37.00	289.34	13	68%	326.34	27	12.09
"	"	3NXC2	28886	H		63.00	238.59	39	44%	301.59	117	2.58
9-23-60	55671	1BXC2	27150	A		17.00	139.49	101	79%	156.49	101	1.55
"	"	1BXCS	28863	B 13'	REAMING	20.00	61.26	—	68%	81.26	—	—
"	"	2NXC2	28886	H 1-00	FOOTAGE	42.00	176.25	8	49%	218.25	16	13.64
"	"	3NCBW	14854	H	204' REAMING	90.00	334.80	—	68%	424.80	—	—
"	"	2 "	7902	B	48' "	50.00	344.21	—	88%	394.21	—	—
		36 Bits		57% Loss.		1630.00	5772.01			7402.01	2875	2.574
10-4-60	55956	1NXC2	28933	H		25.00	70.57	8	34%	95.57	8	11.95
"	"	9 "	28486	H		189.00	647.30	56	35%	836.30	504	1.66
						1844.00	6489.88			8333.88	3387	2.460

JHC

3

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

March 14, 1961

CONFIDENTIAL

FILE MEMORANDUM

EL TIRO - IMPERIAL AREAS
Silver Bell - Drilling

At the present rate of drilling with two rigs, several years will elapse before (1) delineation by drilling, (2) metallurgical experimentation, (3) mining layout, and (4) ore estimation all can be completed.

The following is not written as a proposal; rather it is a recordation of some opinions held by Mr. Von Fay, Mr. Courtright and myself, so that those receiving copies can be aware of the situation.

The results of the first 23 holes in this project have been generally encouraging. A few holes have been disappointing, but almost all holes have encountered lenses of sulphide ore. Altogether, 26 intercepts (excluding several thin intercepts), or a total of 2038' of clean sulphide ore, average 78' in thickness and .96% Cu. Some of these intercepts are deep and low grade, and it is uncertain now which ones will be accessible to open pit mining. This will be dependent upon results in interspaced and surrounding holes. If a few of these interspaced holes encounter material of better-than-average grade here and there, many of the deep, low grade ore lenses will be mineable.

Most drillholes have intercepts of oxidized material of ore grade. 19 intercepts, or total of 1399', average 74' in thickness and .69% total Cu. Preliminary metallurgical tests seem to indicate that at least some of this material may have commercial value. Ultimately these mineralized zones, both oxidized and sulphide, will have to be drilled on unusually close centers for measurement of ore lenses. We can now see a minimum of 3 years of drilling at the present rate to measure completely the presently indicated ore blocks within the entire favorable area. It is conceivable that as much as 5 years will be required to do this at the present rate.

Due to the erratic distribution of copper within the mineralized zones, and to the probable complexity of relating laboratory metallurgical tests to the types and quantities of oxidized ore in place, the estimation of ore reserves related to mining plans will be an unusually complicated matter. This easily could require a couple of years of office work after all of the measurement drilling is completed.

At the present rate of drilling, therefore, somewhere between 4 and 7 years would be required for complete ore estimation and mining layout. More drills should be used if at any time it can be foreseen that the final information will be needed sooner.

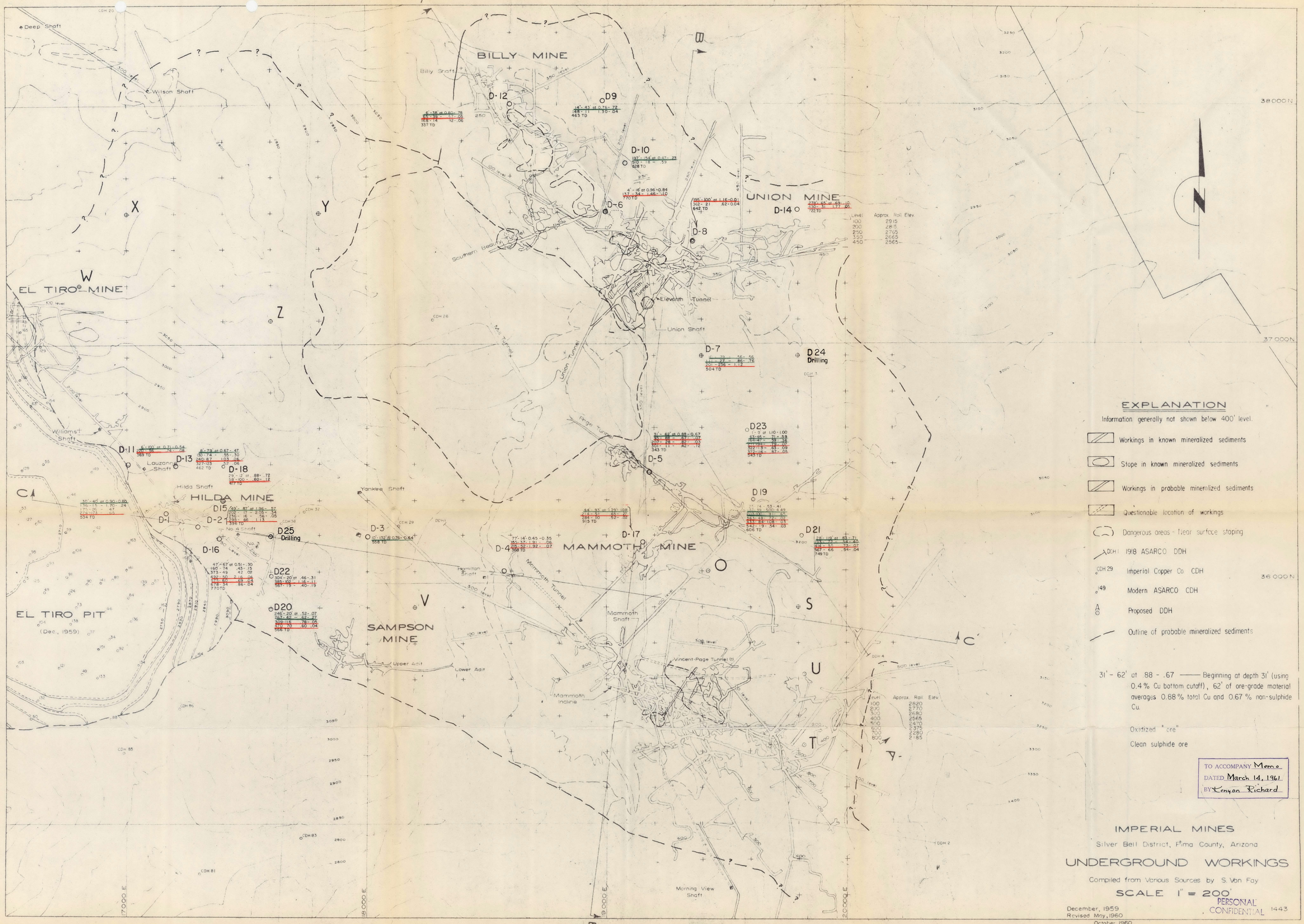
Of course that portion of the area lying along the immediate east and northeast edge of the El Tiro pit can be treated separately and sooner, in the matter of ore estimation and engineering planning. One of the two drills currently is being confined to that area beside the pit, and this will be continued. However, it will be a year before there will be enough drillhole information to permit much engineering study in that area.

As being of general interest, an up to date drilling map is attached.

Kenyon Richard
KENYON RICHARD

Attachment - Map
KR/ds
cc, w/att, all Confidential:

CPPollock
DJPope
TASnedden
ACHall
DRJameson
WCWaidler
CWHaynes
JNCourtright
SVonFay


BILLY MINE
UNION MINE
EL TIRO MINE
HILDA MINE
MAMMOTH MINE
SAMPSON MINE
EL TIRO PIT
(Dec., 1959)
Deep Shaft
Wilson Shaft
Billy Shaft
Eleventh Tunnel
Union Shaft
Union Tunnel
Mil Tunnel
Forge Tunnel
Williams Shaft
Lauzanne Shaft
Hilda Shaft
Yankee Shaft
No. 4 Shaft
Hamilton Shaft
Mammoth Tunnel
Mammoth Shaft
Vincent-Page Tunnel (?)
Mammoth Incline
Upper Adit
Lower Adit
Morning View Shaft
Southern Belle Vein
D-12
D9
D-10
D-6
D-8
D-14
D-7
D24 Drilling
D23
D-5
D19
D-17
D21
D-3
D-4
D-1
D-2
D-16
D25 Drilling
D22
D20
D-11
D-13
D-18
D15
38000N
37000N
36000N
17000E
18000E
19000E
20000E
EXPLANATION
Information generally not shown below 400' level.
Workings in known mineralized sediments
Stope in known mineralized sediments
Workings in probable mineralized sediments
Questionable location of workings
Dangerous areas - Near surface stoping
DDH 1 1918 ASARCO DDH
CDH 29 Imperial Copper Co. CDH
49 Modern ASARCO CDH
A 6 Proposed DDH
Outline of probable mineralized sediments
31' - 62' at .88 - .67 —— Beginning at depth 31' (using 0.4 % Cu bottom cutoff), 62' of ore-grade material averages 0.88 % total Cu and 0.67 % non-sulphide Cu.
Oxidized "ore"
Clean sulphide ore
TO ACCOMPANY Memo
DATED March 14, 1961
BY Kenyon Richard
IMPERIAL MINES
Silver Bell District, Pima County, Arizona
UNDERGROUND WORKINGS
Compiled from Various Sources by S. Von Fay
SCALE 1" = 200'
December, 1959
Revised May, 1960
October, 1960
January, 1961
March, 1961
PERSONAL CONFIDENTIAL
1443

Notes on Chase Report - Imperial

Holes 1 to 31 incl
Southern Beauty + chase adits

Ore types

1. Sulphide, both cc + cpy
2. Sedimentary oxide - calcareous gangue
3. Igneous oxide - low lime, aluminous silicat gangue

Moly composite of 31 holes - .023 % MoS_2

Type 1 - Excellent recov. of cpy - may justify lower cutoff.

Type 2 - Variable results in flotation of oxide - good recov of carbonate - but poor conc grade -
Banner caustic leach may be applicable - (NaOH)
but this process not yet ~~tried~~ proven on pilot plant scale
Ammonia leach considered more promising

Type 3 - Heap or agitation leach can be used - however
Recommends hydro metallurgical plant - crushing, grinding at El Tiro add acid and pipe slurry to plant site east of tailings pond - recovery of "solubilized" copper by ion exchange - produce cement copper then recovery of sulphide copper by flotation
Estimates 80 ¢ ton operating profit on .5 % ore

Tailings - @ 15 ¢ per lb of acid (produced by acid plant using elemental sulphur) - and 30 ¢ cu - tailings .22 % cu - cost per lb cu produced = 21 ¢
profit per ton tails = 20 ¢

recovery of "oxidized" copper then rec. of sulphide by flotation

mos

Banner Caustic leach

overall extraction of Helvetia ore reported to be 80% to 90%

17% NaOH leach of minus 10 mesh ore @ 175°F (80°C) in rotating drum

- contact time for sands 6 hrs
- slimes — minutes

Caustic consump. for 2.5 lbs NaOH/ton or 8¢ per ton

filtration — preg sol to electrolytic cell — product is CuO at 80% Cu —

99% Cu produced by furnace

Ammonia leach O_2 recovery copper

Sodium

Leached and discharged sands are further ground and subjected to flotation in alkaline circuit for recovery of sulphide cu + some oxide —

JHC S-7.7 14 (142)

J. H. C.
FEB 17 1961

February 16, 1961

Mr. P. A. Park
Assistant Manager, Drilling Division
Boyles Bros. Drilling Company
1624 Pioneer Road
Salt Lake City, Utah

BOYLES DRILLING CONTRACT
El Tiro-Imperial Area
Silver Bell, Arizona

Dear Sir:

On January 17 you and Mr. Roberts met with Mr. Courtright, Mr. Von Fay and me to discuss the performance and costs of your company under its drilling contract at the subject locality. You gave us figures indicating you have had a loss of $.80/ft. for 8199' of drilling, attributing this to bit cost of $2.14/ft. in contrast to your original estimate of $1.10/ft. for this item. You suggested that in the future this Company compensate you for bit costs in excess of $1.25/ft. Since then we have considered the matter carefully and have compiled some figures of our own relating to your drilling performance. Mr. Smedden and Mr. Jameson agree that we should make the following corrective proposal.

The rates paid you per foot of hole drilled under the present contract (June 6, 1960) for two rigs, operating two shifts each per day are as follows:

	AX	BX	NX	NC
0 to 500 ft.	$4.60	$4.70	$5.80	$7.00
500 to 1000 ft.	5.50	5.70	6.70	
1000 to 1500 ft.	6.50	6.70	7.40	

We now propose a "base" rate plus a bonus tied to core recovery. This base would be obtained by subtracting $1.60 from each of the above figures. These new base rates then would be as follows:

	AX	BX	NX	NC
0 to 500 ft.	$3.00	$3.10	$4.20	$5.40
500 to 1000 ft.	3.90	4.10	5.10	
1000 to 1500 ft.	4.90	5.10	5.80	

(In the event that more than two drill rigs were to be used on this job, the base rates would be similarly adjusted.)

In addition to the base rate, you would be paid a bonus of $3.00 per foot of core recovered. For example, in the category of NX size, depth 0 - 500', under the existing contract you would receive a total of $5.80 per foot of hole drilled. Under the present proposal you would receive $4.20 as a base rate, plus $2.70 as a bonus, assuming your core recovery were to be 90%. Thus, you would be paid a total of $6.90 per foot of hole drilled, assuming there were no core runs of less than 50% recovery, as will be explained below.

The footage of core recovery would be determined by us. We would use our present method of weighing all the core recovered from each run, making a specific gravity measurement by water immersion of a representative piece of core from each run, and computing the percentage and footage of recovery. As a means of detecting mechanical or arithmetical errors, a lineal measurement of the core would also be made by us.

The occasional core runs of low (or no) recovery are particularly damaging to the usefulness to us of the drilling information as a whole. Therefore, in the case of any individual coring run in which core recovery is less than 50%, you would be paid only the base rate for footage drilled. You would receive no bonus for the core in that run. In this connection, it is acknowledged that "vuggy" ground -- that is, open cavities of a few inches or even one or two feet, -- are encountered in rare instances. In case of legitimate vuggy ground where core recovery is less than 50%, you would be allowed the full bonus of $3.00 per foot of hole drilled. These situations would be adjudged by our geologist representative after study of all facts.

We wish to encourage you in employing all measures to insure the best core recovery. For example, your recent action to obtain expert advice on the quality and conditioning of the drilling mud is commendable. This appears to have resulted in improved core recovery as well, probably, as lower costs for you. The use of the face discharge bit also improves core recovery and we would like for you to continue experimentation with this type of bit. In this connection, the following figures compiled from our records should be of interest to you:

Core Recovery Related to Bit Type

FACE DISCHARGE BITS

Rock Hardness	VH	H	M	S	VS	Total
Footage drilled	1.7	144.6	274.2	66.4	85.8	555.1
Core Recovery, %	95.5	90.6	91.4*	82.9*	70.2*	84.0

CONVENTIONAL BITS

Rock Hardness	VH	H	M	S	VS	TOTAL
Footage drilled	957.0	2773.4	1442.0	268.5	40.2	5481.1
Core recovery, %	88.7	88.7	75.9*	68.8*	49.1*	83.3

*Significant comparisons

As you of course know, figures such as the above are not subject to precise derivation, but at least they are indicative of the effectiveness of the face discharge bit. In the future we may in some cases be able to advise you ahead of time where there will be intercepts of soft ground amenable to the face discharge bit.

It is suggested that, after you have drilled for an additional five months from February 1, 1961, we should confer again about your costs and performance and possibly make further revisions in rates or payment procedures at that time.

This proposal would be effective February 1, 1961 and would be a supplement to the existing contract.

If your company is in agreement with this proposal, please advise us so that we can draw up the necessary supplemental agreement.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
Att: 3 copies
cc: Joe Roberts
bc: TASnedden
KvdSteinen
DRJameson
JHCourtright
SVFay

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

February 3, 1961

MEMORANDUM FOR T. A. SNEDDEN

BOYLES DRILLING CONTRACT
Imperial Area, Silver Bell

On January 17, 1961, Roberts and Parks came in to discuss Boyles drilling costs for the first 15 holes in the Imperial area. According to their records Boyles incurred a loss of $6550.30, or $.80 per ft. for 8199 ft. of hole (see cost breakdown sheet attached). This deficit, they pointed out, was not due to poor progress as the average advance per shift was 19.2 ft., but due entirely to their bit costs which amounted to $2.14 per ft., or about $1.00 per ft. more than they had estimated in their bid on the job. The data on various types of bits used showed that the diamond loss for the face discharge type was in part responsible for the high average bit cost (face discharge bit cost for 626 ft. of drilling: $4.77 per ft.). Their proposal was that the contract be continued at the existing prices per foot, but with the provision that Boyles be compensated for bit costs in excess of $1.25 per foot.

An analysis of our data (see attachment) shows that in medium and soft ground substantially higher core recoveries were obtained with the face discharge bit as compared to those obtained with the conventional type. Therefore, continued use of the face discharge type is essential. The softer, more difficult coring ground constitutes only 10 to 15% of the total footage drilled so far.

It is believed apparent that some upward revision of the contract price is justified, but it should be in the form of an increase in the price per foot, rather than a cost plus arrangement for diamond loss, thereby keeping the responsibility of improving bit life on the contractor.

It is proposed that the contractor be offered the following:

Increase in price per foot of drilling $ .75
Plus $2.00 per foot of drilling with face discharge bits.

Assuming 10% of the drilling is with the face discharge type, the overall average increase would amount to $.95 per foot. The use of the face discharge bits would be at our specification.

Rates per foot of drilling under the existing contract (June 6, 1960) for two rigs operating two shifts each per day are as follows:

	AX	BX	NX	NC
0 to 500 ft.	$4.60	$4.70	$5.80	$7.00
500 to 1000 ft.	5.50	5.70	6.70	
1000 to 1500 ft.	6.50	6.70	7.40	

Original signed by
J. H. Courtright
J. H. COURTRIGHT

Attachment
JHC/ds

cc: KERichard
DRJameson
SVon Fay

BOYLES BROS. DRILLING CO.

CONTRACT 6-225 A.S.&R. - Silver Bell MONTH Start of Job thru Dec 31

	COSTS					PER FOOT				
	Dec. THIS MONTH	Nov. LAST MONTH	YEAR TO DATE	~~PRIOR~~ Per ft.	TOTAL COST	THIS MONTH	LAST MONTH	THIS YEAR	PRIOR YEARS	TOTAL COST
LABOR	5043 40	4096 35	40700 79	2.54						
SUPPLIES	2020 94	1931 06	8040 50	.98						
DIAMONDS	4226 50	3772 10	12545 86	2.14						
RENTALS Company Equipment	1319 00	1620 00	5540 00	.68						
RENTALS OTHER	50 00	50 00	245 00	.03						
REPAIRS MAINTENANCE	419 18	554 62	1[illegible] 37	.22						
SERVICES PURCHASED	13 22	11 41	117 64	.01						
TRAVEL Fat, & Mob.	470 24	2 591	2198 00	.26						
WAGES P.R. and W.Comp	506 70	410 54	2193 74	.27						
FRINGE BENEFITS - VAC PAY	112 56	78 21	483 71	.06						
OTHER	227 62	264 58	1256 79	.15						
TOTAL DIRECT COST	14555 36	12580 99	40146 52	7.34						
ADMINISTRATION	1311 28	1076 63	4765 14	.58						
TOTAL EXPENSE	15866 64	13657 62	64931 66	7.92						
CONTRACT INCOME	13456 02	12507 51	58391 36	7.12						
GROSS PROFIT LOSS	(2410 62)	(1140 11)	(6540 30)	- .80						
FOOTAGE	1975	1365	8191							
DAYS WORKED										

DIAMOND DRILL DATA - IMPERIAL
(Holes 1 - 15 Inclusive)

February, 1961

	Number	Footage	Foot per Bit	Average Bit Cost per Ft.	Diamond-Loss
Face discharge bits	28	653	23.32	$4.77	37%
All other bits	145	6579	45.37	1.80	28%

Core Recovery Related to Bit Type

FACE DISCHARGE BITS

Rock Hardness	VH	H	M	S	VS	Total
Footage Drilled	1.7	144.6	274.2	66.4	85.8	555.1
Core Recovery	95.5	90.6	91.4	82.9	70.2	84.0

CONVENTIONAL BITS

Rock Hardness	VH	H	M	S	VS	Total
Footage Drilled	957.0	2773.4	1442.0	268.5	40.2	5481.1
Core Recovery	88.7	88.7	75.9	68.8	49.1	83.3

ABBREVIATIONS

Used on El Tiro-Imperial
and Mission Drill Logs

Rock Types

Al	Alluvium
Ccg	Caliche Conglomerate
Sed	Sedimentary
Arg	Argillite
S-Arg	Sandy Argillite
C-Arg	Calcareous Argillite
Ark	Arkose
Qtzt, Qt	- Quartzite
Cgl	Conglomerate
Ls	Limestone
Ss	Sandstone
Sh	Shale
Sltst	Siltstone
Met	Metamorphic
Mb	Marble
Tac, Tt	- Tactite
DHF	Diopside Hornfels
AHf	Actinolite Hornfels
Hf	Hornfels
Volc	Volcanic
Ig	Igneous
Dior	Diorite
Gb	Gabbro
Ap	Andesite porphyry
An	Andesite (post mineral)
Mz	Monzonite porphyry
Ak	Alaskite
Da	Dacite
Dp	Dacite porphyry
Mp	Metaporphyry
Fp	Felsite porphyry
Fr	Feldspathized rock
Qf	Quartz feldspar rock

Formations

Pif	Pima formation
Pgf	Papago formation
Kf	Kino formation

Structures

BR	Bedrock
frac	fracture
vlt	veinlet
vn	vein
gg	gouge
bx	breccia
flt	fault
peb	pebble
diss	disseminated
ct, cnt	- contact
mtx	matrix
br	broken
sh	shear (ing) (ed)
jt	joint
por	porphyritic
fr, frag	- fragment
bd, bed	- bedding, bedded

Minerals

Cup	Cuprite
CuSi	Chrysocolla
CuOx	Copper oxide
CuCo3	Malachite Azurite
Nat Cu	Native Copper
Suls	Sulphides
Cpy	Chalcopyrite
Cc	Chalcocite
Bn	Bornite
Cov	Covellite
Lim	Limonite
LLm	Live Limonite
Py	Pyrite
Hem	Hematite
Mag	Magnetite
Spec	Specularite
Sph	Sphalerite
Gal	Galena
Moly	Molybdenite

ABBREVIATIONS - Continued

Minerals - continued

Fl	Fluorite
Gar	Garnet
Feld	Feldspar
Qtz	Quartz
Biot	Biotite
Chl	Chlorite
Serp	Serpentine
Ep	Epidote
Act	Actinolite-tremolite
Diop	Diopside
Asb	Asbestos (asbestiform)
Wol	Wollastonite
Cal	Calcite
CO3	Carbonate
WO3	Tungstate
CaSiO3	Lime Silicates
Bar	Barite
Gyp	Gypsum
Smiths	Smithsonite
Calc	Calcareous
Si	Silica

Others

hor	horizontal
vert	vertical
sp	sparse
sc	scarce
r	rare
tr	trace
abun	abundant
num	numarous
sct	scattered
st	strong
mod	moderate
wk	weak
v	very
silf	silicified
sil	siliceous
cs	coarse
fg	fine-grained
mg	medium-grained
cg	coarse-grained
sd	sandy
slty	silty
PM	post mineral
min	mineral
xtl	crystal
rext	recrystallized
RB	Rock Bit
RoBit	Rotary Bit
trans	transitional
poss	possible
pat	patches
alt	altered, alteration
dk	dark
lt	light
blk, bl	- black
wht, wh	- white
gr	gray
brn	brown
pk	pink
grn	green
yel	yellow

To Dec 31, 1961 - 7 yrs 8 mo. - Gross 82 million
Net 42 "
After deprec. depl 30 "

August 22, 1960

SILVER BELL

January 1, 1960 Reserves and Production

Prod. '53 to '60	Oxide	12 mil at	.99
	El Tiro	4 mil at	.73
		16 mil at	.92
	Leach	8 mil at	.37
Reserves - Oxide and El Tiro		23 mil at	.89

July 1960 Report

	1959	1960 (to date)
Concentrate		
Payable Cu	36,702,365 lbs	-
Ore breaking	1.641¢/lb	1.379
Stripping	.637	.618
Development	-	.011
Milling	5.577	5.254
Indirect	4.239	4.179 - ± 60¢ per ton
Fr., Smelt, etc.	6.191	6.523
Sub total	18.285	17.964
NY administration	.413	.502
Dep'n, Dep'l	4.323	3.823
Other income exp.	.136	.073
MoS2 conc. income	.958	.535
Cost	21.927	21.681 ¢ per lb. Cu
Precipitate		
Payable Cu	252,657	1,202,855
Direct		10.391 ¢/lb.
Indirect		2.458
Frt. Smlt., etc.		4.952
	15.730	17.801
Dep'n.	.680	.845
Cost per lb.	16.410	18.646

Recovery of copper in solution -- 99%

16 lb per ton

2¢ x 16 = 32¢

Fresh Water Consumption	gpm
Camp	257
Mine	46
Precip. plant	198
Mill	1,171
	1,672
Cost per 1000 gals. -	$.082

There was a drop of 1.7' in water level, bringing total to 45.3' since March, 1954.

	MILL	Year to date
KWH per ton ore milled		17.64
Assay of feed	Total Cu	.99
	NS	.16
	% Fe	2.8
Extraction	Total Cu	77.7
	Sulph Cu	88.5

Total MoS2 prod. for June 28,187 lbs.

Lbs per day	864
Cost per lb.	$ .54

Month prod. 16.0 dry tons at 86.3 MoS2 and 1.00% Cu

	% MoS2	
Mill Feed	.0166	) 53% recovery from concentrate
Tails	.0067	) (overall rec - ± 40%)

Recover about 0.2 lb. per ton - (about 5¢ per ton profit)

Conc. - .41 MoS2)
Tails - .19 MoS2) 53% rec.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

J. H. C.

MAY 1 3 1960

May 13, 1960

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

IMPERIAL AREA
Silver Bell District

Dear Sir:

Attached is a map showing revised locations and order of drilling of proposed holes in the Imperial Area. This map originally was Attachment 4 of Mr. Von Fay's report dated April 11. The proposed hole locations appeared originally also on Attachment 7.

The revisions were occasioned: (1) by restudy of geological information in the Hilda mine area, (2) by recent surveys of shallow mine workings (not shown on the original map and not known at the time that map was made) which should be avoided with drill holes, and (3) by Mr. Pope's request that holes be located on a drill-grid except where special reasons require locations off the grid.

The selection of a drill-grid prior to drilling any holes in an orebody is an awkward problem because it presupposes knowledge of the number of samples (or, in other words, the spacing of drill holes) which ultimately will be needed to define ore blocks. Actually, this matter of optimum spacing varies from ore body to ore body and from place to place within any one ore body; and, the optimum spacing depends on so many factors that it is not really known, usually, until a large number of holes has been drilled. For these reasons I have usually advocated random spacing, as was done at Quellaveco, at Oxide and El Tiro, and the earliest holes at Mission. However, holes might as well be spotted on a drill-grid wherever there is no specific reason to avoid the grid.

Hole-spacing for measurement of ore blocks in the Imperial Area ultimately will be unusually close, the principal reasons being the multiplicity and irregularity of bodies of barren igneous rocks and the spotty distribution of copper in the sediments. For these same reasons and, to some degree, because of difficulties imposed by topography and old mine workings, many holes will have to be located off the drill-grid. Where these reasons do not apply, holes will be spotted on the drill-grid, or very near it.

The selection of the spacings 150' north-south and 200' east-west is rather a compromise with the present thought that ultimately spacing of 100' may be needed in at least one direction in portions of the zone.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
Att: Map
cc: DJPope - w/att
DRJameson - w/att
RJLacy - w/att
File copy routed to: TASnedden, ACHall,
JHCourtright, SVon Fay

IMPERIAL AREA
Proposed Hole Depths

Locations Revised
May 11, 1960

A	1	500'
B	2	500'
C	3	900'
D	4	900'
E	5	300' - may deepen
F	6	800'
G	7	800'
H	8	600'
I	9	500'
J	10	350'
K	11	350'
L	12	650'
M	13	850'
N	14	600'
O	15	400' - may deepen
P	16	650'
Q	17	600'
R	18	750'
S	19	600'
T	20	750'
U	21	1000'
V	22	800'
W	23	1000'
X	24	1000'
Y	25	1000'
Z	26	1000'
		18,150'

AMERICAN SMELTING AND REFINING COMPANY
SILVER BELL UNIT
Silver Bell, Arizona

May 6, 1957

ORE RESERVE CALCULATIONS
TRIANGLES vs. AREA OF INFLUENCE (POLYGONS)

A comparison was made calculating ore reserves by the triangle method and the polygon method and compared with the actual tons removed. This was done on the 2900 and 2860 benches of the Oxide Pit. The results are as follows:

2900 Bench

Total tonnage 5,300,000 tons.
27% of total tonnage is ore.

		Tons	% Cu. Assay	Assay Tons
Polygons	+0.4% Cu.	1,216,000	0.90	1,094,400
Triangles	"	1,516,000	0.75	1,137,100
Actual	"	1,451,300	0.83	1,204,600

2860 Bench

Total tonnage 5,800,000 tons
36% of total tonnage is ore.

		Tons	% Cu. Assay	Assay Tons
Polygons	+0.4% Cu.	2,049,600	0.90	1,844,600
Triangles	"	2,384,000	0.76	1,811,800
Actual	"	2,114,200	0.96	2,029,700

Two benches at the top of the ore body cannot be considered representative of the whole pit, but an indication is shown. The horizontal extremeties of the ore are cut off sharpely thus the sharp cut off of the polygon method is more representative. This is reflected in the grade. The combined tons, % Cu. and units is as follows:

2900 & 2860 Benches

		Tons	% Cu. Assay	Assay Tons
Polygons	+0.4% Cu.	3,265,600	0.90	2,939,000
Triangles	"	3,900,000	0.76	2,948,900
Actual	"	3,565,500	0.91	3,234,300

The polygon method is considerably faster than the triangle method. Using the triangle method, three areas within each triangle could occur requiring each area to be planimetered, while using the polygon method only one area would be involved. The areas in the triangles vary from bench to bench while the areas of the polygons remain constant, being affected only by the back slope cutting off portions of the polygons, however, portions of triangles are also cut off for this reason. Considering the number of triangles involved there were 49 on the 2900 bench and 82 on the 2860 bench as compared to 16 polygons on the 2900 bench and 27 on the 2860 bench. Another comparison is the number of areas on the two benches that were planimetered by the triangle method was 301 while those planimetered by the polygon method was 38.

Considering all points the polygon method is less work with results as accurate if not more accurate than the triangle method as indicated by information obtainable to date.

R. B. Meen

RBM/jg

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

July 27, 1954

MEMORANDUM FOR MR. R. R. PURVIS

SILVER BELL
Geologic Summary, Geologic Pit

The following Memorandum summarizes recently acquired geologic information which may be of aid in planning future mining and milling operations. This will supplement my Memorandum to Kenyon Richard dated December 4, 1953.

The attached map shows the general outlines of ore now available for mining. On this map ore areas have been separated into two types, proven and probable. The term "proven ore", as used here, indicates material lying directly beneath an area where sulphides were present on the level above. Since structural features which partially controlled the extent of oxidation generally have steep dips, it can be assumed with reasonable accuracy that material lying directly below known sulphide occurrences will be unoxidized.

A probable ore area is one which has been penetrated to some extent by drill holes or where geologic mapping has indicated that ore is likely to occur. The extent of probable ore generally cannot be determined with great accuracy. Side notes are used on the map to indicate conditions in areas where ore and capping are likely to be mingled.

Because of the extreme irregularity of oxidation, any map outlining ore areas can only be a generalization. This irregularity of oxidation is particularly noticeable on the Copper Girl Hill side of the pit. Here the base of oxidation, as indicated by exploration holes, occurs at depths ranging from 40 to 255 feet; the two holes showing those extreme variations were only 200 feet apart.

In some areas the capping appears to be separated from sulphide material by an irregular but more-or-less horizontal surface. If the sulphide thickness above the level is great enough, this material can be sorted out as ore. However, standard blast hole sampling procedure would give erroneous results because the sample would contain a much greater proportion of capping than present in the material sent to the mill. It is suggested that in areas where such conditions are expected to occur -- as on much of the 2780 level -- it might be possible to take two separate samples from each drill hole. One sample could be taken during the run through barren capping, and a second sample taken of sulphide material. If such a procedure is not practical, grab-sampling along the face might be used to good advantage to determine more closely the actual mining grade.

Four rock types are now recognized within the pit area -- limestone, dacite porphyry, andesite porphyry, and monzonite porphyry. There is as yet no indication that one igneous rock is particularly more favorable than another with respect to either primary mineralization or secondary enrichment. The limestone, however, definitely is unfavorable toward porphyry-copper-type mineralization. Primary mineralization in limestone was somewhat lower in grade and

extremely spotty; the solutions causing secondary enrichment did not penetrate the limestone for more than a short distance. These two factors have resulted in only weak mineralization in most of the limestone masses. The above generalization, however, does not eliminate the possibility of small replacement deposits of higher grade being found in the limestones in or near the Oxide pit area.

While no definite trend is recognized to indicate whether one type of igneous rock is more favorable than another, a difference in the occurrence of the chalcocite is evident. Mineralization in the monzonite porphyry is mainly concentrated along narrow, commonly sub-parallel veinlets; up to three-fourths of the chalcocite may occur in these veinlets. Only a small proportion of the chalcocite is present as disseminated grains. Mineralization in the andesite porphyry is at the other extreme. Chalcocite generally is disseminated throughout the rock mass rather than concentrated along veinlets. In some cases almost all of the sulphide material is present as small, discrete grains. The distribution of chalcocite in the dacite porphyry tends to be intermediate between these two extremes. In some areas veinlets are more important, in others disseminated grains predominate.

The nature of the occurrence of the chalcocite is important because of its influence on the ease with which a rock is leached of its copper content. When chalcocite is concentrated along veinlets the rock generally is leached to greater depth and more cleanly leached than when the chalcocite is disseminated. Thus, the andesite porphyry often contains ore while the adjacent monzonite porphyry on the same bench is barren of copper.

A difference in degree of silicification has also been noted. There is very little silicification in any of the andesite porphyry now exposed in the pit area. However, since most of the andesite porphyry occurs in the southern half of the pit where all types of rocks show but little silicification, it cannot be stated definitely whether the andesite porphyry was less favorable for the addition of silica.

There has been difficulty in milling some of the ore taken from Copper Girl hill, due to the presence of considerable amounts of sticky clay. Most of this clay is believed derived from alteration of limestone. This clay (argillic) alteration is believed due to the action of ascending solutions; these same solutions were responsible for the silicification that is common in the limestone in the same area.

Since the formation of the clay was probably due to ascending -- rather than descending -- solutions, the presence of clay will continue to be a problem as lower levels are opened. However, since much of the mineralization in limestone is marginal or below ore grade, careful mining might make it possible to avoid much of this clay.

The Center fault formed a sharp boundary between ore and waste on most of the 2940 and 2900 levels on Portland Ridge. On the 2860 level a large mass of probable ore is present on the north side of the fault (see attached map).

Memorandum for Mr. D. R. Purvis

This material, however, usually will be topped by a variable thickness of waste capping. Therefore, the Center fault should still constitute an important mining control, separating clean ore from ore requiring considerable sorting.

West of the 2860 level the position and nature of the Center fault has not been established. There is some suggestion that the fault turns southward into the strike-direction of the numerous veinlets in the area. The Center fault was not shown on surface geologic maps.

Little additional information is available on the northeast-trending fault "B". As mentioned in my Memorandum of December 4, 1953, there is a good possibility that fault "B" had some post-chalcocite displacement, dropping the east (hanging wall) side. This fault, as well as the parallel fault "A", was mapped by Kingsbury, Entwistle and Schmitt. According to their report, on the 130-foot level of the Copper Girl workings there is a width of 110 feet of strongly leached ground on the footwall of fault "A". At present there is not enough information available to determine whether this zone represents deep leaching along the fault or whether there might have been downward displacement on the west (footwall) side of this fault.

A bound set of geologic maps of the Oxide pit has been prepared and this is to be kept permanently at Silver Bell for use by the staff. These maps are on 50-scale, with geology shown at the elevation of the level.

Keith G. Papke

KGP:ar

KEITH G. PAPKE

Attachment: Map

cc: WHLandwehr
TASnedden
KERichard
RBMeen

SEC 26700E
SEC 26900E
SEC 27100E
SEC 27300E
SEC 27500E
SEC 27700E
SEC 27900E
SEC 28100E
SEC 28300E
SEC 28500E
N
30000 N
29000 N
27000 E
28000 E
SEC 29900N
SEC 29600 N
SEC 29300 N
2970
2940
2900
2860
2820
2780
2740
2906
Ore Drilled
Probable Ore With Some Cap.
Hole 181 (Ore)
Some Ore
Fit A
Fit B
Minor Ore In Siliciified Rock
Scattered Masses of Ore
Probable Ore on 2900 Mixed With Considerable Capping
Possibly Some Ore
Some Ore, Covered With Cap.
Center Fit
Mainly Ore
C.G. Shaft
Upper Half Generally Capping
Mainly Clean Ore
Ore With Some Capping
Mixed Capping And Ore
Probable Ore (Some Proven)
Minor Ore
Ramp 2900 to 2940
PIT OUTLINE
LEGEND
Crest
Toe
Proven Ore
Probable Ore
TO ACCOMPANY Memo
DATED 7-27-54
BY KGP to DRP
AMERICAN SMELTING AND REFINING COMPANY
SILVERBELL UNIT
PIMA COUNTY, ARIZONA
PLAN OF OXIDE PIT
SCALE: 1" = 200'
MAP NO. S-121-85 B

J. H. COURTRIGHT

New York, April 21, 1954

MEMORANDUM TO: Mr. D. J. Pope

GEOLOGICAL MAPPING AT SILVER BELL

On April 8th, Messrs. T. A. Snedden, J. H. Courtright, together with the Chief Engineer at Silver Bell, and Mr. K. G. Papke, reviewed the problem of mapping the important geological features, and discussed the methods by which this data could be recorded to be most useful in connection with operations. Mr. Kenyon Richard was ill at the time of these meetings, but the entire subject was reviewed with him later.

In general, it was concluded that a set of 50-scale plan maps would be prepared on tracing cloth, with a sheet representing the top of each bench in the pit. Geology would be posted at the elevation of the top of the bench. On the principal set no assay data, ore reserve blocks, or other complicating details, would be recorded. These assay data would be assembled in a separate set of identical maps, also at 50 scale. The question was raised as to whether or not it would be necessary to make up a set of tracings for this assay ore reserve record, since the Engineering Department keeps most of this data on flat sheets and it was thought that the Geological Department could use these sheets with the Engineering Department, for the interpretation of ore trends, lay-out of ore blocks, and advance planning. Because of the fact that much of this lay-out procedure would be subject to change and revision, as additional data is required, it is certain that it will be advisable to maintain the complete duplicate set.

Referring again to the geological mapping procedure, the system to be used will be based upon structural mapping, on which all significant mineralized breaks and faults will be mapped as near as possible to scale, in plan, at the toe of the bank. The field sheets will be made up on a coordinate system and will be identical with the finished office map set, with the possible exception of additional descriptive details, which may be referred to in the field sheet files when necessary.

Some cut-and-try procedure will be necessary to determine the best background coloring to show (a) leached oxide capping, as compared to (b) sulphide ore. Also, a background color may be required to show (c) barren capping below which no sulphide enrichment is anticipated. Finally, another color (d) will be required to show the barren sulphide areas as they appear below commercial ore. A light shade of red would probably apply satisfactorily to the leached outcrop areas, beneath which commercial mineralization is anticipated. A darker shade of red would then designate the boundaries of sulphide mineralization throughout areas averaging above cut-off grade. A shade of yellow would serve well to indicate the barren sulphide ridges below commercial ore. No specific color was suggested to apply to barren capping over sections where commercial ore is not expected, since it is possible that it will be sufficient to merely leave such areas uncolored. Major rock types will be designated in conventional hatching methods, and dikes, etc., may be readily noted in heavy solid color.

It was also agreed that a separate set of field note sheets could be used, upon which dip-slope geology would be mapped in accordance with the plan proposed by Mr. Kenyon Richard earlier this year. Since this type of mapping would not permit continuous accumulative plan interpretation, it was decided that the dip-slope sketches would be constructed on separate field note sheets. This work would be limited to areas where third dimension information is particularly important. In other words, on a trial basis, this procedure was accepted in advance of formal construction of longitudinal projections. If it develops that these sections are sufficiently valuable, the Resident Geologist is instructed to keep such sections as are needed.

In order to properly visualize the over-all picture, it will be necessary to construct a standard set of vertical sections. This may not be possible until the preliminary mapping program is nearly complete. At that time, or as early as sufficient data is available, a series of vertical sections laid out on coordinates, will be required. It was not decided, however, whether these would be required at 100 ft. intervals, or whether 200 ft. intervals might suffice. This may be determined by trial as the work progresses.

It is obvious that the above program will require a considerable amount of work and it is not possible for this to be brought up to date, and the results made available at this critical time in the operating cycle, without assigning additional personnel to this project, at least temporarily. In discussing this with Mr. F. V. Richard and Mr. W. R. Landwehr, it was suggested that Mr. Owen Evans might be loaned from the Salt Lake office for a period of two or more months, to assist Mr. Papke in bringing the work up to date. I have also recommended that a junior geologist be assigned to this project to permanently assist Mr. Papke during the early operating stages, after which it may be possible for the junior assistant to carry on the work, thereby releasing Mr. Papke.

L. H. HART

cc: CPPollock
FVRichard
TASnedden
WRLandwehr
RBMeen - Chief Eng.-Silver Bell
Kenyon Richard
JHCourtright
KGPapke

C
O
P
Y

J. H. COURTRIGHT

New York, January 18, 1954

FILE MEMORANDUM

SILVER BELL OXIDE AND EL TIRO PIT GEOLOGICAL MAPPING

I have received the letter from Mr. F. V. Richard of January 4th, addressed to Mr. D. J. Pope, on the above subject, together with attachments, including a letter from Mr. Snedden to Mr. Richard, transmitting memoranda by Mr. Kenyon Richard and Mr. K. G. Papke.

In general, from my review of exhibit maps, it is evident that much thought and excellent work is being done in connection with geological mapping at the Silver Bell property. I concur with Messrs. Richard and Snedden in their opinion that the information being collected will be of great assistance to the mine operating program. However, there are certain points with which I disagree in connection with the mechanics of collecting and recording of data, because I believe that a more effective method can be adopted for cumulative presentation of information. It has been my experience that much work done by geologists assigned to operations is lost because of failure to assemble data in a form which is usable to maximum advantage by the production staff. Since this is the principal reason for doing the work, every effort should be made to standardize the assembly of information with that objective.

The following procedure is standard practice in most pit operations known to me and it has been found to be satisfactory for purposes we have in mind. A geological plan on a tracing sheet is made up for each bench in the pit and each sheet in this set of sheets is oriented on identical coordinates and so constructed that it may be bound in a looseleaf cover which will fix each sheet correctly in relation to the other sheets. In other words, this may be likened to a glass model in which a glass sheet represents each bench, but for convenience in posting and use, tracing sheets, assembled as noted, are substituted for glass sheets. The vertical scale as represented in a conventional model may not be similarly represented in a map set, but this is unimportant because of the more or less standard spacing between bench levels.

On each sheet the geology is posted at convenient intervals, or when the toe of the bench has advanced sufficiently to justify remapping, (25 ft., more or less). The geology as observed at the toe of the bench is then posted in ink, but only in plan at the bench level, as mapped. Correlations back to the last toe map may be made, particularly with reference to major structures. Projection in ink ahead of the toe will be very limited, since the facts will be obtained at the naxt mapping interval and structures then correctly connected thereto. It is extremely confusing to map true strike in plan up to the toe and then show the trace of a structure up the slope of the bank, from toe to crest, as it would be viewed from directly above, and as has been done on the exhibit sheet attached to Mr. Richard's memo referred to above. If the sheets such as the 2900 bench progress map are used as work sheets, there may be some limited value in this combination mapping, in that it shows the trace of structures in the actual bench slope. However, when this method is used, correlation from one unit to the next mapping unit, (the position of the bench at a later date) is impossible without an intermediate transfer stop. All of this is complicated and adds nothing which may not be

available by standard procedure. Therefore, our standard practice will be to accurately map the geology at the bench toe and this will be transferred to the corresponding tracing without including any of the detail sketch on the slope itself. In this way, correlation from successive mapping intervals is simple, and when data is complete, for, let us say, a part of the 2900 bench, and the next lower bench is advanced, it will be possible by projection to post in pencil, the structural features almost exactly as they will be expected on the lower bench. Thus, it will be possible to line up blast hole drilling and sampling work with maximum efficiency with respect to the geology. Obviously, after the new lower bench has been advanced, the projected geology will be erased and the correct geology, as mapped, may then be posted on the tracing in ink, as a permanent record. This simple standard procedure offers the greatest opportunity to be of service to the members of the operating staff.

In addition to the plan of mapping and recording procedure there is a problem as to what details shall be recorded. It is extremely dangerous to attempt to code such details as dip of structures and spacing. This tends to produce a mechanical result which is theoretical and idealized and ceases to be factual. The objective in geological mapping is to reproduce the geological facts. Structural features must be presented in a manner which resembles a photographic picture in which the relative weights of component structures are readily observed. Other elements, such as mineralization, alteration, etc., sometimes may be portrayed on a structural map, but should never be included when and if it confuses structure, in which case separate maps or overlays are necessary.

As an example of mapping of the type which I consider essential at Silver Bell, I cite the detailed work which is being done at the Galena Mine in Wallace. A glance at the geological plan maps of the 2800 or 3000 level of this mine permits a very accurate visualization of all important structural detail. The governing control is to map as nearly as possible to scale. In a maze of minor fractures with no measurable predominating trends, it is incorrect to map in a way approximating generalization. When this is done, it weakens confidence in all of the mapping. It is far better in these places to map accurately only those stronger joints, using hair-like lines and add side notes to cover the unmapable features of importance. On the whole, anyone familiar with structural geology will observe the principal major structures and readily visualize the intervening structure, if only the more prominent joint breaks are indicated. Minor breaks may better be forgotten, since it is impossible to map to scale, and galse sketching leads to false interpretation.

Referring again to the 2900 bench geological plan map submitted, my criticism is simply that an effort has been made to present more information than it is physically possible to do intelligibly. There are a number of elements in this work which are confusing and the resulting map is not acceptable as a structural map or sufficiently complete to adequately present the mineralogy or alteration detail. Some overlap may be possible, but in no event will any system be acceptable which fails to give the best possible structural facts. Other information is important, perhaps equally important in some situations, but it must not be presented in a manner which results in distortion of structural interpretation. Herewith, I suggest a means by which the Silver Bell mapping may be revised to provide all of the useful data without the use of an overlay and without distorting structure. Since we have geological maps from all parts of the world coming into this office, it is necessary that some general standardization of methods and color usage be adopted, but otherwise I have accepted all of the symbols, etc. proposed by Richard, that will conform. My instructions

with reference to his table of symbols are:

MINERALIZED JOINTS - Comments above.

* DIP - Will accept this for a trial.

SPACING OF JOINTS - This section must be omitted in total. Map only measurable, key breaks, approximating scale as nearly as possible.

INTENSITY OF MINERALIZATION - This section must be omitted in total. Instead, a pale solid color background (red - orange - green) may be used to apply to varying degrees of copper sulphide mineralization, if this is considered the most pertinent mineralogic data. I suggest adding yellow to indicate barren pyrite, and a heavier red for primary sulphides when copper content is above, say 0.5%. Obviously this system may not be used with complex host rocks - then mineralogic information must be on overlay.

VEINS - Forget code. Instead map to approximate scale. Designate measured dip. Use side notes to describe mineralization, since all veins, copper, iron, quartz are all mapped in solid red.

FAULTS - Use blue ink, without dip bulges. Mark dip with direction arrows and measured attitude.

ROCK TYPES - If above mineralogic color background used - then hatch symbol for rock variations may be required. Use USGS standard symbols.

OTHER SYMBOLS - O. K.

The use of lines, varied as to space and color, in an attempt to designate intensity of deformation and indicate character of mineralization, would be fine if it could be done without sacrificing some of the basic elements of geology required, but the system proposed fails for this reason and the only possible result is that intensity of deformation is confused with character or intensity of mineralization.

Obviously, when we refer to mapping to scale, we must accept a certain amount of generalization. This becomes a matter of judgment by the workers most familiar with a particular district or type of deposit. Certainly when it becomes apparent that a fault such as the Center fault has a movement of at least 70 ft., this structure is mapped more strongly than another structure on which a 40 or 50 ft. displacement has been determined, although an inspection of the fault itself will rarely permit recognition of differences of this magnitude. Similarly, well defined mineralized veinlets that exhibit a definite trend, are mapped more strongly than fragmental veinlets of equal or larger dimention but with no apparent continuity. Oftentimes,

it is doubtful how useful the detail within a breccia zone may be. Still the trend and boundaries of the zone itself are always important, and certainly a false suggestion of structure within the zone, by code mapping, is incorrect. It is true that the average attitude of minor joints does have a significance with reference to the immediate environment, but this may change within a few feet and it becomes much more important to concentrate attention on the controlling structures which are themselves responsible for the development of the adjoining complexes. Above all, I wish to warn against generalizing joint systems, when as a matter of fact, parallelism and frequency rarely, if ever, reach the uniformity implied in the exhibit map, particularly between Holes Nos. 114 and 116 in the example submitted. Even if this be true, use of heavy, green lines as is done on the exhibit, tends to weight these observations out of proportion to the key structure elements.

Referring again to Mr. Kenyon Richard's memorandum to Mr. Snedden, I am in full agreement as to the value of geological work, provided as Mr. Snedden has warned: "interpretations should be confined to prints or separate maps", and I believe that it is essential to keep one man available for this work on a full time basis. Once under way, one man can keep up with the work at both the El Tiro and Oxide pits. We can determine later if this may require a full time geologist when the first program is completed. I certainly wish to emphasize the point brought out by Mr. Richard, namely that the work must be continuous from the beginning, since it is true that some important information was lost by failure to start mapping during the earlier phases of stripping of the Oxide ore body. I also object to the work being done by different individuals, since someone must be held responsible.

One point which occurs to me is that since trends or troughs of mineralization have been recognized by Mr. Richard to an extent beyond that predictable by interpretation of drill results, it will be possible ultimately to plan the bench positions in such a manner as to permit breaking along the trends as much as possible, rather than across them, and in this way, a much cleaner ore recovery may be made. The more completely the geological work is carried out and applied, the greater the selectivity that will be possible in the pit, and control by geology will permit a considerable reduction in the amount of sampling and assaying necessary.

L. H. HART

cc: DJPope
FVRichard
WRLandwehr
Kenyon Richard

* After reviewing this with Mr. Pollock, he has indicated objection to the use of the code to represent approximate dip of any structures, joints, veins, or otherwise. Therefore, in the future, we will show the direction of dip with measured angle on all important structures.

ADDITIONAL GENERAL COMMENTS

Mr. Pollock has also suggested that the general principle set out in the book on Mining Geology by J. D. Forrester of Rolla School of Mines, is probably the best resume of working methods applying to mapping of geology in mines. Familiarity with the principles contained in the above book would be helpful to all of our junior men.

L. H. H.

Copied at Tucson, Ariz., Jan. 29, 1954, for K. Richard,
J. H. Courtright and K. G. Papke.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 28, 1953

MEMORANDUM FOR MR. T. A. SNEDDEN

SILVER BELL UNIT
GEOLOGICAL MAPPING
OXIDE AND EL TIRO PITS

Reference is made to letter of December 1 from Mr. Pope to Mr. F. V. Richard and letter of December 3 from Mr. Richard to you, subject above.

Attached for transmittal to Salt Lake are two copies each of the following:

(1) Print of portion of the Geologic Bench Progress Map of the 2900 level, Oxide pit.

(2) Explanation of Symbols.

(3) Memorandum with map by Mr. Papke on the subject of sulphide ore available in the present Oxide pit benches.

Item (1) above is a copy of a portion of one of the level maps which are being compiled as a basic record of significant geological detail. As mining progresses each bench will be mapped periodically and the information added to each level map. Thus each level map will eventually consist of a series of strips of geological detail.

Item (2) describes the kind of geological detail now being recorded. Care has been given the problems of what kind of geological detail to record, and how to symbolize it. This tabulation represents the consensus of Messrs. Papke, Courtright and me.

Mr. Papke has mapped carefully, and I believe this basic information is in such shape that it can be used in the solution of various operating problems which depend in some degree on geological interpretation.

Item (3) is an example of the use of these data — in fact, the problem treated was the principal reason for starting this pit mapping project. In the Oxide pit, sulphide ore was encountered at higher elevations than indicated by drill holes. Questions arose as to whether these were small pods of no concern, or larger masses which should be left in place or stockpiled; and where should stripping be done so as to expose enough ore to assure an adequate production rate when milling first gets underway? These questions could not be answered adequately without a basis of mapping. As a result of his mapping, Mr. Papke has predicted the probable distribution of ore and waste ahead of the various benches. As mining advances he will continue to map and can adjust his predictions periodically. This particular problem of the position of the capping-sulphide contact in the Oxide pit will continue to exist for some time, but it will become of less concern a few months after production starts.

Mr. Papke has been spending about 70% of his time on the Silver Bell work. It was my original thought that, after an experimental period of getting the maps, symbols, and methods set up, he could maintain the work by devoting about half his time to it. It now is apparent that the job will continue to be a full time one, at least for a year or two and probably permanently. The original questions have been partly answered, but a number of others can be foreseen.

For example:

(1) The same capping-sulphide problem will arise at El Tiro.

(2) For the purpose of aiding in the revision (a) of ultimate stripping limits and (b) of ore reserves, as a result of new churn drill data, geological sections need to be constructed for El Tiro. Mr. Papke has started on this job, but considerable work remains to be done.

(3) His maps show trends of stronger and leaner zones of mineralization. These data will contribute to the problems of grade control and planning the mining sequence both at Oxide and El Tiro. But the geological mapping will need to be kept up-to-date to be useful in these respects.

(4) As viewed in plan, the edges of both the Oxide and El Tiro ore bodies are probably "sawtooth" in outline due to alternating lenses of stronger and leaner mineralization. Drill hole data do not precisely define these outlines. This problem will not become acute until the last few years of mining. But it can be dealt with properly at that time only if detailed geological data are accumulated throughout the course of mining, in the manner which Mr. Papke has started.

(5) The faults with large, post-chalcocite displacement which he has found in the Oxide pit will affect the shape of the bottom of the ore body as they do the top. Here again, in order to understand them properly, they must be mapped progressively as exposed by mining.

It was not my original intention that Mr. Papke would stay on this Silver Bell job very long. I would like to put him back on porphyry copper exploration as soon as possible. Consequently, I suggest that another man be put on the job full time, and Mr. Papke could then be available for other work as soon as he has trained the new man. This man need not necessarily have much experience; but he should be capable of learning to do open-cut mapping carefully and conscientiously, and he should have sufficient ingenuity to make subjective interpretations and present the geology in the form of special maps (such as the one accompanying Mr. Papke's Memorandum) so that it will be useful to those concerned with planning, engineering and operating.

In connection with this last point, it is intended that the Geologic Bench Progress Maps will be kept at Silver Bell and no regular attempt will be made to prepare copies. There are two reasons for this: (1) Due to the use of colored ink symbols (and this could not be avoided) the copying job would be so time-consuming

T-10.9
December 28, 1953

Memorandum for Mr. T. A. Snedden

as to be entirely impractical. (2) For any particular problem — ore reserve revision, structural control study, fault offset analysis, etc. — the pertinent geological features will be taken from the base maps and compiled in a simplified form on new maps.

Original Signed By
K. Richard

KR:ar

KENYON RICHARD

cc: WRLandwehr with copy only of Mr. Papke's Memorandum
JHCourtright " " " " " " "
DRPurvis with no attachment
KGPapke " " "

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 4, 1953

MEMORANDUM FOR MR. KENYON RICHARD

SILVER BELL
ORE AVAILABLE, OXIDE PIT

The following memorandum and attached map are in response to your request of November 23rd. It is hoped that the map, which shows the general distribution of easily available ore, will be of aid in planning future pit operations.

Mapping in the Oxide pit has shown that certain structural features are present which should be taken into consideration when outlining areas of ore. These structures include mineralized fissures and post-enrichment faults.

Mineralized fissures appear to have closely controlled oxidation; this has resulted in an extremely irregular contact between capping and sulphide material, rather than a uniform plane surface. In general mineralized fissures are sub-parallel, trending northeasterly with steep dips. The base of oxidation has the form of a series of crests and troughs with northeast-trending axes; the troughs were formed along zones of more permeable fissures. When mining approximately at right angle to the trend of mineralized fissures — as will be the case during early operations on the Portland Ridge side — it can be expected that alternating bands of capping and sulphide ore will be encountered, with the proportion of sulphide ore increasing as operations proceed. Mining in such areas will require close control.

A striking feature in the oxide area is the presence of faults that appear to displace the chalcocite blanket. Two faults which had considerable movement are recognized; continued detailed mapping probably will reveal others.

One of these faults, the Center fault, may have dropped the chalcocite blanket as much as seventy feet on the north (footwall) side (see attached map). On three benches where the fault has been definitely located, exposed sulphide material is mainly restricted to the south of the fault. This structure might be utilized in future operations; stripping operations north of the fault can remove a large volume of capping without the necessity of extensive stockpiling.

The second of these faults, the "B" fault, may have dropped the chalcocite zone forty or more feet on the east (hanging wall) side (see attached map). Because of the presence of this fault, it appears probable that a fairly large volume of ore, not included in original estimates, will be available during mining of the northwestern part of the 2900 level.

On the accompanying map, areas where sulphide ore can be expected have been outlined. This is based upon information obtained from mapping of pit

Memorandum for Mr. Kenyon Richard

faces, from churn drill exploration holes, and in some cases from blast hole assays. In some areas, however, little information is available. For this reason and because of the irregular nature of the capping-sulphide contact, the map is in many cases only a generalization.

Some qualifications have been made on the map; these include the designation of probable ore, possible ore, and mixed ore. Areas of probable ore have been outlined on the basis of only limited information. In areas of possible ore, definite information is meager or absent but there is reason to suspect that some ore may be present. In areas of mixed ore, sulphide material and capping are so intermingled that separation during mining may be impossible. Blast hole assays will determine whether this material is to be classified as ore, leach, or waste. The term "mixed ore" does not refer to oxide copper in sulphide ore but to mingled sulphide-bearing rock and capping. In general, little oxide copper is present in sulphide ore.

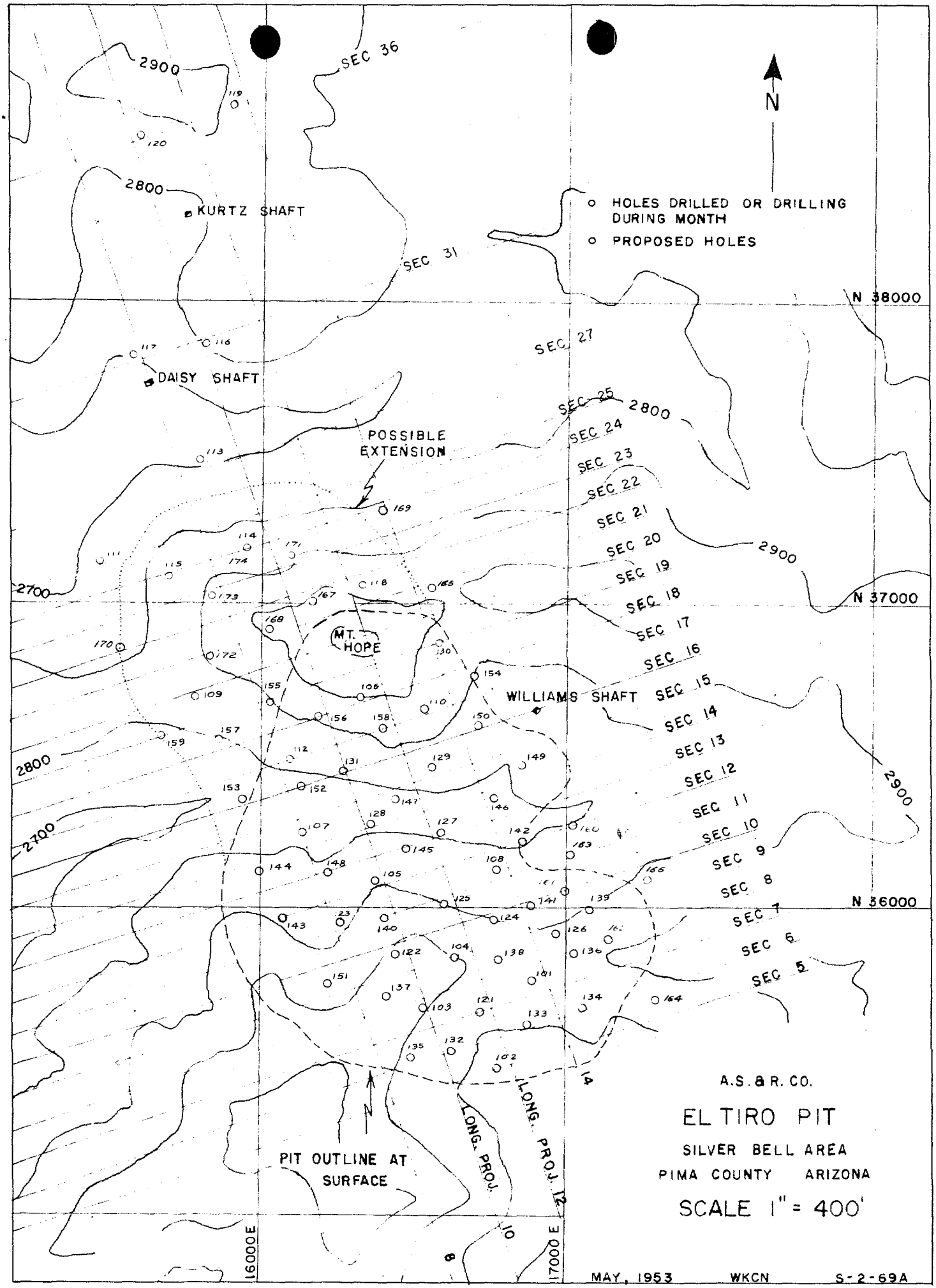
It is anticipated that data accumulated as mining proceeds will aid in outlining areas of ore more accurately.

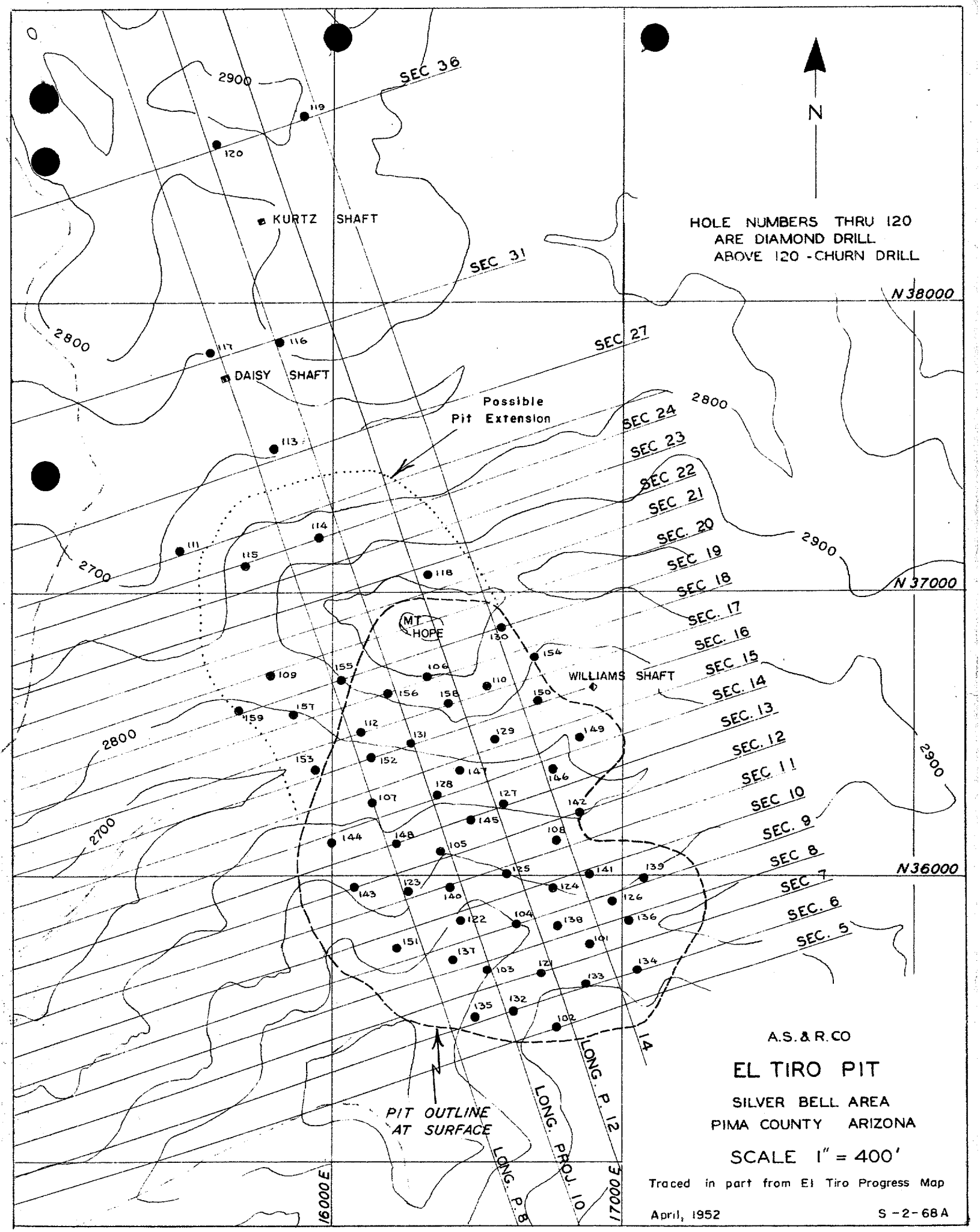
Keith G. Papke

KGPlar

KEITH G. PAPKE

SEC 26700E
SEC 26900E
SEC 27100E
SEC 27300E
SEC 27500E
SEC 27700E
SEC 27900E
SEC 28100E
SEC 28300E
SEC 28500E
N
30000 N
29000 N
27000 E
28000 E
SEC 29900N
SEC 29600N
SEC 29300N
2970
2940
2900
2860
2820
2780
Probable Mixed Ore
Ore (Drilled)
Probable Ore
Capping (Drilled)
Fault "A"
Fault "B"
Capping Possibly Some Ore
Principally Capping.
Some Ore Along Face
Badly Oxidized
Mixed Ore and Capping
Ore with Some Capping
Mixed Ore
Possible Ore
Possibly Some Ore, Badly Mixed
Center Fault
Mixed Ore (Lower Half Ore-Upper Half Capping)
Alternating Ore and Capping
Principally Ore
Capping
Mixed Ore
Probable Ore
Unknown Possibly Some Mixed Ore
Possibly Some Ore
Ramp 2900 to 2940
Ramp 2940 to 2980
PIT OUTLINE
LEGEND
Bench
Crest
Toe
Overlap
TO ACCOMPANY MEMO
DATED 12-4-53
BY KGP
AMERICAN SMELTING AND REFINING COMPANY
SILVERBELL UNIT
PIMA COUNTY, ARIZONA
PLAN OF OXIDE PIT
SCALE: 1" = 200'
PROGRESS FOR NOVEMBER 1953
MAP NO. S-121-85 B


N
HOLES DRILLED OR DRILLING DURING MONTH
PROPOSED HOLES
KURTZ SHAFT
DAISY SHAFT
POSSIBLE EXTENSION
MT. HOPE
WILLIAMS SHAFT
SEC 36
SEC 31
SEC 27
SEC 25
SEC 24
SEC 23
SEC 22
SEC 21
SEC 20
SEC 19
SEC 18
SEC 17
SEC 16
SEC 15
SEC 14
SEC 13
SEC 12
SEC 11
SEC 10
SEC 9
SEC 8
SEC 7
SEC 6
SEC 5
2900
2800
2700
N 38000
N 37000
N 36000
16000E
17000E
LONG. PROJ. 12
LONG. PROJ. 10
PIT OUTLINE AT SURFACE
A.S.&R. CO.
EL TIRO PIT
SILVER BELL AREA
PIMA COUNTY ARIZONA
SCALE 1" = 400'
MAY, 1953
WKCN
S-2-69A


N
HOLE NUMBERS THRU 120
ARE DIAMOND DRILL
ABOVE 120 - CHURN DRILL
SEC 36
SEC 31
SEC 27
SEC 24
SEC 23
SEC 22
SEC 21
SEC. 20
SEC 19
SEC 18
SEC. 17
SEC. 16
SEC 15
SEC. 14
SEC. 13
SEC. 12
SEC 11
SEC 10
SEC. 9
SEC 8
SEC 7
SEC. 6
SEC. 5
KURTZ SHAFT
DAISY SHAFT
WILLIAMS SHAFT
MT. HOPE
Possible
Pit Extension
PIT OUTLINE
AT SURFACE
2900
2800
2700
N38000
N37000
N36000
16000 E
17000 E
LONG. P. 8
LONG. PROJ. 10
LONG. P. 12
14
A.S. & R. CO
EL TIRO PIT
SILVER BELL AREA
PIMA COUNTY ARIZONA
SCALE 1" = 400'
Traced in part from El Tiro Progress Map
April, 1952
S-2-68A

Mr. Courtright
S-1.1
General

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

February 6, 1951

MEMORANDUM FOR MR. RICHARD

SILVER BELL
Pima County, Ariz.
Exploration of Proposed Mill Site

Reference is made to our recent conversation regarding the new site selected for the mill at Silver Bell. As you have advised, it is believed necessary to make certain, as far as possible, that the plant is situated clear of any non-submarginal copper mineralization that might become commercial ore at some future date. Herewith are my comments and recommendations, accompanied by a 1000-scale map of the area.

The south ore body, formerly known as the Oxide, is a disseminated copper deposit of the enriched type occurring within a broad belt of mineralization and alteration. In general, surface indications of copper (limonite derived from the leaching of chalcocite) are strongest in the immediate vicinity of the known ore body; elsewhere within the altered zone, excepting a few small areas, copper mineralization appears to be relatively weak and spotty. The results of holes drilled outside the stronger surface showings tend to support this conclusion. However, should the tenor of minable material continue to decline as it has in the past, portions of the mineralized belt, now in the submarginal or waste category, may become workable.

There are several variables to consider in applying the term "ore" to copper-bearing material. To be brief, it is assumed that under present economic conditions a sufficiently large area having a 100-foot thickness of .5% to .6% sulphide copper with a one-to-one stripping ratio is workable, providing plant costs have been written off. It is possible that in the future this minimum grade may be reduced to .4%, or even .3%.

In the area under consideration, south and east of the South ore body, there is little information in the way of drill results on which to base an estimate of average copper content. Available results are as follows (please refer to attached map for locations):

Churn Drill Hole No.	Total Depth	Interval and Assay
12 }		Early Hole drilling; less than
13 }		0.25 Cu reported.
60	215'	Oxide to 120 feet. "No values" reported.
66	215'	90'-140' = 50' of .71% Cu; 140-215 - Tr. Cu.
69	230'	180'-230' = 50' of .45% Cu; last sample .55% Cu.
131	265'	85'-175' = 90' of .49% Cu; 175-265 - .16% Cu.
132	315'	115'-215' = 100' of .63% Cu; 215-315 - .37% Cu.
133	265'	100'-265' = 165' of .30% Cu.

As may be noted, at least three of the holes listed in the foregoing (Nos.

Memorandum for Mr. Richard

66, 131 and 132) cut values equivalent to 100 feet of over .4% copper, beneath approximately 100 feet of waste rock. No. 66 is situated in an area of stronger surface showings of copper (its identity is open to question). No. 131 is in an area showing some unmineralized outcrops and therefore its results are probably higher than might be expected as an average. No. 132, however, lies only a few hundred feet easterly from No. 129 which contained over 200 feet of some .7% Cu. Around the south and east margins of the south ore body a definite weakening of copper mineralization is evident in the drill results; however, the grade and extent of this fringe material is unknown in the absence of definitely delimiting holes.

It is, of course, not economically feasible to test the grade of all material that might eventually become commercial, but in considering plant installations and dumps some exploration is justified to make sure that the locations of such do not interfere with future operations, as they have in certain well known cases of the past.

To secure the necessary information I believe about five holes are needed. The positions of these are shown on the attached map. The average depth should be around 300 feet, or a total of 1500 feet. Each hole should be drilled vertically (by either diamond or churn drill) at least 100 feet below the top of the sulphide zone regardless of values encountered. Should a substantial number of the holes encounter the equivalent of 100 feet at .4% copper beneath 100 feet or less of waste, additional drilling may be required, or a consideration of different locations for plant and waste dump.

While all areas colored green on the map are considered to be essentially barren, the area along the south edge of Portland Hill is covered by mantle rock and therefore the position of the south margin of mineralization as shown is questionable. For this reason one proposed hole (No. 5) is located within the limits of the alternate mill site. Should this hole encounter barren, unaltered rock, as is expected, it may be discontinued at, say, 100 feet or less.

J. H. Courtright
J. H. COURTRIGHT

JHC:ar

cc: DiTrapo 2, with enc.
File - 3, " "

El Tiro

F.M. Stephens - July 7, 1950

1.	Ore reserve —	8,651,772 tons
2.	Cut off	0.6 % Cu
3.	Grade of reserve	.78 %
4.	Waste / Ore	1.52 to 1
5.	Prelim strip	4,766,000
6.	pit slopes	1 to 1½

Mr. Courtright
6-10.6.0

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 12, 1950

CONFIDENTIAL

MEMORANDUM FOR MR. RICHARD

EXPERIMENTAL GEOPHYSICAL INVESTIGATION
Silver Bell, Arizona

INTRODUCTION

The following comprises a brief description of the experimental work conducted at Silver Bell, Arizona, by the Texas Company's Research Division. The objective of this project was to test the possible application of radioactive measurements to porphyry type copper exploration; more specifically to determine whether or not a correlation between known structural and mineralogical data and radioactive data could be obtained.

PROCEDURE

Field work began in December, '48 under the supervision of Mr. Evan Pancake. Preliminary tests with portable instruments (highly sensitive Geiger Counters?) were made to determine the approximate range of intensity of radioactive emanations to be expected over various rock types in and around the mineralized zone. These measurements were made by carrying the instruments on foot and traversing across the area, taking radioactive "counts" at regular intervals.

The airborne operation started in February, '49. The crew was composed of five men: Two ground operators carrying "walkie-talkies", one helicopter pilot, one observer in radio contact with the ground crew and one helicopter mechanic. The new camp at Silver Bell was used as an operational base.

The measurements of radioactive intensity were taken by flying lines spaced 300 feet apart, laid out to cut the northwest-trending zone of mineralization at right angles. The ship, equipped with an electronic altimeter to maintain an altitude of 150 feet above the ground surface, was flown over these lines at a speed of 30 miles per hour. A continuous record of radioactive (gamma ray?) emanation intensity was produced by tape recorder.

Figures representing the value of intensities were plotted at regular intervals on 200-scale transparent sheets. Lines of equal intensity, in the manner of contours, were drawn. From this, the shape, position and extent of areas of high or low intensity were determined.

The area covered comprised some 12 square miles, roughly a rectangle 7 miles long and 1-3/4 miles wide, extending from the Atlas Mine on the northwest to within 3,000 feet of Cocio's Well on the southeast. This block almost completely covered the known extent of mineralization in the Silver Bell area.

The 200-scale "contour" maps were reduced to 1,000 scale and colors assigned

Memorandum for Mr. Richard

to various ranges of intensity. This map, used as an overlay on an areal geologic map and on a mineralization map of the same scale, served as a means of appraising correlation.

RESULTS

In short, the well-defined, long and narrow zone of mineralization and attendant alteration at Silver Bell could not be related to the pattern of high, intermediate and low intensities of the radioactive survey. Neither of the two known porphyry copper deposits, the Oxide and El Tiro appeared to possess any relation to radioactive pattern. However, the pattern of rock types was in a general way reflected by the pattern of highs and lows in radioactive intensity. With variations on the order of less than 200 feet the areal distribution of the alaskite conformed to the area of highest intensity; the monzonite and dacite occupied areas of intermediate intensities; the sedimentary rocks, chiefly Paleozoic limestones, fitted rather closely into the pattern of low intensities. Southeast of the Oxide deposit a pronounced "low" occurred in the volcanics along the southwest fringe of the mineralized belt. The lineation produced on the "contour" map marks the southeasterly trend of monzonite in the mineralized belt. On toward Cocio's Well there appeared to be suggestions of lineation which possibly indicated the extension of monzonite belt beneath this alluvial covered area. The cover is, however, not deep, probably ranging to a maximum of 20 feet.

Locally, the highest intensities recorded were over post-mineral andesite and rhyolite dikes. These results were checked with ground readings.

CONCLUSIONS

The results obtained indicate that the porphyry type copper mineralization in the Silver Bell district possesses no detectable variation in emanations of a radioactive origin. Thus, the possibility of applying intensity measurement techniques to exploration are quite remote. This, however, does not necessarily apply to porphyry copper deposits in general.

Unquestionably, the general pattern of the major rock units at Silver Bell corresponded to the pattern of relative intensities in radioactive measurement. According to Mr. Pancake, however, the practical application of this demonstrated phenomenon is severely limited by alluvial or other cover. That is, such a method would not produce results in areas covered by more than a few feet of alluvium — where more conventional methods of geologic mapping are applicable.

GENERAL

The work was interrupted on two different occasions - first by the State of Arizona, a local helicopter service possessing an exclusive franchise having filed suit against the out-of-state Company and second, by a crash-landing caused by a tail rotor failure. The project was finally completed two weeks ago, the total field work occupying about three months' time.

The ship, a Bell 47 B1, is valued at $23,500 and is operated by the Bell Aircraft Corporation under contract at $7500 per month, plus $15.00 per hour flying time.

J. H. Courtright

J. H. COURTRIGHT

JHC:ar
cc: LRWilson

J. H. Courtright

Proposed nomenclature of Pennsylvanian & Permian rocks in southeastern Arizona

(Bryant, 1954)

Thicknesses in type areas

		east	west	Rocks	
PERMIAN	SNYDER HILL GROUP	absent ?	Rainvalley formation 400'	Limestone, dolomitic limestone, dolomite, varicolored, some sandstone toward top. Thinner bedded than Conchs	
		Zone of Fusy's → ⬭ Zone of lt brn wthy chert with horn corals below, and Neospirifer above. Concha limestone 600'		Massive gray limestone, cherty, especially toward the base: very fossiliferous.	
		Scherrer formation 600'		Quartzite &/or sandstone, separated by dolomitic limestone.	
		Empire siltstone & shale. Epitaph dolomite 800'	Gypsum in Empire Mts → Andrada formation 1500'	(east) Dolomite and dolomitic limestone.	(west) Sandstone, limestone, dolomitic limestone, siltstone, varicolored, weak; marl and gypsum in upper part in some places.
		Colina limestone 600'		Black limestone.	
PENN. & PERMIAN	NACO GROUP	Earp formation 800'		Varicolored limestone, dolomitic limestone, sandstone, siltstone, marl.	
PENNSYLVANIAN	NACO	Upper part in Empires. Horquilla formation 1100'		Limestone, in places dolomitic, with thin interbeds of red, black and green shale, especially toward the top.	
MISS.		Escabrosa limestone massive (cliff type)		Light colored, coarse limestone	

Andrada

Naco

AMERICAN SMELTING AND REFINING COMPANY
Tucson, Arizona

April 7, 1949

Mr. F. V. Richard, Manager
Southwestern Division, Mining Department
American Smelting and Refining Company
Tucson, Arizona

SILVER HILL, ARIZONA
Porphyry Copper Mineralization

Dear Sir:

This letter will serve as an explanation of the two accompanying maps of the entire property, showing (Plate I), the extent and nature of mineralization and (Plate II), the positions and relative copper values of all known drill holes.

General Features of Mineralization -

Copper, essentially as secondary chalcocite, is dispersed throughout a northwest trending belt of pyritic mineralization over five miles long and from one to five thousand feet in width. This copper, derived for the most part from the leaching of chalcopyrite bearing veinlets, occurs in significant concentrations approaching commercial size in but two areas, three miles apart. Both deposits are characterized by relatively strong fissuring or sheeting, striking across the major structural break which is marked by a belt of intrusive rocks trending northwest. The most prominent of these rocks are: alaskite, dacite, porphyry and monzonite.

In these deposits, the Oxide and the El Tiro, the ore containing around 1.0% Cu and 5.0% sulphide iron, occurs in flat lying rudely tabular bodies, one to two hundred feet thick, beneath an average of one hundred feet of leached capping. As evidenced by numerous drill holes which were extended one to two hundred feet below the chalcocite zone, the unenriched or primary mineralization contains from .2% to .4% copper in the form of chalcopyrite.

Outside the limits of the aforementioned deposits, copper is widely dispersed throughout the pyritic belt in relatively small, discontinuous zones.

Classification of Leached Outcrops -

All degrees or shades of intensity of mineralization are present in the area, however, for the sake of clarity, only four classifications were used in mapping (Plate I). These are discussed below in the order in which they occur on the map legend. In areas obscured by alluvium or mantle rock, the strength and nature of mineralization, shown on the map, was inferred from the character

of the nearest outcrops, or determined by drill data.

1. Moderate to strong chalcocite -

In this classification are placed areas exhibiting relatively strong concentrations of maroon to black limonite, occuring essentially as narrow vein or seam fillings. These dark colored veinlets of residual limonite in the outcrops are assumed to have been formed by the oxidation and leaching of pyritic chalcocite veinlets, a process which took place beneath cap rock subsequently removed by erosion. This assumption is based on observations which support the conclusion that over known ore bearing areas the outcrops show a much closer spacing of seams bearing the dark colored limonite than the outcrops over areas known to be sub-marginal in copper values; over areas known to be practically free of chalcocite, the dark colored limonite is very sparse or absent entirely.

According to Mr. Louis Reber of the Phelps Dodge Corporation at Morenci, the dark maroon or purplish tone of the limonite derived from the leaching of chalcocite-pyrite is due to the presence of minor amounts of cupric oxide.

2. Pyritic Mineralization, chalcocite sparse to absent -

The interpretation in this case is based on the yellow to brown or red staining in the outcrops. Cavities and open seams, indicative of pre-existing sulphides, are present, but for the most part these are devoid of the dark colored pulverent limonite, characteristic of pre-mineral rock surfaces over supergene copper deposits. The generally accepted theory is that copper free pyrite leaves little or no residual limonite, but often staing the host rock various shades of brown or red.

Alteration, evidenced by the general bleached appearance of the outcrops, is present throughout the pyritic zone in various degrees of intensity. It is characterized essentially by the development of various clay minerals in the feldspars, and by the bleaching of the ferro magnesian minerals, represented mainly by biotite mica. The alteration appears to be more intense in areas of close-spaced fissuring accompanied by relatively strong mineralization, which includes the ore bearing areas. However, it has been noted in drill samples that the rock increases in hardness and possesses a comparatively fresh unaltered appearance in the primary zone, below the zone of secondary chalcocite. Thus it appears that descending acid solutions, derived from the

oxidation of pyrite mainly, may have been responsible to a large extent in producing the altered appearance of the outcrops. This observation does not imply that hydrothermal alteration (associated with primary mineralization) is entirely absent.

3. Tactite - Garnetized, Silicified Limestone and Shale -

This unit includes areas of so-called contact metamorphism, commonly termed "tactite". This type of mineralization is confined to a narrow belt in the limestones and limey shales along the major break trending northwest. The weathered surfaces of this material are characteristically black, a color produced by residual oxides of manganese and iron. A major portion of the copper produced in the past was derived from replacement type bodies along fissures in the garnetized limestone of the Mammoth and Union mines. Copper mineralization of the disseminated type is generally very weak or absent in these rocks in the Silver Bell district.

4. Fresh or Very Weakly Mineralized Rocks -

This classification includes all rocks that exhibit in general a relatively fresh, unaltered appearance. Due to the fact that transition from the fresh to strongly mineralized type is often gradational, the boundary between the two represents an arbitrary division.

Past Exploration -

Perhaps, the first to pursue the limonite, residual after chalcocite, in the outcrops of the Silver Bell district were the Indians which at one time inhabited the region. Evidence of their work is found in a large number of open cuts which, without exception, are located in outcrops containing prominent seams of the maroon or black limonite. Since the base and precious metal content of these deposits is very low, a plausible explanation ~~is~~ might be that the Indians used this particular limonite as a pigment--war paint, perhaps, or pottery coloring. The ancient character of the excavations is evidenced by the advanced weathering of the dumps and by the vegetation growing in the cuts; saguaros over 25 feet high were noted in some cases, indicating an age of at least 200 years. Kenyon Richard was the first person to call attention to the antiquity of these workings.

During the period of early activity in the low grade copper field (around 1910), an extensive search was carried on in the Silver Bell area for this type of ore. The disposition of the old churn drill holes, shafts and trenches indicate that the old timers recognized, to some extent at least, the significance of

dark colored residual limonite. The trenches were apparently excavated for the purpose of exposing bedrock in areas covered by a thin mantle of slide rock or alluvium so that a close appraisal of the nature and frequency of the limonite could be made. Where the evidence was considered favorable, a drill hole, a shaft or a drift was driven to the sulphide zone. It is notable that in many areas in which the old trenches expose comparatively little residual limonite, no other prospecting was done. An example of this is found in the area immediately east of the Oxide deposit where numerous trenches were dug, but no drilling was done, even though some of the eastern most holes in the Oxide contained ore. Recently, three holes drilled in this area proved it to be sub-marginal.

In conclusion, it is considered evident that, (1), secondary enrichment is entirely responsible for the commercial grade of the known copper occurrences of the disseminated type, and (2), commercial possibilities are confined to the two recognized deposits, the Oxide and El Tiro.

These conclusions do not preclude the possibility of higher grade primary copper mineralization occurring at depth, however, drill results obtained thus far in the two areas of strongest primary copper mineralization (the Oxide and El Tiro) provide no particular encouragement for deeper exploration.

Kenyon Richard, in his report of July 26, 1948, on El Tiro, recommended that the possibility of primary disseminated copper ore occurring at depth along the structure marked by the zone of brecciation passing through the Williams, Hilda and Daisy shaft areas, should be tested by extending an occasional drill hole several hundred feet below the chalcocite zone. I am in accord with this recommendation, which has already been carried out to some extent in recent diamond drilling. During the current churn drill program, it is planned that two holes, located in areas which showed the best primary copper values in the diamond drilling, will be extended two or three hundred feet below the chalcocite zone.

Yours very truly,

J. H. Courtright

J. H. Courtright

JHC:cms
Enclosures - 2
cc-W. M. Loerpabel, w/enc.
D. J. Pope, w/enc.
W. H. Landwehr, w/enc.
Silver Bell - 2

March 28, 1949

AIR MAIL

Mr. F. V. Richard, Manager
Southwestern Mining Department
American Smelting and Refining Company
P. O. Box 2229
Tucson, Arizona

SILVER BELL
CHURN DRILLING AND SAMPLING

Dear Sir:

This will acknowledge receipt of your letter of March 16th with which came Mr. Courtright's excellent report and description on the churn drilling and sampling at Silver Bell. I would like to have two more copies of this report for future use.

In studying over the report, Mr. Tainter and I have noted especially the conclusions on Page 10 as to the accuracy of the old churn drilling with various factors for reduction in grade. I am sure that in Mr. Stephen's calculations sent with his letter of February 21st, he made reductions in the assaying grade as determined by the old drilling schedule greater than Mr. Courtright has recommended, but for the record I would like you to confirm this. Actually, the copper occurrences in the northern part of the deposit are so erratic that the only safe method seemed to Mr. Stephens and me to take the individual samples corresponding to each bench and each hole and make conservative reductions after studying them in relation to the surrounding holes.

I am sure that Mr. Courtright's work and description thereof in the report will be of considerable use to us in future problems of this nature.

Yours very truly,

ORIGINAL SIGNED BY
D. J. POPE

D. J. POPE

DJP:bm
cc:W.H.Loerpabel
J.H.Courtright
F.M.Stephens

MINING DEPT.
MAR 30 1949
TUCSON

AMERICAN SMELTING AND REFINING COMPANY
Tucson, Arizona

March 10, 1949

MEMORANDUM TO:

Mr. F. V. Richard

EL TIRO PROJECT
Pima County, Arizona
ORE ESTIMATE AND
FURTHER DRILLING

ORE ESTIMATE

Herewith a rough approximation of ore indicated by recent diamond drilling and early churn drilling at El Tiro. The horizontal and vertical extent of the material included is shown on the attached plan and section. Results calculated by Mr. Desvaux are as follows:

Ore	12,945,236 tons	@ .77% Cu
Waste capping	9,646,616 tons	
Waste - ore ratio		.76 to 1.00

North of this area, containing an indicated 13 million tons, there is room for a possible 5 million tons, or a total of 18 million tons for the entire area.

DATA USED

Old churn drill results	Over 1.00% Cu reduced 30% Over 1.50% Cu reduced 50%
Diamond drill results	Core-sludge combined assay
Cut off, ore	.40% Cu
Density - ore	12.3 Cu. ft. per ton
waste	13.0 Cu. ft. per ton
Slope of boundaries	55 degrees

The area and grade of ore on each of eight sections (Nos. 7, 8, 9, 11, 12, 14, 17, 18) were used to compute the tonnage and average grade.

CURRENT STATUS OF PROJECT

As of March 1st, sixteen holes, totalling 6035 feet, had been drilled. Of the original twenty proposed holes, four holes, or 1600 feet remain. The balance remaining in appropriation 8911 is approximately $72,000.00, an amount sufficient to drill at least fifteen holes, or 6000 feet.

FUTURE DRILLING

No holes have yet been drilled north of the Daisy shaft, however, results obtained thus far in drilling 75% of the area possessing favorable aspects (outlined on the 400 scale plan) indicated that the chances for developing commercial ore are confined mainly to the south portion. It is recommended that the balance of the appropriation be expended in more closely defining the grade and extent of this indicated ore. Results obtained from ten additional holes, spotted in the widest gaps in present data, would provide a more firm basis for determining the advisability of proceeding with a larger program of drilling to measure the grade and tonnage. It is believed that this would be the most advantageous use of the funds available. In view of the near-marginal tenor of the ore occurring within the outline of strongest copper mineralization, exploration outside this zone holes little promise and none is recommended for the present.

DRILLING METHODS

It is proposed that the churn drill rig, now operating west of the Oxide, be transferred to El Tiro when the prospecting in the West area is finished, probably around March 18th.

It is believed, as stated in previous reports, that the churn drill sample is more reliable than the diamond drill sample, principally because of its larger size and the higher recovery represented. The diamond drill is useful in the scout phase of exploration, in that it provides more geological information and more suitable metallurgical samples; however, in the development phase of exploration, the churn drill is considered a more dependable means of measuring the average porphyry copper ore body.

DIAMOND DRILL RESULTS

Core recoveries (83% average) obtained in the diamond drilling at El Tiro have been above the average obtained in similar deposits, however, the average sludge assay runs 10% higher in copper than the average core assay in eight out of ten holes drilled. This average difference of .05% to .10% copper may be due to values ground out of the cores, or to values washed from the walls, or to both. At any rate, the possible error is of importance in a near-marginal ore body.

COSTS COMPARED

The two methods are approximately equal in respect to cost per foot. The extra road work required in churn drilling amounts to around $.50 per foot drilled. At present the direct drilling cost (exclusive of sampling, assaying, roads, campsoverhead and supervision) is approximately $6.50 per foot in both cases; the overall cost is approximately

$12.00 per foot in both cases.

J. H. Courtright

J. H. COURTRIGHT

JHC:oms
cc-D. J. Pope
Silver Bell - 2

AMERICAN SMELTING AND REFINING COMPANY
Tucson, Arizona

March 4, 1949

Mr. F. V. Richard, Manager
Southwestern Division
American Smelting and Refining Company
Tucson, Arizona

SILVER BELL PROJECT
PIMA COUNTY, ARIZONA
AREA EAST OF OXIDE

Dear Sir:

Herewith is Mr. Playter's East Area report, in which he concludes that there is no reasonable chance of developing commercial ore on the property. This conclusion is based essentially on:

1. The generally feeble and discontinuous character of the copper mineralization, evidenced by the nature of the limonite in the leached outcrops, and

2. The negative results of early churn drill prospecting which extended the full length of the area.

The recent investigation represents a thorough study and a careful appraisal of an area in which ample bedrock exposures exist. I am in full agreement with the conclusions set forth and believe the property merits no further consideration as a possible source of disseminated copper ore.

The foregoing implies that the allocation for diamond drilling in appropriation 8904 will not be used and that the property now held under location may be abandoned.

Yours very truly,

J. H. COURTRIGHT

JHC:ams
cc-W. H. Loerpabel
D. J. Pope
W. R. Landwehr
Silver Bell - 2

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

February 28, 1949

Mr. J. E. Courtright
American Smelting & Refining Co.
Silver Bell Project
P. O. Box 2229
Tucson, Arizona

SILVER BELL
Pima County, Arizona
East Area Exploration

Dear Sir:

Herewith is my report on the area southeast of the Oxide pit area, acquired by location in May, 1948. Data included consists of (1) a brief summary of major geological features, (2) discussion of exploration possibilities, (3) recommendations concerning further disposition of the area, (4) an outcrop map outlining and classifying outcrops, utilizing frequency and intensity of limonite after chalcocite as a gauge for indicated copper mineralization.

SUMMARY AND CONCLUSIONS:

The area comprises a belt of strong alteration and weak copper mineralization, having an average width of 2300 feet and a minimum length of 7000 feet. Parallel northwest trending faults mark the southwest and northeast margins.

Hydrothermal alteration, ubiquitous within the margins of mineralization, is due to sulfide mineralization of both iron and copper. The copper mineralization is spotty and occurs in small, disconnected bunches. Results of churn drilling in 1909 support this conclusion.

Copper values which occur in this area are substantially due to supergene enrichment. Leached outcrops indicate that inadequate primary copper was present to form an enriched zone of sufficient grade and thickness to be economic.

It is my opinion that this area, located as the Ox Group of Claims, warrants no further consideration.

FIELD WORK

The actual field mapping was begun December 1, 1948. Plane table and transit-stadia methods were employed. Topographic sheets prepared by Fairchild's, Inc. covered only the northwestern tip of the area and hence were of little benefit. No effort was made to extend the topography in this initial study of the area. Triangulation control was extended to the southeast from the Oxide Area, nine new stations being located. Transit traverses between triangulation stations furnished secondary control. Elevations

of all plane table and stadia shots have been computed and filed to be used if topographic extensions are desired.

In lieu of topography, the drainage pattern of the area has been mapped in considerable detail. This detail in addition to newly located and well-marked claim locations furnish sufficient orientation for any additional work deemed necessary.

W. K. Nourse, W. T. Barlow and W. L. Loring have alternatingly served as instrument operators for the work.

GEOLOGY

Structure: The formations in the area consist of Cretaceous volcanic flows with intercalated sediments. Their trend is generally N 75 W with dips to the southwest at approximately sixty-five degrees. These have been intruded by diorite and quartz monzonite, the latter usually following trends earlier taken by the diorite. Structurally, the most prominent feature is a nearly vertical quartz vein, marking an old fault line and trending persistently N 75 W which strikingly defines the southwestern edge of mineralization. The northeastern limit of mineralization is marked by a fault paralleling this vein, the margin being less conspicuous and slightly gradational, however. This fault probably represents a spur of the major east-west break delimiting the north margin of mineralization in the Oxide Area.

These parallel structures delimit the hydrothermal alteration and mineralization of the area which averages 2300 feet in width. This zone, as evidenced by outcrops, extends for a distance of approximately 7000 feet southeasterly; beyond this point gravels conceal the possible continuation.

HYDROTHERMAL ALTERATION AND MINERALIZATION

Copper is erratically dispersed throughout a zone of moderate to strong alteration defined by the parallel northwest-trending faults. The entire zone is thoroughly discolored with the characteristic brownish-yellow of limonite after pyrite.

Following the invasion of quartz monzonite, mineralization, consisting essentially of pyrite with minor chalcopyrite, occupied a fracture pattern composed of three trends: N 75 W, N 60 E and N 30 W. Of these three sets of steeply-dipping fissures, the former is the oldest, the latter the youngest.

Chalcopyrite, which appears to be slightly later than pyrite mineralization, was deposited as narrow stringers, or occasionally as discrete grains, along the two sets of fractures which break across the dominant N 75 W trend. Greater concentrations appear to occur at intersections of at least two of these systems.

Moderate to strong hydrothermal alteration, evidenced by the bleached appearance of the rocks, is characteristic of the entire mineralized zone. This widespread alteration appears to be coincident with sulfide mineralization of both iron and copper.

While there is no direct evidence that the values encountered in the old churn drilling were the result of chalcocite enrichment, the position of these values in respect to the surface (underlie a barren zone and are underlain by a lean primary zone) is fairly good evidence of a supergene origin. In the Battery Shaft, at the base of an oxidized zone, small amounts of chrysocolla and chalcocite were noted in the pyritic material present there.

No particular rock type in the area is recognized as being an exceptionally favorable host for mineralization. Diorite is never strongly mineralized, but with this exception, rock types seem equally favorable.

LEACHED OUTCROPS

The oxidation and leaching of sulfide copper minerals leaves a residue of limonite unique in color and texture in the leached rocks. Dependent upon a "live" color varying from purple-tinged dark red to chocolate brown, outcrops are classified as having formerly contained pyritic chalcocite. Areal mapping of this "live" rock constitutes an outcrop map and serves as a rough quantitative index of copper previously available for supergene enrichment.

Areas of essentially pyritic mineralization provide a color contrast to areas which contain copper. Limonite after pyrite is characteristically yellow to brownish-yellow in color. Botryoidal textures characterize limonite after pyrite as opposed to thin-walled cavities and cellular texture of limonite after chalcocite.

This interpretation is based on information available throughout this area and the adjoining Oxide Area. The majority of drill holes and shafts (deep enough to penetrate the sulfide zone) collared in light brown or buff outcrops encountered submarginal copper values. In contrast, over known ore occurrences, the outcrops display for the most part purple-tinged dark red colors. Such observations formed the basis for classification of leached outcrops in the East Area.

Depiction of the zones of copper mineralization on the accompanying 200 scale map is the same as was earlier presented on an outcrop map of the Oxide Area. However, theareas shown as containing moderate to strong copper mineralization are less intensely mineralized than in the Oxide ore zone.

OLD CHURN DRILL DATA

Seventeen churn drill holes were drilled in 1909 to test portions of this area. The E. W. Mudd interests of Los Angeles did this work and have supplied portions of the results which were available. Eighteen holes are on record although Hole No. 16 was reportedly not drilled. Logs of Nos. 7-15 inclusive and Nos. 17-18 inclusive are available. No record of holes Nos. 1-6 are available but they reportedly encountered no ore.

Ten of these drill holes are within the area covered by the 200 scale map accompanying this report. The collars of holes Nos. 17, 18, and 8 were found and located by survey. Six holes were located solely by charcoal remnants near old boiler sites, and stakes marking approximate locations were surveyed. The location of hole No. 15 was taken from a plan map obtained from old reports. Newly-surveyed locations checked very closely with those shown on the available map of the area.

Only three of the seventeen holes encountered noteworthy values. These are No. 11 which cut 115' averaging 0.91 % Cu, No. 15 which showed 85' averaging 1.41% Cu, and No. 7 which had 35' of 1.12% Cu. This last hole is just off the 200 scale map to the southeast along the road. These averages were calculated using 0.6% cutoff.

EXPLORATION POSSIBILITIES

The largest areas of copper mineralization, as shown on the attached map, occur as widely separated zones of three to four hundred feet in diameter. While the characteristic limonite is disseminated throughout these areas, the intensity is low; that is, the limonite occurs essentially as very thin fillings along rather widely-spaced joint planes in the rock. At best, these areas might be expected to contain less than half of the copper present in an equivalent portion of the Oxide Area, where for the most part the outcrops show stronger mineralization in the form of closely-spaced parallel veinlets.

The two ore holes, as determined from old churn drill data, are almost completely bracketed by barren holes, and present a typical example of the spotty mineralization characterizing the area.

Insufficient primary copper is indicated as having been present to provide secondary enrichment of commercial extent. Although the hydrothermal alteration of the Oxide deposit extends into this area, there is a definite weakening in intensity of copper mineralization.

It is concluded that there is no reasonable chance of finding mineable tonnages of disseminated copper ore, and

therefore no exploration is recommended.

Yours very truly,

J. C. Playter

J. C. PLAYTER

jcl/cms
Enclosure-Map
cc-W. H. Loerpabel
D. J. Pope
W. R. Landwehr

COPY

December 22, 1948

MEMORANDUM TO MR. D. J. POPE:

ARIZONA, PIMA COUNTY
SILVER BELL PROJECT
OXIDE AREA

Exploration Recommended by Dr. Kerr:

Dr. Kerr, in his alteration report, has proposed numerous drill locations both east and west of the Oxide. I believe that possibilities for commercial tonnages of ore are definitely remote in both directions. This conclusion is based on a study of the leached outcrops. However, should a test of Dr. Kerr's theories (that disseminated ore might occur anywhere within the pattern of strong alteration in the monzonite and other rocks) be desired by others concerned, at least seven holes are considered necessary. Three of these (K1, 2 and 3) are spotted on the proposed locations east of the Oxide, on Figure 9 of the alteration report (see attached 400-scale map). The purpose of these holes would be to test, to a certain degree, Dr. Kerr's contention that any highly altered area, regardless of whether or not additional indications of mineralization are present, is potentially "ore"-bearing.

The other 4 holes (E4, 5, 6, and 7) are spotted on Dr. Kerr's proposed locations along the narrow belt of monzonite extending westerly from the Oxide. It so happens that this area, which lies along the major east-west structural break, does contain evidence of strong chalcocite mineralization, and therefore holes drilled here are likely to encounter ore grades; however the zone is considered too narrow to contain minable tonnages.

7 holes (K1, 2, 3, 4, 5, 6, 7) at 350' = 2450'

Should ore be encountered, additional drilling would be required to determine the width of the zone.

AREA EAST OF OXIDE:

Mapping of this area will be completed within one month. It is believed that this map, which will be designed to show the distribution of stronger chalcocite mineralization as evidenced by characteristic limonite in the leached outcrops, and also the pattern of strong alteration, will provide a satisfactory basis for appraisal of the possibilities of the area. Judging from a brief reconnaissance of the area, the chances for commercial tonnages of disseminated copper ore are quite remote. Little encouragement is to be found in old drill results obtained from S. W. Mudd. Only two holes, Nos. 11 and 15, contained ore columns, and these are bracketed with four holes in waste. (See accompanying 1000-scale map.) A decision on drilling in the area should be deferred until the mapping is completed.

J. H. COURTRIGHT

JHC:si

COPY

Mr. A. E. Ring

Dec. 18, 1948

A I R M A I L -
CONFIDENTIAL

Mr. W. H. Loerpabel, General
Manager Mining Department
New York Office

SILVER BELL -
PIMA COUNTY, ARIZONA

Dear Sir:

The purpose of this present letter is to summarize in a general way our results at Silver Bell up to date. In order to get this to you before you leave on your vacation, it will not be possible to present a lot of supporting data nor final detailed calculations.

O X I D E A R E A

Results of Check Drilling - Here we have finished approximately 10,000 feet of check churn drilling with careful casing and sampling of the holes. In the southern part of the deposit where the old holes were widely spaced we drilled a new row which has been called B - B'; for the general location please see Mr. Courtright's last report to Mr. Ring dated Dec. 11, 1948. The primary reason for drilling this row of holes was to make sure that there were not large islands of waste in the area that had not been drilled. If such islands of waste existed, then the tonnage of ore previously estimated might be seriously reduced. The results of this drilling were quite encouraging because no poor holes were found, and in fact the average grade of the material encountered is somewhat higher than shown by the old churn drill holes to the North and South of the new row.

In addition to this drilling in the relatively untested area a number of holes were drilled in the northern part of the deposit for the purpose of making a check against the old churn drill assays. The results of this work showed that the copper occurrences in this northern part are extremely erratic. The new drilling indicates a copper content of 20 or 30% lower than does the old. We now think that the great discrepancy is due almost entirely to the nature of the ore occurrences, although there may have been a minor amount of salting of the old samples due to the fact that the old churn drill holes were not cased. Mr. Courtright by his detailed work has arrived at a logical explanation of the great variation in the indicated ore occurrences in the northern part of the Oxide Area. This he believes is due to the fact that a number of silicified limestone masses occur, which were impermeable to the solutions which made the secondary enriched zones possible. In the southern part these limestone masses, or islands, do not occur and hence the dissemination of the secondary copper values is much more general and uniform.

The result is that for the northern part of the ore body it would be almost impossible to arrive at a very accurate estimate of the copper

content with any reasonable number of holes. Therefore, about all that we can do is to reduce the old churn drill assays to approximately the grade of the new drilling, although we feel that the old holes can be used as an indication of where the ore occurs, at least. Fortunately this erratic area only amounts to about one third of the prospective pit area, so that the effect of the reduction in grade on the whole tonnage being estimated is not as great as was at first feared. The change in the character of the deposit seems to occur between Sections A - A' and C - C' as shown on Mr. Courtright's progress maps. Furthermore, the relatively small reduction in tonnage indicated for the northern area by the new drilling over that of the old drilling is just about compensated for by the extension to the eastward of the ore beyond the old pit outline at Section C - C' made possible by the results of drilling in holes 113 and 116.

On this basis the general tonnage calculations indicate that with a 0.8% copper cutoff we still calculate approximately 13,000,000 tons with a grade of 1.22%. This is before any reduction factor and compares with the old calculation of 1941 of about the same tonnage with 1.32% copper which when reduced by 6.7% gave the figure used for the 1941 and 1946 estimates of 1.23%. I think that we should still allow a certain dilution factor when making our outcome estimates which I would estimate to be about 0.1% copper, and making the final tonnage and assay for calculating outcomes 13,000,000 tons assaying 1.12% copper. I believe that this is a conservative figure, but not too much so considering the nature of the ore body with which we are working. This is also a preliminary figure because we have a few assays still to come in and there has not been time for finishing a complete detailed calculation of the grade of the whole ore body by mining benches which I think is the only way to arrive at reliable figures with the relatively thin and irregularly lying ore body which we have at Oxide.

We do not have the assays for all the samples giving oxidized copper content of the ore. We do have anough, however, to say that the oxidized portion as now determined is slightly lower than the previous figure, so we feel that the laboratory tests used in previous estimates were conservative. Some new laboratory tests were made on churn drill cuttings but, as expected, these were erratic and not reliable.

<u>Additional Drilling Recommended</u> - You have Mr. Ring's letter of Dec. 7 listing the additional drilling that he and Mr. Courtright have recommended. Naturally by doing the additional work within and around the fringes of the recognized ore body we can further refine the estimate of tonnage and grade, but Messrs. Landwehr, Hart and I feel that this relatively large amount of additional testing within the known ore body is neither required for arriving at the magnitude of the business nor is it justified for achieving an additional relatively small degree of accuracy. Accordingly, I am merely attaching the necessary original and three copies of the formal application for appropriation - S.L. No. 29 for the $30,000. already approved in principle, for completing this drilling on the Oxide ore body proper. As soon as the hole now being worked on, which is No. 130 at the east end line of B - B' has been completed, we will do no more drilling within the Oxide ore body proper or around its immediate fringes unless you instruct otherwise.

Estimated Probable Outcome on the Oxide Ore Body - In addition to the calculation of tonnage and grade at 0.8% copper cutoff made above, we have also made a similar preliminary estimate at 0.6% copper cutoff and 0.4%. As you found to be the case before, the 0.8% cutoff gives the best over-all outcome results, so the estimates for the other cutoff bases will not be repeated here. For arriving at the general picture at this time we have not endeavored to make a complete re-estimate of capital cost because of the time and work required to do so, but we have made a number of inquiries on present mining and stripping costs as well as the increase which has occurred since 1946 when the last estimate was made. Mr. Weiss has also secured some figures from Western Knapp and has made a re-estimate of the mill cost.

We have also assumed that electric power could be obtained at 0.52¢ per kilowatt hour, this being 10% higher than that used in the previous estimates of 1941 and 1946, but actually at the present time the power situation is worse than it has been at any time in the past when serious estimates were made, so without some sort of Government help, such as allocation of power from the Davis Dam, we do not know where power might be obtained at the present time. This, of course, makes our estimated outcome entirely theoretical until these problems have been solved.

We have also obtained a new smelter schedule from Mr. Rickard, copy of which is attached, from which Mr. Weiss has estimated the net smelter value of ores of different grades at different copper prices, and I am attaching a copy of the table which he prepared showing this.

I am also attaching some general summaries of calculations which I have made giving the outcome to be expected and the break-even price required for copper just to get our money back. You will note that at the present time with the price of electrolytic copper at 23.2¢ per pound I calculate a profit of $5,850,000. for working this ore body over its life of seven years. To break even the price of copper would have to be 20.4¢. An interest rate of 5% was used as in previous estimates.

This represents, of course, a considerable increase in break-even price over that previously estimated, but we mention among other things the increased costs which would have to be borne by the operation compared with your 1941 basis which are as follows:

1. The freight rate to El Paso instead of to Hayden, the rate being more than double. It is $5.00 per ton as compared with $2.20 in your 1941 estimate. Also taxes on freight have increased.

2. The increased smelter treatment charges, now being quoted at $5.00 as compared with $2.00 in 1941.

3. The increase in copper deduction in the smelter schedule from 15 to 20 lbs. per ton of concentrates; and in price deduction from 2.5¢ to 2.87¢.

4. You will recall that in 1946 wages were up 52% over 1941 and we estimate that now they are up 20% more over 1946.

5. Supply items have of course also increased along with wages.

The following table gives for ready reference the essential data in connection with the Oxide ore body:

Ore Reserves	13,000,000 tons
Cut-off grade	0.8% copper
Grade	1.12% total copper
Mill Recovery	77% of total copper
Grade of Concentrates	24.0% copper
Ratio of concentration	1 to 25
Tons treated per day	5,000
Tons treated per year	1,800,000
Life of operation	Seven years
Ratio of total waste stripped to ore	1.5 to 1
Tons of waste	19,500,000
Tons of preliminary waste stripping	8,000,000
Tons of waste remaining to mine with ore	11,500,000
Average waste to ore ratio during operations	0.885 to 1

E L T I R O

As you have mentioned in your letter of Dec. 1st, we all agree that the diamond drilling underway at El Tiro should be completed. I will not attempt to analyze the results of this diamond drilling in detail at this time, but will only say that I think that it is proving satisfactory for this prospecting phase of the work. The saving in cost over churn drilling has been disappointing, and furthermore the men in charge of this work have decided so far to drill all the holes vertical, so that the advantage of being able to drill inclined holes when using the diamond drilling method is not present.

When you are here we will have ready a number of sections indicating on tracing cloth all this information so that you can see what the drilling shows so far. In a general way it is demonstrated that the churn drilling at El Tiro by the old Imperial Copper Company was not nearly as accurate as that done at Oxide. Indications are that there may be at El Tiro about half the tonnage of copper ore that there is at Oxide, which can be worked by open pit methods and which will have an average assay slightly lower than that at Oxide.

OTHER PROSPECTING DRILLING

Since obtaining the appropriation for exploring the alteration area recognized by Dr. Kerr east of the Oxide ore body where we have taken up about 28 new claims, we have obtained the results of drilling done some years ago by the Mudd Interests. This disproves the existence of important tonnages in a considerable part of the area. However between the Mudd drilling and the Oxide ore body there is some unexplored ground where we wish to drill some holes.

Furthermore, we all feel that a limited number of holes either by churn or diamond drilling should be put down in some of the other principal alteration areas recognized by Dr. Kerr toward the Northwest of the Oxide ore body. I believe that it is reasonable to use the money appropriated for the exploratory drilling to the east of the Oxide ore body also in part for doing similar drilling toward the west and we will do so unless

you have some objection. Mr. Courtright is making up some plans showing which of Dr. Kerr's areas we expect to drill in and you will receive these in a few days or at least by the time of your visit here.

GENERAL CONCLUSION

In general then it can be said that we have proven that there is a marginal ore body at Silver Bell which can be worked only under favorable conditions. If we had assurance that current copper prices would continue, then the property could be developed under present conditions. So far, every time the copper price has gone up high enough, construction costs have also been up and it has been felt that the copper price structure was not secure enough to warrant the large investment required to open up the property. This will probably be the case now, so development of the property will have to await a more favorable price outlook in relation to construction costs.

Yours very truly,

Original signed by D. J. Pope

D. J. POPE

DJP/emf

cc Reg. Mail
AERing

Encls. - Silver Bell Appropriation request - Orig. & 3 copies.
Smelter Schedule (El Paso Smelting Works)
Attach. 1 - Summary of Capital Expense.
" 2 - Estimated Milling Costs.
Tabulation 1 - Estimated Recovery of Copper and Value.
" 2 - Value of One Ton of Concentrate.
Estimated Outcome

COPY

cc: D.J.Pope E.McL.Tittmann
A.E.Ring

PURCHASE SCHEDULE Tentative

American Smelting and Refining Co.
EL PASO SMELTING WORKS
EL PASO, TEXAS

Date Effective Dec. 2, 1948

Mine SILVER BELL UNIT

Location Silver Bell Mining District
Pima County, Arizona

Shipper AMERICAN SMELTING AND REFINING COMPANY

Address 600 Pacific National Life Bldg., Salt Lake City 1,Utah

Character Ore COPPER CONCTS.

R.R.Station Naviska, Arizona

The following purchase terms are subject to the General Clauses shown on the back of this sheet, and are subject to prompt acceptance. Unless shipments are begun within 30 days this quotation is automatically cancelled.

PAYMENTS

GOLD: If 3/100 of an ounce per dry ton or over pay for all at the rate of $19.50 per Troy ounce, plus 90% of the realized gold premium in excess of $20.67 per Troy ounce. Under present Government net realized price, this is equivalent to paying for 100% @ $32.31825 per Troy ounce.

SILVER: Pay for 95% (minimum deduction of 1/2 ounce) at the average Handy & Harman New York Silver quotations for the calendar week, including date of delivery of last car of each lot at plant of Buyer, or, if higher, at the realized Mint price provided silver qualifies for Government purchase and affidavit is furnished, less a deduction in either case of 1-1/2¢ per ounce.

COPPER: Deduct from the wet copper assay 20 pounds and pay for the remaining copper at the daily net refinery domestic quotations for electrolytic cathodes as published in the E. & M. J. Metal and Mineral Markets of New York averaged for the calendar week preceding date of delivery of last car of each lot at the plant of the buyer less a deduction of 2.87 cents per pound of copper accounted for. Nothing paid for copper if less than one-half per cent by wet assay.

No payment will be made for any metal or content except as above specified.

DEDUCTIONS

BASE CHARGE:* $5.00 per net dry ton of 2,000 pounds; provided the sum of payments for gold, silver, lead and copper does not exceed $ -- per ton. Add to the base charge ten per cent of the excess over $ -- to a maximum charge of $ -- per dry ton.

The base charge just specified is for ores containing at least eight pounds of copper per ton; when a smaller quantity is contained, there will be added to the base charge a sum equivalent to the value of the deficiency between actual contents and eight pounds per ton computed according to the terms specified herein for copper payment.

INSOLUBLE: Allow all units free; charge for excess at cents per unit, fractions in proportion.

ZINC: Allow five units free; charge for the excess at thirty cents per unit, fractions in proportion.

ARSENIC: Allow two units free; charge for the excess at $0.50 per unit, fractions in proportion.

ANTIMONY: Allow one unit free; charge for the excess at $1.50 per unit, fractions in proportion.

BISMUTH: One-tenth of one percent (0.1%) by wet assay allowed free, excess charged at 50¢ per pound, fractions in proportion.

MOISTURE: A minimum deduction of 1% will be made from wet weight; when over 1% contained actual moisture will be deducted.

DELIVERY: F.O.B. unloading bins American Smelting and Refining Company, El Paso, Texas.

The rates quoted are based upon shipment in dump bottom gondola equipment. Extra unloading charge of $1.00 per dry ton will be assessed for products received in box cars or solid bottom gondola cars. All truck shipments will be assessed an extra handling charge of 50¢ per dry ton.

TAXES: See Clause 1 on reverse side of this Schedule.

FREIGHT: All railroad freight and delivery charges for account of shipper. Deduct from settlement freight and other advances made by Buyer.

TONNAGE: Limited to tons per month except by special arrangement.

*Based on average hourly labor cost of 134.4¢, adding or deducting 6¢ per ton for each 1¢ per hour increase or decrease.

AMERICAN SMELTING AND REFINING COMPANY

By /s/ Brent N. Rickard

BRENT N. RICKARD

(over)

SILVER BELL PROJECT

SUMMARY OF CAPITAL EXPENSE

ESTIMATE - DECEMBER 18, 1948

(1) Milling Plant		
(a) Main Plant incl. tailing thickener, new estimate by WKE Dec. 11, 1948	2199351	
(b) Tailing Disposal - Launders, Dams 1946 estimate plus 8%	48600	
		2247951
(2) Water Supply		
(a) Purchase of land & drilling of wells - 1946 estimate plus 15%	46000	
(b) Power Line to wells, WKE 12-11-48	48300	
(c) Pumps, pipe lines, reservoirs WKE 12-11-48	466000	
		560300
(3) Shops and Offices		
(a) Shops, offices, & shop equipment New estimate WKE 12-48	253159	
(b) Office and Laboratory Equipment 1946 estimate plus 10%	27500	
(c) Shop Tools for Machine Shop, Truck and Cat Shop, Drill Repair Shop, Blacksmith and Tin Shop, Carpenter Shop WKE Estimate PD 200 of 8-42 plus 23%	94887	
		375546
(4) Power		
(a) Main 115 KV line, 40 miles from Coolidge - 1946 est. plus 23% (G.E.)	302840	
(b) Temporary Power Plant New Est. WKE 12-11-48	57600	
(c) Transformer Station at millsite New Est. WKE 12-11-48	163790	
		524230
(5) Mine (Equipment Only)		
(a) Power Shovels, Trucks, Miscl. 1946 est. plus 20%	1137600	
(b) Electric Power Line & distribution to pit - 1946 est. plus 20%	48000	
		1185600
(6) Truck Road - Mine to R.R.		
(a) Truck road, grading, bridges R.R. Sta. 1946 est. plus 20%	276000	
(b) Miscl. Transp. and Maintenance Equipment, 1946 est. plus 15%	88550	
		364550

SILVER BELL PROJECT

SUMMARY OF CAPITAL EXPENSE

ESTIMATE - DECEMBER 18, 1948

(Continued)

(7) Miscellaneous Charges Applicable to above			
(a) Old Age Benefits, Workmen's Compensation & Social Security, 12% of Payroll, Items 1 - 6 or 3.75% of total		197000	
(b) Engineering, Drafting, Supervision 3% Items 1 - 6		158000	
(c) Contractors Profit			
Total 1 - 6	5,258,177		
Less Mine Equip.	1,137,600		
Less Miscl.Transp.	88,550		
5% of Balance		202000	
			557000
(8) Contingencies 10% Items 1 - 6			525800
(9) Mine Camp (Same as 1946)			985000
Total Cost of Plant			7,325,977
(10) Mine Preparation			
(a) Additional Drilling and Testing		--	
(b) Initial Waste Stripping			
1. Preparatory Road Work 300,000 Tons @ 65¢		195000	
2. Stripping first 1,000,000 tons @ 56¢		560000	
3. Stripping 7,200,000 tons @ 29¢		2088000	
4. Contractors Profit on Stripping 5% of		Included	
			2843000
(11) Surface Rights & Patenting Claims			10000
(12) Warehouse Stock and Spare Parts 1946 Estimate plus 20%			330000
GRAND TOTAL (Estimated money required to place property in operation)			$10,508,977

Refunding of Capital

Total Expense	10,508,977
Less cost power line	302,840
Capital to be Refunded	10,206,137

SILVER BELL PROJECT

ESTIMATE OF MILLING COST

December 18, 1948

Labor & Superintendence	Per Month	No. Men
Mill Supt. Metallurgist, Foreman Clerk, Shift foremen, stenog.	2800	8
Warehouse	300	1
Assayer	300	1
Trucks	400	1
Watchman and Tailing Disp.	800	3
Samplers	500	2
Lab Helper	285	1
Janitor	200	1
Repairmen	2120	4
Electrician	445	1
Machinists	920	2
Coarse Crushing Plant	1420	4
Fine Crushing Plant	1420	4
Mill Operators	4270	12
Miscellaneous & Vacations	2000	5
Total	18180	48 - 50
12% FCAB, Comp.Ins.,S.S.	2180	
Total	$20360	
Per Ton C.O.	$0.1357	

Power

	KWH per Ton
Crushing, Conveying, Screens	2.0
Grinding, Classification, Regrind	9.6
Flotation, Pumps	2.9
Dewatering Conct. and Tailing	0.4
Water (Return)	1.1
Miscl., Lab., Shops, lighting, etc.	1.7
Total	17.7

Power cost 0.475¢ per KWH plus 10% = 0.5225

Cost of power per ton Crude Ore Milled = $0.0925

REAGENTS

	Cost Per Ton Milled
6 lbs. Lime @ .011	$0.0660
.05 lb. Reagent 238 @ .24	0.0120
.124 lb. Pine Oil @ .118	0.0146
.02 lb. B-48 @ .24	0.0048
	$0.0974

STEEL AND OTHER SUPPLIES

Balls 1.9# @ .06	$0.114
Crushing & Grind. Steel	0.033
Other Supplies	0.060
	$0.207

SILVER BELL PROJECT

ESTIMATE OF MILLING COST Dec. 18, 1948

(Continued)

MISCELLANEOUS	Cost Per Ton Milled
Lubrication, Heating, Assaying, Sampling, tools, etc. but not including plant labor already taken up	$0.015

FRESH WATER SUPPLY	
Power 2.6 KWH per ton Ore @ .5225¢	$0.014
Labor	0.007
Maintenance Supplies	0.008
	$0.029

TRUCKING CONCENTRATE	Per Ton Conct. (1.1% Cu-5250 Tons/Mo.	Per Ton Conct. 0.9% Cu - 4350 Tons/Mo
21 miles @ 8¢/ton - mile	$1.68	$1.68
Add for 10% Moisture	.19	.19
3% F.T.Tax	.06	.06
Loading Cars, Naviska	.10	.10
Sampling, Weighing, etc	.07	.09
Road Maintenance	.10	.12
Total	$2.20	$2.24
PER TON CRUDE ORE	$0.077	$0.065

SUMMARY

Milling Cost	Per Ton Crude Ore
Labor, Supt'dnce	$0.1357
Power	0.0925
Reagents	0.0974
Steel, other supplies	0.2070
Miscellaneous	0.0150
Total	$0.5476
Water Service	$0.029
Trucking Concentrate	$0.077 per ton C.O. of 1.1% Cu Assay
	0.065 " " " " " " "

COPY

Tabulation I

SILVER BELL COPPER ORE

ESTIMATED RECOVERY OF COPPER AND GRADE OF CONCENTRATE

Based on American Cyanamid Tests

% Cu Crude Ore	Assumed Grade of Conct.% Cu	Assumed % Recovery	lbs. Cu Recovered	Value Cu per lb.@* 15.0¢	Value Cu per lb.@* 23.2¢	Net Smelter Value/ton@** 15.0¢	Net Smelter Value/ton@** 23.2¢	Per Ton C.O. Variation for 1¢ Change Price
1.6	26.0	79.3	25.38	9.644	17.529	$2.448	$4.449	$0.244
1.5	25.0	79.0	23.70	9.550	17.422	2.263	4.129	0.228
1.4	25.0	78.6	22.01	9.550	17.422	2.102	3.835	0.211
1.3	24.0	78.0	20.28	9.450	17.308	1.916	3.510	0.194
1.2	24.0	77.1	18.50	9.450	17.308	1.748	3.202	0.177
1.1	24.0	76.2	16.76	9.450	17.308	1.584	2.901	0.161
1.0	24.0	75.3	15.06	9.450	17.308	1.423	2.607	0.144
0.9	23.0	74.4	13.39	9.339	17.183	1.250	2.301	0.128
0.8	23.0	73.6	11.78	9.339	17.183	1.100	2.024	0.113
0.7	22.0	72.8	10.19	9.220	17.048	.940	1.737	0.097
0.6	21.0	71.9	8.63	9.088	16.898	.784	1.458	0.082
0.5	21.0	71.0	7.10	9.088	16.898	.645	1.200	0.068
0.4	20.0	70.0	5.60	8.945	16.735	.501	0.937	0.053

*From Tabulation
**Includes silver value

Assays and Recovery used in 1946 Estimate, above prices:

1.23	24.0	78.0	19.19	9.450	17.308	1.813	3.321	0.184

Norman Weiss 12-18-48

COPY

Tabulation II

SILVER BELL COPPER CONCENTRATE

VALUE 1 TON CONCENTRATE AND 1 LB. COPPER (INCLUDING SILVER)

Assuming: 1.7 oz. Silver assay of concentrate at 90¢
Tentative Schedule 12-2-48
Freight to El Paso $5.00 per wet ton.
Copper price 15¢ and 23.200¢ E&MJ Wire Bar per lb.
(0.125¢ less for Electrolytic Cathodes)

% Copper In Conct.	Equiv. lbs. Cu.	lbs. Paid For	Value at Price of* 15.000	Value at Price of* 23.200	Fixed Deduction**	Net Value/Ton Conct. 15¢	Net Value/Ton Conct. 23.2¢	Value/lb. Cu. in Conct. 15¢	Value/lb. Cu. in Conct. 23.2¢
30	600	580	69.46	117.02	9.73	59.73	107.29	9.955	17.882
29	580	560	67.07	112.99	"	57.34	103.26	9.886	17.803
28	560	540	64.67	108.95	"	54.94	99.22	9.811	17.718
27	540	520	62.28	104.92	"	52.55	95.19	9.731	17.628
26	520	500	59.88	100.88	"	50.15	91.15	9.644	17.529
25	500	480	57.48	96.84	"	47.75	87.11	9.550	17.422
24	480	460	55.09	92.81	"	45.36	83.08	9.450	17.308
23	460	440	52.69	88.77	"	42.96	79.04	9.339	17.183
22	440	420	50.30	84.74	"	40.57	75.01	9.220	17.048
21	420	400	47.90	80.70	"	38.17	70.97	9.088	16.898
20	400	380	45.51	76.67	"	35.78	66.94	8.945	16.735
19	380	360	43.11	72.63	"	33.38	62.90	8.784	16.553
18	360	340	40.72	68.60	"	30.99	58.87	8.608	16.353

* Wire Bar copper price	15.000¢	23.200¢
Less 0.125 Cathodes	14.875	23.075
Less 2.87 (Schedule	12.005	20.205
Less Bullion Fght.Tax	.029	.029
Net Copper price paid	11.976¢	20.176¢

**Fixed Deduction:

Freight	5.00
Moisture 10%	.56
F.T. Tax 3%	.17
Switching El Paso	.06
Treatment	5.00
	10.79
Silver Credit	1.06
Net Deduction	9.73

Norman Weiss 12-18-48

COPY

Estimated Outcome for 13,000,000 Tons of Ore With 1.12% Copper

OPERATING COSTS			COST PER TON
Mining Ore			$ 0.28
Stripping	.885 T at .28		.25
Milling			.55
Water			.03
General Expense			.26
		Sub Total -	$ 1.37
Hauling Concentrates			.08
		Sub Total -	$ 1.45
Contingencies			.10
		Total Operating	$ 1.55

RETURN OF CAPITAL ($10,206,000 in 7.2 years		
Without interest		.79
Interest on unpaid balance at 5%		.17
TOTAL COST		$ 2.51
N.S.Value per ton of crude ore at 23.2¢ Cu		2.96
PROFIT PER TON		.45
Profit on 13,000,000 tons	$ 5,850,000	

Break even price of copper = $23.2 - \frac{.45}{.161} =$
23.2 - 2.8 = 20.4¢ W.B. at refineries, Atlantic Seaboard

C O P Y

December 17, 1948

MEMORANDUM TO MR. D. J. POPE:

ARIZONA, PIMA COUNTY
SILVER BELL PROJECT
EL TIRO AREA

Appraisal of Recent Diamond Drilling.

To date, 8 widely spaced holes, covering the southern half of the deposit, have been completed. Results indicate the existence of an irregular secondary chalcocite deposit, varying from 50 to 300 feet in thickness and from .40% to 1.50% copper in grade. An average of the ore runs in the 8 holes shows 157 feet at .83% copper on a .40% cut-off. Should comparable results be obtained in the northern portion, an area over 3000 feet in length and about 600 feet in average width will be roughly defined as the locus of a possible 15 to 20 million tons of .80% copper ore.

The copper mineralization encountered thus far is similar to other porphyry coppers of the enriched type, in that secondary chalcocite accounts for about two-thirds, and primary chalcopyrite about one-third, of the copper content. Oxide copper is present in negligible amounts - under .05%.

Additional Drilling.

It is recommended that completion of the program of 20 holes (outlined by Kenyon E. Richard) is justified in view of results obtained thus far, and that diamond drilling be used in this scout phase of the project. If over-all results obtained from the initial phase are sufficiently encouraging, measurement of the ore body should be undertaken by churn drilling for the following reasons:

(1) Churn drilling provides a larger and therefore more representative sample.

(2) Churn drilling provides a more reliable sample in [illegible] recovery is practically 100%. Recovery on recent diamond drilling [illegible] El Tiro averaged 80% and 72%, core and sludge respectively. [illegible] ore recovery is higher than usually obtained in porphyry cop[illegible] however, due to the fact that the sludges persistently run [illegible] (20%) than the cores in copper assay, the combined assay will [illegible] to question regardless of the method used in the calculation.

El Tiro diamond drill results have been calculated thus far by [illegible] the actual weight of sludge recovered, rather than the th[illegible]al weight, resulting in a lower (and more conservative) value fo[illegible] combined assay than would be obtained by use of the theoretical we[illegible]

Comparative Costs.

An approximation of costs obtained recently at Silver Bell follows:

Diamond Drill - $7.00 per foot (including water supply and service)

Churn Drill - $8.00 per foot (including casing and reaming)

Churn drill locations and roads are more expensive; however, the cost is not over $.50 above diamond drilling per foot of hole drilled.

It is possible that we may obtain a reduction in the present churn drill contract price of $7.00 per foot, provided a sufficiently large footage is contemplated. I have recently discussed this matter with the contractor and believe that an agreement can be reached which would reduce the cost at least $.50, or possibly $1.00 per foot. Through increased efficiency in drill operation the contractor has been able to increase the drilling rate some 50% above the rate obtained in the first 5,000 feet drilled.

EL TIRO APPROPRIATION:

To November 1st - $35,000 expended; $118,000 remaining.

To November 1st - footage drilled, 2080 ft. (5 holes)
15 holes remaining at 400' = 6000 ft.

23% of the appropriation has been used (November 1st), and 25% of the drilling completed. Since considerable preliminary expen such as for equipment, surveying, etc., is included in the 23%, the remainder of the appropriation is considered ample for the remainder of the drilling.

The appropriation called for 10,000 feet of drilling, but 8,000 is considered sufficient to cover the 20 holes.

J. H. COURTRIGHT

JHC:si

3-1.1 T.H.C Personal File

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

July 17, 1948

Mr. A.E. Ring, Manager,
Tucson, Arizona

ARIZONA, PIMA COUNTY
SILVER BELL, OXIDE
EXPLORATION

Dear Sir:

This report contains, (1) a brief discussion of recently acquired geological data and its significance in respect to exploration possibilities, (2) recommended churn drilling ~~and estimated costs~~, and (3) map of the Oxide area showing the distribution of copper mineralization and proposed drill holes.

SUMMARY AND CONCLUSIONS

The Oxide deposit consists of an irregular secondary chalcocite accumulation, derived from an even more irregular occurrence of primary chalcopyrite. However, results of the 8 recently drilled holes are within ranges similar to old drill results in respect to tenor and thickness of ore. To provide a means of appraising exploration possibilities, an outcrop map was prepared showing the distribution and relative intensity of chalcocite mineralization. It is concluded that the possibilities are limited to a few minor extensions beyond the margins reached by the old drilling. Small areas of relatively strong chalcocite mineralization occur well outside the limits of the Oxide deposit. With the exception of the area around CDH No. 73, it is advised that consideration of these be deferred for the present, at least.

A total of 20 holes is proposed as the minimum requirement (1) for definition of the limits of the deposit, and (2) to obtain the necessary information in the hole No. 73 area. Additional drilling well may be advisable to provide a basis for reasonably firm tonnage and grade estimates.

GEOLOGY

Structure: Briefly, the Oxide deposit occurs within a series of volcanic flows and intrusive rocks, the latter occupying a major east-west trending fault zone. The Cretaceous (?) flows and Paleozoic sediments (chiefly limestone and quartzite) have been intruded by alaskite, dacite porphyry and monzonite in the order named. Steep northeast to northwest crossbreaking shears are closely spaced throughout the east-west zone.

MINERALIZATION

Copper is widely dispersed throughout a belt of moderate to intense alteration which marks the east-west major structural break occupied by the intrusives. Deposition of primary chalcopyrite and pyrite, mainly in the crossbreaking shears and fissures, occurred after the intrusion of the monzonite. Frequently, both minerals occur as discrete grains; however, disseminated copper in significant concentrations occurs only in the scattered zones of relatively intense mineralization.

The processes of leaching and redeposition of copper as chalcocite enriched the deposit and accomplished a diffusion of copper, which to some extent modifies the original extremely uneven primary distribution.

As determined by examination of samples from recent drilling, ore grade (around 1% Cu.) material is composed essentially of pyrite, chalcocite and chalcopyrite, representing 6 to 7% of the rock. Over 90% of the sulphide copper is in the form of supergene chalcocite, as coatings and partial replacements of both chalcopyrite and pyrite. The former is commonly present as small cores in chalcocite grains. Oxide copper, forming around 20% of the total copper in the upper portions of the chalcocite zone, is present mainly as the silicate chrysocella. Below the chalcocite zone, primary chalcopyrite values are extremely variable, but probably average over 0.3% cu.

An examination of ore exposed on the 130 level of the Copper Girl workings indicates that over 50% of the copper occurs in veins, slips and joints; the remainder as discrete, disseminated grains.

Thus far, no particular igneous rock appears to possess exceptional favorability as a host for disseminated copper mineralization. The three rocks, volcanic flows, dacite porphyry and monzonite, are irregularly distributed through the deposit, crossing rich and lean zones in what appears to be a haphazard fashion. However, the data at hand do not represent a sufficiently thorough coverage to be conclusive. The Paleozoic sedimentaries are considered unfavorable because intense mineralization as a rule extends but a few tens of feet into these rocks.

Summarizing, the deposit represents the product of progressive leaching and enrichment of a group of relatively close-spaced copper bearing shear zones. The irregularity of the chalcocite occurrence is due mainly to the spotty distribution of the primary copper, and to some extent to pre-existing climatic conditions, plus variations in rock permeability. Essentially, the deposit belongs in a category transitional between a typical disseminated "porphyry copper" and a copper bearing vein system.

LEACHED OUTCROPS

A study of the outcrops over the Oxide ore body and adjacent areas disclosed the fact that notable variations in both the color and intensity of residual limonite were present. The attached 200-scale map was prepared to depict the distribution and relative intensity of copper mineralization as evidenced by characteristic limonite visible in the bedrock exposures. This characteristic limonite, apparently derived from pyritic chalcocite, possesses a color varying from purple tinged dark red to chocolate brown. In contrast, the outcrops over essentially pyritic bodies exhibit yellow and brick red colors.

Blue-green stains and veinlets, representing chrysocolla for the most part, are prominent in some of the alaskite outcrops of the area. In these outcrops it is considered that the meager amount of copper originally present in the rock was dissolved by acid leaching and reprecipitated as silicate through the neutralizing effect of a less altered rock. Such areas, classed as weakly mineralized, are not considered to hold potentialities in respect to disseminated copper ore, regardless of their spectacular appearance.

Several limitations are inherent in the interpretation of leached outcrops: (1) The sparse occurrence of good bedrock exposures is perhaps the foremost. Roadcuts provide the best opportunity for appraisal of the nature and intensity of residual limonite; in the weathered croppings, the limonite has been largely brushed out by the elements, leaving quite often nothing more than an obscure "desert polish". (2) The transition from weak to strong mineralization is of a gradational nature; all shades and intensities are present; thus, divisions between classifications must be arbitrarily applied. (3) the surface expression of a mineralized body is not necessarily a vertical projection.

EXPLORATION POSSIBILITIES

On the attached map are shown the important structural features, the distribution of copper mineralization, the location of old and recent churn drill holes, proposed holes, and topography. Rock types were omitted for the sake of clarity. The dashed purple line was used to encompass areas of relatively intense chalcocite mineralization as evidenced by the characteristic limonite in rock exposures, modified in part by drill hole data. It is here emphasized that these outlines are not precise delimitations of commercial ore, but merely a means of segregating areas of stronger copper mineralization - the main objective being to narrow the target: if ore does not occur within any one of these particular areas, the chances outside are indeed slim.

The Oxide ore deposit consists of two strong zones separated by a narrow weak zone trending parallel to the mineralized fissures in the vicinity. Mineralization dies out rather abruptly on the north; on all other sides a tendency to feather out along fissure

trends is apparent. The possibilities appear to be limited to a few very small extensions around the margins of the deposit as defined by churn drilling.

Outside the apparent limits of the Oxide deposit, copper mineralization is generally weak, with the exception of a few rather small areas which are outlined on the map. The fact that "Old Timers" were aware to some extent of the significance of limonite after chalcocite is evidenced by the location of numerous trenches, shafts and drill holes over the whole area. The majority of the shafts, drifts and drill holes outside the Oxide deposit are spotted directly on notable concentrations of this characteristic limonite. The trenches were probably excavated as preliminary exploration in search of the characteristic limonite when alluvium obscured the bedrock.

PROPOSED DRILL HOLES

The locations of 16 proposed churn drill holes in the immediate Oxide area are spotted on the map. Of these, 14 are for the purpose of defining the margins of the deposit where possible extensions exist. P 15 and P 16 are to provide additional information on the extent of ore along the western margin of the lean central zone where a sharp upward warp occurs in the chalcocite "blanket" (see section Oxide churn drill report for June '48.)

West of the Oxide deposit, holes No. 1, 72 and 73 are credited with ore in the logs. These holes, including No. 74, were drilled directly on a strongly mineralized fissure system; therefore, the possibility of a commercial extent of ore here is open to question. Proposed holes No. 17, 18, 19 and 20 are designed as the minimum number necessary to provide an answer to the question.

In addition to the areas discussed in the foregoing, two small irregular areas are indicated on the map. The ore to the west, which includes drill holes No. 21 and 75, may extend westerly beyond the border of the map, passing just north of Wild Hog and Copper Butte, and thence more northwesterly for some 2000 feet. Throughout this extent, a continuous band of stronger copper mineralization does not appear to exist - rather, there is a series of discontinuous lenses of minor size.

Near the east end of Portland Hill another small area of limonite after chalcocite is outlined. One, and possibly two, old churn drill holes were located here. This area may be contiguous with similar small and spotty showings which occur 1000 feet, more or less, to the east.

The potentialities are considered to be of such a limited extent in the above-described areas that no exploration is proposed for the present. In the event an operation is assured on the Oxide deposit, these scattered prospects may merit further consideration as a possible source of a few additional tons of ore.

FOOTAGE ESTIMATE

Total footage drilled to July 1st.....	2585 feet
Amount to complete 12 holes.....	1100 feet
TOTAL	3685 feet
20 proposed holes - averaging 320 ft.	6400 feet
TOTAL	10,085 feet

Yours very truly

J.H. Courtright

J.H. COURTRIGHT.

JHC:m
Enclosure - Map
cc: WHLoerpabel
DJPope

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 25, 1948.

MEMORANDUM

OXIDE DEPOSIT -
Silver Bell, Arizona

Conclusions drawn from a preliminary study of the area, including old and recent churn drill data, underground and surface:

1. Economically, the ore is entirely secondary.

2. The ore body was formed through weathering and leaching of a stockwork of chalcopyrite bearing veins. The chief ore mineral, chalcocite, replaced both pyrite and chalcopyrite. The tenor of the primary (chalcopyrite) ore was around one to two-tenths copper.

3. Commercial ore is confined to areas containing numerous close spaced fissures and veinlets - "sheeted zones". Areas of low grade or submarginal copper mineralization are characterized by more widely spaced veins. This variation in the intensity of mineralization is apparent where sufficiently large areas of bedrock are exposed.

4. Leached outcrops over the area in general show dark red or maroon limonite in the veins. This color is generally thought to be characteristic of limonite derived from chalcocite-chalcopyrite mineralization, in contrast to the yellow and brick reds of limonite after pyrite. However, the mere presence of such evidence of pre-existing copper is considered inadequate as a guide to disseminated ore in the Silver Bell area; the relative frequency of these particular veins or veinlets must be appraised.

5. It is concluded that the exploration possibilities are limited to a few relatively small areas on the fringes of the ore body outlined by earlier drilling.

J.H. COURTRIGHT.

JHC:m

C O P Y

WESTERN MINING DEPARTMENT

Salt Lake City, Utah,
May 22, 1948.

Mr. A.E. Ring, Manager,
Southwestern Mining Department,
American Smelting and Refining Co.,
P.O. Box 2229,
Tucson, Arizona

Dear Sir:

I refer to your letter of May 12 to the El Paso Smelter's umpire laboratory and Mr. Courtright's memorandum to you of May 10, particularly in the matter of analyses of oxidized copper. While at Potrerillos last year I had opportunity to see the work that had been done there to straighten out the confusion in oxide copper assaying which occurred in connection with the Chuquicamata mill project.

The sulphuric acid method referred to in Mr. Platt's letter of May 14 was found unsatisfactory because sulphide copper was dissolved also. They found that the following procedure gave results that correlated very well in flotation and leaching tests. After grinding the sample to 80% through 200 mesh they agitated it in a 3.5 to 4% solution of sulphurous acid at room temperature for one hour, and then proceeded with copper analysis of the solution by conventional methods. Others use a 5% sulphurous acid and agitate at room temperature for 30 minutes.

The Dow Chemical Company uses the following method:

"A 1 or 2 gram sample, according to grade, is weighed into a 250 ml. beaker. Add 80 ml. H_2O, 15 ml. saturated sodium sulfite solution, and 5 ml. H_2SO_4. Boil 2 minutes, filter on a pulped 31 Whatman or O Munktell paper, and wash three times with hot water. Evaporate filtrate to about 20 ml., add excess bromine water, boil a few minutes, cool, neutralize with ammonium hydroxide adding a 10 ml. excess. Filter through a fast paper into a 100 ml. volumetric flask, wash three times with cold water, dilute to the mark and read on the Klett-Summerson colorimeter.

If a Klett-Summerson or other colorimeter is not available, the second filtration should be made into a 100 ml. Nessler Tube and comparison made with standards in the usual manner.

For high oxide coppers continue the boiling after the addition of the bromine water until all the bromine has been expelled. Cool, dilute to about 75 ml., neutralize with ammonium hydroxide, add about 1 gram of ammonium biflouride and 2 grams of potassium biphthalate. Add potassium iodide and titrate in the usual manner".

I believe that the accuracy of the oxide copper determination can best be established by correlation of flotation results. When the drill hole samples are tested by Mr. Mellen in El Paso the various methods should be tried on test products. It is, after all, the product by milling which is of greatest interest to us and if an analytical method can be established which is satisfactory to the test engineer, it will be satisfactory for all other purposes.

Yours very truly,

/s/ Norman Weiss

NORMAN WEISS.

NW:RS
cc: WHLoerpabl
DJPope
RJMellen
JHCourtright.

C
O
P
Y

AMERICAN CYANAMID COMPANY
1937 West Main Street
Stamford, Conn.

May 21, 1948

Mr. J.H. Courtright,
American Smelting & Refining Co.,
Valley National Bldg.,
Tucson, Arizona

Dear Sir:

In accordance with your request we are mailing to you a copy of our method for the determination of non-sulfide copper.

Yours very truly,

AMERICAN CYANAMID COMPANY

/s/ W.B. Hill
Mineral Dressing Laboratory.

WBH:eew

Determinations of Non-Sulfide Copper:

Sample should be 200 mesh and free from metallic iron.

Weigh the proper amount of sample and transfer to a pressure bottle, add 100 ml of a 3% solution of sulfur dioxide and agitate by rolling for two hours.

Filter through a #42 Whatman paper, wash with dilute SO_2 solution. Boil off the SO_2 and determine copper in the filtrate by any of the usual procedures. Care should be taken that excess SO_2 is present when the pulp is filtered. Absence of excess SO_2 may give low results due to the possible precipitation of dissolved copper.

Sulfur Dioxide Solution:

Pass SO_2 from a cylinder into distilled water.

Standardization:

Titrate a measured quantity of standard iodine solution with the SO_2 solution, using starch as indicator.

The strength of the SO_2 solution is calculated according to the equation:

$$SO_2 + 2I + 2H_2O = H_2SO_4 + 2\ HI$$

$$1\ ml\ N/10\ I_2 = .003206\ g.\ SO_2$$

This method will put into solution all oxides, carbonates and silicates of copper and also all metallic copper.

AMERICAN SMELTING & REFINING COMPANY
Tucson Arizona

April 4, 1948.

AIR MAIL

PERSONAL

Mr. W.R. Landwehr, Chief Geologist,
American Smelting & Refining Co.,
700 Pacific National Life Bldg.,
Salt Lake City, Utah.

SILVER BELL
"SAGUAROVILLA"

Dear Walt:

Have picked up a few samplers, a truck driver and a bull cook, and will probably start drilling sometime this week. With a good part of the detail of preparation out of the way, Dick and I will be able soon, I hope, to get some mapping done. (Plane table has been received, thanks). We will map new roads, locate old churn drill holes, geology, and also, I will attempt to record several degrees of intensity of preexisting copper sulphide mineralization, as evidenced by exposed leached outcrops. Am not at all sure that such observations will prove useful, nevertheless, believe it worth a try, using four degrees: (1) unmineralized, (2) weak, (3) moderate, (4) strong. Theoretically, leaching of chalcocite-chalcopyrite frequently leaves a dark maroon or chocolate brownlimonite as contrasted to the brick reds after pyrite. Obviously, it may be impossible to distinguish between, say, 3 or 4 cu, and 1.0% cu; however, judging from recent surface reconnaisance, ore, as indicated by the old drill holes, occurs generally beneath areas of relatively strong mineralization, mainly limonite derived from pyrite, with minor amounts of chalcocite and chalcopyrite.

Further, the ore bodies apparently occur in sheared and fissured zones at or near intersections with the west to northwest trending major structure (Alaskite front). (See Anderson on Bagdad, March '48, Mining Technology). In the Oxide, holes nos. 73, 72 and 74 were drilled within a north trending zone of relatively strong mineralization as evidenced by surface exposure. Copper values progressively decrease to the south in these three holes. Hole No. 77, 600 feet west, is in an area of relatively weak (surface) mineralization, and showed values from trace to .3. It appears likely that Nos. 73, 72 and 74 are in a narrow tongue (300 to 600 feet wide), extending northward to fault "C", and possibly to hole No. 25. Holes east of this "tongue", Nos. 1, 45, 71 and 9, are

generally weak in values, but may not have been drilled deep enough.

My impression of the general geologic history is as follows: (1) Alaskite intruded Paleozoic sediments, and cretaceous sediments with intercalated volcanics, (2) Monzonite (finely crystalline - Schmitt's Dacite) intruded the foregoing, and was followed by an extrusive phase (fragment bearing dacite) (3) Biotite monzonite intruded all of the foregoing. Inclusions of limestone in the alaskite and intrusive contacts between alaskite and "Dacite" in part support these impressions. Thus, the general pattern of the rock masses is likely due to intrusive action, rather than large fault displacements.

Hypogene copper mineralization of the disseminated type came after the biotite monzonite and was deposited as chalcopyrite mainly in fissures, in all rocks. Widespread dissemination of pyrite (with little or no chalcopyrite) accompanied or followed the fissure mineralization. In fact, much of the disseminated pyrite may have been formed through alteration of the ferromags of the igneous rocks. Weathering accompanied by leaching removed the copper from fissure zones (protone, plus or minus .2 cu) and subsequently the copper was deposited as chalconite in the veins, in joints and on the disseminated pyrite. This may all sound somewhat academic, but the point I'm trying to make is : that the primary copper was to a large extent probably localized along fissures, and that the existing appearance of dissemination is due mainly to supergene processes. Such an interpretation means that a very irregular and spotty distribution of ore may be expected; this is evident in many of the old drill results.

I have spent but one day on the El Tiro ore zone. The pattern of mineralization appears to be similar to that of the Oxide. The disseminated ore occurs in a strongly fissured and fractured zone adjacent to the north west trending zone of relatively high grade copper mineralization in sediments. (Daisy, Williams, Hilda, etc.). I believe the immediate area should be mapped on 100 scale before exploration is undertaken; however, check holes could be drilled during this mapping. We would need at least one capable man for this job. The additional surveying and other work connected with the diamond drilling would more than keep Dick busy. If a man were available at least one month before drilling started, the work could probably be done satisfactorily, otherwise, two men would be necessary.

I believe Razor could handle the job. However, Sprague has had more experience with disseminated coppers.

Dr. Kerr has finished mapping (400 scale) the Oxide area, except for a few details. He has mentioned making a 200 scale map and having it reduced to 400. So far, his map appears to represent a more accurate picture of the areal geology than that of Schmitt's report. The four stages of alteration are indicated by numbers (2, 3, 4 and 5) on corresponding shades of color.

I believe he expects to start mapping El Tiro next week. Regarding his "two mile east extension of the Oxide", the alteration is indeed quite strong; however, copper mineralization appears quite weak.

Regards,

JHC:m

AMERICAN SMELTING AND MINING COMPANY
Tucson Arizona

March 13, 1948

MEMORANDUM TO MR. A. H. RING

FROM: J. H. COURTRIGHT

Arizona, Pima County
Silver Bell Project
CHURN DRILLING AND SAMPLING

Herewith a brief discussion of factors which affect the accuracy of samples and, a more or less detailed description of contemplated procedure in churn drilling the Oxide deposit at Silver Bell.

Introduction

The two principal objectives of the initial drilling at the Oxide deposit are, I understand, (1) To determine the accuracy of earlier drill hole samples, and, (2) To determine the extent of ore mineralization in an area which was previously drilled at rather wide spaced intervals. Thus, it is of considerable importance that reliable samples be obtained. However, the methods used in securing the samples should be those which fall within reasonable limits in respect to cost and time involved, and at the same time produce samples which are within an acceptable range of accuracy.

The churn drill has been used to explore a large majority of the porphyry coppers in the states. In general, this method has proven satisfactory, 10% being the largest reported error in average grade estimates as determined by actual extraction. Most of this drilling was done by open hole methods, that is, the holes were not cased, except where caving interfered with drilling. Of considerable importance in respect to the reliability of samples obtained by open hole drilling is the nature of the rock and the distribution of the ore minerals. In general, the porphyry coppers contain copper values distributed as follows: 50% to 75% as discrete grains and 25% to 50% as stringers and veins. The main source of copper which may contaminate the sample is from the veins and stringers which contain relatively high grade values. This material is usually more friable than the enclosing rock and therefore may crumble during agitation by the sludge or abrasion by the tools or rope, and thus trickle down the hole, increasing the copper content of the sample below, but not increasing the total weight in detectable amounts.

Caving of the walls is commonly regarded as the main cause of salting. Obviously, if the caving occurs in a high grade vein

or concentration, the degree of salting will be appreciable. However, if the material caved from the walls is not abnormally high in copper content, the effect on the sample below is negligible, unless the volume of material introduced is sufficiently large - large enough to be noticeable in the weight of the dry sample compared to the theoretical weight as determined by the diameter of the hole.

On the 150 level of the Copper Girl workings at the Oxide deposit, the rock is in general a medium to hard strongly sheared and jointed porphyry. The chief copper mineral, chalcocite, occurs as thin coatings and as replacements of pyrite for the most part. Less than 40% of the values appear to occur as disseminated grains, approximately 50% as small stringers and joint fillings, and 10% as veins 1/2 inch or more in width. Samples obtained by open hole drilling in this area are considered to be subject to salting, to degrees which could cause considerable error in grade and tonnage calculation. Inspection of the surface indicated that the ore as exposed in the Copper Girl workings is probably representative of a major part of the Oxide area.

Drilling

1. Program

The drilling is to be done on a contract basis, two drills being operated two 8-hour shifts per day each. Depths for the first 12 holes will range between 250 feet and 600 feet. The expected average advance is 10 to 15 ft. per rig per shift. Water for drilling and sampling purposes will be hauled by the contractor from the company tank at the camp. Expected rate of consumption: 200 to 500 gallons per rig per shift.

2. Procedure

The method described here is recommended as a means of obtaining samples, acceptable both in degree of accuracy and in cost.

Conductor pipe (to prevent sloughing at collar) will be set and a 12 inch hole drilled through the leached capping and to the approximate top of the ore zone. The hole will then be cased with 10 inch (ID) and drilling continued for a distance of 30 feet with a 10 inch bit; an 8 inch (ID) liner (two joints of casing, about 40 feet total length) will be run and an additional 30 feet of 8 inch hole drilled; a 7 inch (ID) liner will be run and an additional 30 feet of 6 inch hole drilled; a 5 inch (ID) liner will follow with 30 feet of 5 inch hole. If, at this depth (120 feet below top of ore) the bottom of the ore zone has apparently been reached, the 5 inch hole will be continued for whatever distance appears necessary. If, however, the bottom of the hole is still apparently

an appreciable distance short of complete penetration of the ore zone, all three liners will be removed and the hole straight reamed with a 10 inch bit. Subsequently, the procedure described above (30 ft. interval reductions) will be repeated until the desired depth has been reached.

The foregoing procedure provides for a 30 feet maximum length of open hole while drilling through ore. Theoretically, the first 5 foot sample obtained below the end of the casing will be affected the least by salting. The 5 samples taken subsequently will each be subject to salting in amounts increasing as the length of open hole increases to the 30 foot maximum. Thus, if salting (sloughing of copper minerals from the walls of the hole) is occurring to an appreciable degree, the copper content will increase in each successive sample as the length of open hole increases. The increases will not be necessarily proportional to the distance, as the abrasion of the walls of the hole may be effected by several processes, namely: surging of the sludge and action of the bit shank, stem, rope socket and rope against the walls.

By plotting the assays and corresponding depths graphically a curve will be obtained for each 30 foot interval in each hole. Due to the uneven distribution of copper values in the deposit, a single curve will have little significance, but the average of a sufficient number of these 30 foot interval curves should provide a means of determining the percent increase in copper content caused by salting.

It has been suggested that 30 feet of open hole is too much and that the holes should be underreamed and the casing driven to bottom after each five foot sample. I do not believe the use of this relatively slow and costly method is warranted even though it is found that the physical characteristics of the rock are amenable to this operation. In theory this method has as its objective the most reliable sample obtainable, however the practicability of the method is open to question. For example: To start the underreaming bit, the casing must be raised a few feet off the shoulder or rim of rock that is to be removed. As soon as the cuttings fill the hole below the underreamer, no further progress can be made until these cuttings have been churned up with a conventional bit and cleaned out by bailer. Thus, in order to underream to the bottom of the existing hole, the foregoing practice must be repeated several times. In practice, underreaming is carried to within 5 or 10 feet of the bottom of the hole. At Chino and at Bingham Canyon Kennecott Copper used an underreaming interval of 20 ft., which they considered the shortest practical distance.

As a check on the holes drilled by the method I have proposed in the foregoing (liners run at 30 feet intervals), one or more holes may be drilled using liners at 5 feet intervals. This would involve running through the series of reductions from a 10 inch to a 5 inch hole while advancing 20 feet. The liners would then be removed and the 20 feet of hole straight reamed to the bottom. This process would be repeated until the desired depth was reached.

All possible precautions will be taken to prevent grease or oil from entering the drill hole and rendering samples unfit for metallurgical tests.

Water for drilling purposes will be lowered into the hole by means of the bailer to avoid washing of the walls in sections unprotected by casing.

3. Drilling Muds

Aquajell (Bentonite) has proven useful as a thickener of sludge to reduce caving or sloughing of the walls of an open hole, to raise cuttings from the bottom when insufficient clay is present to form a sludge of proper gravity, and to lubricate the casing and thus facilitate its removal. The only known objection to its use in drilling for sampling purposes is the dilution of the sample. In drilling below the water table, the column of water in the hole will take up part of the aquajell and consequently the amount contained in the sample cannot be accurately determined. In drilling above the water table the amount added to each sample can be rather closely determined. As thus far known, the Oxide deposit lies entirely above the water table.

It is recommended that tests be conducted to determine the minimum amount that must be added to a five foot run to obtain the desired results. Should this amount be 5% or less of the total weight of the rock material in the 5 foot section of hole, it is believed that the aquajell might be used to an advantage, as a substitute for casing, underreaming, etc.

Sampling

1. Bailing

Samples will be taken at the customary 5 foot interval by means of a dart-valve or flat bottom valve bailer. Both types will leave a few inches of sludge in the bottom of the hole. Unless classification has taken place, that is, concentration of copper sulphides or oxides in the bottom of the hole, the effect

on the next sample will be negligible. Since it is not practical to closely control the gravity of the sludge, a sand pump bailer will be used to clean out the bottom at regular intervals. By comparing the assay of this material from the bottom with the assay of the sample, a check on possible concentration will be obtained.

2. Splitting of Sample

The sludge will be dumped from the bailer into a dump box which will be connected by lumber to a 4-tier Jones type splitter. To prevent splashing and consequent loss of part of the sample, care must be used in releasing the sludge from the bailer.

The objective will be to obtain a sample weighing between 10 and 15 lbs. dry, this amount being ample for all purposes. The number of splits will vary with the diameter of the hole being drilled, for example:

Diam. of Hole	Wt. of rock in 5 ft. sample	Number of Splits	Dry Wt. of Sample
12"	650 lbs.	6 - $\frac{(1)}{64}$	10 lbs.
10"	445 lbs.	5 - $\frac{(1)}{32}$	14 lbs.
8"	288 lbs.	5 - $\frac{(1)}{32}$	9.3 lbs.
7"	220 lbs.	4 - $\frac{(1)}{16}$	13.4 lbs.
5"	110 lbs.	3 - $\frac{(1)}{8}$	13.4 lbs.

The desired number of splits may be secured by blocking off various tiers in the splitter. Due to the fact that the gravity of the sludge will vary considerably, depending on the nature of the rock encountered, the exact size of a sample cannot be predetermined. Also, the size of the hole will vary somewhat, that is, the diameter of the hole tends to increase over the diameter of the bit in the softer and more friable rocks. This increase may be as much as 10% by weight, therefore considerable caving must take place before it becomes noticeable in the weight of the dry sample.

Extremely thick sludges will not readily pass through the splitter. At the end of a 5 foot run, when the bit is raised, if exceptionally thick sludge is noted clinging to the bottom,

the sludge in the hole may be diluted before bailing. Wet samples will be transported to the drying room in 5 gallon cans.

After the bailing process has been completed the splitter will be washed clean; however, this material will not be added to the sample, as the washing tends to concentrate heavy minerals in the launder and splitter. In forcing the concentrates on through the splitter, an uneven division may result.

A sampler, employed by the Company, will be assigned to each shift on each rig. In addition to the sampling he will record data pertaining to operation of the drill (see "Drill Hole Data"), and pan out a small portion of the rejects from each sample. These will be available for inspection by the geologist or engineer in charge and will serve as an aid to field control of the drilling and casing.

Sample Treatment

1. Drying

Samples will be dried on four steam heated plates, 34 inches square, at 250 degrees F. maximum. At this temperature no appreciable oxidation of sulphides or loss of water of crystallization contained in the clays will occur. It is expected that the drying of each sample will require from 1 to 2 hours.

After drying, tramp iron, such as bit fragments, will be removed by means of a permanent magnet. Metallic iron causes the precipitation of metallic copper insoluble in the dilute sulphuric acid leach test for soluble (non-sulphide) copper. The dry sample will be weighed and then divided by means of a Jones splitter into four equal parts, each weighing from 2 to 3 lbs. One part will be pulverized for assay, one used for sludge and geologic log, and two parts for storage.

2. Assaying

The 1/4 split will be ground to minus 60 mesh by pulverizer and then rolled and divided into four parts.

One of these pulps, 6 to 10 ounces, will be shipped to the Jacobs laboratory in Tucson and assayed for total copper by the permanganate method. These results will serve to some extent as field control on the drilling. Non-sulphide (soluble copper) assays by the dilute sulphuric acid leach method will be run also.

Composites assays will be run for total copper, gold, silver, mercury, molybdenum and any other elements which might be of economic importance.

A duplicate pulp will be sent to the Umpire Lab at El Paso to be assayed for total copper by the electrolytic method. Composites and non-sulphide coppers will also be run. Should it be found, after several holes have been sampled and assayed, that Jacobs results and those from El Paso were reasonably close, it would be necessary then to check only an occasional sample, say every tenth sample.

It has been suggested that the Mexican Dept. laboratory in El Paso is equipped to provide the most reliable results in non-sulphide assaying. Samples are ground under water to avoid oxidation and also, iron, introduced into the sample by regular grinding, is eliminated. It may be advisable to select a few samples at regular intervals for non-sulphide and total copper assays at this laboratory, as a check on results obtained by other methods. Such sample would be 1/4 splits of the dried sample, not pulverized.

The two remaining pulps will be placed in envelopes and stored for future use.

3. Geological Examination

One-fourth of the dried sludge will be washed free of slimes, weighed and prepared for application to a sludge board, four feet in length. The sands and panned concentrate of each sample are glued to the board in 1/2 inch strips. Each strip represents 5 feet of hole; each board will hold 400 feet of samples. The approximate percentage of slimes (clay,etc.) present inthe sample will be determined by the weight before and after washing.

The column of samples on the sludge board provides a ready means of rock and mineral classification and distribution, depth of oxidation, etc.; the board also serves as a permanent and accessible file of the samples.

In exploration and development drilling the most accurate interpretation possible of rock structures and the nature and distribution of economic mineralization is desirable from the standpoint of further exploration and subsequent mining. Since megascopic classification of rocks and minerals is as a rule inadequate, microscopic examination must be employed to determine the presence or absence of diagnostic rock minerals and to identify the various ore minerals. Briefly, the procedure is as follows:

The sludge board is examined under a binocular type microscope and the rock and mineral identities noted on the geologic log. Rejects from the sludge board samples are examined by petrographic microscope using oil emersion of the panned concentrate. To estimate closely the percentages of the various ore minerals present, briquettes must be prepared and examined under a reflected light attachment of the petrographic microscope; to approximate the same, the binocular microscope is adequate.

4. Storage of Samples

The two unused parts of the dried sample will be placed in one quart fruit jars, labelled and stored in a nearby adit. If air and moisture proof bags can be secured, these will be used rather than the jars. The stored samples may be used in metallurgical or other tests.

Records

1. Engineering Data

Drill hole locations will be surveyed before and after the hole is collared. The coordinates and collar elevations will be recorded in a book, exclusively for that purpose. The depth of the hole will be measured by means of a steel tape and cord at 200 foot intervals, as a check on the depth reported by the driller.

2. Assay Data

Each sample assayed will be assigned a number. The record book will contain a cross-index of the numbers and the identity of the sample (churn drill hole number and depth). Assay results will be recorded on the sludge board, on the geologic log and on the composite log.

3. Operational Data

A copy of the Daily Shift Report is attached to this Memo. This record, which will include all necessary information pertaining to the drilling and sampling, will be kept by the sampler on the drill. This report will be checked and filed in the camp office, a copy will also be filed in the Tucson Office.

4. Geologic Data

A copy of the Geologic Log, designed exclusively for churn drilling disseminated coppers, is attached to this Memo. This log, which will contain in condensed form the necessary information

pertaining to the rocks and minerals encountered, will be filed with a list of abbreviations used in the camp office. Copies of this log will also be filed in Tucson.

5. Composite Log

The essential features contained in all four of the foregoing items, (1) Engineering Data, (2) Assay Data, (3) Operational Data and (4) Geologic Data, will be drafted on a tracing and will comprise the composite log. The drill hole will be shown on appropriate scale. This log, which is a useable compilation of churn drill hole data, will be reproduced in white prints for distribution to those requiring a record of such information.

Reports

The monthly report will contain: (1) a small scale plan and section showing progress and proposed drilling, (2) written summary of results.

J. H. Courtright
J. H. COURTRIGHT

JHC:W
Enclosures:

Copy of Daily Shift Report
Copy of Geologic Log

CC: WHLoerpabel with 2 encs.
HAKurzell - with 2 encs.
DJPope - with 2 encs.
WHLandwehr with 2 encs.
Kenyon Richard with 2 encs.
Lester Kitch with 2 encs.

JHC

GEOLOGIC LOG

AMERICAN SMELTING & REFINING CO.

FILE NO.

CHURN DRILL HOLE NO.

DATE

TOTAL DEPTH OF HOLE

PROPERTY

LOG BY

DEPTH OF SAMPLE	COPPER ASSAY		ROCK CLASSIFICATION	MINERALIZATION			ALTERATION	HEAVY MINERALS IN CONCENTRATES	REMARKS
	TOTAL	NON-SUL		OXIDE	SULPHIDE	SILICIF.			

FILE NO. _____

CHURN DRILL SHIFT REPORT

AMERICAN SMELTING & REFINING CO.

PROPERTY _____

HOLE NO. _____ DATE _____ 19____

DRILL NO. _____ SHIFT _____

BIT TYPE _____ DRILLER _____

CASING LOWERED - SIZE - FROM - TO HELPER _____

_____ FEET WATER - DEPTH ENCOUNTERED _____ FEET

_____ FEET

BIT USED _____ FEET

_____ FEET

EMPLOYMENT OF TIME

MOVING AND SETTING UP _____ REPAIRING ENGINE OR RIG _____

DRILLING AND BAILING _____ CEMENTING HOLE _____ FROM _____ TO _____

SETTING CASING _____ FISHING _____

REMOVING CASING _____ REAMING HOLE _____ FROM _____ TO _____

EQUIPMENT REPAIR _____ CLEANING HOLE _____ FROM _____ TO _____

OTHER DELAYS _____

SAMPLES

DEPTH		COLOR OF SLUDGE	CONDITION OF HOLE	HARDNESS OF ROCK V.H. VERY HARD H. HARD M. MEDIUM S. SOFT V.S. VERY SOFT	IS SAMPLE RELIABLE, ETC.	SIZE TO WHICH SAMPLE WAS CUT (NUMBER OF SPLITS)	NUMBER OF BAILERS	DRY WEIGHT OF SPLIT SAMPLE	REMARKS (NOTE THICKNESS OF EXTREMELY SOFT AREAS) (SPECIFY DRY WEIGHT OF AQUA-GEL ADDED)
FROM	TO		CAVING, ETC.						

GENERAL REMARKS

DEPTH OF HOLE AT BEGINNING OF SHIFT _____ FEET

DEPTH OF HOLE AT END OF SHIFT _____ FEET

SAMPLES LEFT IN TUBS _____

SAMPLES CANNED _____

SAMPLER _____

Feb. 11, 1948

OXIDE COPPER

Method used by Ray E. Stiles, Chemist
U.S.Bureau of Mines, Tucson, Ariz.

Treat approximate weight of sample (1/2 to 5 gm.) with 10 ml of 5% H_2SO_4 saturated with SO_2 for each gm. of sample. Leach for two hours at room temperature with periodic agitation - (every 15 minutes). Filter, wash four or five times with hot water and determine copper in filtrate by any appropriate method.

NOTES:

1. Sample must be free of metallic iron which would precipitate some of the copper taken into solution. Iron may be removed with a magnet, or its absence may be insured by grinding sample in agate or porcelain.

2. Basically, every sample is a problem in itself for oxide copper determination. Thus, if the copper minerals are associated with easily decomposable sulfides, H_2S may be generated and precipitate some of the dissolved copper, or, on the other hand, if appreciable ferric iron is present, ferric sulfate may be formed, which would exert a solvent action on sulfide copper. However, the above procedure will suffice for most ordinary mixed copper ores.

LONG IODIDE METHOD FOR COPPER:

Method used by Ray E. Stiles, Chemist
U.S.Bureau of Mines, Tucson, Ariz.

Decompose appropriate weight of sample (1/2 to 2 gms.) with HNO_3 and HCl. Add 10-15 ml. conc. H_2SO_4 and take to heavy fumes of SO_3. Remove from plate, cool, add 100-125 ml. H_2O. Boil 5 minutes. Filter. Wash 5 times with hot H_2O. Dilute filtrate to 250-300 ml with hot water, heat to boiling and add 20 ml of 50% soln. of $Na_2S_2O_3$. Boil for 20-30 minutes until copper sulfide has coagulated and solution is clear. Filter, wash 6 to 10 times with hot water. Place paper & ppt in porcelain crucible, dry on hot plate & ignite in muffle at about 600° C until all carbon has burned off. Transfer as much as possible of ignited residue to beaker in which copper was precipitated and add 5-10 ml conc. HNO_3 to crucible & heat on plate for 5-10 minutes to effect solution of any copper

remaining in crucible add a few mg. $KClO_3$ or $NaClO_3$ to aid solution. Remove from plate, cool, and pour into beaker containing residue & rinse with water to make sure all copper is transferred back to beaker. Place on plate and take just to dryness. Do not bake as the copper nitrate will blacken and results will be erroneous. Take up dry residue with 50 ml. of hot H_2O, add 5-10 ml. of sat. soln. of bromine water & boil until all bromine is expelled. Add just enough ammonia (4-5 drops usually) to neutralize any free nitric acid, boil a few minutes and add 5-10 ml. of conc. acetic acid. Remove from plate, cool to room temperature and titrate with a standard soln. of $Na_2S_2O_3$ after adding 1-2 gms. of KI and 3-5 ml. starch soln as indicator.

For further details see W.W.Scott - Standard Methods of Chemical Analysis.

OFFICE OF
S. W. MUDD

ALICE CLAIM

HOLE No. 7

Depth 200

Geology	Depth	Length of Sample	KCN
	0		
	25		
oxidized	50		
		5	0
		5	TR
		5	Tr
		5	Tr
	75	5	.85
		5	1.09
		5	1.50
		5	1.38
		5	1.38
Rhyolite-Porphyry	100	5	.85
		5	.80
		5	.53
		5	.48
		5	.48
	125	5	.33
		5	.36
		5	.42
		5	.40
		5	.42
	150	5	.42
		5	.29
		5.7	.29
		4.3	.35
		5	.35
	175	5	.35
		5	.27
		5	.16
		5	.16
		5	.05
	200	5	.10

Water level 140
Pyrite clean below 150

F. H. JUNIOR CLAIM

HOLE No. 8

Depth 150

Geology	Depth	Length of Sample	KCN
	0		
	25		
		5	tr
		5	tr
		5	
		5	.24
	50	5	
		5	
		5	.05
		5	
		5	
	75	5	.19
		5	
		5	
		5	tr
		5	
	100	5	
		5.7	.12
		4.3	.26
		5	.16
		5	.26
	125	5	.20
		5	.17
		5	.17
		5	.13
		5	.17
	150	5	.32

Water level 105

F. H. JUNIOR CLAIM.

HOLE NO. 9

Depth 192.

Geology	Depth	Length of Sample	KCN
	0		
	25		
Oxidized			
	50	5	.13
		5	.13
		5	.11
		5	.13
		5	.49
	75	5	.48
		5	.42
		5	.32
		5	.18
		5	.21
	100	5	.16
		5	.17
		5	.18
		5	.20
		5	.15
Rhyolite-Porphyry	125	5	.21
		5	.18
		5	.21
		5	.19
		5	.21
	150	5	.20
		5	.18
		5	.21
		5	.16
		5	.24
	175	5	.14
		5	.08
		5.5	.16
	190	5.5	...
	192	2	...

Pyrite clean below 110

Water level 175

L O O K O U T C L A I M.

HOLE NO. 10

Depth 230

Geology	Depth	Length of Samples	KCN
Oxidized	0		
	25		
	50		
	75		
Rhyolite Porphyry	100	5	tr. ✓
		5	tr. ✓
		5	.13 ✓
		5	.26 ✓
		5	.44 ✓
	125	5	.44
		5	.61
		5	.46
		5	1.30
		5	.50 ✓
	150	5	.34
		5	.12
		4.7	.13
		5.5	
		5	tr.
	175	4.5	.10
		5.7	
		5	
		5	tr.
		5	
	200	5	tr.
		5	tr.
		5	tr.
		4.5	
		5.5	
	225	5	
	230	5	

Pyrite clean below 160 but rusts quickly

E S M A V. C L A I M.

HOLE NO.11

Depth 250

Geology	Depth	Length of Sample	KCN
	0		
	50		
	75		
		5	tr.
		5	.10
		5	.37
		5	.68
	100	5	.97
		5	1.12
		5	.84
		5	.75
		5	1.29
	125	5	1.32
		5	1.54
		5	1.16
		5	1.29
		5	1.03
	150	5	.99
		5	.95
		5	.70
		5	.59
		5	.65
	175	5	.59
		5	.80
		5	.72
		5	.83
		5	.75
	200	5	.85
		5	.62
		5	.52
		5	.16
		5	.26
	225	5	.28
		5	.26
		5	.16
		5	.16
		5	.13
	250	5	.13

Pyrite clean below 215

Water level 245 ft.

TROJAN CLAIM

HOLE No. 12

Depth 195

Geology	Depth	Length of Sample	KCN
	0		
	25		
	50		
Oxidized			
	75	5	tr
		5	tr
		6.5	.25
		3.5	.35
		5	.43
	100	5	.20
		5	tr
		5	tr
		5	tr
		5	tr
Rhyolite-Porphyry	125	5	tr
		5	tr
		5	
		5	
		5	tr
	150	5	
		5	
		5	tr
		5	
		5	
	175	5	tr
		5	tr
		5	tr
		5	
	195	5	

Pyrite clean below 165
Water not reached

CHRYSALIS CLAIM.

HOLE NO.13

Depth 153

Geology	Depth	Length of Sample	KCN
Oxidized	0		
	25		
	50		
	75		
Rhyolite Porphyry	100	5	tr.
		5	.22
		5	.55
		5	.13
		5	.13
	125	5	tr.
		5	tr.
		5	tr.
		5	tr.
		5	tr.
	150	5	
	153	3	

Pyrite nearly clean below 120

Water level not reached.

V.

E S M A C L A I M.

HOLE NO.14

Depth 190

Geology	Depth	Length of Sample	KCN
	0		
	25		
Oxidized	50		
	75		
		5	tr.
		5	.28
		5	.66
		5	.37
	100	5	.33
		5	.47
		5	.37
		5	.44
		5	.33
Rhyolite-Porphyry	125	5	.28
		5	.19
		5	.19
		5	
		5	
	150	5	tr.
		5	
		5	
		5	.19
		5	
	175	5	
		5	
		5	
	190	5	

Pyrite clean below 140

Water not reached.

MAZEPPA CLAIM.

HOLE NO.15

Depth 235

Geology	Depth	Length of Sample	KCN
	0		
	25		
	50		
oxidized	75		
	100		
		5	tr.
		5	tr.
	125	5	tr.
		5	tr.
		5	.40
		5	1.23
		6	1.70
	150	4	1.75
		5	1.43
		5	1.13
		5	1.11
		5	1.36
Rhyolite-Porphyry	175	5	1.36
		5	2.15
		5	1.72
		5	1.62
		5	2.28
	200	5	1.62
		5	1.33
		5	.86
		5	.61
		5	.66
	225	5	.35
		5	.25
	235	5	.20

A L I C E C L A I M.

HOLE NO.16

Depth 25

Geology	Depth	Length of Sample	KCN
	25		

Drilling Stopped.

M A Z E P P A C L A I M.

HOLE NO.17

Depth 195

Geology	Depth	Length of Sample	KCN
	0		
	25		
	50		
Oxidized			
		5	0
	75	5	0
		5	0
		5	tr.
		5	.09
		5	.09
	100	5	.11
		5	.20
		5	.15
		5	
		5	
	125	5	TR.
		5	
		5	
		5	tr.
		5	
	150	5	
		5	tr.
		5	
		5	
		5	0
	175	5	
		5	
		5	0
		5	
	190	5	0
Rhyolite-Porphyry			

Pyrite nearly clean throughout.

Water not reached.

M A Z E P P A C L A I M.

HOLE NO.18

Depth 125

Geology	Depth	Length of Sample	KCN
	0		
	25		
Oxidized	50		
		5	0
		5	0
		5	0
	75	5	0
		5	0
		5	0
		5	tr.
		5	tr.
Rhyolite Porphyry	100	5	
		5	
		5	tr.
		5	
		5	
	125	5	0

Pyrite clean and brassy

Water not reached.