CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
520-770-3500
http://www.azgs.az.gov
inquiries@azgs.az.gov

MIS 3.05

ASARCO

Mineral Beneficiation Department

July 6, 1977

J. H. C.

OCT 17 1977

Mr. T. E. Scartaccini, Manager
Southwestern Mining Department
Building

file

Mission Tungsten Recovery

Dear Mr. Scartaccini:

As you are aware, several of the local copper companies were contemplating a joint research effort (including ASARCO if desired) directed toward tungsten and other heavy metal recovery from flotation tailing. Consequently, we had monthly tailing composites from Silver Bell, Sacaton, and Mission assayed by Central Research to determine the tungsten content. Results were all negative with less than .01% WO_3 present.

During subsequent discussions with Mr. Anzalone, it was determined that most, if not all, of the tungsten present at the Mission unit would occur in the tactite ore. This has been confirmed by Central Research assays on specimen samples of intrusive and tactite ores with the tactite assaying .029% WO_3 (which is high enough to be recoverable) and intrusive assaying only .0004% WO_3.

It appears that a tungsten recovery scheme would be feasible only if pure tactite ore were to be mined for extended periods of time, and I assume that this would be impossible to accomplish. In view of these facts, we will inform the other companies involved that we are not interested in a joint research effort on tungsten recovery.

It is interesting to note that a moderate amount of uranium was detected in both of the specimen samples. However, I believe that other, more representative ore samples have recently been assayed for uranium with negative results.

Yours truly,

D. E. Crowell
Director

vh

T.D.H.

JUL 19 1977

cc: CWCampbell
RSHerde
TDHenderson/file

MS 3.05

ASARCO

Central Research Department
South Plainfield, N.J. 07080

S. A. A.
JUL 5 1977

July 1, 1977

MINERAL
JUL 5 1977
BENEFICIATION DEPT

Mr. D. E. Crowell
TUCSON OFFICE

Mission Ore Samples

The two hand specimens that were sent from Mission have been examined and the results are reported in the attached memorandum by Mr. D. D. Maier. As you will note, the intrusive sample is extremely low in tungsten whereas the level in the tactite is appreciably higher. Since this is a single handpicked specimen, it probably is not representative of the ore body in general. Unless areas of considerable amounts of tactite of this type are encountered, it is expected that the overall tungsten content of the ore body is too low for economic recovery of tungsten.

If there is any additional information you would like on this, please let me know.

V. Kudryk

VK/lk
Attach.

cc: CWCampbell
MElTawil
RBHaagensen
TDHenderson
RSHerde
DDMaier
EMartinez
TEScartaccini

D. E. C.
JUL 5 1977

ASARCO

Central Research Department
South Plainfield, N.J. 07080

June 24, 1977
Re: 1176

Dr. V. Kudryk
B U I L D I N G

Mission Ore Samples (MR-1226 A and B)

Two hand specimens of Mission ore sent from the Mineral Beneficiation Department were received at Central Research (T. D. Henderson, Jr. letter to Dr. V. Kudryk, June 6, 1977). As requested, these samples were submitted for tungsten analyses and the results are as follows:

Sample Description				
M.B.D. Designation	Gross Appearance	Approx. Sample Wt.	Research No.	% WO_3
Intrusive	Medium to coarse-grained rock with few fluorescent grains.	130 g	MR-1226A	0.0004
Tactite	Massive chalcopyrite with fair amounts of fluorescent grains.	425 g	MR-1226B	0.0290

Attached are spectrographic analyses on the two Mission ore samples. The results indicate a significant level of tungsten in the tactite sample (MR-1226B). In addition, moderate levels of uranium were present.

Further studies of these Mission ore samples are in progress including microscopical, X-ray diffraction, infrared, thermal and electron microprobe analyses.

Don L. Maier

D. D. Maier

DDM:rg
cc: MElTawil
RBHaagensen
EMartinez

SPECTROGRAPHIC ANALYSIS

ASARCO Incorporated
Central Research Department
South Plainfield, New Jersey 07080

MISSION ORE SAMPLES

SAMPLE No.	MR1226 A	MR1226 B	Sample No.	MR1226 A	MR1226 B
Si	MC	MC-	Cu	L	MC-
Al	MC	MC-	Zn	ND	M+
Fe	S+	MC	Ag	VFTr	L+
Ca	S+	MC	Mn	L-	M
Mo	S+	L-	Pb	L-	ND
Mg	S-	M	Sn	FTr	Tr
Na	S+	ND	V	FTr	ND
Ba	S	ND	Co	ND	FTr
Ti	M	ND	Ni	FTr	FTr
U	M-	M-	Zr	L+	ND
Mn	L-	M	Sr	L	Tr
W	ND	M			

Not Detected: Cd, Be, As, Te, B, P, Hg, Sb, Pt, Au, Tl, Ge, In, Bi, Ce, Y, La, Th

CODE:

CMC - Chief Major Constituent
MC - Major Constituent
LMC - Low Major Constituent
S - Strong
M - Moderate
L - Low
Tr - Trace
F Tr - Faint Trace
V F Tr - Very Faint Trace
N.D. - Not Detected

Mission 3.05

June 6, 1977

Dr. V. Kudryk, Manager
Central Research Department
ASARCO Incorporated
901 Oak Tree Road
South Plainfield, New Jersey 07080

Tungsten Analysis of
Mission Samples

Dear Dr. Kudryk:

As a follow-up to the analyses of mill tailings samples from Mission for tungsten and other heavy minerals, we would like to have two samples of Mission Ore analyzed for tungsten.

I am sending you these samples under separate cover. One is marked Intrusive-West End Mission Pit and the other Tactite-East End Mission Pit. These samples have shown traces of schealite under an ultraviolet light and we would like to know their actual WO_3 content.

Yours truly,

T. D. Henderson, Jr.

vh

cc: TEScartaccini
RSHerde
SAAnzalone
DECrowell/file

D. E. C.
JUN 6, 1977

ASARCO

Mission 3.05

Central Research Department
South Plainfield, N.J. 07080

April 21, 1977
Re: 247

MINERAL
APR 25 1977
BENEFICIATION DEPT.

Mr. D. E. Crowell
TUCSON OFFICE

Heavy Mineral Analyses of Copper Mill Tailings

Three samples of pulverized composite tailings from the Mission, Silver Bell and Sacaton units were received. The objective was to determine the feasibility of by-product heavy mineral recovery from these tailings (T. D. Henderson,Jr. letter to V. Kudryk, March 30, 1977).

The following are the analytical results:

	Assays, %					
	Sn	WO_3	TiO_2	U_3O_8	Pb	Zn
Sacaton	.002	<.01	0.35	.0077	<.001	.004
Mission	.002	<.01	0.29	.0051	.005	.019
Silver Bell	.001	<.01	0.26	.0060	.013	.019

The spectrographic analyses are attached.

E. Martinez

EM:rg
cc: TREdwards
TDHenderson, Jr.
RSHerde
DRJameson
VKudryk
TEScartaccini

SPECTROGRAPHIC ANALYSIS

ASARCO Incorporated
Central Research Department
South Plainfield, New Jersey 07080

S.W.M.D. Mill Tailings

	Sacaton	Mission	Silver Bell
MR No.	1201	1202	1203
Si	MC	MC	MC
Fe	MC	MC	MC
Al	MC	MC	MC
K	LMC	LMC	LMC
Ca	M	LMC	LMC
Mg	LMC-	LMC	LMC-
Na	M	S	S+
Ti	M+	M	M
Ba	M	M	M
Mo	L	L	L
V	L	L	L
Cu	L+	L	M
Cr	L	L	L
Sr	L	L	L
Mn	L	L	L
Pb	Tr	L	L+
Ni	L-	L-	L-
Be	FTr	FTr	FTr
Co	FTr	FTr	FTr
Ag	VFTr	VFTr	VFTr
Zn	N.D.	L+	L+
Sn	L	L	L-

CODE:

CMC - Chief Major Constituen
MC - Major Constituent
LMC - Low Major Constituent
S - Strong
M - Moderate
L - Low
Tr - Trace
F Tr - Faint Trace
V F Tr - Very Faint Trace
N.D. - Not Detected

Not Detected: Tl, As, Te, Cd, B, P, Hg, Sb, Pt, Au, Bi, W, In, Ge

ASARCO Mission Unit

Mission 3.05

March 30, 1977

MEMORANDUM TO MR. ROY S. HERDE

Re: Recovery of By-Product Heavy Minerals from Mill Tailing

On March 28, 1977, Mr. Al Kuestermeyer gave to Mr. T. D. Henderson a 200-300 gram sample of Mission mill tailing for the year 1976 as requested by Mr. Henderson.

H. W. Walker
Mill Superintendent

HWW/mln

cc: TEScartaccini
TDHenderson
DRJameson
TEEdwards
DECrowell

T.D.H.
MAR 3 1977

Mis. 3.05

ASARCO

Mineral Beneficiation Department
D. E. Crowell
Director
T. D. Henderson, Jr.
Chief Metallurgist

March 30, 1977

Dr. V. Kudryk, Manager
Central Research Department
ASARCO Incorporated
901 Oak Tree Road
South Plainfield, New Jersey 07080

Heavy Mineral Analyses of
S.W.M.D. Mill Tailings

Dear Dr. Kudryk:

I am sending you under separate cover a sample of mill tailings from each of the S.W.M.D. concentrators -- Mission, Silver Bell, and Sacaton. These are composite (pulverized) assay pulps representing the following periods of operation:

Sacaton Sample	August 1976 - February 1977 Mill Tails
Mission Sample	1976 Composite Mill Tails
Silver Bell Sample	August 1976 - February 1977 Mill Tails

As Mr. Crowell discussed with you recently, we are trying to determine the feasibility of byproduct heavy minerals recovery from these tailings. In order to get a handle on amounts of such minerals in the tailings, we would like these samples analyzed for the following:

Sn, WO_3, TiO_2, CaF_2, U, Au, Ag, Rare Earth metals (Ce, La, Y, Th), Platinum Group metals.

Also, lead and zinc analyses would be of interest as well as spectrographic analyses to determine other metals of economic importance.

Yours truly,

T. D. Henderson Jr.

T. D. Henderson, Jr.

vh

cc: TEScartaccini RSHerde
DRJameson TREdwards

D. E. C.
MAR 30 1977

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703
1150 North 7th Avenue (602) 792-3010

Mission 3.05

HAZEN RESEARCH, INC.

7511 SO. HOUGHTON RD.
POST OFFICE BOX 17928
TUCSON, ARIZONA 85731
TELEPHONE (602) 886-5545

March 29, 1977

Mr. Don Crowell
ASARCO Incorporated
P. O. Box 5747
Tucson, Arizona 85703

Re: HRI Proposal No. 77/12 T
By-Products Recovery

Dear Don:

In accordance with our recent discussions, this is to notify you formally that within the next two weeks we will offer our proposal for a research program to define effective means for the recovery of by-product materials including, but not necessarily limited to, WO_3 minerals from concentrator tailings. As you know, this proposal will also be made to Anamax and Pima in the hope that a jointly funded program, applying to Anamax, Pima, and Mission tailings, can be arranged.

Identical letters have been sent to Messrs. Krist and Huch.

Any comments you have about the proposal, before or after its submittal, would be appreciated.

Yours very truly,

Peter N. Thomas
Vice President

PT/js

cc: Applegate/Shaw

T.D.M.
MAR 30 1977

Mission 3.05

ASARCO

Mineral Beneficiation Department

March 21, 1977

Memorandum To: Mr. T. E. Scartaccini

Subject: Recovery of Byproduct Heavy Minerals from Mill Tailings

Hazen Research Inc. is proposing a test program to determine the feasibility of heavy mineral recovery from copper flotation mill tailings. It is my understanding that they are also approaching Anamax and Cyprus-Pima with this proposal.

Before considering such a program, we should determine what minerals of possible economic interest are present in our mill tailings. Therefore, we would like to have samples of tailings from the Mission, Silver Bell, and Sacaton Units. These would be analyzed for tin, tungsten, titanium, rare earth metals, fluorspar, uranium, etc., by the Central Research Department. Mr. Crowell has discussed the analysis of these samples with Dr. Kudryk.

For analytical purposes, 200-300 grams of sample should be sufficient. If yearly composites are available, the 1976 sample would be best. If not, an unweighted composite of last year's monthly composites using as many months' samples as are on hand would serve the purpose.

These samples should be sent to me and I will forward them to Dr. Kudryk with a letter requesting the appropriate analyses.

Yours truly,

T D Henderson Jr

T. D. Henderson, Jr.

vh

cc: DRJameson
RSHerde
TEEdwards
DECrowell/file

MAR 23 1977

W.E.S.
NOV 13 1969

WES

to develop a meaningful plan and the creation of useful concepts. Several different exploration approaches are currently used, depending on the nature of the terrain, presence of postore cover, and degree of surface oxidation and leaching.

Probably the most well-established exploration approach is the examination of prospects described in the literature and documented in company files. New submittals are also encouraged from prospectors and promoters. Since most prospects have been previously examined by competent exploration geologists, it becomes a question of recognizing new features or developing new ideas of ore localization to establish unrecognized exploration opportunities. The relative effort devoted to this type of work is a continuing problem of those responsible for planning an exploration program. Failure to make any prospect examinations will identify the group as being nonreceptive to submittals from the public, and it is thus unlikely to take advantage of new opportunities generated outside its organization.

A successful variation of the prospect examination is the "elephant country" approach, whereby mining districts and ore-body clusters are re-evaluated for exploration opportunities.

A saturation type of exploration approach is frequently used in areas of thin postore cover, where all relevant techniques are applied in a systematic manner over wide areas. This approach is used, for example, in the Canadian Shield in the search for massive sulfide bodies under a thin postore cover.

The concept-oriented approach is a variation of the saturation approach, whereby specific geologic and mineralogic associations are used as a guide to a systematic exploration program. This approach has gained growing acceptance during the last decade, especially by the integrated exploration groups, with research staffs and specialists in the use of geophysics and geochemistry. The essence of this approach is the guidance of a systematic exploration program by the use of specific geological and mineralogical associations. In some instances, the approach can extend to systematic use of certain exploration techniques where geologic guidance is the focus of the program. The successful application of the concept-oriented approach requires the careful study of mineral associations with specific geologic environments. These studies will, in some instances, also lead to the definition of metallogenetic provinces. Examples of deposits discovered as the result of applying a geological concept are Mission (use of halo mineralogical characteristics in defining a target under gravel cover), Kalamazoo (blind ore-body discovery based on application of a fault concept), Kennecott's Safford deposit (use of halo mineralization in projecting an ore body under volcanic cover), INCO's Ely deposit (recognition of sulfides at the base of a layered gabbro), Carlin–Cortez discoveries (fine disseminations and colloidal gold in previously unrecognized geological environments), New Missouri lead belt deposits (blind ore bodies found by testing favorable stratigraphic facies adjacent to Precambrian domes), and Henderson (a blind molybdenum ore body found through structural projections in a favorable geologic environment).

One of the better methods of making maximum use of available exploration resources is effective expenditure control. There is generally no lack of available exploration opportunities; the problem involves setting priorities between the undertakings so as to allow the best chance for achieving the ojectives of the program. Estimates of discovery probability for individual undertakings are particularly useful in establishing priorities as well as for obtaining a guideline for exploration expenditures. The maximum expenditure that logically can be made on an individual undertaking is approximated as a product of the potential profitability of the deposit sought and a factor reflecting the probability of discovery. For instance, if an exploration group thought it had a possibility of finding a hundred-million-dollar ore body in a particular area with a chance of discovery of one in fifty, the group would be justified in spending a maximum of two hundred thousand dollars in the search. Obviously, this is just a rough guide, but is quite useful in setting priorities between projects. This exercise helps an explorationist by preventing him from "falling in love with a prospect" and conducting an exhaustive search, only to find the potential rewards are out of proportion to the exploration funds expended.

CLASSIFICATION AND USE OF TECHNIQUES

To discuss some of the more specific uses of exploration techniques, it is useful to start with a definition and classification. *Exploration techniques* is defined here as the set of procedures of observation, measurement, and interpretation of the characteristics (geological, physical, and chemical) of mineralized areas and their associated effects. *Techniques* comprise the data-gathering methods the explorationist uses to test concepts of ore localization. The location, size, shape, and composition of unusually high concentrations of potentially valuable elements associated with crustal rocks are tested by physical work such as drilling, trenching, or underground excavations. Exploration techniques generally involve various combinations of geological, physical, or chemical measurements, which are graded by the writer into three broad categories on the basis of their discriminating capabilities. The following description, although not necessarily comprehensive, is intended to provide numerous examples in each category.

Techniques placed in the first category possess high discrimination capabilities for the detection of ore-grade material, such as visual observation or ore exposed at surface; gossan and leached capping appraisal where a high degree of confidence can be placed on the interpretation; ore-boulder tracing to locate source of ore; and scintillometer and berylometer measurements for the detection of radioactive minerals and beryllium. Since a minimum of geological knowledge is needed for the successful application of these techniques, they are attractive to the

New Mexico Bur mines, Circ: 101 Exploration for mineral Resources – June '68

NC

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

January 29, 1969

Mr. Wm. G. Salisbury
American Smelting & Refining Co.,
Northwestern United States
Exploration Division
Room 1401, W. 422 Riverside Avenue
Spokane, Washington 99201

Mission Drilling and
Sampling Report

Dear Mr. Salisbury:

This will acknowledge your letter of December 19, 1968 regarding reports on drilling procedures and sample processing.

The only reports we have which contain detail on processing of diamond drill samples and the preparation of sample boards are those on the Mission Project and Michiquillay, Peru.

Enclosed herewith is the report on the Mission Drilling and Sampling. It is somewhat out of date in that we discontinued the collection of diamond drill sludges (utilizing mud circulation) during this project. However, the preparation of sample boards and the treatment of drill cores is essentially the same as that now used.

As this is the only copy we have left with photographs, please return it when it has served your purpose.

Yours very truly,

J.H. Courtright

JHC:lzb
Encl.

ASARCO

TE 8-8725

J. H. C.

DEC 23 1968

AMERICAN SMELTING AND REFINING COMPANY
NORTHWESTERN UNITED STATES
EXPLORATION DIVISION

ROOM 1401, W. 422 RIVERSIDE AVENUE
SPOKANE, WASHINGTON 99201

December 19, 1968

MR. ~~JDS~~, JRW

READ AND RETURN ✓

PREPARE ANSWERS ____ HANDLE ____

FILE ____ INITIALS ____

Mr. J. H. Courtright, Supervisor
American Smelting and Refining Co.
1150 North 7th Avenue
P. O. Box 5795
Tucson, Arizona 85703

Dear Mr. Courtright:

I would like to thank you for the courtesies extended by you and members of your staff during my visit to Tucson and for the valuable data which you provided.

Peter Walker obtained a copy of a Samplers Manual prepared by Mr. Wojcik which he forwarded to me. This paper contains some useful information, particularly with regard to rotary drilling, but on our visit to Sacaton Mr. Sell mentioned that Wojcik had also prepared another paper which contained information as to your procedures on weighing core, constructing core boards and a generalized flow sheet of your core preparation. If this is available, I would very much appreciate receiving a copy.

I have not as yet had an opportunity to review the data that is to be returned to you but expect to do so in the near future. I assume that you are in no particular hurry to have this material.

Yours very truly,

Wm. G. Salisbury

Wm. G. Salisbury

WGS/ir

10M FORM HB-132110

AVOID ORAL ORDERS

Oral Orders are often forgotten or misunderstood. Use this blank for all important instructions or requests.

To Mr. S. Tainter - Mission Unit

Would you please send us the proper key to the outside gate at Mission so that we may get to the Core Storage Bldg.? Am returning one that does not work.

Date 3-4-68

Signed J. R. Wojcik

File: Mission

J. H. C.

MAR 24 1967

RBM

MAR 23 1967

MINING DEPT.

MAR 21 1967

TUCSON

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 21, 1967

MEMORANDUM FOR R. B. MEEN:

A. C. H.

The Cordilleran Section of the Geological Society of America will hold its next meeting in April 1968 at Tucson. Mr. Dean Lynch of Duval has advised that they are attempting to arrange a field trip through the Pima Mining District for April 17, 1968. They anticipate hiring 2 buses for the trip which would include a brief visit to the Mission, Pima, Twin Buttes and Esperanza pits. Please advise if permission is granted for the visit to Mission.

J. H. Courtright
J. H. COURTRIGHT

JHC/kw

MEMORANDUM FOR J. H. COURTRIGHT:

Permission is granted for the Cordilleran Section of the Geological Society of America to visit the Mission Unit April 17, 1968. By copy of this memorandum we are advising Mr. Lewis of this visit.

R B Meen
R. B. MEEN

mg

AMERICAN SMELTING AND REFINING COMPANY
SOUTHWESTERN EXPLORATION DEPARTMENT
P. O. BOX 5795, TUCSON, ARIZONA 85703

J. H. COURTRIGHT
CHIEF GEOLOGIST
L. P. ENTWISTLE
ASSISTANT CHIEF GEOLOGIST
W. E. SAEGART
ASSISTANT CHIEF GEOLOGIST

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

January 24, 1966

AIR MAIL

Mr. Glenn C. Waterman, Assistant Vice President
Anaconda American Brass Limited
Britannia Beach, B. C., Canada

AIME BOOK ON SURFACE MINING
MISSION DEPOSIT

Dear Mr. Waterman:

Reference is made to your letter to Mr. Pollock of October 19 and his letter to you of November 12.

The Mission Deposit, consisting principally of pyrite and chalcopyrite disseminated in tactite, is overlain by 200 feet of alluvium. Discovery of the deposit was based on projection of a possibly large zone of mineralization-alteration indicated by adjacent underground and drill hole information coupled with outlying small mineralized outcrops. The large extent of this zone was first confirmed by the results of 12 widespaced holes drilled to bedrock with tricone bit, followed by one or two diamond drill coring runs in bedrock. Subsequently, the area was drilled out on a grid 250' x 300'. Coring was principally NX with some BX size. Sludges were found to be unreliable, and only the core was used in determining the grade of the deposit. Non-rotating type core drills were used with water circulation. Core recovery averaged between 85% and 90%. Near the end of the program, mud circulation with wireline equipment was introduced.

To check the grade and continuity of copper mineralization in and between holes, and to obtain metallurgic samples, a shaft was sunk and laterals driven with raises on some of the drill holes. This work, which totaled about 2000 feet, provided an acceptable check with copper grade and distribution as indicated by the drilling.

Open pit ore reserve estimates were prepared using the adjusted polygon method wherein regular polygon outlines were modified according to the structure and distribution of copper as interpreted from the drill hole information.

There were no water problems of any consequence.

For additional information, please refer to Tainter's article in Mining Engineering for December, 1965, Engineering Methods at the Mission

Mine; and also for reference I am enclosing a copy of Some Geologic Features of the Mission Copper Deposit, by Kenyon Richard and myself.

Please feel free to bring up any questions which you might have.

Yours very truly,

J. H. Courtright

J. H. COURTRIGHT

JHC/kw
Enclosure
cc: KERichard TASnedden
RBMeen

J. H. C.

NOV 15 1965

November 12, 1965

AIR MAIL

Mr. Glenn C. Waterman, Assistant Vice President
Anaconda American Brass Limited
Britannia Beach, B. C., Canada

Dear Mr. Waterman:

This is to acknowledge receipt of your letter of October 19, 1965. We have referred the matter of providing data on the Mission Mine for your chapter in the AIME volume on "Surface Mining" to our Tucson Office. I am sure you will receive a summary of the information you have requested from Mr. Meen or Mr. Courtright in the near future.

It was nice to see you in Las Vegas and with kind personal regards, I am

Sincerely,

C. P. Pollock

Bld. CC - R B Meen
J H Courtright

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

ASARCO

KENYON RICHARD
CHIEF GEOLOGIST

J. H. C.

NOV 15 1965

Air Mail

November 11, 1965

Mr. J. H. Courtright
American Smelting & Refining Company
Box 5795
Tucson, Arizona

AIME Book on Surface Mining

Dear Sir:

Enclosed are copies of correspondence which are more or less self-explanatory.

In my personal files, I have information on both Toquepala and Mission but I do not have time to sort out this material and try to provide Mr. Waterman with the information he would like on Mission. It is my thought that you probably have the same information that I do and could put one of your men on the project of summarizing the data and transmitting it to Mr. Waterman.

Toquepala, of course, is entirely Mr. Archibald's concern. If he decides to provide Mr. Waterman with information on Toquepala, I doubt that the various preproduction ore reserve estimates will be taken into consideration. That, however, is not our concern.

In regard to Mission, several of Mr. Waterman's requests involve "operating" ore reserve estimates which again are not our concern. I suggest you talk with Mr. Meen and you and he can decide what data can be put together and given to Mr. Waterman. In this connection, it would seem to me that we should attempt to cooperate with Mr. Waterman in so far as calculation methods and other techniques could be described without giving figures such as grade and tons which the Company would not want to be released.

Yours very truly,

Kenyon Richard

Kenyon Richard

Attachments

CC-RBMeen } with attachments
TASnedden }

Copy to Courtright 10/25/65.

KR — If this information is not currently available here I assume the Tucson Office can summarize the data for Glenn CPP

ANACONDA AMERICAN BRASS LIMITED

WESTERN EXPLORATION DIVISION

BRITANNIA BEACH, B.C.

ASST. VICE PRESIDENT
AND CHIEF GEOLOGIST.

PHONE AREA CODE 604
896-2242

K.R.
OCT 25 1965

October 19, 1965

RECEIVED
OCT 25 1965
C. P. POLLOCK

Mr. C.P. Pollock, Vice President
American Smelting & Refining Co.
120 Broadway
New York 5, N.Y.

Dear Clem:

I was nice to see you for a moment or two at the Mining Congress. However I forgot to thank you for your letter of June 21, in answer to my request for information for the A.I.M.E. volumne on "Surface Mining".

Following your suggestion I have written Mr. Archibald, President of Southern Peru for information on development drilling etc. (Copy enclosed)

Our chapter is to include data on development work as opposed to details on operating phases and therefore, it seems to me, that you offer to provide us with information on the Mission Mine should cover the data included in your "geological reserve". The rest of the information that would be desireable to have is outlined in my letter to Mr. Archibald.

I know how troublesome ~~are~~ requests such as mine. My only excuse for asking for help is that I feel that Asarco geology and engineering on two recent important copper mines should be included in any important reference on open pit mining.

Best regards.

Sincerely,

Glenn

Glenn C. Waterman

GCW:am

cc. Scott Hazen

October 19, 1965

Mr. F.W. Archibald, President
Southern Peru Copper Corporation
Casilla 303
Tacna, Peru

Dear Mr. Archibald:

As you probably know, the A.I.M.E. is preparing a volumne "Surface Mining" which will cover almost all aspects of open pit operations on coal, base metals, and metallic deposits. Mr. Gene Pfleider, Editor, has asked Scott Hazen (U.S. Bureau of Mines) and me to co-author a portion of the chapter on "Mine Development".

I recently wrote Clem Pollock and asked if A.S.&R. would be willing to contribute pertinent data on its Southern Peru operations. Mr. Pollock suggested I write to you.

Mr. Hazen and I are particularly interested in "Development Drilling and Bulk Sampling". In more detail, the data we are requested to assemble would include the following:

1. Development drilling, hole spacing, hole size, drilling problems, drilling techniques.
2. Geologic mapping programs that influenced development testing and interpretation of data.
3. Ore reserve calculation methods.
4. Test mining for grade confirmation and metallurgical sampling
5. Data on water problems that could require engineering attention
6. Computer techniques for probability reliability relations and also for processing data.
7. Other pertinent field data that bear on the problems connected with appraisal of mineralized ground to determine potential economic worth.

Mr. Hazen and I would greatly appreciate any information you can give us. Southern Peru operations are recent and very significant, and we feel that our chapter summation should include data from your mines.

Sincerely,

Glen

Glenn C. Waterman

GCW:am

cc. C.P.Pollock
Scott Hazen

CPP

June 21, 1965

AIRMAIL

Mr. Glenn C. Waterman, Assistant Vice President
Anaconda American Brass Limited
Western Exploration Division
Britannia, B. C.

AIME Book on Surface Mining

Dear Mr. Waterman:

I have your letter of June 16 asking whether we are agreeable to supplying information on drilling, bulk sampling, methods of ore reserve calculations and other pertinent data to be included in the forthcoming AIME volume of "Surface Mining" in connection with the Southern Peru and Mission operations.

Although I have no jurisdiction over Toquepala operations, I feel sure Mr. Frank Archibald will cooperate in supplying the information if you address a letter to him in Peru:

F. W. Archibald, President
Southern Peru Copper Corporation
Casilla 303
Tacna, Peru

We can provide you with excerpts and summary of drilling and sampling techniques and procedures covering the Mission project. I might point out, though, for your information, we employ two kinds of ore reserve calculations; one concerned with the exploration phase, which we call a geological reserve, and the other is calculations by operating engineers after the mine is in production. The engineering calculation procedures usually are different than the procedures used for the geological reserve.

I can provide date on the geological calculations, but I suggest you communicate with Mr. R. B. Meen, Manager of our Southwestern Department in Tucson if you wish information on ore reserve calculations made by the operating engineers.

With best wishes and kind personal regards,

Sincerely,

C. P. Pollock

cc:
Mr. Frank Archibald, Tacna, Peru, A/M

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 15, 1965

J. H. C.
DEC 15 1965

Mr. G. R. Means, Chief Accountant
American Smelting and Refining Company
Mission Unit
Sahuarita, Arizona

MISSION UNIT
Accounting

Please refer to Mr. Goodenough's letter of December 13, 1965, captioned "New York Appropriation Number 1244." When the new core storage shed has been completed, Mission Unit should charge the Southwestern Exploration Department a monthly rental sufficient to cover one-half of the depreciation, property taxes, insurance, and maintenance expense on the building. Your advice to Tucson Office should designate the item as "Core Storage Shed Rental for the Month of ____________" and should show that it is chargeable to the Southwestern Exploration Department. You should credit this rent to a/c 9300 - Other Income and Expense.

ORIGINAL SIGNED BY
K. A. von den Steinen

K. A. von den Steinen
Chief Accountant

KvdS/ma
cc: HLGoodenough
RRichter
TASnedden
PALewis
JHCourtright
WGKellogg

JHCourtright

W.E.S.
DEC 16 1965

J. H. C.
DEC 15 1965

MR. WES
READ AND RETURN
PREPARE ANSWERS HANDLE
FILE INITIALS

New York, December 13, 1965

New York Appropriation Number 1244

Mr. G.R. Means, Chief Accountant
Mission Unit

On December 8th, the Advisory Committee approved New York Appropriation No. 1244 for the construction of a core storage shed at Mission Unit.

I note from the appropriation that the use of this shed will be shared by Mission Unit with the Southwestern Exploration Department. I assume the latter will receive some charges from Mission Unit for the use of the shed. If so, such charges should in no way indicate depreciation expense on the advice to Southwestern Exploration Department. Copy of this letter to those concerned at Tucson Office advises that the charges be treated as Field Office Expenses, not distributable to individual Mining Authorizations.

H. L. GOODENOUGH

ORIGINAL SIGNED
H. L. GOODENOUGH
H. S.

EJK:w
cc: R.Richter
T.A.Snedden
R.B.Meen
J.H.Courtright
K.Von den Steinen

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 10, 1965

Mr. T. A. Snedden, General Manager
United States Mining Department
American Smelting and Refining Company
P. O. Box 5795
Tucson, Arizona 85703

MISSION UNIT
Mill Expansion

Dear Sir:

Attached are three copies of Mr. Lewis' estimate, covering the cost of additional buildings and equipment required to increase the capacity of the Mission concentrator 50 per cent.

Added to the present ore reserve is the West Extension--all of which is on our property and includes 26,918,400 tons of ore and 51,825,900 tons of waste. The accelerated program will give 8.4 years of life to the property.

The pit will require only 16 additional 60-ton trucks, at a cost of $1,600,000 for the accelerated program.

The crushing plant will require, mainly, an additional seven-foot short-head crusher and screens, a 50 per cent increase to the mill building and equipment, an additional tailing thickener, a 50 per cent increase to the filter plant, an additional well and pump, booster pump, and another 18-inch main water line for a cost of $6,135,500. The cost of construction of the present mill has been escalated to arrive at these figures.

A more detailed estimate, using present costs, would have to be made to arrive at an exact figure.

Yours very truly,

R. B. Moen
Manager

RBM/jah
Enc.

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

J. H. C.
APR 2 1965

KENYON RICHARD
CHIEF GEOLOGIST

Air Mail

March 29, 1965

Mr. J. H. Courtright
American Smelting & Refining Company
Box 5795
Tucson, Arizona

Core Storage-Mission Laboratory

Dear Sir:

In referring to your letter of March 25, either or both of your proposals for making more room in the Mission laboratory, seems alright to me.

Yours very truly,

Kenyon Richard

Kenyon Richard

CC-TASnedden
NWeiss
RBMeen
PALewis
WESaegart

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 25, 1965

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

CORE STORAGE-MISSION LABORATORY

Dear Sir:

I have been advised that there is little space left for sample storage in the building which served as the laboratory for exploration drilling on the Mission and San Xavier Reservation areas.

Some additional space can be gained by discarding the crushed core rejects and the pulps for drill intercepts which fall in the mined out portion of the deposit. The corresponding split core portion of the sample would be retained.

More space could also be freed for use by discarding all crushed core rejects, providing that care was taken to save the reject in cases where there is insufficient pulp remaining for assays of, say moly or zinc.

Please advise if you agree to one or both the above proposals.

Yours very truly,

Original signed by
J. H. Courtright

J. H. COURTRIGHT

JHC/jak
cc: TASnedden
HWeiss
RBMeen
PALewis
WESeegart - File copy

1141 Palmerston Ave.,
West Vancouver, B.C.

J. H. C.

MAR 17 1965

March 16,1965.

Mr J.H. Courtright,
Chief Geologist,
S.W. Exploration Dept.
ASARCO.

Dear Harold:

I'm trying to tie up the dissertation and am scheduled to present it in final form and defend it at Stanford on April 20th. I hope you recieved the copy I sent you, although I dont imagine you've had much chance to look at it.

I'm having some trouble checking on some of the references I cited, as the publications are'nt available up here. I quoted from articles by MacKenzie and Mayo in Arizona Geol. Soc. Digest v.6,1963, and now cant get another look at these papers. I wondered if I could trouble you to get someone to photocopy these two articles if you have the digest and the copying facilities there. Otherwise, if you could send me a copy of the digest or tell me who to contact to obtain one, I would appreciate it very much.

Keith Whiting gave us a resumé of the meeting in Phoenix. I was interested to see also, in some publication that Mission now has a moly and a zinc section in the mill.

Hope all is going well with you.

Regards Bob Galo

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 16, 1965

Mr. P. A. Lewis, Superintendent
Mission Unit
American Smelting and Refining Company
P. O. Box 111
Sahuarita, Arizona 85629

WATER SUPPLY - MISSION UNIT

Dear Mr. Lewis:

My letter of March 23, 1964, transmitted Mr. Whaley's comments on the drop in the static water level at Mission and future water supply considerations. It was recommended that the advice of a consultant, such as L. C. Halpenny of Water Development Corporation of Tucson, be obtained.

The attached memorandum of March 3 contains information on Anaconda's well recently drilled near Continental and consists of another reminder that the water supply in respect to the Mission be given further study.

Anaconda's well is regarded as one of the best in the state south of the Salt River Valley. Anaconda's well was cased at 2516' and was unperforated above 601'. The well produced over 4,000 gpm with negligible drawdown. Mr. Whaley notes that the selection of the location of this well was no doubt influenced by Turner's opinion of the questionable reliability of water supply derived from more convenient sites close to the mine area.

I believe Mr. Whaley's original recommendations, as mentioned above, should be carried out without further delay. The recommended steps in a further study of the potential of the Mission water well field are contained in the attached copy of Mr. Whaley's memorandum of April 30, 1964.

Yours very truly,

Original signed by
J. H. Courtright

J. H. COURTRIGHT

JHC/ja
Attachments
cc: KCRichard
TASnedden
RGHeon
WESaegart
MPWhaley

All with attachments

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 23, 1964

Mr. P. A. Lewis, Superintendent
Mission Unit
American Smelting and Refining Company
P. O. Box 111
Sahuarita, Arizona 85629

WATER SUPPLY -- MISSION UNIT

Dear Mr. Lewis:

Attached are Mr. Whaley's comments on the drop in static water level at Mission and future water supply accompanied by a chart and section through the four wells now pumping.

The drop in the static water level in wells No. 6, 7, and 8 for the past four years ranges from 34 feet to 45 feet, or 11% to 16% of the water column (top of older conglomerate forming the base of the column).

While there appears to be an ample supply remaining for the life of the mine, Mr. Whaley points out that it is not practical to consider the remaining water columns totally available, and also calls attention to the city of Tucson's accelerated program of water development in the Santa Cruz valley east of the Mission wells. He suggests, and I concur, that a study be made with the objectives of insuring an adequate supply for the future.

This evaluation is based on the assumption that the older conglomerate is relatively impermeable and not a suitable aquifer. Should this not be the case, there would be an ample supply for all future needs. This possibly could be determined by securing diamond drill cores of the older conglomerate. However, before such drilling is done, the advise of a consultant should be obtained. The Water Development Corporation of Tucson (L. C. Halpenney and Don Greene) has been consulting for the city in adjacent areas and is regarded by us as the best choice.

Yours very truly,

Original signed by
J. H. Courtright

J. H. COURTRIGHT

JHC/jk
Enclosures
cc: KERichard
RBMoen (2)

J.H.C.

MAR 9 1964

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 9, 1964

MEMORANDUM TO MR. J. H. COURTRIGHT

MISSION UNIT - WATER SUPPLY

Throughout the last four years water levels in the Mission Unit well field have declined rather sharply. If these declines are viewed as a percentage of the original columns of water in the wells they become more meaningful, and I believe warrant being brought to your attention. The attached table summarizes the changes which have occurred, and the copy of a pencil-sketch cross section illustrates them graphically.

I am aware of the fact that current "static" water level measurements in one well reflect the influence of adjacent pumping wells and do not represent full recovery. For our purposes however, these factors can be treated as constants and ignored as long as the Mission Unit mill is in production. Assuming status quo conditions the theoretical life of a well can be calculated by simply projecting the apparent declines observed.

Realistically however, status quo conditions cannot be assumed. We have recently put an additional supply well into production, and rates of regional decline are accelerating as ever increasing withdrawals from the aquifers occur throughout the valley. Both are auguries of even greater declines in the future.

Also worthy of mention are the following thoughts: 1) It is not mechanically practical to consider the remaining water columns totally available, 2) At present the underlying conglomerate is not considered to be an appreciable source of water, 3) Accelerated growth of the city of Tucson and the attendant requirements for municipal supply are actuating an enlargement of the city's present well field and threatening to extend it southward, and, 4) While I do not know what the future plans for mill production at the Mission Unit are, an additional increase in tonnage could require an additional water supply.

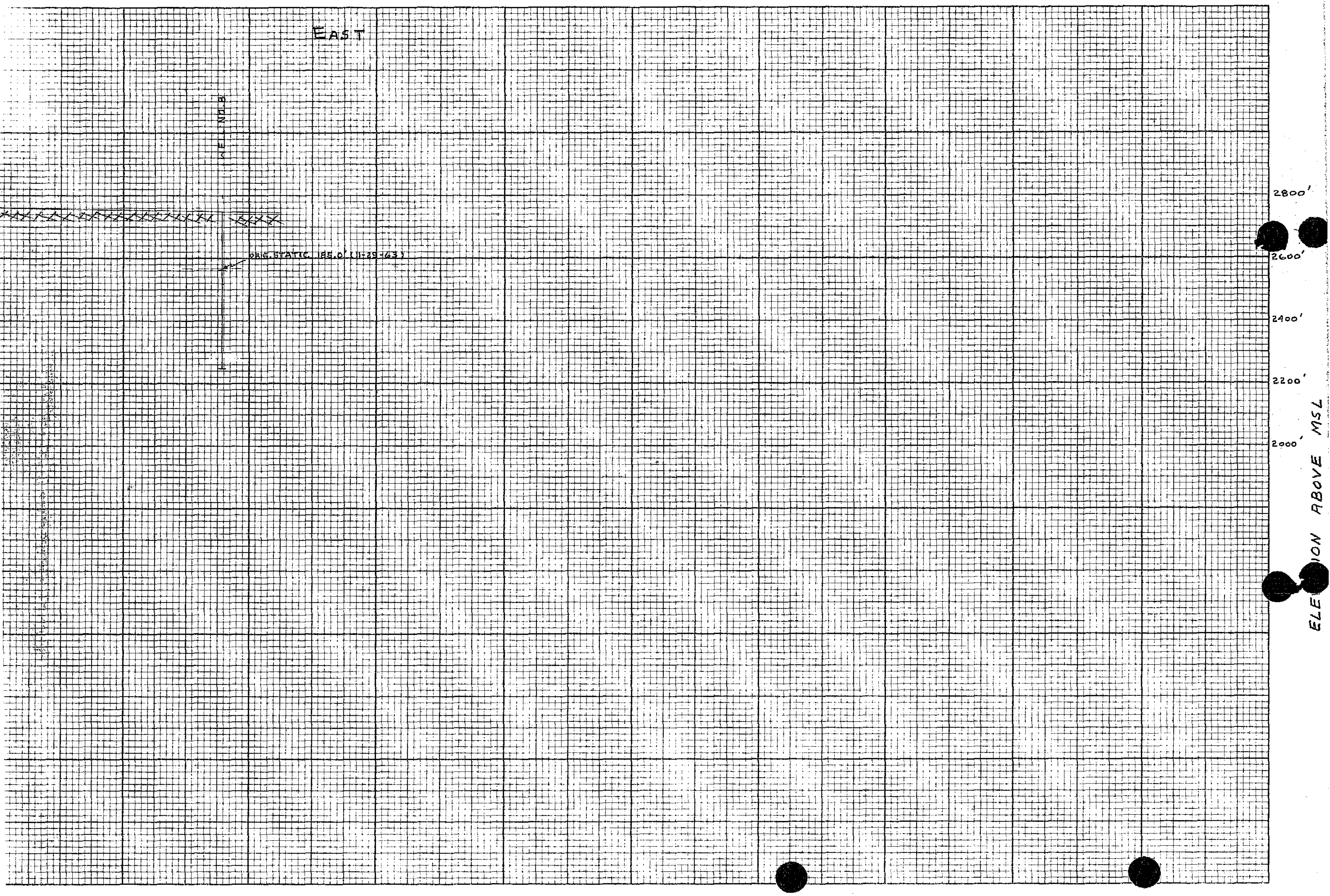
In view of the rather rapid declines in water levels over this relatively short period of time and the potential problems inherent in the above thoughts, would we not be justified in initiating a request for a study to assure an adequate, equitable water supply for the life of the property?

Norman P. Whaley

NORMAN P. WHALEY

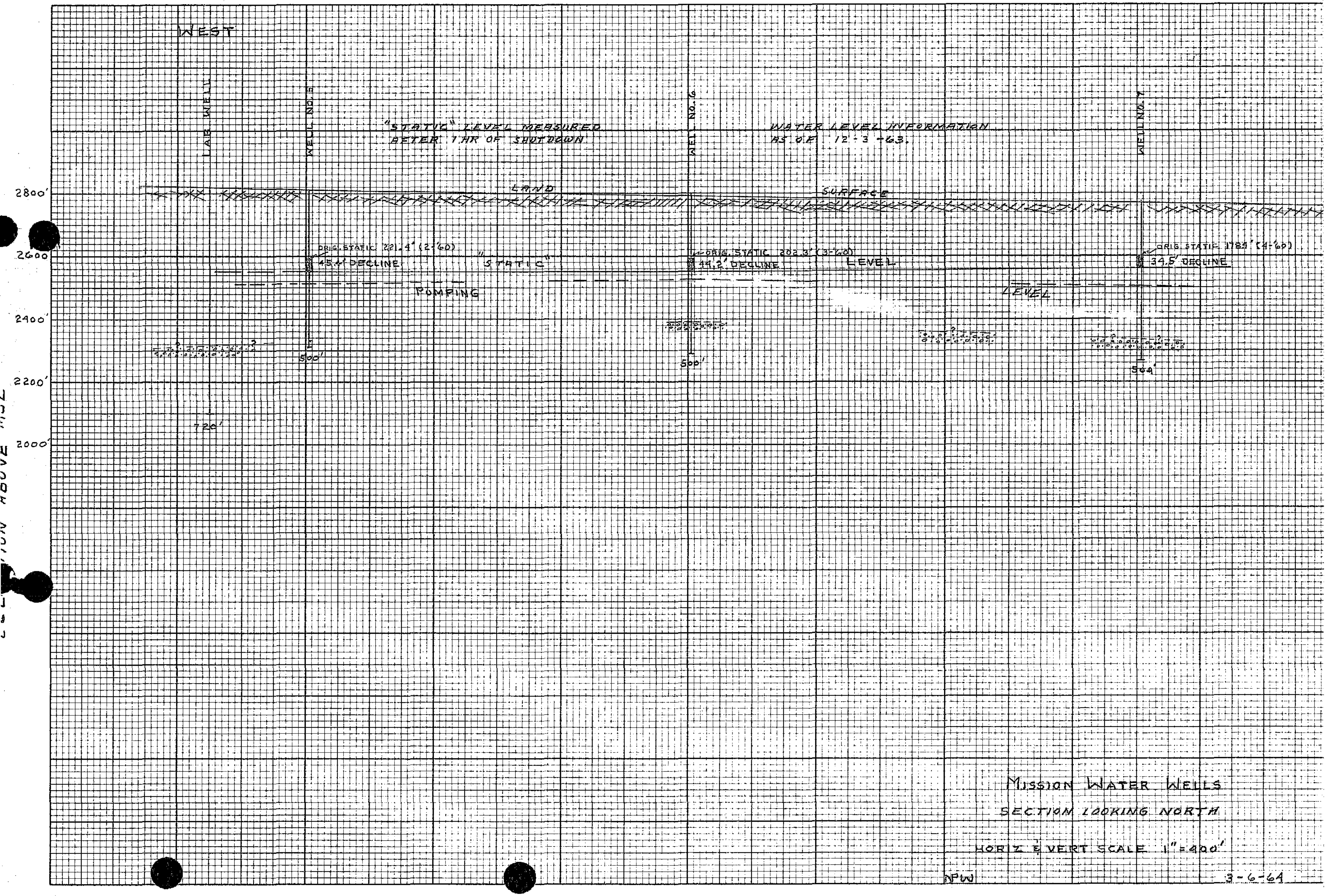
NPW/jk
Attachments
cc: NPWhaley

MISSION WATER WELL NO.	ORIGINAL STATIC W.L. (FT.) (FEB.-APR., 1960)	ORIGINAL COLUMN OF WATER IN WELL (FT.)	"STATIC" W.L. ON 12-3-63 (FT.)	DECLINE (FT.)	COLUMN OF WATER IN WELL ON 12-3-63 (FT.)	PERCENT OF COLUMN DEWATERED IN 4 YRS.	PERCENT OF COLUMN DEWATERED IN 1 YR. (DEC. '62-DEC. '63)
5	221.4	279	266.82	45.4	233	16	4
6	202.3	298	246.48	44.2	254	15	3
7	178.4	322	212.93	34.5	287	11	2


EAST
WELL NO. 8
ORIG. STATIC 185.0' (11-29-43)
2800'
2600'
2400'
2200'
2000'
ELEVATION ABOVE MSL

NO. 340R-20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH

EUGENE DIETZGEN CO.
MADE IN U. S. A.



MISSION WATER WELLS

SECTION LOOKING NORTH

HORIZ. & VERT. SCALE 1" = 400'

RPW

3-6-64

J. H. C.
MAR 3 1965

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 3, 1965

TO: J. H. COURTRIGHT

FROM: N. P. WHALEY

WATER SUPPLY INFORMATION
RELATIVE TO UPPER SANTA CRUZ
VALLEY AND MISSION UNIT

On March 9, 1964, I directed a memo to you which summarized the changes which had occurred in the Mission Unit well field between early 1960 and December, 1963. These changes involved declines in static water levels (and consequently pumping lifts) which I considered auguries of a probable inadequate water supply in the not too distant future.

In July of 1964, Short Brothers Drilling Company of Phoenix, Arizona, completed a deep well just west of the Nogales Highway for Anaconda. This well is approximately 20 miles south of Tucson in the SE$\frac{1}{4}$, SW$\frac{1}{4}$, SW$\frac{1}{4}$, Sec. 25, T.17S., R.13E. It will eventually serve as a source of supply for Anaconda's new installation south of Twin Buttes.

The well, described in the attached driller's report and well log to the State Land Department, was located by Sam Turner and Associates of Phoenix at Anaconda's open request for a water supply which would be adequate for the life of their mine. To my knowledge no restrictions of cost or source were placed on Mr. Turner, and his selection of a seemingly somewhat remote site probably reflects an awareness of the questionable reliability of a supply derived from more convenient sites proximate to the mine area.

This is most likely one of the best producing water wells in the state south of the Salt River Valley. It was test pumped at over 4000 gpm with negligible drawdown...an interesting phenomenon since the casing above 601 ft. was not perforated.

Developments such as this well which, with superficial evaluation, might seem extravagant are indications of the ever growing awareness of a pending water problem in the Santa Cruz Valley.

This memo might be regarded as a postscript to the feelings expressed in my memo of March 9, 1964, emphasizing what could someday be a critical problem for the Mission Unit.

N. P. Whaley
N. P. WHALEY

NPW/jak
Attachments

STATE LAND DEPARTMENT
GROUND WATER DIVISION
STATE OF ARIZONA

REPORT OF WELL DRILLER

1. OWNER Anaconda (D-17-13) 25 ccd
Name

Address

2. Lessee or Operator The Anaconda Company
Name

P. O. Box 3039, Tucson, Arizona
Address

3. DRILLER Short Bros. Drilling Co.
Name

428 Security Bldg., Phoenix, Arizona 85004
Address

4. Location of Well: Twp. 17S Rge. 13E Sec. 25 SE 1/4 SW 1/4 SW 1/4
(10-acre subdivision)

5. Intention to Drill File No. D(17-13)25 ccd Permit No. ______

DESCRIPTION OF WELL

6. Total depth of hole 2,786 ft.

7. Type of casing Seamless

8. Diameter and length of casing 20 in. from 0' to 1213',
16 in. from 1206' to 2042', 9 5/8 in. from 1976' to 2516'

9. Method of sealing at reduction points Bell Reducers

10. Perforated from 601' to 2516', from ____ to ____, from ____ to ____

11. Size of cuts 3/16" X 3" Number of cuts per foot 12

12. If screen was installed: Length ____ ft. Diam. ____ in.

13. Method of construction Rotary - gravel-packed?
Drilled, dug, driven, bored, jetted, etc.

14. Date completed July 12, 1964

15. Depth to water 140 ft. (If flowing well, so state.)

16. Describe point from which depth measurements were made and give sea-level elevation if available Rotary table measurement of 5' above ground level elevation of 2,789'

17. If flowing well, state method of flow regulation ______

18. REMARKS:

______

DO NOT WRITE IN THIS SPACE

SHORT BROS. DRILLING CO.

WELL LOG

THE ANACONDA COMPANY

CONTINENTAL NO. 1

PIMA COUNTY, ARIZONA

Clay, sand and gravel	0' - 350'
Sand	480'
Sand and gravel	500'
Sand	615'
Conglomerate	730'
Sand and clay	750'
Conglomerate	790'
Conglomerate and clay	800'
Sand and clay	820'
Conglomerate	860'
Sand and clay	870'
Conglomerate and clay	1,110'
Sand and clay	1,210'
Sand and gravel	1,270'
Conglomerate	1,300'
Sand and gravel	1,520'
Sand and clay	2,780'
Sand, hard	2,786'

Copy for RBM

J. H. C.

MAY 1 1964

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
April 30, 1964

MEMORANDUM TO MR. J. H. COURTRIGHT

MISSION UNIT - WATER SUPPLY

Subsequent to my memorandum of March 9, 1964, on the same subject, we discussed certain steps as perhaps logical developments in any further study of the potential of the Mission Unit well field.

These steps are outlined below for your reference should the need arise.

Study should include:

a) Review of changes which have occurred since pumping was initiated.

b) Evaluation and association of these changes within the framework of the regional setting.

If a problem or potential problem is found to exist...

c) A study of alternative measures should be made...incorporating estimated future requirements relative to the regional framework.

d) Recommendations made to assure supply...re feasibility of deepening present wells, additional wells similar to, or deeper than, existing wells, but within our present ground, or acquisition of new land or sources.

Norman P. Whaley

NORMAN P. WHALEY

NPW/jk

MR. ~~WES~~, JEJ

READ AND RETURN

PREPARE ANSWERS ..... HANDLE

FILE ✓ INITIALS

J. H. C.

MAR 10 1965

W.E.S.

MAR 11 1965

AMERICAN SMELTING AND REFINING COMPANY
Tucson, Arizona

February 9, 1965

Mr. T. A. Sneddon, General Manager
United States Mining Department
American Smelting and Refining Company
813 Valley National Building
Tucson, Arizona 85701

MISSION UNIT
Mining Schedule 1965-1969

< JHC file

Dear Sir:

Enclosed are two copies of the Mission mining schedule for the Years 1965 through 1969--a period of five years--with maps and Mr. Lewis' cover letter.

This schedule is based on 358 shovel shifts per year, producing 88,200 tons of ore and waste per day on a seven-day week. This schedule requires an additional seven trucks in July to cover extended haul distance when the pit will be deepened two more benches. Other pit equipment that will be required to maintain the pit consists of four rubber-tired dozers (one to be purchased each quarter to replace the present equipment that had accumulated an average of 18,400 hours each as of January 1, 1965) and one D-8 Catapillar dozer (to be purchased the second quarter to replace one that had accumulated 22,700 hours as of January 1, 1965).

'64 prod 7,579,800 Tons milled

The mining schedule for the Year 1965 shows 5,753,800 tons of plus 0.40 ore available, and an additional tonnage of minus 0.40 material will be added to hold the capacity of the mill at 6,800,000 tons. These tonnages are regulated by the amount of hard ore encountered with a low milling rate.

Referring to last year's report, you will note the ore faces for 1965 decreased from 3390 feet to 1820 feet at the beginning of this year. This decrease is due to a change in the location of the ramps and allowing more working width on the benches (150 feet).

The following tabulation shows the amount of face to be developed each year:

Beginning of	Feet of Ore Face	No. of Benches
1965	1820	6
1966	3170	9
1967	3670	7
1968	4840	9
1969	4010	7

A review of last year's schedule for the Year 1964 predicted production of 6,800,000 tons at 0.75 per cent Cu. The actual production of 7,579,800 tons at 0.77 per cent Cu is a net gain in units produced. The ore reserve of January 1, 1965 shows a net gain of 2,000,000 tons of 0.51 per cent Cu, of which 1,700,000 tons are due to mining ore outside of the delineated ore block. So what? Therefore, it is my conclusion that, although it is necessary to readjust the feet of ore face for each year just prior to production, this does not conclude that less ore than predicted is available.

Yours very truly,

R. B. Moen
Manager

RBM/jah
cc: PALewis

OBED M. LASSEN
STATE LAND COMMISSIONER
PHONE 271-4621

STATE LAND DEPARTMENT

STATE OF ARIZONA
STATE OFFICE BUILDING
PHOENIX 7, ARIZONA

J. H. C.
OCT 22 1963

October 3, 1963

Mission

American Smelting & Refining Co.
813 Valley National Bldg.,
Tucson, Arizona 85701

Permit No. 777 & 779

Dear Leaseholder:

The State Land Department has issued a Prospecting Permit on the following land:

PP-777 - W2; W2E2 of Section 34, Township 16-S, Range 13-E.
PP-779 - Lots 3 & 4; S2NW; SW of Section 2, Township 17-S, Range 13-E.

You have surface rights on this land under Lease No. G-2856 and it is the policy of the State Land Department to notify all surface leaseholders that this office has issued a prospecting permit. The permittee has the right to enter upon the land and explore for a valuable mineral deposit as required by the State Land Department in order that the permittee may apply for a mineral lease. The name and address of the permittee is as follows:

J. Harry Fieldman, etal
2706 Silverbell Rd.,
Tucson, Arizona

The terms of your lease written in accordance with the laws of the State of Arizona, provide that the State Land Department may issue a lease of a mineral claim located within the area covered by your lease. At such time the mineral lessee would acquire certain additional rights, including a limited surface use. It is hoped that any problems that may arise as a result of such multiple use can be worked out equitably by the lessees involved. The Department stands ready to be of assistance, where necessary in resolving any questions.

STATE LAND DEPARTMENT

8-8-61
2-70

Memo of it for RB Meen - JW Courtright
10/4/63

TAS

LAW OFFICES

Evans, Kitchel & Jenckes

363 NORTH FIRST AVENUE

PHOENIX 3, ARIZONA

PHONE 254-8101

WILLIAM A. EVANS
DENISON KITCHEL
JOS. S. JENCKES, JR.
RALPH J. LESTER
JOHN F. BOLAND, JR.
EARL H. CARROLL
JAMES H. BUSH
L. RAY HAIRE
EDWARD C. LEBEAU

ALFRED S. CARR
LESLIE T. JONES, JR.
DONALD V. PEARSON
GEORGE MARISCAL
BURTON M. APKER
STEPHEN W. POGSON
WILLIAM T. BOUTELL, JR.
NEWMAN R. PORTER
CONRAD R. KOHRS

J. H. C.

OCT 22 1963

September 18, 1963

Mission

Mr. A. C. Hall, Assistant Manager
American Smelting and Refining Company
Southwestern Mining Department
813 Valley National Building
Tucson, Arizona

Re: MISSION UNIT
Notice of Prospecting Permit
From State Land Department
to Peter M. Mosier
All of Section 3, T 17 S, R 13 E

Dear Mr. Hall:

This will acknowledge your letter of September 13, 1963, with enclosed notice from the State Land Department that a prospecting permit has been issued to Peter M. Mosier on essentially all of Section 3, Township 17 South, Range 13 East.

The correspondence in 1957 was with respect to an application for mineral lease made by International Copper Development Corporation which involved the question of whether a discovery of a valuable mineral deposit had been made to support the mining location upon which the lease application was based. Since that time the legislature enacted the statutes governing prospecting permits. These statutes do not require a discovery of a valuable mineral deposit as a basis for the permit, and prospecting permits are intended for a situation such as is presented by Section 3, Township 17 South, Range 13 East.

Under the circumstances, I do not believe that it would be in order to register a protest with the State Land Department.

Yours very truly,

William A. Evans

WAE:hp

thereupon for SWcentralfile

J. H. C.
APR 20 1964

AMERICAN SMELTING AND REFINING COMPANY
MISSION UNIT

SUMMARY OF DIAMOND-DRILLING COST AND PERFORMANCE

YEAR 1963

	Rotary Drilling	Core Drilling	Total Drilling
Contract	$ 19,773.28	$122,138.77	$141,912.05
Per ft.	2.95	5.49	4.90
Labor	3,436.85	33,478.84	36,915.69
Per ft.	0.51	1.50	1.27
Supplies	-	2,392.05	2,392.05
Per ft.	-	.11	.08
Other	-	9.29	9.29
Per ft.	-	-	-
Total Amount	$ 23,210.13	$158,018.95	$181,229.08
Per ft.	$ 3.46	$ 7.10	$ 6.25
	'64 3.46	'64 6.97	

3.50   7.30

2.81 cont.   5.60 (cont[illegible]

	Rotary Drilling	Core Drilling	Total Drilling
Number of holes			35
Drilling shifts	69.3	883.8	953.1
Machine shifts (total)	114.4	1,114.6	1,229.0
Footage drilled	6,713.8'	22,262.3'	28,976.1'
Drilling rate/drill shift	97.0'	25.2'	30.4'
Advance/shift worked	58.7'	20.0'	23.6'
Core recovery, pct.		91.4%	

Average depth of hole = 827.88 ft.

17- 10.5/1(4)

STATE LAND DEPARTMENT

OBED M. LASSEN
STATE LAND COMMISSIONER
PHONE 271-4621

STATE OF ARIZONA
STATE OFFICE BUILDING
PHOENIX 7, ARIZONA

September 10, 1963

Mission

American Smelting & Refining Co.
813 Valley National Bldg.,
Tucson, Arizona

Permit No. 780

Dear Leaseholder:

The State Land Department has issued a Prospecting Permit on the following land:

17-S R-13 E

Lots 1 to 4; S2N2; S2 of Section 3, Township 13-E.

You have surface rights on this land under Lease No. 0-2856 and it is the policy of the State Land Department to notify all surface leaseholders that this office has issued a prospecting permit. The permittee has the right to enter upon the land and explore for a valuable mineral deposit as required by the State Land Department in order that the permittee may apply for a mineral lease. The name and address of the permittee is as follows:

Peter M. Mosier
5542 E. Burns
Tucson, Arizona

The terms of your lease written in accordance with the laws of the State of Arizona, provide that the State Land Department may issue a lease of a mineral claim located within the area covered by your lease. At such time the mineral lessee would acquire certain additional rights, including a limited surface use. It is hoped that any problems that may arise as a result of such multiple use can be worked out equitably by the lessees involved. The Department stands ready to be of assistance, where necessary in resolving any questions.

STATE LAND DEPARTMENT

8-8-61
2-70

Thompson for T H Cartwright
10/4/63

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 7, 1962

Mr. S. L. Tainter
Mission Unit

MISSION COMPOSITE
DRILL LOGS

Dear Stan:

In accordance with our telephone conversation, you will find enclosed the following:

(1) one book of original Mission composite logs, hole nos. from 16 to 230, but not complete.

(2) folder of partially completed logs representing those logs missing in No. 1 above.

(3) set of Mission composite log work sheets.

(4) plus or minus 200 log forms with orange carbon paper.

(5) Pima Mining Co. drill logs.

We have a set of prints corresponding to No. 1 above, and would like to receive prints of any logs you complete to add to this set.

Yours very truly,

J. H. COURTRIGHT

JHC/kw
Encls.
cc: TASnedden
KERichard

JHG

Mission Prod. to April 1, 1962

Bench	Mill Tons (100)	Mill % Cu	Ore Estimate Tons (1000)	Ore Estimate % Cu
2970	431.0	.61	96.7	.61
			1882.7	1.11
2930	209.99	.76	1809.9	.77
2890	1,676.99	.74		
2850	579.30	.75	728.5	.67
	4,787.10	.74	4517.8	.89 -12%

to May! 5.2 millin .75 — 5.0 mill .90

Jan 1, 62

Prod. -	3,441	.75
Geol Poly -	2,962	.96
Unif Var -	1,877	.77

JHC.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

March 30, 1962

MEMORANDUM FOR MR. T. A. SNEDDEN:

MISSION UNIT

Factors bearing on Mission production forecasts are discussed in the following. In summary, the deficit in copper production to date rests principally on an erroneous projection of one high grade drill hole intercept. This projection is confined to two benches, the 2930, and the 2890, and thus the outcome on these two benches should have no direct bearing on production forecasts for mining on lower benches. Within the present open pit area it is considered probable that: (1) The 2850 and 2810 levels will show a relatively small deficit in copper (as compared to the 2930), (2) 2770 -- gain, and (3) 2730 -- gain.

Mission production records to March 1st, 1962 show 14% less copper than estimated in the ore reserve calculation of 1959, as follows:

Bench	Production Tons (1000)	% Cu	Ore Reserve Estimate Tons (1000)	% Cu	% diff.
2970	431.0	.61	96.7	.61	+ 446
2930	2,070.8	.76	1,850.7	1.12	- 24
2890	1,528.2	.75	1,755.9	.77	- 15
2850	225.4	.96	332.4	.64	+ 02
	4,255.4	.75	4,035.7	.92	- 14%

As may be seen, results on the 2930 level account for a major part of the 14% overall difference. Due to the small tonnage mined so far on the 2850, results on this level are of little significance.

While the distribution of copper encountered in mining so far has a much greater degree of irregularity than anticipated, the total shortage of copper rests largely on one drill hole intercept, and is due principally to misinterpretation of structure involving this high-grade intercept in hole 136. Rather than a high-grade bed overlying the No. 1 thrust, the intercept proved to be part of a narrow, discontinuous vein in the 2930 bench. This "bed" was projected down dip onto the 2890 bench, but only a part of the high-grade area thus calculated has been mined to date on this bench; however, geologic and blast hole data indicate that conditions on the 2890 will be similar to those on the 2930, so ultimately the deficit on this bench will be greater than the existing 15%. The influence of the high-grade in hole 136 was confined to these two benches and thus has no bearing on what may be expected in succeeding benches below. However, substantial amounts of high-grade are shown in the ore estimate on the first four benches below. The tonnage and grade of these, and the two benches above are as follows:

Memo for T. A. Snedden   March 30, 1962

12 mo. ore est
5.7 million tons
@ .82 - includes
.5 million on
2770 - after
reduction of 12%
in grade

Bench	Tons (1000)	% Cu	Grade-Tons (1000)
2930	121	7.83	949
2890	93	5.96	553
2850	139	4.71	656
2810	78	5.50	430
2770	82	8.21	669
2730	28	6.80	189

High-grade estimated on the 2930 bench (above) amounted to 121,200 tons at 7.83% copper, or 948,700 grade-tons. This is roughly two times the deficit on the 2930 bench of 518,600 grade-tons (tons at 1.% copper). Judging from the blast hole assay map, less than one-tenth of the expected copper was recovered from this high-grade area. Part of the loss here was recovered elsewhere (probably much of it from high-grade pods along the east vein zone) so that the net loss on the level amounted to 518,000 grade-tons.

A substantial part of the calculated high-grade area on the 2890 remains to be mined, and as noted above, a much greater deficit can be expected.

As exposed in the 2810 level underground workings, a vein-like zone of plus 3.0% copper formed the eastern side of the ore zone. Two crosscuts showed an average width of 25 feet. Continuity in depth was indicated by inclined hole U-4, as well as by H-5, a hole drilled in the pit recently. However, upward continuity failed to materialize, as only a few, disconnected high-grade pods were encountered on the 2930 and 2890 benches. Mining so far on the 2850 has shown a similar erratic distribution of high-grade, but some 700 linear feet of the east vein zone remains to be mined. On the 2810 and the three succeeding benches, this zone can be expected to average something on the order of 25 feet in width over a length of at least 800 feet. This amounts to about 80,000 tons per bench of around 3.0% ore (240,000 grade-tons) which was not included in the ore estimate.

The foregoing list of high-grade ore (taken from the ore estimate) shows amounts ranging from 656,000 grade-tons on the 2850 to 189,000 grade-tons on the 2730. This ore represents projections of high-grade intercepts in hole 130. The underground workings on the 2810 level failed to encounter the projected high-grade, but drill hole U-5 stopped in .5% Cu on the 2850 above, U-6 cut 15 ft. of 3.0% Cu on the 2770 below, and U-11 (100 ft south of U-6) cut 40 ft. of 10.%, also on the 2770. These results, plus those of H-10, indicate substantial continuity of high-grade copper mineralization in the form of an inclined bed, or tabular body which occurs <u>below</u>, rather than on the 2810 level as calculated in the ore estimate. Thus, a deficit is to be expected on the 2810, but production from the east vein zone should compensate in part for the shortage.

Assuming that outside of the high-grade zones production continues to equal, or exceed the ore estimate as it has in the past, future production in the east end down through the 2730 bench should be something within range of the following:

Memo to T. A. Snedden March 30, 1962

Bench		% above or below expected
2890	----------	minus 25%
2850	----------	minus 10%
2810	----------	minus 5%
2770	----------	plus 25%
2730	----------	plus 25%

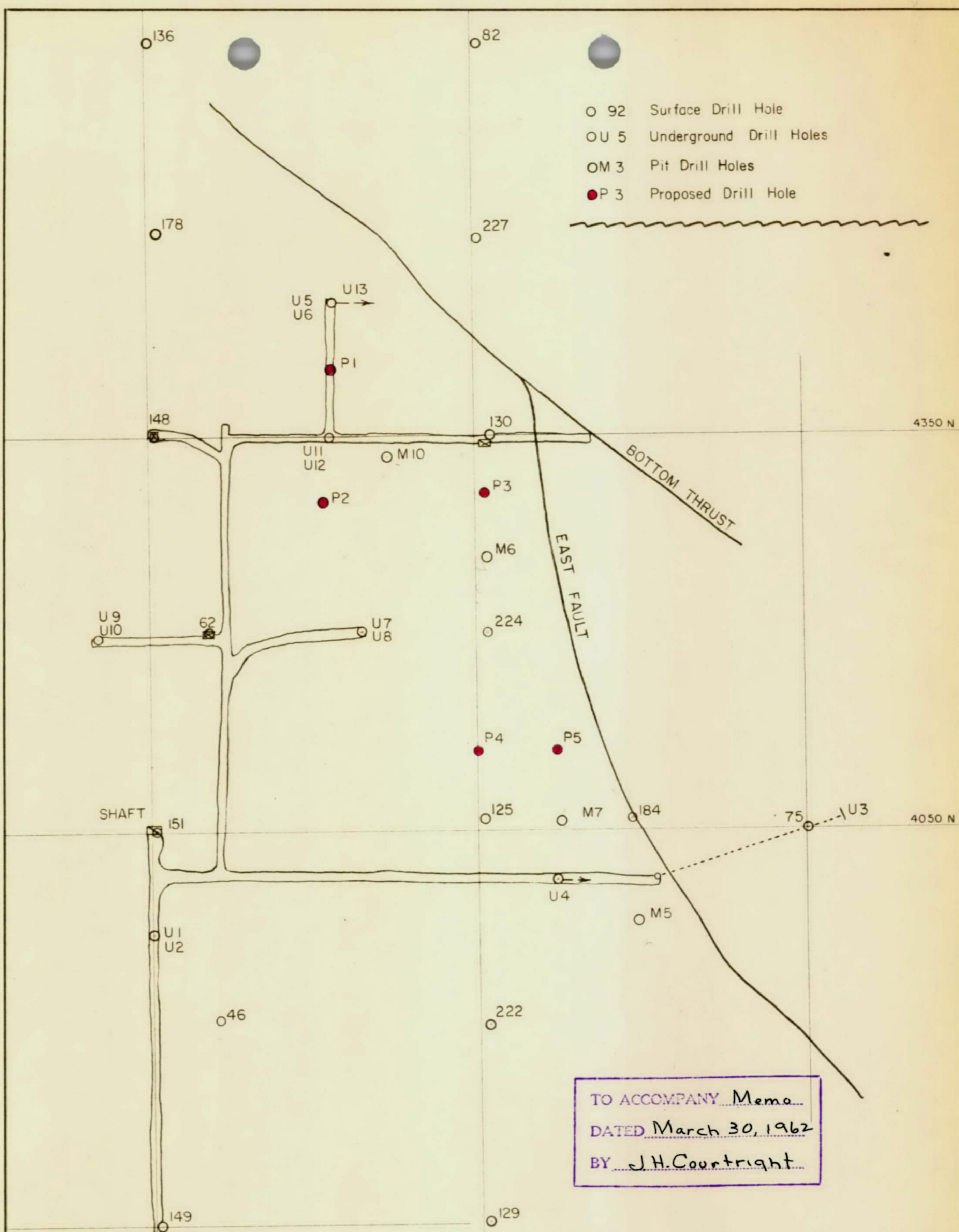
The 2730 bench will be essentially complete in the east end of the pit at the end of the 4th year of mining, according to Mr. Schubel's pit layout.

When space for a drill rig becomes available in the pit, at least three more holes should be put down in the vicinity of hole 130. The positions of these, plus two additional holes near hole 125, are shown on the attached plan map.

Original signed by
J. H. Courtright

J. H. COURTRIGHT

Attach.
JHC/ls
cc: KRichard
RDMeen



TO ACCOMPANY Memo
DATED March 30, 1962
BY J.H. Courtright

MISSION PROJECT
UNDERGROUND PLAN MAP
2810 LEVEL
SCALE 1" = 100'
MARCH, 1962

J. H. C.
SEP 8 1961

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

July 7, 1961

MEMORANDUM FOR T. A. SNEDDEN

MISSION EXPLORATION
Banner - Asarco
Joint Drilling

I have reviewed the results of recent drill holes C-1 through C-4, in accordance with instructions from Kenyon Richard prior to his departure for South America.

The attached map shows the location of these four diamond drill holes, and a rather generalized picture of ore distribution. Bob Gale and Ray Stauffer of Mission logged the holes.

Holes C-2 and C-4 demonstrate that the area of weak mineralization in the east end of Banner's Eisenhower group extends all along the west flank of the Mission "northeast" ore zone (see sketch). From the standpoint of future pit plans this shows that the "northeast" ore zone will stand or fall largely on its own merits, for its probable pit limits will strip waste to the west of the high angle fault shown on the attached sketch. Mr. Richard has, I believe, pointed out that this area consists of inclined b odies of moderately high-grade ore separated by waste, and that some interspaced drilling will be necessary before a firm ore calculation can be made.

A deep high-grade ore lens in C-2 begins at 650 feet; being 40 feet which averages 4.28% Cu. Under special conditions (for example, if the "north-east" ore body is mined and strips considerable waste above this deep lens) this might become available to pit operations, but is likely not open pit "ore" by itself. And of course the assays represented by this single penetration may not be representative.

Hole C-1 was a blank. Coupled with weak mineralization in Banner DDH 82, it adds to the southerly extent of the weakly mineralized area discussed above.

Hole C-3 was an exceptionally good hole which penetrated 345 feet of sul-phide ore which averaged 1.21% Cu. Values begin near bedrock. The bottom 35 feet average 4.76% Cu, and contain 10 feet of 10% Cu. From the stand-point of pit expansion into the central portion of Banner claims this hole may be significant. No other holes are sufficiently close to demonstrate the size of this well mineralized area, although its possible maximum dimen-sions may be seen from the attachment. Additional drilling in this area to complete the grid pattern is clearly warranted.

Memo for T. A. Snedden
Banner - Asarco Joint Drilling

July 7, 1961

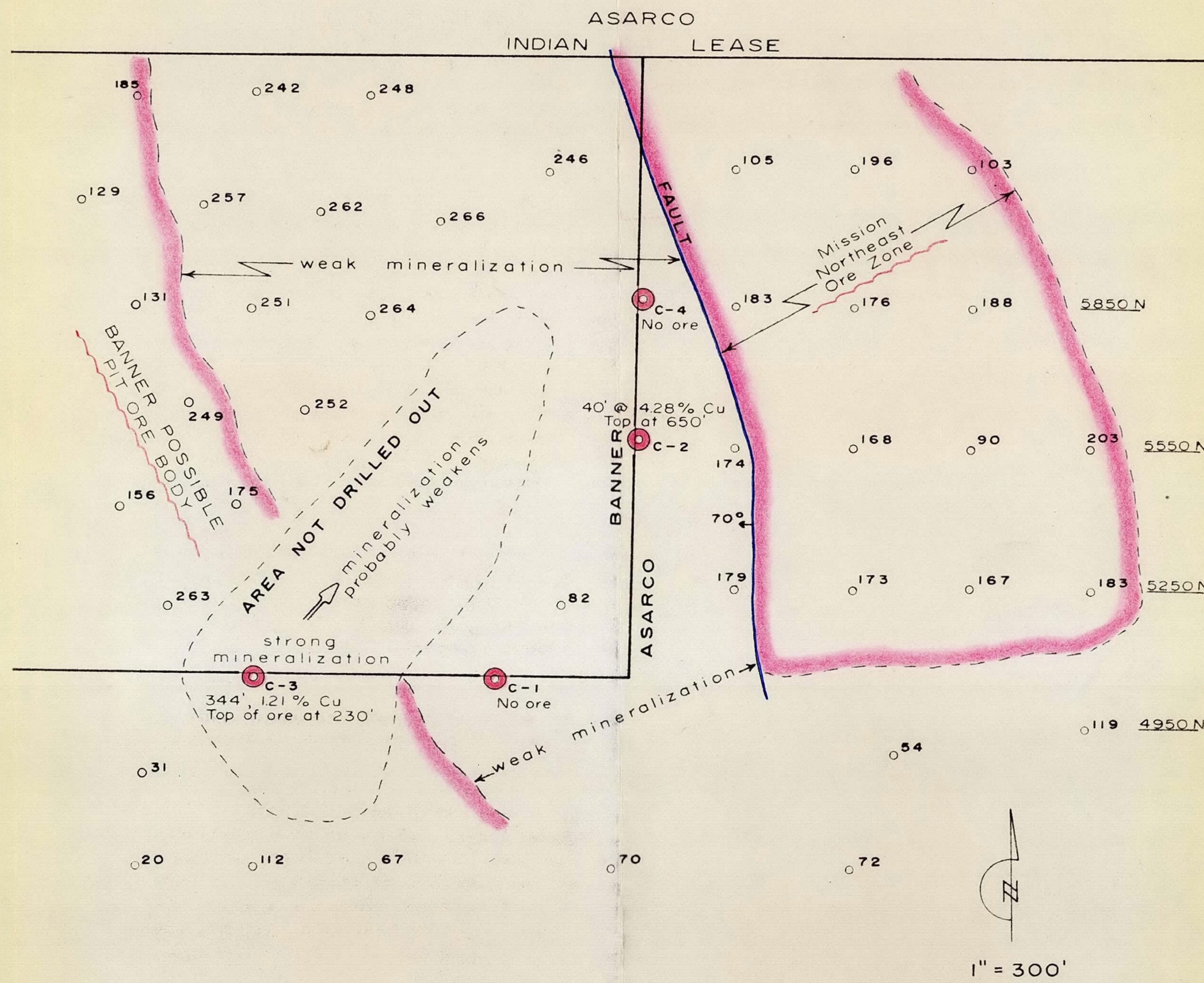
Underground exploration by Banner may be encouraged by the deep layer of high-grade in C-3. C-2 also penetrated a deep layer of possible underground ore (40 feet of 4.28% Cu, 10 feet of which is 10% Cu) below the weakly mineralized argillite. Banner geologists may infer that the deep layers in these holes are continuous, and so may be encouraged to do additional drilling on that basis. This deep high-grade lies along a tactite-marble contact, and the two drill penetrations show remarkably similar thicknesses and grades. Nevertheless, I am reluctant to suggest direct continuity of values over this distance (1000 ft.), because our experience at Mission demonstrates the erratic habit of ore distribution.

ORIGINAL SIGNED BY
JOHN E. KINNISON

JOHN E. KINNISON

JEK/z
cc: KERichard
JHCourtright
JEKinnison

TO ACCOMPANY Memo
DATED July 7, 1961
BY J. E. Kinnison



MISSION - BANNER
HOLES C-1, C-2, C-3, C-4

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 9, 1960

MEMORANDUM FOR T. A. SNEDDEN

MISSION PIT
Geological Mapping

It is anticipated that, due to the erratic distribution of copper, ore/waste sorting will be a major mining problem in the Mission pit -- in fact, it will be more critical than in any other of the larger copper pits in the Southwest.

It is expected that in some instances ore/waste contacts will be sharp and clearly apparent to shovel operators and others. However, in many cases contacts will be gradational and obscure. In these circumstances all information of possible benefit to the sorting procedure should be made available in simplified form to the operators prior to digging a bench.

There are four sources of information: (1) blast hole assays, (2) geological map of the bench face itself, (3) projection of data from previously mapped bench faces, and (4) comparison of the foregoing information with those ore reserve level maps already prepared which show structure and ore/waste distribution as predicted from exploration drill holes.

It is suggested that all of this information should be gathered and analyzed by the geologists and put in simplified form on an individual 20- or 50-scale(?) map on a letter-size sheet showing each bench blast area before it is blasted. This can be termed an ore/waste prediction map and will show blast hole locations and their assays along with ore/waste contacts as mapped on the bench face and as projected into the bench face. It will carry only those notes and symbols which would have a direct bearing on the predicted shape of the ore lenses, and which, presumably, would be of use to the operators in sorting and blending.

The preparation of these ore/waste prediction maps will be the principal objective of geological mapping in the pit. They will be prepared and handed to operating personnel as quickly as possible -- probably in pencil to save time. This brings us to the mechanical problems of getting the bench face geologically mapped.

The pit surveyors will, as I understand it, tie in each blast hole and the toe and crest line of each bench. However, often this might not be done until just before the bench is blasted, leaving no time for the geologists to do their mapping using the surveyors' control points. The geologists, then, must survey their own control along the toe and crest. Whenever possible, they would do this as soon as a bench is cleaned up. Preferably, this surveying would be done with alidade and plane table.

A possible alternative method to plane table surveying would be to stretch a tape between the two end blast holes. From this control the blast hole positions, the bench toe and crest, and the geological features could be sketched. The resulting ore/waste prediction map would have all contacts and data referenced to blast holes and thus would be useful even though the geometry would not be precise. The geologists later could adjust their basic field notes to the pit surveyors' control points.

The first ore-grade material encountered in mining probably will be mixed chalcocite and chalcopyrite cut by zones of various oxidized copper minerals. Much of this can be sent to waste, but some of it may have commercial possibilities and may have to be dealt with metallurgically. This supergene zone is thin and represents only a small part of the ore body, but for a time it probably will cause particularly difficult sorting and blending problems. The exploration drill holes indicate that both the copper mineralogy and structure of this supergene zone are erratic, but the holes are too far apart to provide any details on these irregularities. Knowledge of this supergene zone can best be obtained by mapping as soon as bedrock is exposed in the pit.

For the first months of mining in bedrock, according to Mr. Meen and Mr. Sense, bench blasts will be small and there will be little if any time (or room) for the geologists to survey and map between the episodes of digging and blasting. During this early phase the geologists will attempt to survey and map on a catch-as-catch-can basis whatever important features they can get to without recording much detail, and without much regard for accuracy. No doubt many short bench faces will be missed entirely. It is hoped that this condition will have improved after a few months of ore production. In any event every effort will be made to systematize the geological surveying and mapping procedures and the resulting output of ore/waste prediction maps as early as possible.

The geologists' field sheets will contain all detail which would seem pertinent to record, and they will be inked and colored as a permanent record of geological detail. Instead of projecting all structure to a plane at the buried toe of the bench, as is done on Silver Bell field sheets, it is planned that on the Mission field sheets the data will be recorded as on a topographic map, with the bench toe and crest lines providing geometric control.

The important geologic features mapped on bench faces will be plotted on a tracing base "progress" map for each level. These tracings will be similar to the Silver Bell level maps, with the exception that geology will be shown at mid-bench elevation in order to permit direct comparison with the level maps of the ore reserve estimate. It is expected that proper analysis of structures and ore distribution eventually will require sets of "progress" sections corresponding to the level maps; but this will not be undertaken at the beginning.

Although the first concern of pit mapping will be primary structures and ore distribution, post-mineral faults and slips also will be mapped wherever practicable. After being recorded on the level maps, these structures will be studied with the idea of trying to predict locations where pit walls might be subject to slumping such as has occurred in the present south wall of the Pima pit. With the latter as an example, there is cause for concern in the Mission pit because the same brittle rock type exists there.

Slumping of pit walls usually is caused by special combinations between attitudes of post-mineral faults (or systems of tiny parallel slips) and attitudes of pit walls, such that digging tends to undercut and produce a free or weakened block. After slumping has occurred, the planes of weakness are easy to see. However, in the undisturbed rock the real significance of any one fault or slip in terms of potential weakness often is not apparent. Observations during bench mapping are limited in time and the recordation of an abundance of small slips is of uncertain practicality. The point of all this is that every effort will be made to accumulate data on this problem of potential slumping, and I believe this information eventually will permit recognition of certain dangerous slump conditions in advance. However, this should not be construed as meaning that it will be possible to collect enough information for predicting all potential slump zones.

KENYON RICHARD

KR/ds

$43 MILLION MINE PLANNED

15 Miles From Tucson

By JOHN RIDDICK

[redacted]

سنة 1959

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

693,126

261/773

[illegible]

August 11, 1960

Mr. John Cooper
U. S. Geological Survey
Federal Center
Denver 2, Colorado

AERIAL PHOTOGRAPHY
Pima District, Arizona

Dear Sir:

You have asked about our aerial photography coverage in the Pima District in connection with your need for an accurate contour map for large-scale mapping, particularly in the Helmet Peak-Mineral Hill part of the district.

The photography covering the large area shown on the attached map and the 5' contour maps (1" = 200') of the smaller area were made for us by American Aerial Surveys, Inc., 265 E. Rowland Avenue, Covina, California, in December, 1956. That companydid the field ground control for the area of 200-scale contour maps. We have the tracings and can provide you with prints of these maps if they would be of use to you. However, they do not include much of the actual area of outcrops in which you would be interested; and the culture is, of course, quite out of date.

In case the USGS wants any of the photographs (contact prints, scale 1" = 1000'), we will be glad to give American Aerial Surveys permission to make them for you. If you want to have contour maps made for additional areas, the ground control will have to be extended from that which was established for our maps. Our Mission engineering department could give you the basic survey data you would need for any extended ground control surveys.

Please accept my congratulations on your recent Bulletin on the Pima area. It is a fine piece of work in every respect. This opinion is held also by Harold Courtright and John Kinnison; and you can assume that we have been checking over your text and map with a good deal more than casual interest. You established a new world record for early publication, too, did you not? We are looking forward to further discussions when you return this fall.

Yours very truly,
Original Signed By
K. Richard

KENYON RICHARD

Att.
KR/ds
cc: Stanton Tainter- Chief Engineer, Mission Unit
JHCourtright
JEKinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
June 10, 1959

MEMORANDUM FOR T. A. SNEDDEN

MISSION UNIT
Chemical Analyses

Mr. Pope's letter of May 1 requested chemical analyses of the Mission ore body.

Heretofore we had prepared 28 composite pulps representing all drill hole ore intercepts within the open pit ore body. I selected six of these pulps as being representative of the principle ore types, and sent these to the El Paso Umpire Lab for analysis. Results are not yet at hand; but I am leaving on vacation, and am writing this memorandum in case you wish to transmit the analyses to Mr. Pope before I return.

Significant data on the samples is contained in the following table:

Composite Sample Number	Portion of Ore Body	Footage of Drill hole Making up Sample	% Cu (Silver Bell)	Ore Type
A 1	East	1023	1.55	Hornfels & Tactite
C 1	East	1290	1.00	Hornfels and Tactite
C 4	East	198	1.30	Quartzite
H 1	West	858	.99	Hornfels and Tactite
G 2	West	891	.82	Argillite
I 3	West	96	.43	Mixture of Hornfels, Tactite, Argillite, Porphyry and Gypsum

If any of the analytical results on the above samples appear to be anomalous, I suggest you check with Mr. Courtright.

Samples C 4 and I 3 represent localized, small tonnages of ore; and I 3 will become available only after the 8th year of mining.

The other samples each represent a block of several million tons of ore. Any one block could have considerable internal variation in chemical composition, but we do not know the range of these variations. If this information were to become needed, it could be acquired by making up and analyzing about 20 new composites, each representing about 40' of drillhole core.

KENYON RICHARD

KR/ds
cc: JHCourtright

May 19, 1959

MEMORANDUM FOR MR. A. A. BROWN:

MISSION PROJECT
UNDERGROUND WORK

I am attaching a copy of the excellent and comprehensive report prepared by Messrs. Kenyon Richard and Harold Courtright on the underground work done at the Mission Project to check ore reserves.

In my opinion, the results of this underground work have been highly satisfactory. It is true that at no points have there been exact checks on grade, but this variation was really to be expected. In perhaps the majority of check areas, the grade of ore as determined by the new work has been somewhat lower, but as opposed to this, there are important areas where new high grade zones have been discovered or previously known ones have been found to be larger than some of us had previously hoped.

On average, I believe that we can expect to mine at least the tonnage estimated in the report of Richard and Schmbel dated March 2, 1959 at approximately the estimated average grade.

I think that all concerned in doing the underground work and reporting thereon are to be complimented on the performance.

If you agree, as soon as we are authorized to go ahead with this project, we will strip the underground workings and remove the surface plant.

D. J. Pope

DJP:mt
Att.
cc: CPPollock
LHHart
TASnedden
KRichard
JHCourtright

April 27, 1959

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

MISSION PROJECT

Dear Mr. Richard:

This refers to your summary of underground development at the Mission Project, dated April 25. I agree with your general conclusions. However, I would like to emphasize even further that the amount and type of work done is too limited to permit more than a general grade comparison with ore reserve estimates. I had hoped that a larger number of new diamond drill penetrations would be completed in the course of this program. Although a number of such penetrations were made, I believe that (to be really significant for grade comparison) the number of such penetrations should have been greater. Raises on drill holes do not add to grade information, but are useful in confirming the accuracy of the individual drill holes and also in giving visual access to the column penetrated by an individual drill hole. This latter provides a better knowledge of mineral distribution, which is important. Your detailed geological mapping of the raises contributes something of real value in this connection.

Confirming drilling information, the underground work makes it thoroughly evident that copper mineralization is distributed very irregularly throughout the deposit. I believe this irregularity will be found to bear a close relation to structural deformation and when general structural control is learned more fully, a reasonably close grade control in mining may be obtained by use of detailed geological mapping. This is obviously a situation which we cannot fully anticipate in advance, but we should be alert to modifying the type of geological work to best fit the problems of mining as it progresses.

Very truly yours,

L. H. HART

cc: DJPope
JHCourtright

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
April 25, 1959

AIR MAIL

Mr. L. H. Hart, Chief Geologist
American Smelting and Refining Company
120 Broadway
New York 5, New York

SUMMARY GEOLOGICAL REPORT
Mission Underground Workings

Dear Sir:

This letter contains a summary of the results of the Mission underground work to date, and a comparison between these results and those obtained in surface diamond drilling, as requested by Mr. Pope. In a broad sense, but within inherent limitations, the underground work supports the validity of the ore reserve estimate.

A report with maps, sections and other detailed information supporting this summary is in preparation. In the meantime reference can be made to interim reports of November 21 and 25, 1958 by Kinnison and Richard, which are similar in form and content to the detailed report being prepared.

A sheet (Attachment A) of two long sections (EW and NS, 1" = 500') showing the district geological environment of the Mission ore zone is attached. The underground workings and the "ultimate" pit appear on these sections. (As being of possible general interest, an additional long section (Attachment B) showing the water supply source and surface topography from the ore body easterly to the Santa Cruz River also is attached.)

The workings were laid out primarily to secure bulk metallurgical samples and at the same time gather some detail on the character and distribution of copper values, structure, and other geological features. Subsequently, the program was expanded to include additional drifting, underground diamond drilling, and raising on four of the surface drill holes. As a result, general structural concepts have been confirmed, but copper values have proved to be somewhat more erratic in local distribution than was interpreted from the surface drill hole information. In the matter of grade comparisons, the average of the calculated ore blocks is substantially higher than that of the underground work. This difference, however, is not to be regarded as a real measure of the accuracy of the ore estimate, as it derives largely from unsymmetric, partial sampling of a relatively small part of the ore body. The results can be viewed in their proper perspective only on sections and plans. In the absence of these, certain fundamental factors will be briefly reviewed.

As can be seen on Attachment A, the underground workings penetrate a relatively small part of an ore body. Grade variations from point to point are considerable -- from a few tenths up to 15% Cu. In other words these workings constitute a small "sample" of the total ore body; and in serving as a so-called "check" of ore estimation, this small sample can show an appreciable difference, with this difference still being acceptable because it is within the range of probability.

The rather small part of the ore body which is presently under consideration is comprised of a number of ore lenses. As pictured on the ore reserve geological sections, these lenses mostly had low angle dips. The underground drifts and drill holes now demonstrate that these lenses are somewhat more irregular in shape than was originally pictured; however, most importantly, there is no indicated change in volume of individual lenses. In regard to copper content of these individual lenses, and disregarding the geometry imposed by the polygon ore estimation method, comparison of assays between surface drill holes and underground drifts and drill holes within a single lens show variations of as much as 40%, but usuallywithin 10 or 20%. These variations are expectable and within an allowable range, considering particularly that the workings tend to follow along the low-angle mineralization trends rather than crosscutting them.

In the ore reserve calculations the occasional high assays were not arbitrarily reduced, the theory being that high grade pods would exist between drill holes here and there in the ore body with sufficient frequency that the high values should be given the same volume weight as lower values are given. For example, in the underground work the two east drifts crossed the East fault and disclosed that it consists of an irregular, vein-like zone of high grade ore. One drift averaged 3.57% Cu for 30 feet; the other 8.98% Cu for 25 feet. Hole U-4 was angled down through this zone; it averaged 2.19% Cu for 178 feet, with a 16-foot portion of this averaging 7.60% Cu. This near-vertical zone, amounting to possibly a million tons or more, was missed by the vertical, surface holes. For this reason the appreciable amount of copper in this zone does not appear directly in our ore calculation polygons at that position. This copper will be gained in mining, however, and more than compensate for any of those high grade polygons which might, by chance, have been over-weighted in other parts of the ore body.

In our opinion the foregoing methods of comparison represent the proper approach in analyzing the correspondence between ore estimation and underground drift and drill hole assays; and, acceptable variations are indicated.

Another approach involves comparison of (a) the grade of individual polygons of the ore reserve with (b) the underground drill hole and drift assays falling within these polygons. While this method produces results which can be boiled down to one simple ratio, it is objectionable in the following respects: (1) The adjusted polygon method of ore estimation derives its accuracy from the gross compensating effect of large numbers of grade-polygons. Considered individually, the grade of each polygon is more-or-less erroneous; as the number of polygons increases, the overall accuracy improves. (2) Each polygon is a regular geometric figure, set up for convenience of volume measurement, which only approaches the true shape and position of the ore lens. For example, a polygon representing a 40' average of 10.23% Cu in hole 130 was, for structural reasons, drawn around the hole with an elongation to one side. Underground hole U-11 penetrated this elongated end of the polygon at a distance of 125' from hole 130. It cut 40' of ore averaging 10.64% Cu. This intercept corresponds precisely to the one in hole 130, but it is 20' lower in elevation and, consequently, is only partly reflected in the straight arithmetic comparison of drill hole and polygon. (3) Due to the low-angle attitude of most ore lenses in the Mission deposit, horizontal workings tend to be situated along internal mineralization layers. The assays from these workings are, therefore, subject to being unrepresentative in contrast to vertical drill holes which have a more crosscutting relationship.

Within the above limitations the following comparisons are made:

Drifts and Grade-Polygons

Avg. of drifts (weighted)	*1.21% Cu
Avg. of polygons (weighted)	1.80
Tons of rock in polygons	.9 mil.
Footage of drifts	1,622.0'
Footage of surface drill holes	360.0'

Underground Drill Holes and Grade-Polygons

Avg. of drill holes (weighted)	1.66
Avg. of polygons (weighted)	1.82
Tons of rock in polygons	1.7 mil.
Footage of underground drill holes	614.0'
Footage of surface drill holes	960.0'

*Comparison of assays of grab muck samples from the raises with assays of bulk samples put through the sampling plant indicates that the grab muck samples are consistently low by 4%. Hence, the grab muck assays from the drifts have been upgraded 4%.

The average of the underground drill hole core assays is within 9% of the average of the 24 grade-polygons penetrated by the underground drill holes. In 11 instances the drill core ran higher than the polygon; in 13 instances, lower. Considering (a) the small number of polygons involved, (b) the very high grade of some of the polygons, and (c) the relatively low footage of penetrations by underground holes, the correspondence is very close. In fact, it may be fortuitous.

The average of drift assays, however, is 33% less than the average of grade-polygons penetrated. This is a wide divergence, and should probably be considered as the extreme range of acceptability. In view of the limitations expressed in the foregoing and other paragraphs, as well as the fact that these drift samples do not by any means reflect the volume of copper in the East fault zone, there appears to be no cause for concern in regard to the validity of the ore reserve estimate as a whole.

The bulk samples from raises driven along drill holes are intended for assay comparisons with the corresponding drill cores. They of course give essentially no data for making ore reserve tonnage comparisons. To date assays for 164' of raises are at hand.

Avg. of bulk samples from 164' of raises	1.92% Cu
Weighted avg. of corresponding cores	2.34% Cu
Avg. core recovery	97.0 % Cu

The raises cut a few intercepts of waste but were mostly in ore. The average grade of the raise assays, however, is much higher than the average grade of ore in the ore body, .90% Cu. The entire ore body contains 14,704' of drill hole in ore. The raises, then, constitute a comparison of 1.1% of total drill hole in ore.

The bulk assays are 18% lower than the core assays. Detailed round-by-round mapping in the raises clearly demonstrates the erratic distribution of copper from one wall of the raise to another. This, together with the facts (a) that the area of the raise compared to the area of the core is on the order of 1000 to 1, and (b) that only 1.1% of the total core in ore is represented, demonstrates that the average variation of the cores is within an acceptable range. From a statistical standpoint something on the order of 1000 feet of raises would be required to reach close correspondence.

Yours very truly,

Original Signed By
K. Richard

Original signed by
J. H. Courtright

KENYON RICHARD
J. H. Courtright

KR
JHC/ds
Attachment: Two sheets of sections
cc: DJPope - 2 w/att.

JHC

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
April 24, 1959

FILE MEMORANDUM

MISSION PROJECT
Laboratory Processing of
Underground Samples

The samples obtained from the underground workings in the Mission Shaft were reduced to assay pulp at the Company's Mission sample laboratory. Several slightly different procedures and flow sheets were used in the preparation of the samples, as required by size, purpose, and physical state of the samples.

Muck grab and channel samples were delivered to the laboratory in 70 lb. sample sacks, weighed, placed in open pans and dried in ovens for 8 to 24 hours at 230°F. After drying the sample was crushed to -1/2" in the 4 x 6 jaw crusher (a screen analysis of 21 samples of this product showed 100% -1/2" and 77% -1/4") and reduced to two 1/16 portions (or approximately 8 lbs.) in a Jones splitter. The remaining 7/8 was discarded. One of the 1/16 portions was placed in a quart Mason jar for storage.

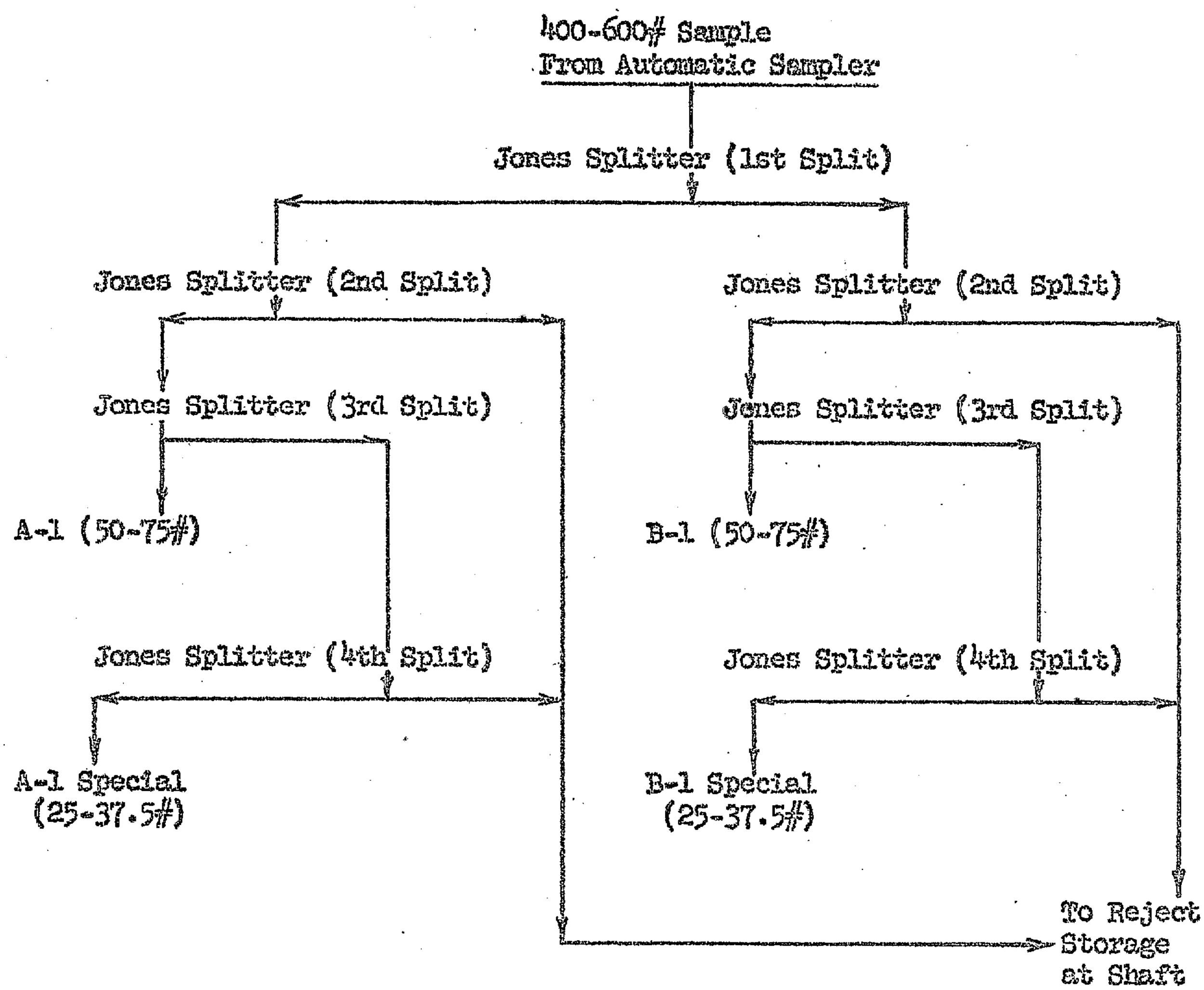
The remaining 1/16 portion was crushed to -10 mesh in the 10" gyratory crusher and split to approximately 500 grams by a Jones splitter. The sample was then ground to about -100 mesh in the pulverizer, well mixed by rolling on a plastic sheet and split once more by a Jones splitter. One 250 gram pulp was sent for assay and the other stored at the laboratory for future reference.

The core and sludge samples from the underground drilling were processed in nearly the same manner. The average run of core weighed between 2 and 4 lbs. After being logged it all was crushed to -1/2" and split once. One half was stored and the other was reduced to -10 mesh in the gyratory crusher and split to about 500 grams by a Jones splitter. The pulps were then prepared by following the same procedures outlined for the grab and channel samples.

A sludge sample was dried and the cake broken up by mortar and pestle. The small (1 to 1-1/2 lb.) sample was then mixed by rolling and split to about 250 grams. The reject was stored while the sample was reduced to -100 mesh in the pulverizer and sent for assay.

The bulk samples obtained from the sampling plant at the shaft site were processed in a different manner from those discussed above. The procedures for handling these samples were suggested by Mr. Courtright (memorandum for T. A. Snedden January 21, 1959) as a substitute for the more refined and lengthy procedure recommended in Mr. Vincent's letter of January 5, 1959. Subsequent check samples of three test lots proved that a 35 to 50 lb. cut from the 400-600 lb. product of the automatic sampler would be within the required accuracy.

The test lot samples were obtained by running the muck piles from three drift rounds through the bulk sampling plant. The 400 to 600 lb. sample cut out by the automatic sampler was then reduced by a Jones splitter at the shaft site. The following diagram shows how the A-1, A-1 Special, B-1 and B-1 Special samples were split out:



The A-1, A-1 Special, B-1 and B-1 Special samples were then sent to the laboratory in 5-gallon milk cans and processed for assaying.

The following table compares assays obtained from the test lot samples and includes assays of the grab samples from the drift rounds:

Test Lot Number	Grab Sample	A-1 Sample (50-75#)	A-1 Special (25-37.5#)	B-1 Sample (50-75#)	B-1 Special (25-37.5#)
		ASSAYS			
94-D	0.94	1.08	1.10	1.09	1.11
165-D	6.78	5.35	5.52	5.31	5.43
193-D	2.19	2.87	2.96	2.89	2.93

The four samples representing the various splits from the three test lots all were within very close correspondence, and the A-1 special sample was considered to be sufficiently representative for the purposes of the raise bulk sampling program. The procedures used at the laboratory for preparing the above and other samples from the bulk sampling plant are described below.

The A-1 Special and the B-1 Special products from the bulk sampling plant were delivered to the laboratory in 5-gallon milk cans. The B-1 Special sample was placed in storage and the A-1 Special sample was processed for assaying.

The sample was first weighed, dried 16-24 hours at 230°F, weighed again, and screened for + and - 10 mesh. The +10 mesh was reduced to -10 mesh in the gyratory crusher and recombined with the other -10 mesh material. The sample was then thoroughly mixed on a rolling cloth and split down to two 3 lb. (approximately) portions by a Jones splitter (split four times). One 3 lb. portion was placed in storage while the other was reduced to -100 mesh in the pulverizer. This 3 lb. -100 mesh sample was then mixed, coned and reduced by a spatula to 150 grams. The 150 gram pulp was sent for assay, while the reject was placed in storage.

As a check on the accuracy of the bulk sampling plant itself, one sample (R&SP Repeat A1, from Raise 4350-1250W, interval 17.7 to 21.5') was run back through the plant. The two runs assayed 3.96 and 3.97% Cu, a flat check.

To date a total of 73 samples have been run to check (a) the accuracy of sample preparation and (b) the assaying of underground samples. These check samples compared duplicate pulps and new pulps from crushed reject samples with the original pulp assays. The check assays were high in 28 cases with an average difference of 0.035% Cu; low in 37 cases with an average difference of 0.064% Cu; and the same in 8 cases. The total average difference in the 73 assays is 0.019% Cu.

The following is a tabulation of the check assays, included here as a matter of record:

Sample No.	Original Pulp Assay	Duplicate Orig. Pulp Code No.	Duplicate Orig. Pulp Assay	Stored Reject Pulp Code No.	Stored Reject Pulp Assay
60-D	1.58	G-5	1.61	G-15	1.57
86-D	1.09	G-6	1.05	G-16	1.14
5-D	0.87	G-7	0.85	G-17	0.86
83-D	0.60	G-8	0.61	G-18	0.61
178-D	0.42	G-9	0.43	G-19	0.43
20-DC	2.17	G-10	2.14	G-20	2.17
55-DC	0.98	G-11	1.02	G-21	1.00
125-DC	0.82	G-12	0.87	G-22	0.83
155-DC	0.62	G-13	0.58	G-23	0.63
165-DC	0.43	G-14	0.40	G-24	0.46
213-D	1.26	G-37	1.25	G-61	1.30
215-D	1.41	G-38	1.48	G-62	1.47
217-D	1.37	G-39	1.39	G-63	1.19
219-D	2.39	G-40	2.45	G-64	2.19
221-D	3.21	G-41	3.24	G-65	3.07
223-D	4.19	G-42	4.19	G-66	3.79
225-D	2.18	G-43	2.13	G-67	2.09
227-D	1.31	G-44	1.19	G-68	1.16
229-D	1.03	G-45	1.02	G-69	1.07
231-D	0.69	G-46	0.67	G-70	0.66
225-DC	0.56	G-47	0.55	G-71	0.58
226-DC	0.48	G-48	0.46	G-72	0.44
227-DC	0.54	G-49	0.53	G-73	0.49
228-DC	0.73	G-50	0.73	G-74	0.70
229-DC	1.18	G-51	1.16	G-75	1.17
230-DC	1.89	G-52	1.93	G-76	1.86
231-DC	0.94	G-53	0.96	G-77	1.04
232-DC	0.80	G-54	0.81	G-78	0.74
233-DC	0.31	G-55	0.32	G-79	0.28
234-DC	0.07	G-56	0.07	G-80	0.06
183-D	1.86	G-57	1.70	G-81	1.73
184-D	1.00	G-58	1.00	G-82	0.93
194-DC	0.02	G-59	0.01	G-83	Tr.
195-DC	0.06	G-60	0.06	G-84	0.07
1-RSP	1.76	G-86	1.76		
2-RSP	2.47	G-87	2.41		
3-RSP	6.92	G-88	6.92		
4-RSP	2.97	G-89	3.10		
DDH U-5 26.0 - 28.3	0.15			G-90	0.17

SAMUEL C. FALL

SCF/ds
cc: Norman Weiss) w/copy Courtright
JDVincent) memo 1/21/59
ACHall
WCWaidler
KERichard
JHCourtright

Courtright

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 20, 1959

FILE MEMORANDUM

MISSION PROJECT
Check Assays

Since December 1, 1958 numerous check samples have been sent to Silver Bell for re-assaying to check various phases of the Mission sampling program. This memo will describe the check samples and tabulate the assays to date.

Code numbers G-1 through G-4 were not used in the check series to avoid confusion with composite sample pulps having these designations.

Check samples G-5 through G-24 were re-assayed to check assaying procedures of random muck and channel samples from the Mission underground workings. Assay comparison among (1) original pulps, (2) other pulps made up from the crushed rejects, and (3) duplicate original pulps, are as follows:

Sample Number	Original Pulp Assay	Stored Reject Pulp Code No.	Stored Reject Pulp Assay	Duplicate Orig. Pulp Code No.	Duplicate Orig. Pulp Assay
60-D	1.58	G-5	1.61	G-15	1.57
86-D	1.09	G-6	1.05	G-16	1.14
5-D	.87	G-7	.85	G-17	.86
83-D	.60	G-8	.61	G-18	.61
178-D	.42	G-9	.43	G-19	.43
20-DC	2.17	G-10	2.14	G-20	2.17
55-DC	.98	G-11	1.02	G-21	1.00
125-DC	.82	G-12	.87	G-22	.83
155-DC	.62	G-13	.58	G-23	.63
165-DC	.43	G-14	.40	G-24	.46

Check series G-25 through G-36 compares assays of grab samples of fine (-1") and coarse (+3") material from random piles of the underground bulk material. These samples were taken to determine if the values systematically favored the coarse or the fine material.

Sample Number	Original Pulp Assay	Coarse Material Code No.	Coarse Material Assay	Fine Material Code No.	Fine Material Assay
64-D	.94	G-25	1.38	G-26	.98
115-D	1.71	G-27	1.94	G-28	1.29
28-D	2.04	G-29	2.99	G-30	2.28
192-D	3.03	G-31	2.68	G-32	2.75
147-D	.37	G-33	.25	G-34	.45
165-D	6.78	G-35	4.39	G-36	7.97

Samples numbered G-37 through G-84 are re-assays of duplicate original pulps and new pulps of stored crushed reject from other underground muck and channel samples.

Sample Number	Original Pulp Assay	Dup. Orig. Pulp Code No.	Dup. Orig. Pulp Assay	Stored Reject Pulp Code No.	Stored Reject Pulp Assay
213-D	1.26	G-37	1.25	G-61	1.30
215-D	1.41	G-38	1.48	G-62	1.47
217-D	1.37	G-39	1.39	G-63	1.19
219-D	2.39	G-40	2.45	G-64	2.19
221-D	3.21	G-41	3.24	G-65	3.07
223-D	*0.14	G-42	4.19	G-66	3.79
225-D	2.18	G-43	2.13	G-67	2.09
227-D	1.31	G-44	1.19	G-68	1.16
229-D	1.03	G-45	1.02	G-69	1.07
231-D	0.69	G-46	0.67	G-70	0.66
225-DC	0.56	G-47	0.55	G-71	0.58
226-DC	0.48	G-48	0.46	G-72	0.44
227-DC	0.54	G-49	0.53	G-73	0.49
228-DC	0.73	G-50	0.73	G-74	0.70
229-DC	1.18	G-51	1.16	G-75	1.17
230-DC	1.89	G-52	1.93	G-76	1.86
231-DC	0.94	G-53	0.96	G-77	1.04
232-DC	0.80	G-54	0.81	G-78	0.74
233-DC	0.31	G-55	0.32	G-79	0.28
234-DC	0.07	G-56	0.07	G-80	0.06
183-D	1.86	G-57	1.70	G-81	1.73
184-D	1.00	G-58	1.00	G-82	0.93
194-DC	0.02	G-59	0.01	G-83	Tr.
195-DC	0.06	G-60	0.06	G-84	0.07

*This assay was obviously in error and was rechecked by sample No. G-85 re-run from the pulp returned from Silver Bell. The assay rerun showed 4.19% Cu.

Check assays numbered G-86 through G-89 are from duplicate pulps taken by coning and removing assay pulp with a spatula compared to the original assay which was from a pulp reduced by a Jones splitter.

Sample Number	Original Pulp Assay	Dup. pulp by Spatula Code No.	Dup. pulp by Spatula Assay
1-RSP	1.76	G-86	1.76
2-RSP	2.47	G-87	2.41
3-RSP	6.92	G-88	6.92
4-RSP	2.97	G-89	3.10

G-90 was a recheck of drill hole intercept 26.0 - 28.3 in U-5. The sample was re-run from the stored crushed core reject.

Sample Number	Original Assay	Crushed Reject Code No.	Crushed Reject Assay
U-5 26.0-28.3	0.15	G-90	0.17

SAMUEL C. FALL

SCF:S
cc: TASnedden
ACHall
KERichard
WCWaidler
JHCourtright
JEKinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

J. H. C.

FEB 2 1959

February 2, 1959

MEMORANDUM FOR K. E. RICHARD

MISSION PROJECT
Screen Analysis of Crushed
Sample Reject

A screen analysis was made of several crushed core samples in storage at the Mission laboratory by passing the rejects through screen sizes of 1/2", 1/4" and 10-mesh. The samples selected for analysis consisted of eleven intercepts of argillite, four of hornfels, and six of tactite.

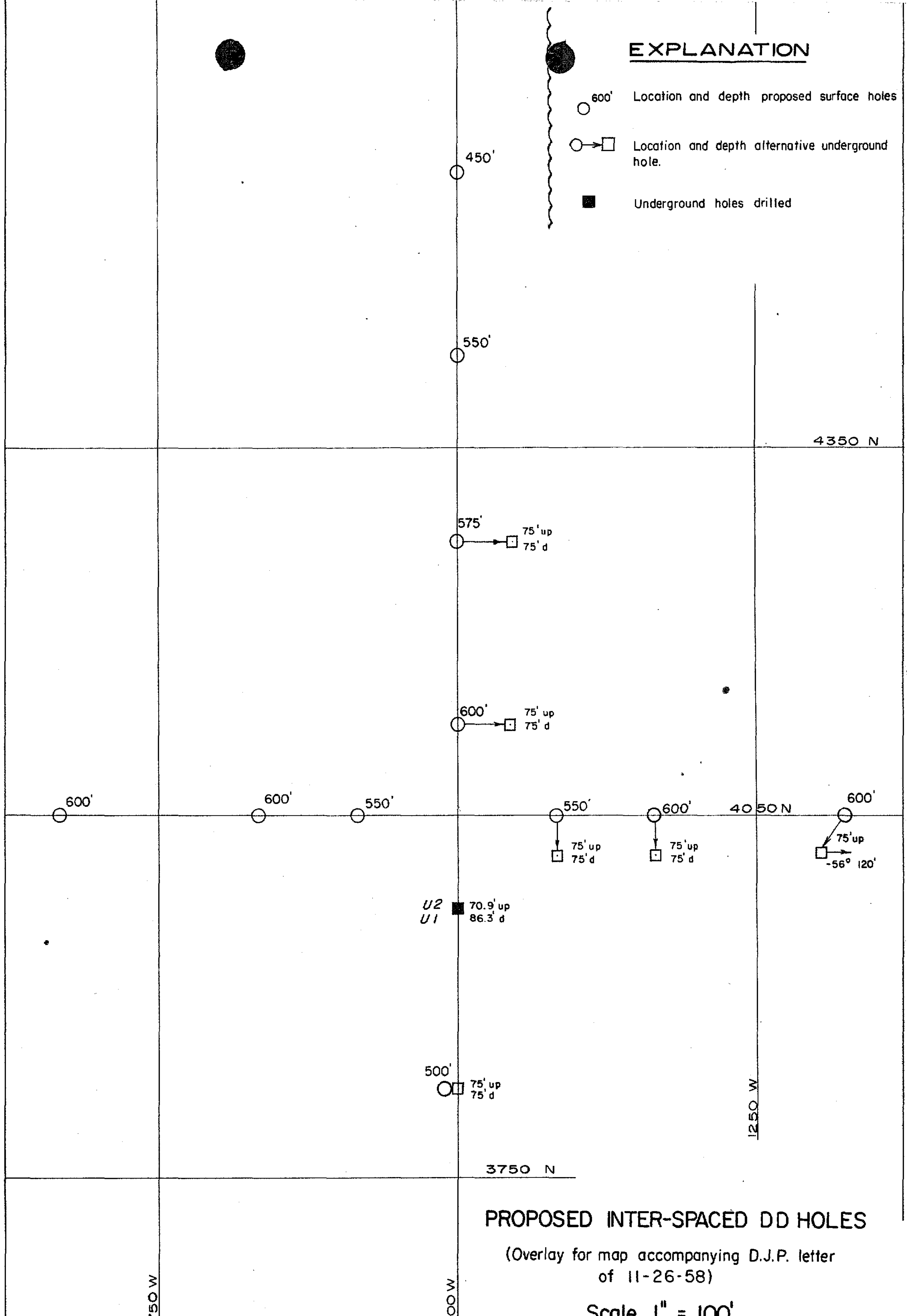
The following is a tabulation of these data:

Hole Number	Interval (Ft.)	Wght(lbs) of Sample Reject	+1/2" (%)	-1/2" +1/4" (%)	-1/4" +10 Mesh (%)	-10 Mesh (%)
	ARGILLITE					
48	287.9 - 294.9	3.03	0	17	46	37
68	254.2 - 263.9	2.69	0	21	49	30
68	270.1 - 281.3	2.99	0	22	43	35
78	320.6 - 331.7	3.05	0	35	40	25
83	296.8 - 309.4	3.04	0	14	53	33
88	348.5 - 358.2	2.73	0	37	38	25
88	385.1 - 397.6	2.82	0	30	47	23
92	320.9 - 325.9	2.24	2	37	39	22
111	455.9 - 465.0	3.13	0	19	45	36
153	269.2 - 279.4	2.86	0	34	41	25
163	348.0 - 355.0	2.50	0	20	45	35
	Weighted Average		0	26	44	30
	HORNFELS					
49	597.2 - 607.9	3.27	0	9	37	54
68	400.0 - 407.6	2.77	0	13	50	37
111	620.7 - 630.8	3.28	0	9	40	51
148	332.7 - 343.0	3.15	1	38	37	24
	Weighted Average		0	18	40	42
	TACTITE					
128	246.3 - 252.2	3.95	0	13	47	40
128	459.2 - 469.4	3.07	0	25	52	23
129	430.5 - 438.6	3.15	0	20	54	26
136	362.0 - 369.7	3.41	0	15	50	35
142	261.5 - 271.6	3.65	0	18	51	31
178	304.6 - 314.1	3.62	0	28	43	29
	Weighted Average		0	20	49	31

SCF/ds

SAMUEL C. FALL

cc: JHCourtright
JEKinnison



PROPOSED INTER-SPACED DD HOLES

(Overlay for map accompanying D.J.P. letter of 11-26-58)

Scale 1" = 100'

ESTIMATED YEAR BY YEAR FINANCIAL OUTLOOK CALCULATION

Year	Smelter Value(1)	Income Before Depr., Depl., Adm., & Inc.Tax	General Admin.	Depreciation	Cost Depletion	Percentage Depl. for Tax Purposes	Taxable Income	Fed. & State Taxes @ 53.7%	Income After Taxes
1	$ 21,169,000	$ 11,744,200	$ 300,000	$ 2,275,400	$ 651,700	$ [illegible],173,400	$ [illegible],400	$ 3,161,500	$ [illegible] 7
2	21,182,500	10,598,500	300,000	2,253,000	645,300	[illegible],177,400	[illegible]	2,588,000	[illegible] 6
3	21,780,000	10,575,500	300,000	2,265,100	649,900	[illegible],267,100	4,724,300	2,49[illegible],500	[illegible]
4	24,540,100	13,614,300	300,000	2,292,900	656,700	3,728,900	7,4[illegible],700	3,612,500	[illegible]
5	28,093,100	18,350,500	300,000	2,270,100	650,200	4,384,9[illegible]	11,415,300	6,021,600	[illegible] 7
6	23,780,600	13,544,600	300,000	2,265,300	640,000	3,567,100	7,408,200	3,907,800	[illegible] 800
7	20,908,500	10,832,[illegible]	300,000	2,266,700	655,400	3,149,800	5,0[illegible],500	2,687,[illegible]00	[illegible] 100
8	16,120,400	5,916,[illegible]	300,000	2,233,100	654,500	1,666,300	[illegible],[illegible]56,500	879,100	[illegible] 000
9	18,472,500	8,350,[illegible]	300,000	2,271,200	650,500	2,770,800	[illegible],[illegible]5,700	1,587,100	[illegible] 700
10	16,870,700	7,081,[illegible]	300,000	2,271,200	630,500	2,254,900	[illegible],2[illegible]4,900	1,189,500	[illegible],500
11-14.2	69,083,100	32,626,4[illegible]	1,260,000	9,415,100	2,690,600	10,497,800	1[illegible],500	6,041,700	2[illegible] 700
TOTALS	$284,305,700	$143,436,[illegible]	$4,260,000	$32,135,100	$9,210,800	$41,618,700	$6[illegible],[illegible]12,200	$34,497,200	$104,[illegible] 800

(1) Includes Molybdenum Credit

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
December 15, 1958

MEMORANDUM FOR T. A. SNEDDEN

MISSION PROJECT
Raises on Drill Holes

I talked to Kenyon Richard by phone this morning regarding the problem of locating certain diamond drill holes in the Mission underground workings. We both feel that if any raises are driven, they should be driven on the drill holes; that is, if the drill holes are not encountered in the drifting, they should be reopened and located underground by the use of geophysical equipment. The cleaning out of the two holes (130 and 62) that are plugged could be done by the Boyles Company when they move in to drill the mill site hole.

We believe that the driving of raises positioned simply on vertical projections of the hole collars would provide data which would lead only to further complexity in evaluation of the drill results.

J. H. COURTRIGHT

JHC/ds
cc: ACHall
KRichard

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
December 12, 1958

FILE MEMORANDUM

PROBE OF DDH NO. 190
Mission Project

On December 11, 1958 Diamond Drill Hole 190 was probed in order to determine its present condition.

A piece of 1" diameter (O.D.) pipe was lowered into the hole by means of a small steel cable. The hole was found to be standing open to a depth of 101.7' and to be closed by solidified drilling mud (Bentonite) at that point.

By washing the mud from the hole re-entry to the bottom (256.3') should be easily accomplished.

SAMUEL C. FAIZ.

SCF/ds
cc: TASnedden
ACHall
KRichard
JHCourtright

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 25, 1958

J. H. C.
NOV 2 6 1958

FILE MEMORANDUM

MISSION SHAFT SAMPLES
Reduction to Assay Pulps

Bulk and channel samples from the shaft and underground workings in the Mission Project were prepared for assaying at the Company's Mission (East Pima) sample laboratory.

The samples were delivered daily to the lab in 50 lb. canvas sample sacks. The samples were weighed, dumped into open pans and placed in drying ovens. Drying required 8 to 24 hours at a temperature of 230° F.

After drying, a sample was crushed to minus 1/2" in the 4" x 6" jaw crusher and reduced to two 1/16 portions, (or approximately 8 lbs.) in a Jones splitter. The remaining 7/8 was discarded. One of these 1/16 portions was placed in a quart mason jar for storage.

The remaining 1/16 portion was crushed to minus 10 mesh in the 10" gyro roll reduction crusher, and reduced to approximately 500 grams in a Jones splitter.

The sample was then ground to about minus 100 mesh in the pulverizer, well mixed by rolling on a plastic sheet, and split once more by a Jones splitter. One 250 gram pulp was sent for assay and the other stored at the laboratory for future reference.

SAMUEL C. FALL

SCF:S
cc: TASnedden
ACHall
KERichard
WCWaidler
JHCourtright
JEKinnison

McDonald E/M

Munson R01

10-10-58

MISSION ESTIMATES

October 10, 1958

MILLING PLANT (including moly $750,000)	$ 18,054,000	
Errors and omissions (12 1/2%)	2,257,000	
Contractors' gen. exp. (4%)	812,000	
Contractors' fee (2%)	422,000	
Arizona Sales tax	215,000	
Company indirect exp. (2%)	430,000	
Total	$ 22,190,000	22576

Water Supply	$ 510,000	610
Buildings and equip.	1,455,000	1895
Utilities (power lines, etc.)	348,000	455
Mine equipment	6,615,000	7,730
Roads, etc. (conc. haulage)	200,000	272
Mine camp - 8 houses	120,000	198
Tailings (land, lines, etc.)	678,000	718
Preliminary stripping	7,125,000	9000
Total	$ 39,241,000	

A

MISSION PROJECT
SUMMARY OF ESSENTIAL BASIC DATA

1. Ore reserves 76,460,000 tons

2. Grade of ore reserves 0.90% total copper

3. Mill recovery 93.8%

4. Grade of concentrates 27.7%

5. Ratio of concentration 32.6:1

6. Pounds Cu paid for per ton crude ore 16.5

7. Tons of ore treated:

Per day	15,000
Per month	450,000
Per year	5,400,000

8. Life of operation 14.2 years

9. Waste:

Alluvial	114,603,000	tons
Conglomerate	13,004,000	"
Rock	101,239,400	"
Total	228,847,000	"

2.3/1

Ratio of total waste to ore 2.99 to 1
Preliminary stripping 45,378,000 tons
Left to mine with ore 183,469,000 tons
Average waste to ore ratio during operations 2.40 to 1

10. Copper and concentrates production:

	Tons Conct.	Payable Copper Tons	Payable Copper Pounds
Per day	458	123.4	246,880
Per month	13,740	3,700	7,405,800
Per year	164,880	44,433	88,870,000
In Total	2,344,565	631,800	1,263,700,000

11. Price of copper used in outcome estimates 28.0¢ refinery

MISSION PROJECT
SUMMARY OF ESTIMATED OUTCOME

15,000 tons per day — Head assay 0.90% Cu

Operating Costs	Per Ton
Mining Ore	$ 0.23
Stripping Alluvial (11.5 x 1.00)	0.12
Stripping Rock (23.0 x 1.39)	0.32
Milling	0.70
Total Direct Cost	$ 1.37
Indirect Cost	.47
Total Operating Cost (Excluding pre-mine Stripping)	$ 1.84
Net Smelter Value (28¢ Cu) plus 2.2/Ton Moly Credit	3.72
Operating Profit Per Ton	$ 1.88
Operating Profit Per Year	$10,152,000
Pounds Cu Paid for Per Ton Crude Ore	16.5

Cost Per Pound of Payable Copper

Operating Cost	$ .111
Smelting and Freight	.062
Total Direct Cost	$ .173
Depreciation and Depletion	.028
General Administration	.008
	$ .209

SAY 21¢

CALCULATION ON RETURN OF INVESTMENT

TABLE A
INVESTMENT INVOLVED IN PROJECT

Year of Construction	Expenditures for Construction		Factor @ 14%		Value at Completion Date
1st	$ 10,412,000	x	1.3905	=	$ 14,477,900
2nd	13,494,000	x	1.2198	=	16,460,000
3rd	15,335,000	x	1.07	=	16,408,500
	$ 39,241,000				$ 47,346,400

TABLE B
EARNINGS FROM PROJECT

Year	Cash Earnings After Taxes		Present Value Discounted at: 14% Factor		Present Value Discounted at: 14% Discounted Value
1	$ 8,282,700	x	.87719	=	$ 7,265,500
2	7,730,600	x	.76947	=	5,948,500
3	7,776,000	x	.67497	=	5,248,600
4	9,561,000	x	.59208	=	5,660,900
5	12,028,700	x	.51937	=	6,247,300
6	9,336,800	x	.45559	=	4,253,800
7	7,844,100	x	.39964	=	3,134,800
8	4,739,000	x	.35056	=	1,661,300
9	6,463,700	x	.30751	=	1,987,700
10	6,691,500	x	.26974	=	1,805,300
11-14.2	25,324,700	x	.19649	=	4,976,100
	$104,678,800				$ 47,892,800

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

J. H. C.
MAY 2 1958

L. H. HART
CHIEF GEOLOGIST

May 19, 1958

AIRMAIL

Mr. K. E. Richard, Chief Geologist
Mr. J. H. Courtright

American Smelting and Refining Company
813 Valley National Building
Tucson, Arizona

EAST PIMA - ORE RESERVE ESTIMATE
ADJUSTED POLYGON METHOD

Gentlemen:

I have just received my copy of your analysis of your method and procedure for calculation of the East Pima ore reserve. This is an excellent review of the extremely careful and thorough study that you have given to this problem. The fact that you are dealing with a deposit which is geologically unusual, in terms of conventional non-selective mining procedure, justifies the thoroughness of your study, and I am sure it will prove to be of great value in assisting all of us to better understand the expected mining problems. You have based your analysis upon geological interpretation of drill hole information and where the structures are complicated both by folding and faulting, and where stratigraphy may be partly deltaic, you have done the best you can under the circumstances. It is hoped that it will be understood by all, however, that this part of the study must be left subject to modification as more accurate data become available.

In general, the application of your adjusted polygon method to the available data should provide a good approximation of the true facts, even though minor adjustments become necessary in the course of mining. Everything you have done is on the conservative side, including both the shaping of polygons and the application of dilution factors. You have also thrown out of your calculation some thin beds of commercial material from which some metal recovery will undoubtedly be possible. I am particularly interested in your dilution factor study, which has been designed to conform to mining practice reported at Silver Bell. At this stage I believe it is perfectly sound to assume somewhat comparable results will be experienced. However, with the probability that East Pima ore will be more difficult to drill and blast, we may find rather wide differences in the amount of selectivity that can be applied in the course of mining. At least these are factors which cannot be predicted until we know much more about the physical properties of the ground at East Pima.

The high stripping ratio is discouraging, but this factor may be somewhat different from a corresponding figure which would be applied to conventional porphyry copper deposits, since a large proportion of East Pima stripping will be post-production sorting within the ore body. It seems to me, therefore, that a pre-production stripping factor, adjusted to take into account the proportional lower ton cost of unconsolidated overburden, would place somewhat less emphasis upon the stripping problem.

It is interesting that by Mr. Schubel's calculations, the inside drilling recently completed, which was confined to an area where drilling was less complete than it is throughout other parts of the ore zone, resulted in a downward adjustment of only 1-1/2% metal contained. It seemed to me, a casual review of these latest data suggested some discrepancies in geological correlation. I would appreciate your comments on this subject.

In conclusion, let me say again, that I feel you and your staff, along with the full cooperation of Messrs. Meen, Schubel and others, deserve congratulations for this excellent ore reserve calculation.

Very truly yours,

L. H. Hart

L. H. HART

cc: DJPope
TASnedden - A/M
WSchubel-
RBMeen - (Silver Bell) a/m

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 7, 1958

MEMORANDUM TO T. A. SNEDDEN

EAST PIMA SHAFT
Sampling

This refers to the conversation with you and Mr. Hall April 3, and to Mr. Hall's memoranda of April 2 to Mr. Waidler and April 3 to you.

Although the shaft and raises are not being driven specifically to check the accuracy of drill hole samples, it seems that certain samples of bedrock should be obtained as the shaft is being sunk.

In addition to piling the material from each shaft round separately, as Mr. Hall's letter instructs, a grab should be taken from each bucket and combined into a sample weighing, say, 50 or 75 pounds and representing the round. These samples will be sent to the East Pima lab where they will be crushed, split and pulverized. A jar of crushed reject and duplicate pulps will be prepared. One pulp will go to SilverBell for assay. The jar of reject and one pulp will be stored in the lab.

A vertical, continuous channel should be cut extending eventually from the top of bedrock to the bottom of the shaft. The position of this cut should be near the drill hole, but otherwise Mr. Waidler should select whatever location would be convenient, providing the same location is used all the way.

The channel should be segmented into individual samples as follows: a sample should end at each set, and the interval between sets should be made up of at least two samples. If the rock is relatively uniform in grade and hardness, the two samples should be of equal length (2' 10", I believe); but the lengths should be varied, according to Mr. Waidler's judgment, to match any distinct rock changes either in grade or hardness. In some instances it may be best to subdivide the set interval into three samples.

These samples should be cut under Mr. Waidler's supervision because it can then be done whenever the wall is exposed and the cutting can best be fitted to the work cycle. Of course, Mr. Kinnison can assist in measuring the channels in advance whenever he is on hand to do so; but he has other work to do and cannot necessarily be present every time samples should be cut.

The channel should be cut approximately 2" deep and 4" wide; but this need not be precise, except that the channel cross-section should be reasonably uniform within an individual sample.

Mr. Kinnison will show the position of each channel sample and each round (approximately) on his geological sketches.

The channel samples will be processed at the lab in the same manner as the grab samples.

Original Signed By
K. Richard

KENYON RICHARD

cc: ACHall
WCWaidler
JEKinnison
JHCourtright

Enclosure for Direct Reference

/ SX-10.11
P-10.11

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
April 1, 1958

Mr. R. J. Lacy
Chief Geophysicist
Salt Lake Office

ELECTROMAGNETIC SURVEYS

Dear Sir:

This concerns Mr. McDonald's memorandum of February 19, on San Xavier, which accompanied your letter of March 25 to me.

In the second paragraph on the first page Mr. McDonald states "....it seems obvious that the emX-1 conductor axis is produced by fault structure, with associated clay and possible graphite." There well may be faults with associated clay in that area because these conditions are found everywhere, but we have no knowledge of a specific fault coinciding with the emX-1 conductor. The mineralization environment indicated by hole X-132 precludes the possibility that massive sulphides could exist in the immediate area of emX-1. Graphite has never been recognized in the district. Therefore, I believe that the cause of the emX-1 anomaly should be listed as unknown.

In his third paragraph Mr. McDonald suggests that the emX-3 anomaly, now proved to lie within a deep sequence of post-mineral rocks, may be due to a fault structure or "may be caused by boundary conditions between the post-mineral conglomerate and the vesicular basalt." What is meant by boundary conditions?

In sub-paragraph No. 1 Mr. McDonald suggests that ionic water traps in the post-mineral rocks may account for certain anomalies on the Reservation. In your letter of February 29, 1956 to me on East Pima Electromagnetic surveys you discounted the effect of ionic conductors. Do you believe now that they can be a factor?

In sub-paragraph No. 5 Mr. McDonald states, "The fact that we do not obtain response in the LL-XX 372-376 block area can be explained by the apparent lack of continuous mineralization." It should be noted that disseminated mineralization is continuous in this block. Also, gouge-filled faults are prevalent, although we do not know their trends. Sulphide veinlets are present but not particularly abundant. It would be my suggestion that, although the percentage of sulphides in this block is about the same as in most of the East Pima zone (both in and out of the ore body proper), the absence of an anomaly may be due to a lack of coincidental interconnection of sulphide veinlets.

My doubts as to the effectiveness of electromagnetic surveys in the Southwest are increasing. For example:

1. At Cocio and on the Reservation several conductors have been found in post-mineral rocks. These, it seems, may be due to clay, to gouge-filled faults, or to ionic water zones. All of these features are ubiquitous and unrelated to sulphide mineralization, and therefore misleading in terms of ore search.

2. When sulphide veinlets are in some manner interconnected, presumably they tend to produce anomalies. This may be a function of the abundance of sulphides, in which case it could be useful in locating zones of sulphides in general, but the e.m. method makes no distinction between copper and iron sulphides. Therefore, at East Pima it does not assist exploration because of this non-selectivity.

3. As I understand it, the electromagnetic method should be most effective in locating massive sulphide bodies. Yet, massive sulphide lenses in the eastern end of the East Pima ore zone contained the best grade and the shallowest ore but did not produce anomalies; and the so-called discovery anomaly, the strongest in the region, was obtained over ordinary disseminated mineralization which drill holes have shown to have no distinctive condition of mineralogy or structure to explain the anomaly.

As you know, some of these points have disturbed me in the past. My reason for bringing this matter up again is that it is my impression that Mr. McDonald's very careful work on the Reservation has emphasized the differences which can exist between the theoretical interpretations of e.m. anomalies and the geological conditions actually found by drilling. In my mind these differences are such as to limit appreciably the value of e.m. surveys. This opinion applies, of course, only to the basin and range province in the Southwest.

Yours very truly,

Kenyon Richard

KENYON RICHARD

KR/ds

cc: LHHart
BCMorrison
JHCourtright
FEMcDonald

5 cylinders

ASARCO

PRELIMINARY GEOLOGIC LOG

SAN XAVIER

D. D. Hole No. X-132

Location JJ

356

Depth of Hole 412.6 (Bottom)

Collar Elev. Unknown

FOOT	APPROX. CORE RECOVERY %	DESCRIPTION
0.0 - 127.9		Drilled with rock bit. Overburden. Consisting of alluvium and caliche conglomerate(?).
127.9 - 130±	0	Caliche conglomerate(?). No core recovery. This extends to bedrock which probably occurs at approximately 130± feet.
130± - 135.4	0	Biotite rhyolite. Similar(?) to below.
135.4 - 161.4		Drilled with rock bit. Biotite rhyolite. Similar(?) to below.
161.4	95	Biotite rhyolite. Typical light gray, pyroclastic material with angular fragments of tan to light to dark gray arkose and dark gray to black argillite. Some intercepts are altered to a near clay-like material. Brown to red iron oxide staining shows on fractures and throughout some intervals to 305±'. There are some scattered pyrite disseminations. Copper mineralization rare.
307.7	91	Fault(?) breccia. Contains fragments of above pyroclastic material and a gray, coarse-grained and poorly indurated arkose. The matrix consists of a pulverized material which has been reduced to a clay-like substance. There is a little scattered pyrite. Copper mineralization rare.
326.2	88	Arkose. Light gray, medium grained, highly distorted, broken, and altered and crushed. Fracture surfaces exhibit some crushed sulphides. Pyrite is scattered throughout. Cu mineralization rare.
345.4±	95	Limestone. Occurs below a broken and distorted contact and is black to blue-gray to green gray with depth, very fine grained, distorted. There are some white intercepts scatter throughout. Graphite occurs on some fractures. Copper mineralization rare.
406.8	91	Granitoid rock. Occurs below a brecciated 50°± slip contact and is coarse grained, distorted, flesh to cream colored, and brecciated and healed. Chlorite is scattered throughout. Hematite shows on some slips. No mineralization observed.
412.6 (Bottom)		NO ASSAYS AVAILABLE

~~From~~ ~~To~~ ~~Assay Data % Cu (Core)~~ ~~From~~ ~~To~~ ~~Assay Data % Cu (Core)~~

cc: LHart
RJLacy

J. L. CLARK
2-4-58

February 19, 1958

MEMORANDUM TO: Mr. R. J. Lacy

<u>SAN XAVIER INDIAN RESERVATION</u>
<u>E.M. PROGRESS REPORT</u>

On January 25, 1958 all e.m. survey work was completed. The e.m. survey map dated December 28, 1957 should be consulted as reference with this memo.

Drill holes recommended in my memo of December 28 have been drilled. One hole intersected emX-1 on JJ 36[illegible].9. Although one drill hole does not thoroughly test an e.m. anomaly, it seems obvious that the emX-1 conductor axis is produced by fault structure, with associated clay and possible graphite.

A drill hole intersected emX-3 on MM 379.5. Again, one hole is not usually adequate, but this hole confirms the gravity data (also recognized in my last memo) indicating post mineral rock sub-outcrop. The conductor axis is located well within the post mineral section. The possibility that this conductor might be produced by fault structure had been recognized. Drill information also suggests the conductor may be caused by boundary conditions between the post mineral conglomerate and the vesicular basalt.

EMX-2 has been more fully developed by detailed survey. Further work, on an experimental basis, should be done on this zone. An apparent structural boundary and an abrupt termination of a strong conductor axis are noted. Detailed work utilizing improved equipment and close spacing techniques is suggested.

A relationship based on evaluation of all the results obtained from the San Xavier survey may demonstrate that the East Pima discovery anomaly is related only to the sulphide mineralization developed by drilling on that conductor axis.

We now know the following relationships:

1. Structure in post mineral rocks is mapped quite readily by e.m. methods, particularly faults, contact zones with pre mineral rocks (probable faults according to the gravity information). The ability of the post mineral rocks to show greater sensitivity to e.m. induction methods may be related to the lithologic composition, permeability (greater ionic water content), and the relationship of the post mineral volcanics to included conglomerates (ionic water traps). Spurious, non-continuous, local, and shallow cross over points occur in the post mineral sub-outcrop. Conditions causing these local conducting conditions can only be related to response from sensitive rock types and/or structure. This is verified by gravity data which show in each instance of local cross over points that the sub-outcrop is the post mineral section.

2. Only well developed fault structure with associated clay is indicated by e.m. in the pre mineral sub-outcrop at San Xavier. EMX-1 is the example.

3. There can then be only two sources for conductors in the pre mineral sub-outcrop, well developed fault structures with associated and responsive gouge material and massive, semi-continuous sulphide bodies.

4. Faulting of the emX-1 type is not present in Zone 1, so mineralization is the only possibility.

5. The fact that we do not obtain response in the LL-XX 372-376 block area can be explained by the apparent lack of continuous mineralization. Some structure is present in this locality as indicated by the impressions of steep dips in the arkose obtained from coring. The structure is either not associated with faulting or faulting in this locality is not well enough developed with associated clays or other gouge material to produce a conductor. A similarity with Zone 1 exists in this case, existing structure, but not the cause of e.m. response.

Electromagnetic induction methods have good application potential in the Southwest, but should have another method, gravity or magnetics, to eliminate ground with unfavorable sub-outcrop which might give erroneous response, as volcanics with included sediments do at San Xavier.

F. E. McDonald

FEM:si
cc:L.H.Hart
T.A.Snedden
B.C.Morrison
K.F.Richard

WESTERN MINING DEPARTMENT
Salt Lake City, Utah

February 29, 1956

Mr. K. E. Richard, Chief Geologist
Southwestern Mining Division
American Smelting and Refining Company
813 Valley National Bank Building
Tucson, Arizona

EAST PIMA AREA
PIMA COUNTY, ARIZONA
ELECTROMAGNETIC SURVEYS

Dear Sir:

I have reviewed Mr. B. C. Morrison's report of February 9 on the subject matter. It indicates an admirable attention to the possible effects and adjustment of the field techniques to clarify these effects. The factual results are clearly defined and possible interpretations are well considered. Such a presentation facilitates further discussion. I should like to discuss the two most important points, namely 1) the strike of the electromagnetic conductor axes, and 2) the geological correlation, or the cause of these anomalies.

Orientation of Conductor Axes

Electromagnetic surveys in the past have been confined almost exclusively to the search for planar sulphide deposits such as vein filling and replacements, contact metamorphic deposits and replacements of favorable horizons, and to massive pipes and blankets. All of these have a more or less definite geometry and appreciable down-dip extent or large mass. The application to continuously interconnected stockworks of veinlets involves new conceptions on which there is naturally very little experimental and field information.

It is conceivable under this latter condition that the profile arrangement and the transmitter-receiver technique could energize dominantly in certain directions controlled by these impressed survey factors within the limitations of the major trends of this type of mineralization. This is more true of the mobile transmitter technique, in which the transmitter-receiver line is maintained at right angles to the profile direction, than it is of the fixed transmitter technique, in which there is only one point on each profile traversed by the receiver for which the transmitter-receiver line is at right angles to the profiles. Whereas the conductor angle at 90° to the profile is emphasized to a certain extent with respect to magnitude of dip angles obtained, detection is possible up to acute angles approaching parallelism. Our subsequent detail technique of setting the transmitter on the strike of these conductor axes serves as one method of distinction with respect to comparative conductivity.

We employed the fixed transmitter technique on the original survey along north-south profile lines. Therefore, I believe that we have established that the major conductors have an east-west or slightly north of east strike. This does not establish that there could not be fair to good secondary conductors with north-south trends. Therefore, the east-west profiles were run in the area confined to Zone I. The mobile transmitter technique was employed on this survey, which may not energize and therefore indicate conductors at acute angles to the east-west profile angles. This range of strikes, however, would have been covered by the north-south fixed transmitter reconnaissance and detail surveys.

Cause of Electromagnetic Anomalies

The first point to clear up here is the list of conductors for the e.m. dip angle technique given in the article "The Inductive Electromagnetic Method Applied to Iron Exploration." In the first place, this is a list of geological conditions that could be detected by the technique without regard to the range of frequencies applied (1500 to 7000 cps) nor depth of burial. The response of these conductors would decrease with decreasing frequency and with increasing depths of burial. These two factors, then, would restrict the list of geological conductors, for low frequency ranges and greater depths of burial, especially tending to eliminate the ionic conductors. The frequency of 1500 cps is comparable to ours at 1000 cps. Their 3500 cps and 7000 cps frequencies are appreciably higher and would cause detectable responses from medium conductors such as the ionic types. Again, the depths of burial in the area they surveyed ranged from 0 to 50 feet for the most part whereas we are dealing with occasionally 150 feet to primarily more than 200 feet of alluvium at East Pima. The difference in the depth factor is self-explanatory with regard to the response of medium conductors.

The above clearly eliminates solution filled ionic conductors of any dimensions or geometry from consideration for the zones of high dip angles and broad polar points of inflection (maxima and minima), indicating 200 to 300 foot depths to the approximate upper conductor axes at East Pima. It certainly eliminates ionic conductors with no down-dip or vertical extent as sub-surface solution paths at bedrock.

The recommendation to conduct electromagnetic surveys on our East Pima property was based on the apparent relation of east-west fissuring or faulting and similar north-south secondary structures to the more heavily mineralized zones in the Pima and Mineral Hill mines. These apparently acted as solution channels for the heavier concentrations of sulphide mineralization from which runs in favorable rock horizons could develop. Whether or not such structures in multiples acted as the main feeder channels from which decreasing mineralization could spread outward in the form of replacements in favorable impure limey horizons and as disseminations and veinlet stockworks in spongy and brittle rocks such as arkose, or whether there was a more pervasive type of mineralization superimposed, they are still our best basis of explanation of these electromagnetic anomalies along zones of greater concentrations of mineralization. This is true, whether the effect may be attributed to more or less solid replacements or to a concentration of interconnected veinlets.

It should be emphasized again that we would not expect to indicate completely disseminated mineralization. Another point to be emphasized is that the electromagnetic conductor axes mark only the lines near the top of conductors and that areas down dip are not outlined in any manner that could be related to the electromagnetic effect. Therefore, holes intersecting ore at down-dip locations away from the conductor axes do not disprove the value of the method.

Further emphasis must be made on the point that this discussion applies to the East Pima property and should not be indiscriminately applied to other areas.

Conclusions

Although we wish to encourage continued geological suggestions as to possible causes of the geophysical anomalies, I hope the above discussion will clarify the technical aspects of our interpretations so that we do not become confused with too many possible interpretations. The fact remains that the electromagnetic plus the gravity surveys have indicated several areas, of which Zone I is the most impressive, which may serve as central locations from which to progress outward on a plan of exploration and development drilling. Some of these anomalous areas, if results are negative, may require only one or two holes. This would seem to be a logical exploration pattern. Later, after these areas have been explored and developed, if the latter is warranted, broad-scale reconnaissance drilling might be in order to eliminate or prove the remainder.

Very truly yours,

R. J. Lacy

RJL:si
cc:L.H.Hart
F.V.Richard
W.R.Landwehr
T.A.Snedden
B.C.Morrison

ELECTROMAGNETIC Prospecting Methods*

By
GEORGE R. ROGERS, '48†

In the search for mineral deposits, additional prospecting techniques are often needed to *supplement* visual observation of the earth's surface. One additional technique, the electromagnetic method, is based on the fact that an alternating magnetic field will cause an electric current to flow in conducting material. This is exactly the same action that takes place between the primary and secondary windings of a transformer. If no conducting material is present, a given electromagnetic field will have certain characteristics. If conductive material is present, the field will be different and this difference can be measured and recognized. In our terminology this departure from normal field characteristics is known as an anomaly.

* Presented at the Fourth Annual Meeting, Rocky Mountain Minerals Conference, (AIME), October 31, 1957.

† G. R. Rogers is Senior Geophysicist, Bear Creek Mining Company, Denver, Colorado.

TABLE OF CONDUCTIVES

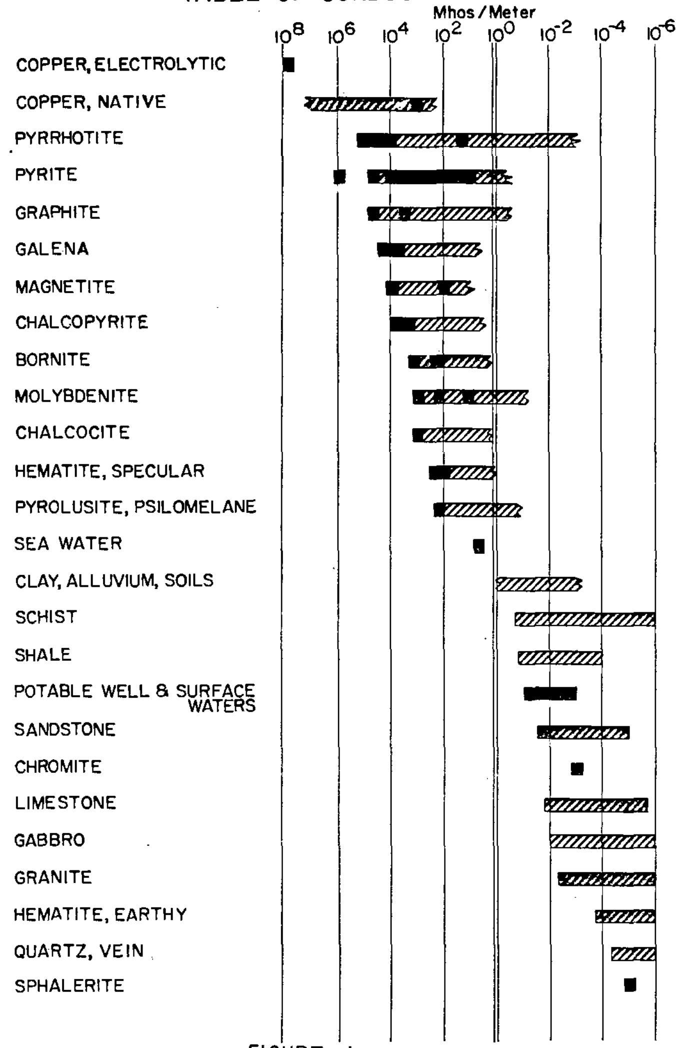


FIGURE I

We say that the electromagnetic methods respond to the electrical properties of large volumes of earth. The most important of these electrical properties is conductivity.

At this point a logical question would be, "All right, assuming you can measure the conductivity of the earth to the 10th decimal place, what has this to do with ore?" A complete answer could be the subject for an entire paper, so the reply I give is somewhat evasive. My answer is that *sometimes* electrical properties have a great deal to do with ore and *sometimes* they have nothing to do with it. This is exactly why technical prospecting methods are *exploration tools* and not complete exploration systems in themselves. On the other hand, in a large percentage of cases, sulfide mineralization is accompanied by good electrical conductivity. By judicious use of electromagnetic techniques, sulfide bodies are being found and their areal extent established. This paper will describe inductive electromagnetic methods wherein transmitting coils are used to induce currents in the earth and receiving coils are used to study the distribution of these currents. I hope to remove some of the mysticism associated with electromagnetic methods.

Figure 1 illustrates the conductivities of some more common materials. A tremendous range is represented—running from electrolytic copper at the top with a conductivity of 10^8 mhos/meter to quartz and sphalerite with a conductivity of 10^{-5}. The scale is exponential and each vertical line represents a change in conductivity by a factor of 100. The solid blocks represent reported measurements on relatively pure minerals while the cross-hatched region indicates the range of values that may be encountered. Materials having conductivities greater than 10^0 (or unity) represent good targets for electromagnetic methods. Most host rocks are insulators, and as the conductive mineral becomes more

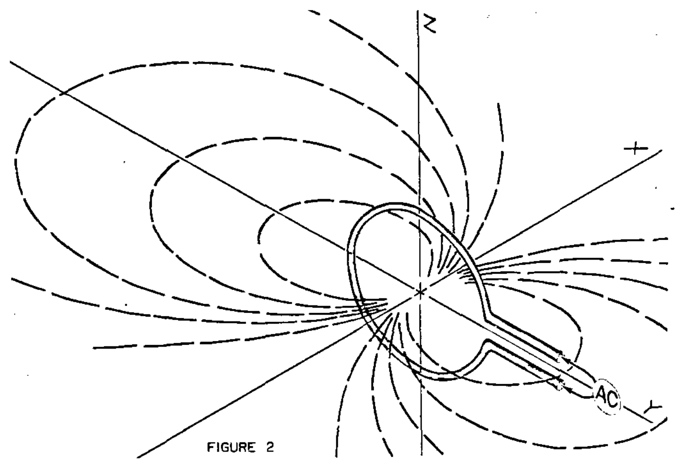


FIGURE 2

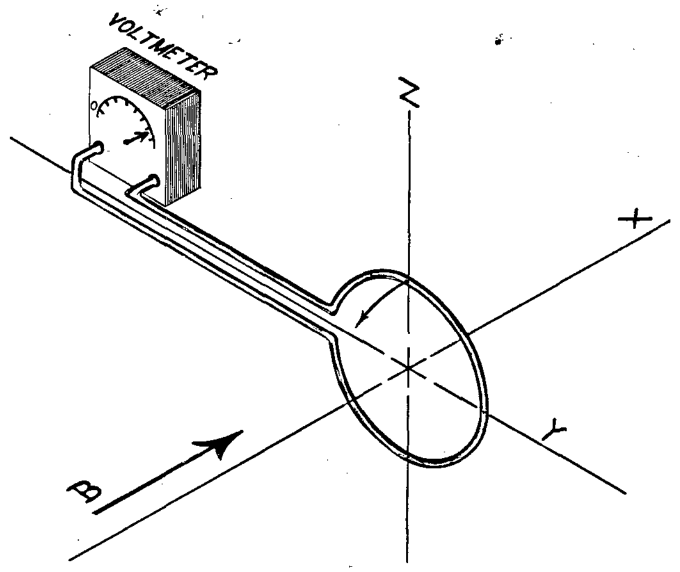


FIGURE 3A

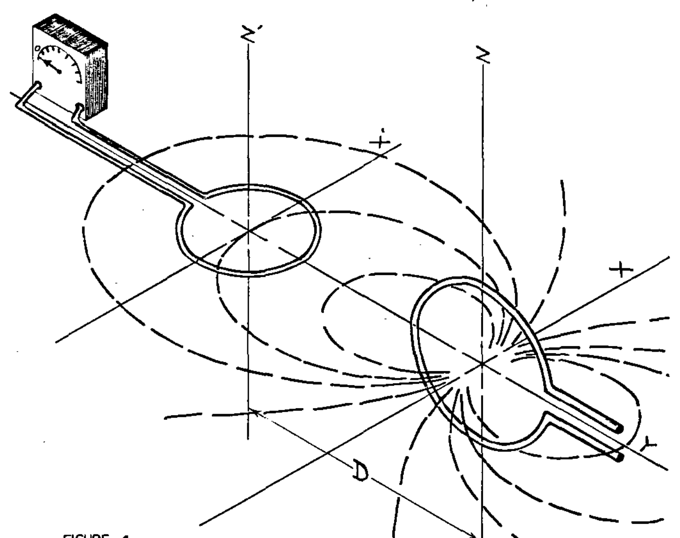


FIGURE 4

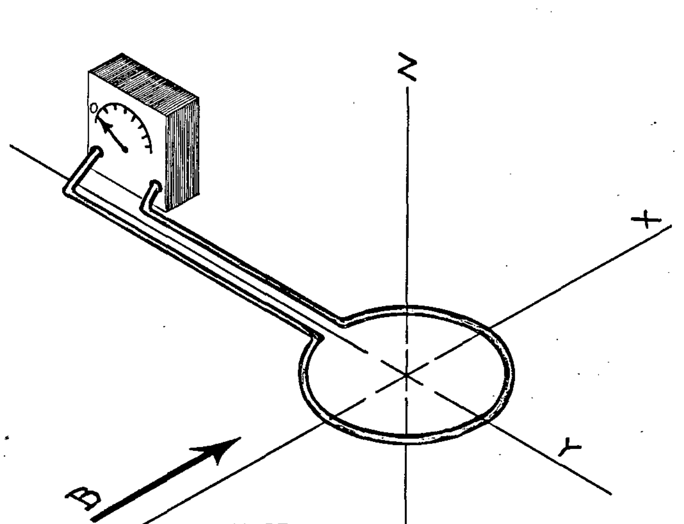


FIGURE 3B

and more disseminated, the conductivity of the aggregate decreases until no anomaly results. At best, conductivity depends upon the total amount of conductive material present and its geometry within the host rock. Only the drill can tell whether the material is ore.

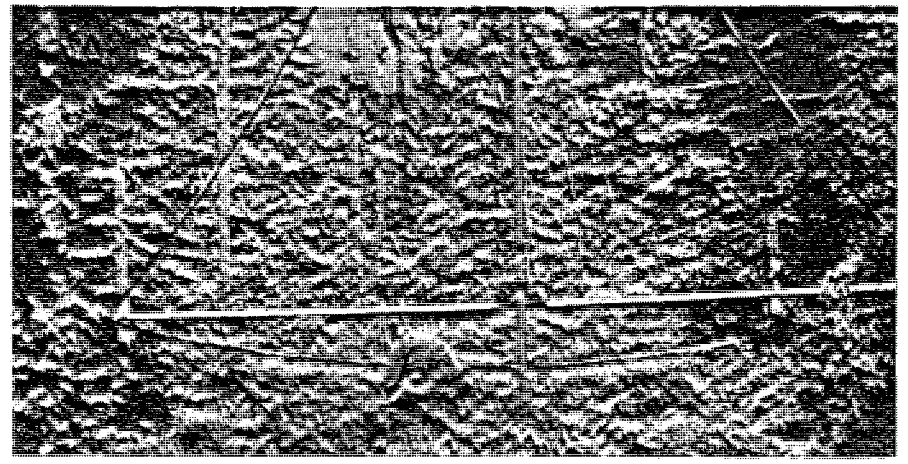
The transmitting system consists of a coil of wire connected to a source of alternating current. Such a coil produces a magnetic field in its vicinity similar to that from a short magnet oriented along the axis of the coil. The chief difference is that the magnetic field of the coil alternates in intensity in the same manner that the current through the coil is alternating. The pattern of the magnetic field in the XY plane is indicated on *Figure 2*. There is rotational symmetry about the X axis so the field in any plane containing the X axis would be identical.

The receiving system, shown in *Figure 3*, consists of a coil of wire connected to a voltmeter, or some other device, for measuring the induced voltage. Consider a coil free to rotate about the Y axis and an electromagnetic field directed along the X axis. As the receiver coil is rotated the voltage induced will vary from a maximum when the plane of the coil is perpendicular to the applied field, as in *Figure 3A*, to zero when the plane of the pick-up coil is parallel to the applied field, as in *Figure 3B*. By combining the transmitting system of Figure 2 with the receiving system of Figure 3, we have an electromagnetic prospecting system.

In *Figure 4* the receiver coil is in the XY plane and has minimum coupling with the transmitter coil in the YZ plane. With this system the voltage in the receiver coil will be zero unless extraneous conductive material disturbs the normal electromagnetic field.

Figure 5A illustrates the effect of a conductive body on the readings. Provisions are made in the field operations to insure that measurements are taken in the plane of the transmitter coil. In the plane of the transmitter, the primary field is horizontal. The primary field induces currents in the buried conductor which give rise to a secondary field that, in general, is not horizontal. The in-phase portions of the secondary field, S, combine vectionally with the primary field, P, to give a resultant field, R, that is not horizontal except directly over the conductor.

The expanded views of points 1, 2, and 3, in *Figure 5B*, show how these fields combine. The null detector will show a minimum whenever the receiver coil is parallel to the resultant field, R. This results in a valuable simplification in instruments since the voltage measuring device need only be a null detector and is not concerned with the absolute value of the voltage. This dip angle of the electromagnetic field can be mapped over large areas



▼FIGURE 6

▼FIGURE 7

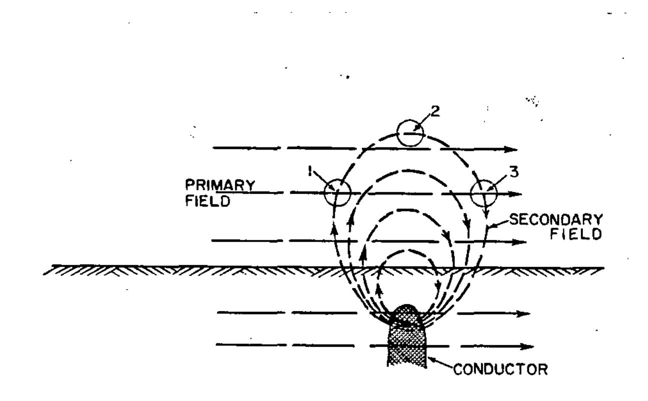


FIGURE 5A

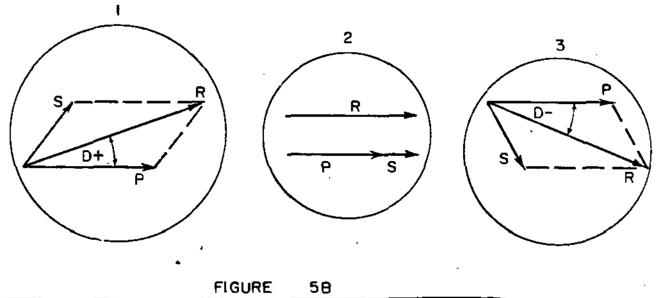


FIGURE 5B

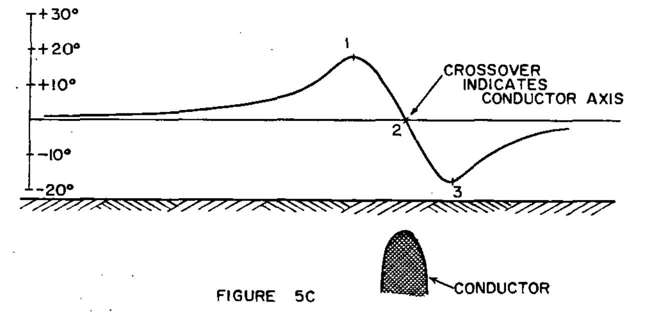


FIGURE 5C

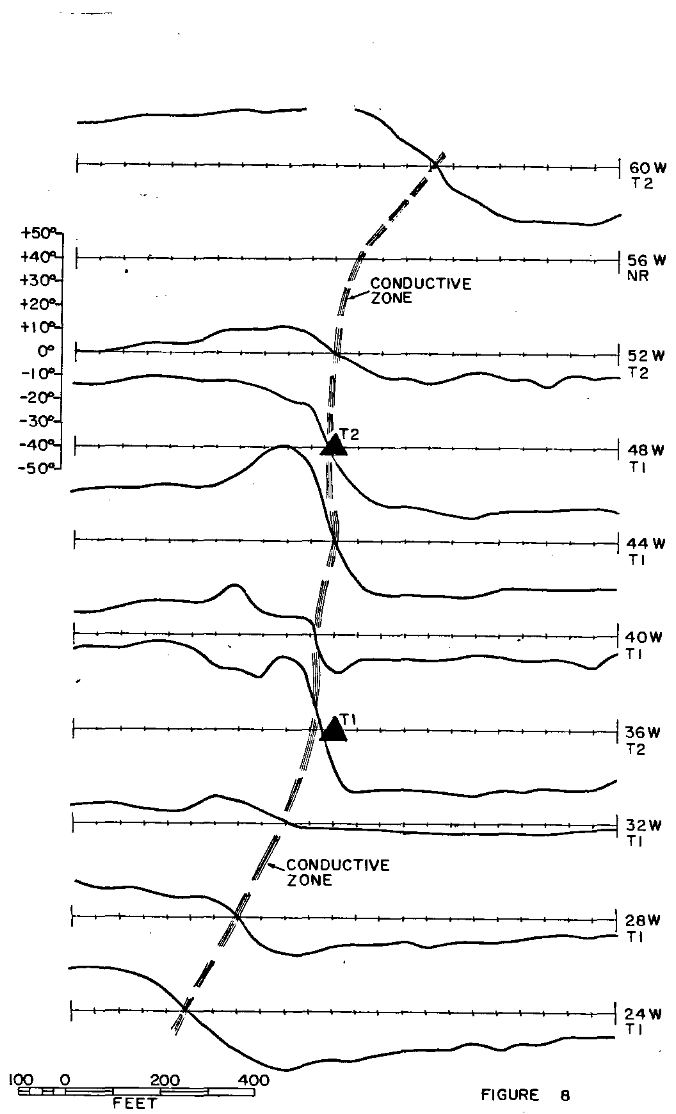


FIGURE 8

▼FIGURE 9

FIGURE 10

by attaching an inclinometer to the receiver coil and finding the angle of the coil to the horizontal at the null point.

A synthetic profile showing a conductor indication is shown on *Figure 5C*, with the crossover occurring directly over the conductor axis. The vertical scale of this profile is in degrees of dip angle.

Figure 6 shows one type of transmitter for a system of this type. It is a triangular loop in the vertical plane.

Power is supplied by a lightweight gasoline engine-generator unit furnishing about 5 amperes at 1000 cycles per second.

Figure 7 shows the receiver coil which has an inclinometer on the front. The null is located by tilting the receiver until minimum sound is heard in the earphones. With this method a three-man crew may cover two to five miles of line per day, taking readings every 100 feet.

Figure 8 shows an actual survey with an instrument of this type. The trace of a conductor is clearly shown by the crossovers.

The method is simple from an instrumental standpoint and has good over-all speed and depth penetration. Because of its dependence on a vertical reference, it is not suited to airborne applications but a variation has been adapted for work in drill holes. In this application the receiver coil is lowered down the hole and the surface transmitter is tilted until the null point is found. Readings are taken at suitable intervals down the hole. *Figure 9* shows the receiver coil and preamplifier about to go into a hole. *Figure 10* shows the transmitter coil and smaller vernier coil that is tilted to obtain a null.

Another method is shown in *Figure 11*. The receiver and transmitter are both in the XY plane and have maximum coupling. In free space or over non-conducting ground, the voltage developed in the receiver will depend on the construction and geometry of the coils—most of which are constant. Since the transmitter and receiver coils are in the same plane, this is

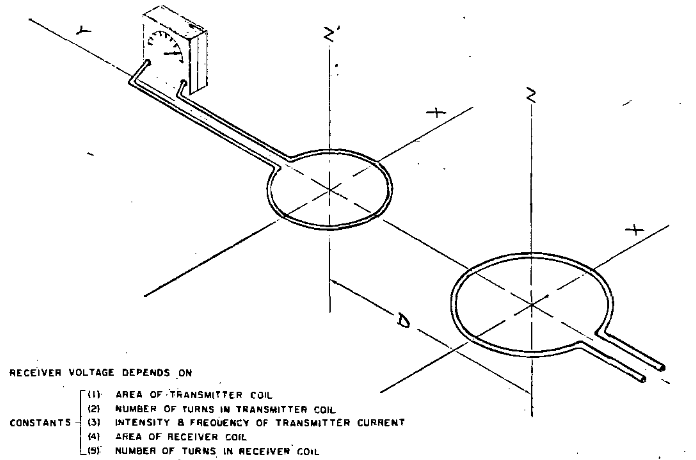


FIGURE 11

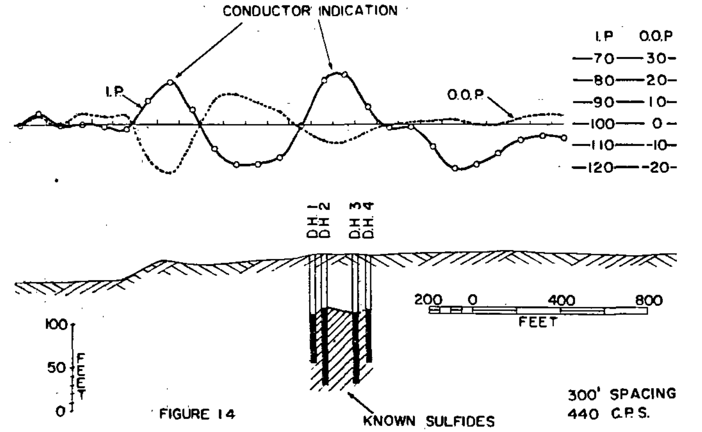


FIGURE 14

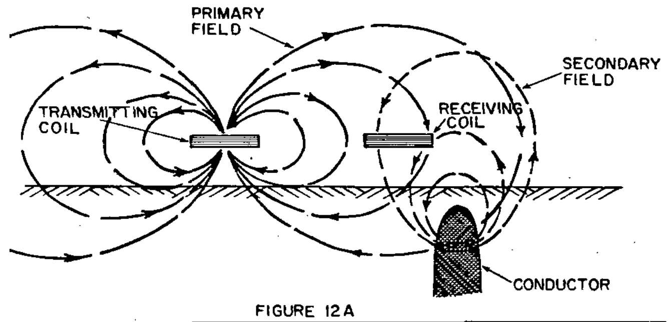


FIGURE 12A

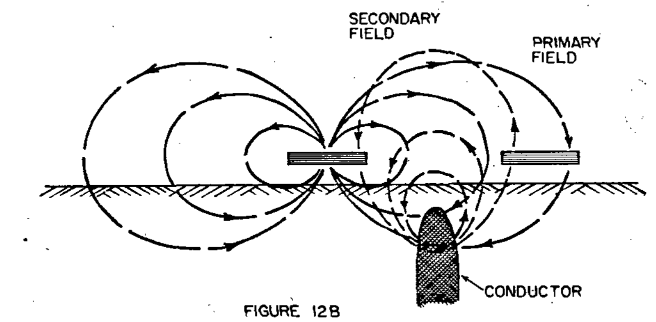


FIGURE 12B

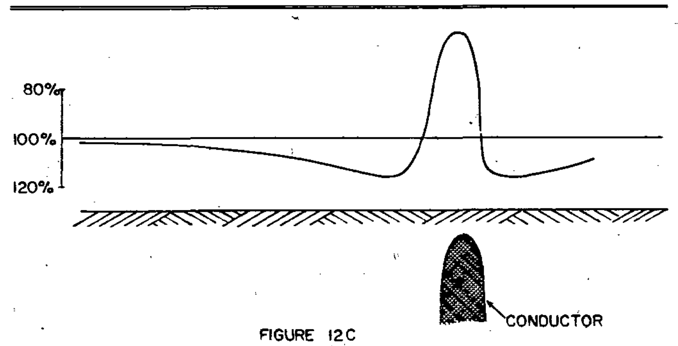


FIGURE 12C

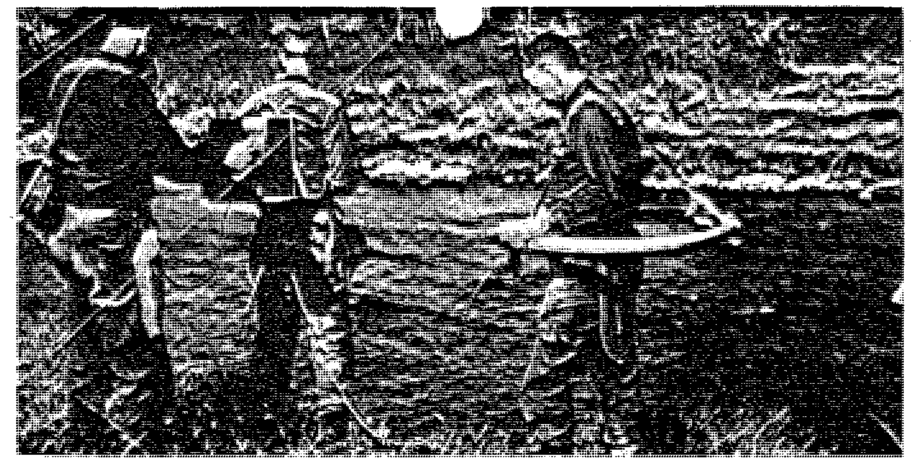


FIGURE 13

known as the co-planar system. Both coils can be traversed across the ground at constant separation, D, or the transmitter can be fixed and readings made at many values of D. As long as no conducting material is within the influence of the coils, normal readings will be obtained. The presence of a conductor will cause a departure from the normal readings.

Figures 12A and 12B illustrate the effect of a conductive body on a coplanar horizontal system. When both coils are outside the conductor, the secondary field produced by the conductor adds to the normal field resulting in an increase in the induced voltage at the receiver. When the coils straddle the conductor, the secondary field opposes the primary field and a marked decrease in voltage is observed. With both coils to the right of the conductor the primary and secondary fields again add. The net result when plotted against the location of the reading is a curve, shaped as shown in *Figure 12C*. The vertical scale is in percent of the normal voltage with *decreasing* intensity upward.

An actual instrument is shown in *Figure 13*. The receiving coil and voltage measuring device are in the foreground. A similar coil and backpack arrangement makes up the transmitting system and is in the background on the far side of the river. In this case a constant separation of 200 feet was maintained between transmitter and receiver. Effective depth penetration for ground units is about one-half the distance between coils. Coil separations of up to 500 feet are quite possible with instruments of this type and new versions are miniaturized for two-man operation.

Actually, with this instrument a cable is run from the transmitter coil to the voltage measuring device or compensator. This cable carries a reference voltage that is proportional to the current in the transmitter coil. The received voltage is compared with the reference voltage.

A field example is shown in *Figure 14*. The solid line represents the in-

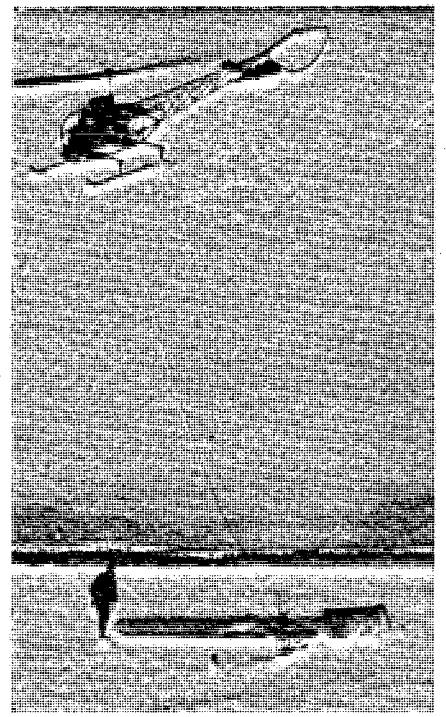


FIGURE 16

phase voltage, which was illustrated in Figure 12, and the dotted line shows the out-of-phase component which is another related quantity. T conductors are clearly indicated through 80 feet of glacial debris with a 300-foot coil separation. In this case the right-hand conductor is sulphides and the other is graphite. The values plotted are in percent of the normal primary field at the coil separation used—a normal reading being 100 on the in-phase and zero on the out-of-phase dial.

In recent years the electromagetic methods have been adapted to airborne operations and several versions of both helicopter and fixed-wing installations are in service. The airborne methods use variations of the techniques described. *Figure 15* shows the installation on a PBY-type aircraft. The horizontal loop running along the wing and back to the tail is the transmitter. The receiving coil is in the bird on the underside of the aircraft. In flight, the bird is towed on 500 feet of cable. A helicopter installation is shown in *Figure 16*. Both transmitter and receiver coil are within the large bird and a recording console is within the helicopter bubble. The airborne systems operate at very high sensitivities but, even so, it is necessary to fly as near the ground as possible.

Areas of severe topographic relief and/or high elevation are not suitable for airborne electromagnetic methods, because of obvious aerodynamic limitations.

From this brief discussion it can be seen that a large variety of electromagnetic methods are possible and a good number of the possible combinations are actually in use. Each has advantages and disadvantages relative to the others and the choice of method to be used depends on the problem at hand and on what equipment is available.

Thanks are due Aeromagnetic Surveys Limited of Toronto for photographs of airborne electromagnetic installations and to numerous Bear Creek personnel who assisted in the preparation of this paper.

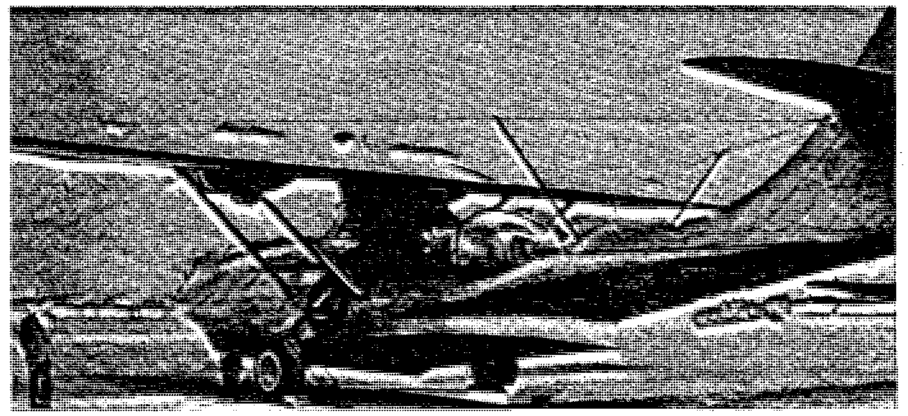


FIGURE 15

ELECTROMAGNETIC Prospecting Methods

By
GEORGE R. ROGERS

Reprinted from
THE MINES MAGAZINE
for December 1957

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 1, 1958

Mr. R. J. Lacy
Chief Geophysicist
Salt Lake Office

ELECTROMAGNETIC SURVEYS

Dear Sir:

This concerns Mr. McDonald's memorandum of February 19, on San Xavier, which accompanied your letter of March 25 to me.

In the second paragraph on the first page Mr. McDonald states "....it seems obvious that the emX-1 conductor axis is produced by fault structure, with associated clay and possible graphite." There well may be faults with associated clay in that area because these conditions are found everywhere, but we have no knowledge of a specific fault coinciding with the emX-1 conductor. The mineralization environment indicated by hole X-132 precludes the possibility that massive sulphides could exist in the immediate area of emX-1. Graphite has never been recognized in the district. Therefore, I believe that the cause of the emX-1 anomaly should be listed as unknown.

In his third paragraph Mr. McDonald suggests that the emX-3 anomaly, now proved to lie within a deep sequence of post-mineral rocks, may be due to a fault structure or "may be caused by boundary conditions between the post-mineral conglomerate and the vesicular basalt." What is meant by boundary conditions?

In sub-paragraph No. 1 Mr. McDonald suggests that ionic water traps in the post-mineral rocks may account for certain anomalies on the Reservation. In your letter of February 29, 1956 to me on East Pima Electromagnetic surveys you discounted the effect of ionic conductors. Do you believe now that they can be a factor?

In sub-paragraph No. 5 Mr. McDonald states, "The fact that we do not obtain response in the LL-XX 372-376 block area can be explained by the apparent lack of continuous mineralization." It should be noted that disseminated mineralization <u>is</u> continuous in this block. Also, gouge-filled faults are prevalent, although we do not know their trends. Sulphide veinlets are present but not particularly abundant. It would be my suggestion that, although the percentage of sulphides in this block is about the same as in most of the East Pima zone (both in and out of the ore body proper), the absence of an anomaly may be due to a lack of coincidental interconnection of sulphide veinlets.

My doubts as to the effectiveness of electromagnetic surveys in the Southwest are increasing. For example:

1. At Cocio and on the Reservation several conductors have been found in post-mineral rocks. These, it seems, may be due to clay, to gouge-filled faults, or to ionic water zones. All of these features are ubiquitous and unrelated to sulphide mineralization, and therefore misleading in terms of ore search.

2. When sulphide veinlets are in some manner interconnected, presumably they tend to produce anomalies. This may be a function of the abundance of sulphides, in which case it could be useful in locating zones of sulphides in general, but the e.m. method makes no distinction between copper and iron sulphides. Therefore, at East Pima it does not assist exploration because of this non-selectivity.

3. As I understand it, the electromagnetic method should be most effective in locating massive sulphide bodies. Yet, massive sulphide lenses in the eastern end of the East Pima ore zone contained the best grade and the shallowest ore but did not produce anomalies; and the so-called discovery anomaly, the strongest in the region, was obtained over ordinary disseminated mineralization which drill holes have shown to have no distinctive condition of mineralogy or structure to explain the anomaly.

As you know, some of these points have disturbed me in the past. My reason for bringing this matter up again is that it is my impression that Mr. McDonald's very careful work on the Reservation has emphasized the differences which can exist between the theoretical interpretations of e.m. anomalies and the geological conditions actually found by drilling. In my mind these differences are such as to limit appreciably the value of e.m. surveys. This opinion applies, of course, only to the basin and range province in the Southwest.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
cc: LHHart
BCMorrison
JHCourtright
FEMcDonald

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 16, 1957

Mr. L. H. Hart, Chief Geologist
New York Office

EAST PIMA
APPROPRIATION REQUEST

Dear Sir:

Calculations of open pit ore tonnage and grade of the easterly extension of the ore body are being worked on now, but no figures are available yet. I believe, however, that by rough estimate we now have something like 100 million tons of indicated open pit ore averaging more than .90% Cu with a waste/ore ratio a bit less than 3 to 1. As explained in my letters of February 7 and 18 to you, a number of additional holes are needed in this ore body for interspaced "measurement" and for local fringe delineation purposes.

Mr. Von den Steinen tells me that our present appropriation MP 744 will be completely expended about the end of March. It is recommended, therefore, that another appropriation be obtained to cover the additional drilling requirements.

It should be noted that this additional drilling is needed primarily to provide a firmly measured tonnage of ore in the eastern and central portions of the ore body so that pit and plant designs can be made. This program does not contemplate complete measurement of the 100-plus million ton ore body or further exploration of the deeper extensions of the ore zone to the south. This means, then, that depending on results of negotiations with Pima Mining Company for surface use, and also depending on results of pit and plant layout studies, it might become necessary to extend drilling beyond this present appropriation request.

Drilling done since my letters of February 7 and 18 has not changed ideas on the number and spacing of drill holes in any important way, so please refer to those letters for descriptions of the necessity of the following categories of drilling. One change has been the idea that at least one of the measurement holes in the middle of the ore body should be drilled to a depth of, say, 1700 feet. This would be done in order to gain information on structure and possible deeper mineralization which could be of value in future exploration on the Indian ground and elsewhere.

If you approve of the following program, please make the necessary arrangements for a new Mining Proposition to be set up.

1.	Completion of holes currently drilling (Nos. 137, 139, 140, 143, 130D, 80D)........	2,450'....	$12/ft...	$ 29,400
2.	Interspaced measurement holes			
	31 holes........... average depth 700'.......	21,700'....	$12/ft...	260,400
	1 of above holes 1000' deeper	1,000'....	$15/ft...	15,000
3.	Fringe holes in southeastern and northeastern corners of ore body			
	6 holes........... average depth 750'.......	4,500'....	$12/ft...	54,000
4.	Holes in the westerly deep ore zone			
	9 holes........... average depth 850'.......	7,650'....	$12/ft...	91,800
5.	Claim validation holes			
	3 holes........... average depth 300'.......	900'....	$10/ft...	9,000
6.	Expenses for preliminary engineering			30,000
7.	Expenses for patenting claims			10,000
	T O T A L S	38,200'		$499,600
	Less -- remainder in present MP 744, approximately			35,000
				$464,600
			Say...	$465,000

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
cc: DJPope
RJLacy

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 11, 1958

MEMORANDUM TO KENYON RICHARD

EAST PIMA
Petrography - Garnet

The rocks at East Pima contain garnet which varies from a very pale straw yellow to brownish color. Some areas contain red garnet, and green garnet has been penetrated in a few drill holes. Because the dominant garnet is light yellow or brown it was assumed to be grossularite.

The Arizona Bureau of Mines has tested a number of garnet specimens on the visual spectrascope, and reports that iron and calcium are abundant, but that aluminum is present only in trace amounts. These results indicate that the garnet is andradite.

Test Results

DDH 44 @ 706.5' (Sirvas SA 17)	Separation of garnet not effected.
DDH 50 @ 458' (Sirvas SB 52)	Andradite. Considerable contamination but non-aluminous.
DDH 51 @ 376.5' (Sirvas SA 20)	Andradite.
DDH 65 @ 304.0' (Sirvas SA 18)	Andradite.
DDH 76 @ 408.5 (Sirvas SB 41)	Probably andradite. Separation of garnet not good.
DDH 32 @ 559'	Close to andradite (relatively non-aluminous). This was a green garnet.
DDH 122 @ 289'	This sample contains garnet dispersed in a slick clay-like material. Bureau Mines reports: Clay-like surfaces very low in aluminum. Potassium not detected. Dominant constituents are calcium, magnesium, and silicon.
DDH 151 @ 273'	Andradite. Trace aluminum, possibly a little more than in the other samples.

Some of the above, and several additional specimens, were tested in 1.76 index oil and all showed high positive relief, showing that oil immersion will probably serve to distinguish the East Pima andradite from any high-aluminum garnet (grossularite) which may be present.

The tactite rocks commonly exhibit a white clay-like mineral previously thought to be clay alteration of the garnet. Since andradite will not alter to clay, this cannot be the case. Petrographic study suggests that the apparent clay alteration of garnet is actually an admixture of diopside. Talc may be present as an alteration product.

It is not necessary, then, to assume any impurity in the original limestone other than magnesium, which may also have been introduced. Silica, of course, may have been anoriginal constituent.

JOHN E. KINNISON

JEK/ds
cc: JHCourtright
JEKinnison
JLClark
RLDubois

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
March 4, 1958

Mr. L. H. Hart
Chief Geologist
New York Office

EAST PIMA INTERSPACED DRILL HOLES

Dear Sir:

Enclosed are three sections, 10.0W, 12.50W, and 34.50N, which show the assay results of the recent interspaced drill holes to date.

In terms of tons of ore these holes have approximately balanced adjacent holes. However, the ore lenses have not all appeared in their predicted positions. These discrepancies can be accounted for by local changes in structural interpretations, which are of only minor consequence in terms of the overall structural pattern. However, some of these discrepancies were quite unexpected.

As you know, this extreme eastern part of the ore body was the most difficult to decipher structurally and stratigraphically. I suppose we will just have to accept the fact that the details of structure and ore distribution cannot be worked out precisely in advance in that area. However, there is sound reason to expect that the total amount of copper now calculated in that area will be recovered during mining.

In addition to holes currently drilling, we plan to drill locations P-8 and P-9; also we plan to drill one hole at coordinate 31.50N and 7.50W. This location is critical insofar as the pit's main haulage system is concerned. It seems to be needed on the theory that if some presently unknown cross structure exists in this southeast corner of the ore body, it could materially influence the pit design. In other words, with this hole we will be buying some insurance against an error in our interpretations.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

Enclosures: 3 sections
KR/ds
cc: WOSchubel - w/o Encl.
bcc: JHCourtright) w/o Encl.
JCKinnison)

F.O.B. Eastern Ref

Dec 15 '57

Outcome

East Pima - Metallurgy

Weiss to Pope - Dec 6, '57

Net value per Ton of conc. & per lb recov. copper

Conc % Cu	Ag oz	Net value of 1 Ton Conc at 21¢	at 25¢	at 29¢	net per lb Cu 21¢	25¢	29¢
20	3.4	$55.62	$71.02	$86.42	13.91	17.76	21.61
25	3.8	72.68	92.08	111.48	14.54	18.42	22.30
30	4.3	89.83	113.23	136.63	14.97	18.87	22.77

Estimated value of Crude ore

Ore % Cu	Conc % Cu	Recov	net Smelter Value 25¢	29¢	Changes for each 1¢ change in price
.7	21	88.7	2.27	2.70	.12
.8	22	90.1	2.60	3.16	.14
.9	23	91.0	2.98	3.61	.16
> 1.0	24	91.7	3.36	4.07	.18
1.1	25	92.3	3.74	4.53	.20

3.91 at 28¢ (1.0% Cu ore)

net value of ore	3.91		3.91
mining (3 to 1) at 30¢		1.20	
milling		.80	
Indirect		.50	2.50
		2.50	1.41

P-5.4.0

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 25, 1957

J. H. C.
NOV 25 1957

NOV 25 1957
J. H. C.

Mr. Norman Weiss
Milling Engineer
Salt Lake City Office

EAST PIMA UNDERGROUND WORK

Dear Sir:

Enclosed is Mr. Courtright's copy of his report on the check drilling program at Toquepala in 1955. You will recall that when you were last in Tucson I mentioned that this report might have information of value to you in designing a sample plant for the underground work at East Pima.

I believe you will find page 12 and Appendices A, B, C, D and E of particular interest, since these deal with the sample mill.

Please return this report to Mr. Courtright when you have finished with it.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
cc: JHCourtright

K. RICHARD
ROOM 809

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
October 24, 1957

CONFIDENTIAL

Mr. T. A. Snedden, Manager
Southwest Mining Department
Tucson Office

EAST PIMA
Proposed Underground Work

Dear Sir:

Enclosed are sections and a plan map showing structure, assay, and rock types which will be encountered in the proposed East Pima underground workings, as described farther along. But first, I should like to express opinions as to the value of this underground work.

Most of those conditions which usually require or justify underground check work do not exist at East Pima. Core recovery has been excellent, and the usual uncertainty as to how to combine core and sludge assays does not exist. The mineralogical texture of the ore types is such that the 10% of core lost to sludge has not had a selective salting effect, as has been the case with many ore bodies; consequently, the East Pima core samples can be considered as an accurate measure of the copper content of the drill holes.

The continuity of values among drill holes is another matter. The East Pima ore body is classed as a disseminated one, but it is unusual insofar as the copper is distributed erratically within a number of ore lenses which themselves are irregular in size, shape, and distribution. In some cases waste-ore contacts are gradational, but more frequently they are sharp, with the waste being nearly barren. Our geological interpretations as to distribution of values within these ore lenses and between holes are subject to uncertainty in some instances. We are sure, however, that a moderate discrepancy of over-estimation of value or tonnage in one locality will be compensated in another. Thus, tonnage and grade calculations on large blocks of ground will be accurate. Any discrepancies will be on a scale involving only weekly or monthly production units, and these will have to be handled as operating problems by coordinating blast hole sampling and detailed geological mapping in the pit. The only way to eliminate this condition now would be to drill a great many interspaced exploration drill holes, a procedure which would not be worth the cost.

Underground workings between drill holes admittedly provides a crude check of this distribution of values. But this method partly checks only the block of ore penetrated, and the results there will not necessarily be indicative of accuracy of ore lens interpretations in other parts of the ore body. The lenses comprising the East Pima ore body are distributed through such a large block of ground that to check the distribution of values within the entire mass by underground workings would be quite out of the question.

Therefore, underground workings are not needed in the East Pima ore body for the usual technological reasons (1) of checking drill hole sample accuracy and (2) of checking continuity of values among holes. A third common reason for such work is the accumulation of bulk metallurgical samples. I have no comments of a geological nature which would bear upon the need for such samples, other than to suggest that large diameter diamond drill holes probably could supply bulk samples at lower cost than underground workings.

Outside of the above technological reasons for or against underground work, there is the psychological factor. If ore can be viewed for a few hundred feet along the walls of underground workings, the viewer may tend to gain a sense of security about the whole ore body. Though non-technical, this may be a valid reason for doing underground work at East Pima. In any event it must be regarded as the principal justification for the work.

The eastern part of the ore body will be mined first, and a fair range of ore types (mineralogical and metallurgical) can be reached here by underground workings with less depth and less lateral extent than would be the case in the western part of the ore body. Therefore, it seems to be the consensus that a shaft and underground workings should be located in the eastern part of the ore body. A proposed minimum amount of workings is shown in solid lines on the attached plan and sections. Possible additional footages are shown in dashed lines. A tabulation follows:

		Ore	Waste
Minimum:			
Shaft on Hole 125	375'	75'	300'
	(Ox. ore	35')	
	(Gravel	190')	
Drifting EW	460	395	65
X-cutting NS	400	380	20
Raise on Hole 62	80	70	10
	1315	920	395
Possible Additional:			
X-cutting NS	360'	280'	80'
Raise on Hole 151	75	35	40
	435	315	120
Total Ore		1235	
Total Footage	1750		

Summary	Minimum	Maximum
Shaft	375'	375'
Horizontal	860	1220
Raise	80	155
	1315	1750
Tons Ore *	3000	4000

Since these workings are not primarily intended as a detailed, sample-by-sample check of drill hole results, it is suggested that shaft and raise rounds need not conform to the irregular assay-intervals of the drill holes. Rather, channel samples can serve this function in detail, and the average of individual round or bulk samples can be compared with the corresponding average of drill hole samples to develop a general check of drill hole sample accuracy.

The raises on holes 62 and 151 may not be needed. I would suggest they be driven only if the horizontal workings show a serious discontinuity of values.

These workings as planned will penetrate hornfels and tactite and will expose a range of mineralogical types which should include practically all of the metallurgical variations of these two main rock types. However, the siliceous ore types (schist, siltstone and argillite) are not found in this eastern ore block, other than in small patches. If bulk metallurgical samples of these siliceous ores are required, another shaft with more extensive lateral workings will have to be planned in the western part of the ore body; or, the material could be supplied from large diameter diamond drill holes.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/de
Enclosures: Plan Map (portion of 2610 Bench Map now being used for Ore Reserve Estimates)
2 Sections (Maps Nos. EP-122-32515 and 11A516)

cc: - Confidential, w/Enclosures -
DJPope
LHHart
ACHall
WCWaldier

K. RICHARD
ROOM 809

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
February 19, 1957

FILE MEMORANDUM

EAST PIMA PROJECT
ASARCO Laboratory
Water Well No. 1

The following summarizes information on Water Well No. 1, which is now supplying water for the East Pima Project laboratory. Analyses of the water and Mr. Norman Whaley's report on the pumping test are attached.

Well Data:

Location: Near NE corner Sec. 34, T17S, R13E.
Drilled by: R. H. Wininger in November, 1956
Depth : . . . . 720 ft.
Casing: 8 inch casing to . . . . 540 ft.
Formation: Valley gravels(?) to . . . . . . 500 ft.
Firm conglomerate (San Xavier?) to 720 ft.
Water Level: . . . . 220 ft.
Perforations . . . Casing perforated from 220--500 ft.

Pumping Test:

Date: . . . . Dec. 21, 1956
By : . . . . Carl Pistor
Rate: Started at 280 gpm, increased to 380 gpm, and then to 460 gpm.
Period: Total pumping time . . . . 2 hours
Drawdown: . . . . 9.5 feet
Water Temperature . . . . 90° F.
Hardness . . (Test by U of A) . . . . . . 10.7 gr. per gal.

Conclusions:

Pistor estimated that with 16 inch dia. casing well would produce 1200 to 1300 gpm with 30 feet drawdown.

J. H. COURTRIGHT

JHC/ds
cc: KERichard

(See file copy for attached data)

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 27, 1956

FILE MEMORANDUM

EAST PIMA
BAILING TESTS

Water Test CDH #2

1st and 2nd Test were conducted without the removal of any casing or liners from the hole: 10" was set at 325'; 8" set at 425: The hole was lined to a depth of 765' with 7" and 5" liners. Hole was bottomed at 880'. Static W.L. of 215' during drilling operation.

1st Test

Bailer Capacity	24.6 gals.	
W.L. before bailing	230'	
W.L. after bailing	266'	
Bailing Time	1 hr.	
No. of bails pulled	60 or 24.6 gals/min.	
Drawdown	36'	
Recharge time	1/2 hr.	1 hr.
W.L. after Recharge	214'	214

2nd Test

W.L. before bailing	214'	
W.L. after bailing	217'	
Bailing time	1 hr.	
No. of bails pulled	57 or 23.4 gals/min.	
Recharge time	1/2 hr.	1 hr.
W.L. after recharge	214'	214

Water Test CDH #2

3rd and 4th Test were made after all the liners and casing were removed from the hole except for the 10" (surface pipe), which was set at 325'.

3rd Test

Bailer Capacity	45.8 gals.	
W.L. after bailing	241'	
W.L. before bailing	273'	
Bailing time	1 hr.	
No. of bails pulled	55 or 42 gals/min	
Drawdown	32'	
Recharge time	1/2 hr.	1 hr.
W.L. after recharge	186'	186

<u>4th Test</u>

W.L. before bailing	186'	
W.L. after bailing	276'	
Bailing time	2 hrs.	
No. of bails pulled	112 or 43 gals/min.	
Drawdown	90'	
Recharge time	1/2 hr.	1 hr.
W.L. after recharge	241.7	241

W.L. November 13 214' (Taped)

<u>Water Test CDH #1</u>

Bailing tests were conducted after the removal of all liners and casing except the 10" (surface pipe).

Bailing tests were conducted for a 1 hour period and for a 4 hour period. Bailing rate was 41 gals/min. on both tests. W.L. remained constant at 248' before, during and after the test. Bailing could not be conducted fast enough to show any drawdown.

Static W.L.	215'
W.L. November 13	235' (Taped)

Water was encountered at 245' in CDH #3. Static standing W.L. is 215' at the present time.

JARVIS KLEM

JK/ds

cc: KERichard
JHCourtright

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
December 17, 1956

M E M O R A N D U M

EAST PIMA PIT
Ore to Waste Ratio Calculation

Following is the procedure used to calculate the number of feet of waste that can be carried by certain intervals of ore at various grades.

BASIC DATA

Copper Price	=	29¢
Avg. % Cu concentrate	=	30.00
Avg % Recovery	=	87
Mining Cost	=	30¢

Milling
Indirect
Deprec. & Depletion
N. Y. Administration

} Costs same as Silver Bell

Step 1. Using an "Ore and Concentrate Liquidation Sheet" the smelter value of one ton of concentrate was calculated as $131.70.

Step 2. The net value of one ton of ore was calculated for various grades of ore.

(a) An estimated % recovery was given to the various grades of ore.
(b) The ratio of concentration was found using 30% Cu concentrate for each grade of ore.

$$\text{Ratio} = \frac{30}{\text{Grade} \times \%\ \text{Recovery}}$$

(c) Calculate smelter value of one ton of ore for each grade of ore.

$$\text{Smelter value} = \frac{\$131.70}{\text{Ratio of Concentration}}$$

(d) Calculate state royalty for each grade of ore.

$$\text{State Royalty} = \frac{5\% \times 131.70}{\text{Ratio of Concentration}}$$

(e) Using basic data and State royalty add up the total cost per ton of ore. Subtract this from smelter value to obtain the net value of one ton of ore for the various grades of ore.

Step 3. Divide the cost of mining one ton of material into the net value of one ton of ore to get the tons of waste that can be mined to mine one ton of ore at that particular grade. The unit tons was changed to feet. The number of feet of ore was multiplied by the factor just obtained for each grade, to obtain the number of feet of waste that could be mined at that grade.

R. A. BARNES

RAB/dm
cc: RBHeen
KERichard
JHCourtright
SVPay

FORM H-22

ORE AND CONCENTRATE LIQUIDATION SHEET

Silver Bell Schedule

Mill Lot No.	Estimated Outcome		
Mine Lot No.			
Class			
Mine	EAST PIMA	Unit	to El Paso
Date			

METAL PRICES

METAL	UNIT	LEAD OR COPPER CONCTS. OR CRUDE			ZINC CONCENTRATES		
		Quotation	Deduction	Net	Quotation	Deduction	Net
Gold	Dollars/Oz.						
Silver	Cents/Oz.						
Lead	Cents/lb.						
Copper	Cents/lb.	29.0 (C.V.)	.3	28.7			
Zinc	Cents/lb.						

WEIGHTS CRUDE ORE

Wet Weight		lbs.
Moist: %		lbs.
Dry Weight		lbs.
Dry Weight		Tons

LEAD OR COPPER CONCENTRATES OR CRUDE

Ratio of Concentration Mill Ore:

METAL	ASSAY		DEDUCT.	NET ASSAY	EQUIVALENT in LBS. or OZS.	PER CENT PAID FOR	NET PAID FOR		RATE	VALUE PER TON CONCT.	VALUE PER TON CRUDE	VALUE TOTAL AMT. FOR LOT
Gold		Oz.						Oz.	$	$	$	$
Silver		Oz.						Oz.				
Lead		%						lbs.				
Copper	30.00	%	0.75	29.25	585	100	585	lbs.	.287	167.90		
TOTAL PAYMENTS FOR METALS										167.90		

DEDUCTIONS	DR.	CR.
Base Treatment Charge	$ 10.83	$
Cu ~~Lead~~ Assay Adjustment (30.0 - 25.0) x $.15	.75	
Zinc Penalty		
Bismuth Penalty		
Labor Adjustment	2.42	
Bullion Tax $.00037 x 585	.22	
Freight: R + D = 585 x $.0294	4.78	
	17.20	
TOTAL TO DEDUCT	36.20	

TOTAL TO DEDUCT: 36.20

NET RETURN PER TON OF CONCENTRATE: 131.70

NET RETURN PER TON OF CRUDE ORE

TOTAL NET RETURN

ZINC CONCENTRATE

Ratio of Concentration Mill Ore:

METAL	ASSAY		DEDUCT.	NET ASSAY	EQUIVALENT in LBS. or OZS.	PER CENT PAID FOR	NET PAID FOR		RATE	VALUE PER TON CONCT.	VALUE PER TON CRUDE	VALUE TOTAL AMT. FOR LOT
Gold		Oz.						Oz.	$	$	$	$
Silver		Oz.						Oz.				
Lead		%						lbs.				
Copper		%						lbs.				
Zinc		%						lbs.				
TOTAL PAYMENTS FOR METALS												

DEDUCTIONS	DR.	CR.
Base Treatment Charge	$	$
Labor Adjustment		
Spelter Price Adjustment		
TOTAL BASE CHARGE		
Spelter Tax		
Freight		

TOTAL TO DEDUCT

NET RETURN PER TON OF CONCENTRATE

NET RETURN PER TON OF CRUDE ORE

TOTAL NET RETURN

TOTAL RETURN PER TON CRUDE ORE FROM ALL CONCENTRATES AND FOR LOT

Orig cc Correct Approved

EAST PIMA PIT

Based on 29¢ Copper

			PER TON OF ORE								
Grade	% Recovery	Ratio of Concentration	Smelter Value	State Royalty	Mining Cost	Milling Cost	Indirect Cost	Deprec. & Deple.	N. Y. Admin.	Total Cost	Net Value
1.50	92	21.7	$ 6.07	$ .30	$ .30	$ .76	$ .44	$ .61	$ .06	$2.47	$ 3.60
1.40	92	23.3	5.65	.28						2.45	3.20
1.30	89	25.9	5.08	.25						2.42	2.66
1.20	89	28.1	4.69	.23						2.40	2.29
1.10	89	30.6	4.30	.22						2.39	1.91
1.00	87	34.5	3.82	.19						2.36	1.46
.90	87	37.5	3.51	.18						2.35	1.16
.80	87	43.1	3.06	.15						2.32	.74
.70	85	50.4	2.61	.13						2.30	.31
.60	85	58.8	2.24	.11						2.28	-.04
.50	82	73.2	1.80	.09						2.26	-.46
.40	82	91.5	1.44	.07						2.24	-.80
.93	87	37.1	3.55	.18						2.35	1.20

EAST PIMA PIT

Ore to Waste Ratio

December, 1956

29¢ Copper @ 30¢/Ton Mining Cost

Feet of Waste @ Grade of Copper

Feet of Ore	.6	.7	.8	.9	1.0	1.1	1.2	1.3	1.4	1.5
5		5	12	19	24	32	38	44	53	60
10		10	25	39	49	64	76	89	107	120
25		25	62	97	122	160	190	222	267	300
40		40	100	156	196	256	304	356	428	480
60		60	150	234	294	384	456	534	642	720
80		80	200	312	392	512	608	712	856	960
100		100	250	390	490	640	760	890	1070	1200
200		200	500	780	980	1280	1520	1780	2140	2400
300		300	750	1170	1470	1920	2280	2670	3210	3600

J. H. C.

August 16, 1956

CONFIDENTIAL

Mr. L. H. Hart, Chief Geologist
American Smelting and Refining Company
120 Broadway
New York 5, New York

EAST PIMA
Ore Reserve Estimate and Outcome

Dear Sir:

A preliminary open pit ore reserve estimate has been made by Mr. Hardie, Mr. Haworth and me with the following results:

	Tons (Millions)	Grade % Cu
Ore:		
Secondary	3.4	0.76
Primary	41.3	0.94
Total	44.7	0.93
Waste:		
Bedrock	58.0	0.16
Gravel*	73.2 (or, 43.4 mil. cu. yds.)	
	131.2	

Ratios:	
Bedrock Waste/Total Ore	1.3/1
Total Waste/Total Ore	2.9/1

*Includes 0.95 mil. tons of Pima mine dumps.

The following basic assumptions were made relative to the calculation procedure:

(1) An open pit has been designed which represents the present theoretical limit of mining. (See attached map.) Maximum pit slopes of 45° were used. The configuration of the pit was determined by personal judgment of the balance between ore grade and waste/ore ratios for small, individual blocks of ore. In other words, the pit was extended to include all small blocks of ore which could be reahhed with waste/ore ratios which were reasonable as compared to the grade of the blocks. Considerable tonnages of ore-grade material

exist below and immediately outside of this pit. Due to high waste/ore ratios, this material was considered not to be ore. As more drill hole information is gained, it may eventuate that some of this material can be reached by a larger open pit.

(2) Due to the unusually sporadic character of mineralization, it is considered that a mining bench height of something like 25' will be necessary in order to permit proper selectivity in mining. Therefore, the ore calculation system was set up on level maps at 25' intervals, and the drill hole assays were weighted in corresponding 25' intervals.

(3) Around each drill hole a polygon was constructed by bisecting the distance to adjacent holes. Each polygon then was considered to be the "area of influence" of each 25' average-assay-segment in the drill holes. This method does not permit the refinement of making adjustments for structural trends of mineralization. (A final ore estimate will probably require such a refinement, but it certainly is not needed in the present preliminary analysis.)

(4) A bottom ore cutoff of 0.40% total Cu was used throughout the zone of primary mineralization.

The thin layers of oxide and chalcocite mineralization required special treatment in the calculation. Mr. Mellon's test work indicated that about 40% of the copper (mostly native Cu and chrysocolla) in the leached zone and 80% of the copper (mostly chalcocite) at the top of the sulphide zone can be recovered in the flotation circuit. These layers are thin, probably highly irregular, and constitute only small tonnages. For the most part they probably cannot be mined selectively. Therefore, it was assumed they would go through the regular flotation mill circuit. In the calculation, then, the oxide and chalcocite total Cu assays were reduced to 40 and 80% respectively and then weighted. If the weighted average thus obtained for a 25' segment was 0.40% Cu or more, the material was classed as ore.

(5) As standard practice, a specific gravity test is made on a specimen from each core run. These specific gravity values range widely due to the spotty distribution of heavy lime silicate minerals. In this circumstance the assumption of a single specific gravity figure for the entire ore body could have been erroneous. Therefore, a weighted average of specific gravities was made for each 25' drill hole segment and applied to each polygon in the same manner as the assay-averages.

(6) As indicated by the rotary drilling through the gravel, the bottom 30' of the gravel consists of a hard, caliche-cemented conglomerate. From a mining standpoint this material should be classed as part of bedrock. Therefore, this conglomerate has been included in our calculations as bedrock waste subject to a higher mining cost than the overlying, loosely consolidated gravel.

A gravity factor of 16 cu. ft. per ton was used for this overlying gravel. This is conservative because we are uncertain of the correct figure. From the earth-moving standpoint this gravel might be more appropriately described as coarse sand and dirt, in which case a factor of something like 18 might be better.

A protective 75' shelf or berm on the top of the caliche conglomerate was layed out around the pit. From this line to the ground surface a slope of 45° was assumed.

(7) Drill hole assays up through hole 94 were used in the calculation.

(8) The ore is classed as "indicated" rather than "measured."

(9) As shown on the attached map, the ore body and the pit extend into Banner ground on the northwest. It has been assumed for the present that an operating arrangement eventually will be made with Banner whereby the pit can be extended into their ground to recover ore for them at no cost to the Company for the mining and stripping in their ground. Therefore, our ore and waste tonnages have been carried up to the vertical property boundary.

Accuracy:

From the mechanical or geometric standpoint the calculation method used is reasonably precise. Discrepancies in the tonnage and grade from this source should be no more than 3 or 4%.

Because of the unusually spotty distribution of copper, the present drill hole pattern is much too wide-spaced. If a large number of inter-spaced holes are drilled (and they should be), the results could effect considerable change in the ore grade and tonnage within the pit as now layed out. The difference could be as much as 15% in tonnage and 10% in grade.

As additional interspaced and peripheral holes are drilled, the configuration of the theoretical ultimate open pit will be changed. Although the end result may be a constriction in certain localities of the pit, I believe that most likely there will be an overall enlargement. This would have the effect of increasing the tonnage of ore and raising the waste/ore ratio, but the ore grade should not thereby be changed materially.

Outcome:

Using the above tonnage and grade figures and assuming, (1) a production rate of 7500 tpd, (2) Silver Bell costs and general experience with some modifications where conditions are different, (3) a 90% milling recovery (verbally recommended by Mr. Vincent), plus a 3% loss to the smelter, or a total recovery of 87%, (4) a 30% Cu concentrate grade, and (5) a copper price of 29¢, Mr. Hayes has calculated the following outcome:

mean 20¢

	Cost/Ton Ore
Stripping	$ .81
43.4 mil. cu. yds. gravel x $.30 58.0 mil. tons bedrock waste x $.40 $\frac{36.22}{44.7} = .81$	
Mining	.40
Present Silver Bell cost: $.36. East Pima will have steeper haul out of pit and a low bench height.	
Milling	.80
Present Silver Bell cost: $.76. East Pima ore is harder.	
Indirect	.62
Present Silver Bell cost: $.4355 Allowance for higher taxes: $.18.	
Amortization	.35
Present Silver Bell: $17.38 mil. Less: S. Bell stripping 4.97 " S. Bell housing 1.33 " Plus: Mine and Equip. 2.60 " Add. Drilling 1.00 " $\frac{14.68}{44.7} = .328$ say, .35	
Total Operating Cost per Ton Ore*	**$2.98**

Operating Cost per lb. Cu*	18.40¢
0.93% Cu x 20 lbs. x 87% Recov. = 16.2 lbs. Cu $\frac{2.98}{16.2} = 18.4$	
Marketing Cost per lb. Cu*	6.18¢
Freight, smelting, etc. per present Silver Bell schedule	
Total Cost per lb. Cu*	**24.58¢**

Yearly lbs. of Cu paid for . . . . 43.74 mil.
7500 tons x 30 days x 12
mon. = 2.7 mil. tons
2.7 x 16.2 = 43.74

Yearly operating profit* . . . . $1.93 mil.
43.74 x (29-24.58) = 193.3

Additional yearly operating profit
per 1¢ increase in Cu price* . . . . $ .44 mil.

Life . . . . 16.6 years

$$\frac{44.7}{2.7} = 16.56$$

Total operating profit* . . . . $31.96 mil.
1.93 x 16.56 = 31.961

*Before Income Tax

The above outcome estimate is commensurate with the accuracy of the ore reserve estimate, but it does not represent a detailed analysis. Both estimates are intended to present only a generalized opinion of the commercial possibilities. Mr. Snedden is on vacation and has not seen these final figures on ore reserves and outcome. He may wish to comment on them later.

Yours very truly,

KENYON RICHARD

cc: DJPope P/C w/Map
FVRichard " "
WRLandwehr " "
RJLacy " "
JDVincent " w/o Map
JHC

AS&R Bids $1 Million To Papagos

Prospecting Right Sought

By JOHN RIDDICK

American Smelting & Refining Co. has bid over $1 million for exclusive prospecting rights on 15,000 acres of the Papago Indian Reservation just south of Tucson.

Bids from four mining concerns were opened yesterday at Sells on the reservation. Other bids came from Pima Mining Co., Banner Mining Co. and American Metal Co.

Before the bid becomes final, it must be approved by the Papago Tribal Council and the individual Indians to whom most of the land is allotted, Fred Haverland, area director for the Indian Bureau, said.

The money will then be paid to the Indians as a bonus. With the right to prospect goes a leasing right to mine. And in that event, the Indians will get a 10 per cent royalty on the shipped ore as well as land rental. The prospecting permit will last two years.

The land is in the Twin Buttes area just south of the San Xavier Mission.

Immediately to the south of the area are the Banner underground and the Pima open pit copper operations.

American Smelting & Refining Co. also has claims in the area which it has been exploring for two years. The company has claims running for a mile and half along the Indian land, T. A. Snedden, southwestern manager for AS&R, said today.

Snedden said that his company plans to begin a drilling program of exploration on the Indian land as soon as the bid is approved.

All but 160 acres of the land has been allotted to individual Indians and all of the allottees must sign the agreement.

The bidding was for three separate tracts. AS&R bid $283,000 for tract No. 1, $757,002.04 for tract No. 2 and $20,005 for the third tract.

Banner bid $357,644.98 for the second tract. Pima bid $37,000 for tract No. 1 and $87,000 for tract No. 2. And American Metal Co. bid $2,713.80, $10,496 and $2,713 for the three tracts.

"From the information that is available to us, it does not appear that other large developments will be found on the reservation," Haverland said.

Only two years ago were the Papagos given mineral rights to their reservation.

The Bureau of Land Management now has two crews on the reservation searching claims to see which are valid.

American Smelting & Refining Co. has the Silverbell copper mine west of Tucson and the Trench Unit lead-zinc mine in the Patagonia Mountains. The southwestern exploration office is in Tucson.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 17, 1956

Mr. W. R. Landwehr, Chief Geologist
Western Mining Department
Salt Lake City Office

PIMA-SAN XAVIER-AREA
Regional Geologic
Report and Maps

Dear Sir:

Enclosed is a preliminary geological report with maps of the Pima region by Messrs. Courtright and Evans.

This report points out that a large zone of disseminated alteration-mineralization probably exists in the gravel-covered area of the San Xavier Indian Reservation. There is a good possibility that a porphyry copper ore body (or related mineralization in sedimentary rocks of the Pima and East Pima variety) can be found, and it is recommended that a substantial exploration program involving geophysical work and drilling is warranted.

Our drawn-out efforts to obtain a prospecting permit with preferential lease privilege on a large tract on the San Xavier Reservation are now in a critical stage and we are preparing a more formal application. (Please refer to my memorandum with map of April 2 to Mr. Snedden.) It is not my purpose here to go into the complications of this leasing business, but rather, to present the facts supporting our favorable opinion of exploration possibilities. With this material as a basis, it can be decided how strong a play should be made toward obtaining the exploration and leasing privileges when the time arrives.

Following are the principal features which make this exploration attractive:

1. The main East Pima ore zone which we are now drilling is not delimited to the north and there is likelihood that it continues beneath gravel cover into the Reservation.

2. About two miles northwest of the East Pima area Mr. Courtright has found two small outcrops of schist intruded by monzonite porphyry. Both rocks are strongly altered and contain significant evidence of original copper sulphides in their leached outcrops. These outcrops are surrounded by gravel for a radius of several miles.

3. Between these isolated outcrops and the East Pima area there is some scanty drill hole information (brief logs of old churn drill water wells) suggesting a possibly continuous zone of alteration-mineralization.

4. At the west end of Black Mountain (in the northern part of the Reservation) there is an exposure of Tertiary conglomerate containing fragments of altered and mineralized rocks derived from some nearby, large zone of disseminated mineralization. Best guess: this zone is buried beneath the gravel two to five miles west or south of Black Mountain. (An occurrence of the same formation carrying similarly mineralized fragments is known at Hieroglyph Hill about 4 miles east of Silver Bell. If the Silver Bell zone of alteration-mineralization happened to be entirely covered with gravels, the conglomerate at Hieroglyph Hill would be a clue which could lead to the discovery of the zone.)

5. Extending a distance of 20 miles from the Esperanza-New Years Eve (Duval Sulphur), through the Pima area, the Reservation, and into the Amole area, a number of porphyry copper type deposits are known despite the fact that much of the region is gravel-covered. Most of these deposits are probably non-commercial and are not connected by continuously mineralized structures. However, they do mark an extensive copper-bearing belt which, geologically, is closely comparable to some of the major porphyry copper districts such as Ely and Miami. These latter districts consist of groups of structurally unconnected porphyry deposits some of which constitute ore bodies and some of which are non-commercial. These districts cover large areas and have more-or-less centrally situated zones which contain major ore bodies. A major zone of mineralization such as these has not yet been found in the Pima-San Xavier region; but the comparison is interesting, and it is a distinct possibility that an important ore zone exists beneath the gravels of the Reservation.

It is assumed that if exploration is undertaken, a considerable amount of geophysical work will be immediately involved. I presume that airborne electromagnetic and magnetic methods would be given first consideration, but that of course will depend on Mr. Lacy's recommendations. In any event, it is suggested that a program of drilling about 50 widespaced, shallow holes would be the first step, in the same manner as the exploration at East Pima was begun. These holes would be drilled rapidly and cheaply just to obtain a few feet of bedrock core. They would be spaced on something like a one-half-mile grid. The objectives would be (1) roughly to locate the margins of alteration-mineralization and thus narrow the overall target and (2) to recognize any indications of stronger mineralization. This drilling would be guided by any available geophysical information, but it should not be delayed while awaiting geophysical results because (1) this drill hole data would be needed, for the most part, regardless of geophysical results, and (2) we would probably face a tight time-schedule.

Concurrently or succeeding the shallow drill hole and geophysical programs, a minimum of 20 deeper holes would be needed.

Not including geophysical work, the above program would cost about $800,000.

The Evans-Courtright maps are intended (1) to show age relationships and in a generalized way the distribution of pre- and post-mineral rock formations and the occurrences of zones of alteration-mineralization, and (2) to portray the geography of the exploration problem. This required that the maps be on a small scale. All of this material is preliminary, then, in at least two respects: Where known, the structure and other details seldom can be adequately represented on maps of this scale, and in several areas the structural relationships remain to be worked out by mapping in more detail. This detailed work is being carried on, and maps of larger scale eventually will be prepared.

Yours very truly,
Original Signed By
K. Richard

KENYON RICHARD

Encls: Courtright-Evans report w/2 maps
cc: LAHart w/encls
FWRichard "
RHLacy "
JHCourtright "
GEEvans "

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 14, 1956

MEMORANDUM FOR KENYON RICHARD

PIMA-SAN XAVIER RESERVATION AREA
Pima County, Arizona

During the past few months, reconnaissance geological mapping has been in progress over a rather large area along the west side of the Santa Cruz Valley, extending from Twin Buttes on the south, through the Pima district and the San Xavier Indian Reservation, to the Ajo Highway in the Tucson Mountains on the north. The objective of this work was to secure information on the general geological environment of the Pima district, with particular emphasis on features of alteration and disseminated sulphide mineralization.

Gravels overlie most of the area, but due to its size --- some 200 square miles --- coverage to date has been necessarily quite superficial. The brief review of geology and exploration possibilities which follows is intended to serve as a preliminary report only. Detailed data on various rock units recognized are attached as an appendix under "Geologic Notes".

The mapping was done on Soil Conservation aerial photographs, one inch to one-half mile scale. To prepare the maps attached, the data was transferred from the photographs to U.S.G.S. topographic sheets, one inch to the mile scale.

GENERAL GEOLOGY

The Twin Buttes and Pima mining districts are situated on a broad, gently sloping, gravel-covered pediment bordering the eastern edge of the Sierrita Mountains. Erosional remnants of the more resistant rocks --- mainly limestone --- protrude here and there above the gravel beds, forming a number of small, isolated hills and ridges (Geologic Map, Att.A.). Extending north, the pediment area includes the San Xavier Reservation and the area surrounding the south Tucson Mountains.

The mapped area is underlain largely by Cretaceous and Paleozoic sedimentary formations, and the Sierrita granite which intrudes them on the west. Early Tertiary extrusive rocks, which are prominent as a thick series of volcanic flows and pyroclastics in the Tucson Mountains, have not been found in the Pima-Twin Buttes region. They may have been removed by erosion, since a conglomerate (Silver Bell formation), which is known to underlie the volcanics, is present there as erosional remnants.

Besides the Sierrita granite, a few small intrusive bodies of premineral age are exposed in the Twin Buttes-Pima vicinity. These include monzonite porphyry, biotite-rhyolite and diabase. In the south end of the Tucson Mountains, two rather large masses of porphyry, which were mapped by Brown (GSA Bulletin May 1, 1939) as flows, were found to be intrusive bodies, plug-like in shape.

An intrusive of post-mineral age (basalt porphyry) forms two large, irregular dike-like bodies, one of which trends easterly through Black Mountain in the northern part of the Indian Reservation and the other through the area south of Helmet Peak. Other post-mineral formations include the recent gravels, the basalt flows and a conglomerate locally known as the San Xavier formation.

Complex folding and faulting is evident in the Cretaceous and Paleozoic sedimentary rocks outcropping in the vicinity of the Banner and San Xavier mines. Some detailed information has been obtained in a few small parts of the district

(Pima reports, October '53 and September '55), but as yet little is known of the major structures involved in the extensive deformation and displacement apparent in the various rock formations. Most of the faults and mineralized fissures strike easterly to northeasterly.

The principal known copper deposits consist of massive and disseminated sulphide mineralization, associated with garnet and other lime-silicate minerals which have replaced the more limey members of the sedimentary series.

Adjacent arkosic beds are altered to quartz-sericite-clay minerals and contain disseminated sulphide mineralization with generally low copper values. Alteration is widespread, forming a large zone enclosing the Pima and East Pima deposits. The Banner and San Xavier deposits are situated near the western margins of this zone.

During the course of our reconnaissance work in the region other occurrences of alteration and mineralization have been found. The distribution and extent of these are shown on the mineralization map (Att. B). Several sizeable zones occur southwest of Helmet Peak. These are partly covered by the Wilson-Chilson-Todd property, and are described in your report of April 9, 1956, to Mr. Landwehr. As evidenced by the leached outcrops in this area, copper mineralization is generally weak in the altered arkose, but stronger mineralization occurs in and around small monzonite intrusive bodies.

In the San Xavier Indian Reservation, about 2 1/2 miles north of Mineral Hill, two small knolls of Cretaceous arkose represent the only outcrops observed for several miles around. These are altered throughout and contain some limonite after chalcocite. An irregular dike of intrusive porphyry cuts the arkose in the smaller outcrop of the two. Sludges, containing altered arkose, with pyrite and small amounts of chalcopyrite and chalcocite, were found near old churn drill holes (water wells) in the area. One of these is located about a mile east and the other about 2 miles south of the mineralized outcrops. Another hole, located about one mile southwest encountered unaltered sandstones and siltstones. The Banner Mining Company recently drilled several holes just south of the Reservation boundary and east of the highway. Some of these encountered mineralization (see Att. B), as noted in sludge remnants around the drill locations. Information from drillers' logs indicates the average depth of the gravel cover to be about 200 feet.

The post mineral San Xavier conglomerate, exposed in small outcrops on the northwest slopes of Black Mountain, contains numerous fragments of altered porphyry and arkose, as well as some siliceous gossan material probably derived from mineralized limestone. The conglomerate, which is earlier than the valley gravels and the Black Mountain lava flows, was obviously derived, in part at least, from leached outcrops of a mineralized zone. This zone probably lies beneath the lavas of Black Mountain or under the gravels of the immediate vicinity, as the mineralized fragments of the conglomerate are sharply angular in shape, indicating that they were not transported far.

In the Amole district on the north a small monzonite plug, known as Saginaw Hill, contains some disseminated copper mineralization. Five diamond drill holes put down to an average depth of 300 feet by Calumet and Hecla in 1917 gave an average of 0.40% copper. No mention is made in the report (by James Pollock, April 6, 1946) as to whether these values were sulphide or oxide. Several narrow chrysocolla veins occur. Some of them are presently being mined and shipped to the Ajo smelter as siliceous flux. The monzonite is generally fresh-appearing; however, small areas of fairly strong alteration were found on the margins of the stock.

In the mountains east of Saginaw Hill, weakly altered zones were noted along some of the more prominent fault structures. The Santa Margarita, an old copper prospect on a narrow, irregular vein located 1/2 mile southwest of Beehive Peak, is within one of these zones.

<u>EXPLORATION POSSIBILITIES</u>

The East Pima property, entirely covered by gravels, was acquired two years ago by the Company for the purpose of exploring possible extensions of the alteration zone enclosing the Pima ore body. The zone has been found to occupy a large area beneath the gravel cover and to contain ore-grade copper mineralization in substantial quantities.

Information we now have indicates that exploration to date in the East Pima area has tested what may prove to be a rather small proportion of the total, potentially ore-bearing ground. Continuity of the zone for at least two miles into the Reservation is fairly certain. An extent beyond to the north for several miles is probable to some degree, considering the indirect evidence in the conglomerate at Black Mountain. As may be seen on the map (Att. B), only the approximate western margin of the zone is known; and, except for the line of outcrops trending northeasterly from Twin Buttes, no limiting features are apparent.

The East Pima ore zone is considered to be a porphyry copper type of deposit even though no monzonite porphyry has been encountered in drill holes. Large tonnages of disseminated ore occur in limestone and shale in the Ely District and lesser amounts in quartzite and limestone in the Bingham Canyon and Santa Rita Districts where these formations extend into the porphyry alteration-mineralization zones. The mineral textures and assemblages in these ores in sedimentary rocks are the same as those in our East Pima ores. Accordingly, we believe that the existence of a mineralized porphyry stock somewhere near the presently known East Pima deposit is a reasonable expectancy, and should be considered as an important factor in evaluation of exploration chances on the Reservation ground.

An application for a prospecting permit on 30 sections in the Reservation has already been filed with the Bureau of Indian Affairs, as stated in your memorandum of April 2, 1956, to Mr. Snedden. These sections comprise a block running 6 miles east-west and extending 5 miles north of the south boundary of the Reservation. It is now planned to submit a revised application to include a total of 49 sections in a block 7 miles wide, extending from the south to the north border of the Reservation. The east boundary of the block passes through the east end of Black Mountain.

Exploration of such a large area is, of course, a sizeable undertaking. We believe the best approach to the problem would be first to employ rotary drills for the purpose of securing, rapidly and cheaply, data on the character of bedrock at a number of widely spaced points, as was done in the East Pima area. Only a few feet of bedrock is cored by this method; but the holes can all be cased with low-cost pipe and any of them deepened by diamond drill later. The higher cost, deep drilling would be guided by interpretation of results from the shallow holes and other information, including that obtained from geophysical work. In connection with the latter, advance information on the extent of the post mineral basalt porphyry beneath the gravels could be useful, as it may occur in very large bodies within, or cutting across, the alteration zone. Since it is a somewhat basic rock and likely relatively high in magnetite content, magnetometer surveys might be used to indicate its extent.

A rough estimate of the cost of a preliminary exploration program is given below. The average depth of gravel is assumed to be 200 feet.

	Average Depth	Total	Cost Per Foot	Total
50 shallow holes	200 ft.	10,000 ft.	$ 4.00	$ 40,000
20 deep holes	500 ft.	10,000 ft.	$12.00	$120,000
Other expense (supervision, surveying, etc.)				$ 40,000
			TOTAL	$200,000

This total of 20,000 feet is considered the minimum footage of drilling that would be needed as an initial test of the area.

J. H. COURTRIGHT

O. D. EVANS

APPENDIX
GEOLOGIC NOTES

SEDIMENTARY ROCKS

Post-Mineral

Qal. Quaternary alluvium is largely a channel wash derived from the granitic mass that makes up the Sierrita Mountains on the Southwestern border of the mapped area. Some of the larger areas of talus are included. In the Pima Area southwest of Helmet Peak the cover is shallow and intermittent. To the east and north on the broad piedmont the alluvial cover thickens toward the Santa Cruz and Altar valleys. Drilled holes north and east of Mineral Hill indicate an average thickness of 150' to 200'. Due to its large areal extent this formation is of great importance as post-mineral cover over possible ore deposits.

Tal. Tertiary alluvium is an older alluvium locally called the San Xavier conglomerate. It is composed of rock fragments with angular to subrounded outlines, and is weakly to moderately consolidated. In places it is distinctly bedded, and has been tilted as much as 73 degrees. At Black Mountain it is overlain by basalt, and south of Helmet Peak it is cut by dikes of hornblend-andesite. Mineralized rock fragments are present in several exposures. Southwest of Helmet Peak these are derived from known zones of mineralization. Northwest of Mineral Hill and at Black Mountain no source is exposed, and the mineralized fragments may be derived from nearby, buried zones of mineralization.

Pre-Mineral

Tsb. Tertiary Silver Bell Formation overlies Cretaceous and earlier sediments unconformably, and is overlain by the Cat Mountain rhyolite. Several units have been recognized. Southwest ofHelmet Peak the formation consists principally of a dark andesite-porphyry conglomerate. Also present are less conscpicuous conglomerates which are generally derived from the Cretaceous sediments.

In the Tucson Mountains the above rocks are represented, as well as additional units not found to the south. These include a volcanic rubble, and a "chaos" of large boulders. The latter is the uppermost unit and is as much as 500 feet thick. It contains blocks of Paleozoic limestone up to 200 feet thick and several hundred feet in diameter, as well as large boulders of Cretaceous arkose and Pre-Cambrian schist. Occasionally, these boulders are set in a matrix of thin-bedded arkose and conglomerate.

} Early Tert? pre-mineral sediments — possibly unconformable on Cret —

Ks. Cretaceous sediments consist of possibly 10,000 feet of dominantly siliceous units including arkose, quartzite, silstones and conglomerate. West of Saginaw Hill and south of Helmet Peak there are 100-200' horizons of limey sediments. Much of the alteration and mineralization in the Pima district is in Cretaceous sediments.

Ps. Paleozoic sediments include formations from the Cambrian Bolsa quartzite through Permian Snyder Hill. Thick bedded, massive limestones predominate. In the Pima district and to the south around the Twin Buttes, 4000 to 5000 feet of these sediments are exposed. At Mineral Hill and San Xavier they are host to base metal replacement and contact-type deposits.

IGNEOUS ROCKS - EXTRUSIVE

Post-Mineral

Tqb. Late Tertiary or Quaternary basalt consists of a maximum of 200 feet of essentially horizontal flows of dense black vescicular basalt and some basaltic rubble layers. At Black Mountain it overlies the San Xavier conglomerate.

Pre-Mineral

Tsa. Tertiary Shorts Ranch andesite is a light purplish-gray rock with a dense groundmass and abundant phenocrysts of plagioclase. Northwest of San Xavier Mission it is about 200 feet thick.

Tcr. Tertiary Cat Mountain rhyolite is a gray pyroclastic with abundant xenoliths in a glassy groundmass containing small phenocrysts of quartz and feldspar. Flow banding is common. In the mapped area it is at least 300 feet thick. It overlies the "chaos" unit of the Silver Bell formation and is believed equivalent to the dacite agglomerate at Silver Bell.

IGNEOUS ROCKS - INTRUSIVE

Post-Mineral

Tha. Tertiary hornblende-andesite is a light brown rock with phenocrysts of feldspar and hornblende in an aphanitic groundmass. It occurs in long, narrow dikes that cut the tilted San Xavier conglomerate and older formations.

Tbp. Tertiary basalt porphyry is a dark greenish-gray rock with abundant coarse plagioclase phenocrysts and smaller pyroxenes in a glossy to aphanitic groundmass. It occurs as large, elongate masses which appear to be intrusive.

Pre-Mineral

Tm. Tertiary monzonite when fresh is a dark rock with small to medium-sized phenocrysts of feldspar in a greenish, medium grained to aphanitic groundmass. Quartz and biotite are common. It occurs as small irregular plug-like bodies that cut Tertiary and older formations. The monzonite weathers easily so is more often found in surface depressions. It is probably more abundant than indicated by present exposures. There is a marked coincidence between the occurrence of monzonite and the stronger indications of copper mineralization. This obviously suggests a genetic relationship between them.

Td. Tertiary diabase is a dense, dark intrusive composed of small feldspar crystals in a black, aphanitic groundmass. It occurs as a few small dike-like bodies cutting Tertiary and older formations.

Tbr. Tertiary biotite-rhyolite is a massive gray porphyry in which small crystals generally predominate. Quartz is the most abundant of the crystals, and feldspar and biotite are common. The rock contains numerous small xenoliths of older formations including diopside-andesite. In the Amole Area near Beehive Peak the biotite-rhyolite is in intrusive contact with the Silver Bell formation. It is somewhat silicified and resistant to erosion. Biotite-rhyolite occurs in the Pima area east and south of Helmet Peak. A hole drilled south of Red Hill cut mineralized rock. The small outcrops farther south are weakly altered to fresh. Upon weathering this rock disintegrates readily to a white powdery mass. Fragments seldom occur in alluvium even a few feet from the outcrop. Because of this weathering characteristic it is possible that a large body of biotite-rhyolite occurs in the area and is concealed by the shallow alluvium. There is no evidence that this rock is genetically related to mineralization, in distinction to the monzonite.

Tda. Tertiary diopside-andesite is a massive gray-green porphyry with phenocrysts of plagioclase and diopside. It intrudes the Cat Mountain rhyolite in the Amole area.

Tsg. Tertiary Sierrita granite is a coarse to medium grained granite from which has been cut the broad pediment extending north and east of the Sierrita Mountains. In the hills west of Mineral Hill pegmatite and aplite banding is prominent. West-northwest of Twin Buttes and in the area west of San Xavier and Mineral Hill, granite underlies Paleozoic sediments. The contact in the latter area is a flatly to moderately east dipping fault plane. In the vicinity of Twin Buttes granite is intrusive into Paleozoic formations causing considerable contact metamorphism. In the Pima area it is generally unfavorable to mineralization.

Pre-C. Pre-Cambrian rocks are exposed in a small isolated hill in the southwestern part of the mapped area. Here, lenses of coarse Bolsa quartzite conglomerate are in sedimentary contact with a coarse grained granitic rock. Associated with the granite are bands of metamorphic rocks including greenstone, coarse quartz, and a fine grained granitic rock.

May 10, 1956

AIRMAIL

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

EAST PIMA DRILLING GRID

Dear Mr. Richard:

This is to acknowledge your letter of May 4th, with attached map showing proposed drill sites. I note that you have conformed this program to a grid system as best you could, considering that much of the prior drilling has been of random nature. It now appears that you will be able to approximate a 250-foot east-west, and a 300-foot north-south, grid spacing. While this is not ideal, I believe it offers the best procedure to follow from this point forward.

You have discussed the history of drilling on this project to date, in some detail, and indicated that there is a good deal of difference of opinion as to where new holes should be drilled. You have also considered drilling in general from a theoretical point of view and while I believe your broad conclusions are sound, I think there are some additional practical matters to consider. Specifically, we are dealing with unknown structural features and it is impossible to interpret random drilling. Therefore, we must adopt the best co-ordinate system available (using past drilling) and adhere rigidly to it henceforth. The reason for this is that until the structural geological controls are better known, it will be impossible to construct accurate sections where projections of even very short distances must be made. I could accept either a triangular or rectangular pattern, but our problem now is to make the best possible use of existing holes and this is done in the grid you have proposed.

Another question which has been raised pertains to close-spaced, inside drilling. Much of this will be required since we are dealing with a marginal deposit whose structural control is unknown. To determine whether or not the cost of close-spaced, inside drilling will be justified, however, it will first be necessary to add more to the broad picture, and for that reason, I approve your general proposed program, with the few exceptions noted below.

Defer drilling the hole spotted 300 feet northeast and the one about 300 feet southeast of D.H. 32. Instead, drill one hole 200 feet south of No. 32, and unless the results of this hole are entirely negative, follow this by another hole 300 feet south of the one just indicated. These holes together with completion of D.H. 65, or possibly two at proper spacing north of D.H. 65, will provide us with another completed section. Later, we may require holes on the north-south coordinate between 35-W + and 30-W. Also, I think it is very important to fill out the 50-W coordinate as soon as this is possible, and therefore, I request that a hole be drilled 300 feet north of D.H. 22 and another 300 feet south of D.H. 24. These will serve the double purpose of adding to the 50-W section and to the 40 + 50-N section. The proposed hole 300 feet north of D.H. 65 should be completed as early as possible, but I would suggest that it might be advisable to hold the proposed hole spotted 200 feet north of D.H. 21 and drill the one spotted 500 feet north, first.

I am very anxious to expand our knowledge north and east of our present concentration of drilling in order to establish some continuity through to D.H. 54 and to D.H. 48. To accomplish this then, your proposed hole north of D.H. 66 on 40-N, is very important, and the one on 46 + 50-N on the same north-south coordinate, is also one deserving priority. For the time being, I see very little encouragement southeasterly, since your holes 58, 63 and 64 appear to be quite negative. Consequently, it is now important to direct attention northerly and easterly. This would mean postponing, indefinitely, drilling at the site 300 feet south of D.H. 66.

I do not know just what holes you have in mind relative to perfecting discoveries on additional claims. I believe the pressure is off in this connection and that our program should be more orderly now, having in mind proving continuity of the commercial ore areas.

In my above comments I have stressed easterly and northerly exploration, but at the same time I believe we must continue to keep in mind tying up the mineralized area in the State No. 1 claim, with the main zone. At least one section should be drilled continuously. This could be on section 46 + 50-N, or assuming that your proposed hole south of D.H. 47 on 40 + 50-N is encouraging, we might prefer to complete that section since it would give us a continuous section throughout the greatest east-west length, upon which we have information.

In the foregoing comments I have approved practically everything you have proposed, with the exception of suggesting a switch away from the 30 + 250 section. Undoubtedly after these holes have been completed, unless they are generally negative, it will be necessary to undertake additional, closely-spaced drilling, but there is no way to predict what will be required. Our information is full of "holes" and we cannot expect to get answers to all questions immediately. At the moment we can only conclude that we are dealing with a very irregular and spotty type of mineralization whose

1..2

geological controls are difficult to analyze from drilling results. As more footage becomes available for study, we will be better able to appraise the problem. We are not dealing with a "porphyry" deposit and there is very little likelihood that we will be able to understand it until we have much additional information. We should keep our sections up to date currently and attempt to interpret results progressively, as far as possible. Also, we should continually be considering what possible extraction program might be applied, and I therefore thoroughly approve of the preliminary estimates which you plan to have Mr. Papke prepare. All concerned, however, must realize that such information is of preliminary nature and subject to possible drastic change, when the data are more complete.

If these estimates indicate a situation of possible commercial worth, we will probably find it necessary to drill additional closely-spaced holes for further refinement of our data. I have been optimistic as to the ultimate outcome of the East Pima program, but I am frank to say that the recent negative drilling in the southwest corner has discouraged me considerably. I feel, therefore, that much depends upon the results which you obtain in the holes to be drilled north and east of the main mineral zone, together with possible further extension northwesterly, toward and into Banner ground.

You have not discussed the subject of depth of holes. Actually, this is a difficult question in itself and we have needed some deep holes to assist in building sections and for purposes of interpretation. It seems to me, however, that the depth of holes should be held to a minimum and when drilling near one or more holes which have been extended to 700 - 800 feet, or more, it might be well in this exploratory cycle to limit drilling to depths within which open pit mining would be feasible. I admit that this does not give us the full geological problem and by rigidly following this procedure, a valuable high-grade ore body at depth may be overlooked. Nevertheless, I believe our primary objective at this time is to determine whether or not we have an ore body which may be mined by open pit methods.

Very truly yours,

L. H. HART

cc: DJPope
~~FVRichard~~ - A/M
WHLandwehr "
RJLacy "
JHCourtright "
KGPapke "

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 4, 1956

Mr. L. E. Hart, Chief Geologist
American Smelting and Refining Company
120 Broadway
New York 5, New York

EAST PIMA DRILLING GRID

Dear Sir:

Attached is a map showing current East Pima drilling results.

In accordance with your telephoned request, a uniform grid has been established and is shown on the map. This grid has 250-foot east-west and 300-foot north-south intervals, a combination which permits a fair proportion of the holes already drilled to be on or near section lines. As you instructed, future holes will be located on these section lines. However, I should like to register a moderate objection to this and suggest a modification, as explained herein.

It now appears that, within our present appropriation, we can drill a few more holes within and around the zones of indicated ore than were planned at the time of the recommended appropriation request in my letter of March 10. I believe we can plan on about 20 more holes here (in addition to 6 or 7 holes for claim discovery work to the east and southeast), since about $200,000 remains in the appropriation.

As a result of recent telephone conversations I have had with Mr. Landwehr, Mr. F. V. Richard and yourself, it is apparent that there are differences of opinion as to where these 20 holes should be drilled. Possibly it would be appropriate to review some of the factors which have controlled the positions of holes drilled, together with the reasoning which I believe should apply to location of future holes.

The target of the first four holes (16 through 19) in the present area of interest was an east-west electromagnetic anomaly which was thought to represent a narrow, massive sulphide replacement deposit; hence, these first holes were close-spaced. When the disseminated character of the mineralization became apparent, holes were spaced at wide intervals; but still the hole positions in many instances were controlled by electromagnetic anomalies. No systematic reference to drilling on section lines was maintained, except that practically all holes were on the 300-foot intersections of the geophysical survey grid.

After about a dozen holes had been drilled, the conflict with Pima's waste dumping and the granting of State mineral leases to us became the expedient factor in determining hole positions. Many hole locations were affected by advancing dumps and, again, section lines could not be followed.

You of course have been aware of the above factors, and they are mentioned only so that those receiving copies of this letter will know that this background is being taken into account.

Another factor in the partly random spacing of holes drilled has been my belief that drilling entirely on systematically spaced section lines is only occasionally applicable to disseminated mineralization and is not particularly desirable on this East Pima zone.

If there is no reason to do otherwise, a systematic grid should, of course, be used. (As a sidelight in this respect, a triangular grid is geometrically more appropriate than a rectangular one.) This applies if there are no indications of complicated structural controls which could produce erratic distribution of values —— that is, if the mineralization is known to be rather homogeneous, or if there is no reason to suspect that it is not. We know now that the East Pima mineralization is unusually erratic.

In situations where values are erratic, different parts of an ore body require different hole spacing in order to achieve adequate measurement of the shape of the ore body and the internal distribution of its values. Also, in practically all open pit ore bodies the definition of the ultimate tonnage available to open pit mining requires closer hole spacing on ore body margins, where waste/ore ratios are critical, than in the interior.

The simple expedient of bisecting the hole spacing where more data is needed can become unnecessarily expensive if a uniform rectangular grid is being used. The reason for this is that reducing the spacing by half can involve more holes than are really needed. Random spacing usually permits adjusting the hole intervals at ore body margins in a manner which provides adequate information with fewer holes.

It has been postulated that holes drilled on a uniform grid measure the ore body more accurately because the holes all fall on section lines. This does not seem valid to me. Ore intercepts in drill holes represent no more than points in space, and the control they exert on interpretations is precisely the same whether they fall on section lines or not. Having all data fall exactly on section lines is no more than a geometrical convenience; in itself it provides no improvement in the accuracy of estimating ore body shape and grade.

The two lines of holes which I had originally planned on section [illegible] and [illegible] were intended (1) to prove whether or not the ore closely follows bedding, (2) to demonstrate the degree of irregularity of copper distribution within and along beds, and (3) to remove some of the many uncertainties which now exist in structural interpretations among the present drill holes. I must admit that it is not vital to have detailed answers to all of these problems now —— providing that it is agreed that without these holes preliminary interpretations of grade and shape of the ore lenses will be subject to moderate errors of, say, 10 or 15%, and that such errors will be acceptable.

In shifting now to a uniform drill grid, a number of awkward situations will arise. A glance at the map in the main ore area will show that in many places where interspaced holes obviously are needed, the grid intersections are poorly situated, too close to some holes and too far from others. Here and there extra holes eventually may be needed to fill in some of these gaps. The term "extra" holes is used in the sense that they would represent a footage of drilling over and above that which would be required if the drilling were to be completed on a basis of partly random spacing. In this connection I suggest that in special situations holes need not be located on the section lines.

As indicated by present drilling, this ore body will probably be commercially marginal at best. This is largely due to high waste/ore ratios. In this circumstance it may eventually be advantageous to have a few "extra" holes rather than just enough holes to "get by." Therefore, my objection to changing to drilling only on section lines is not a strong one.

Gilbert
E. Pima Drilling Cycle
May 6, 1970

-3-

My recommendations for the positions of the 20 holes mentioned earlier in this letter are shown in orange and yellow on the attached map. The orange are locations which should be drilled first. The drilling of the yellow locations would, in most cases, be dependent on the results of drilling nearby orange locations. Of course, the entire layout must remain flexible inasmuch as current results can appreciably affect the priority and position of immediately succeeding holes.

A few interior holes in the main ore zone are proposed. I believe that Mr. Landwehr and Mr. P. V. Richard may be of the opinion that more are needed. However, it seems to me that those I have proposed will be sufficient to support a preliminary open pit ore estimate with accuracy limits of 10 or 15%. (It is planned to make such an estimate when the present appropriation is about used up.)

Our most pressing problem in recent weeks has been Pima's announced intention to cover the Kino No. 3 claim in the SW part of Federal Section 31 with a truck waste dump. In fact they already are dumping in the SW corner of the claim. Recent drill holes 57, 58, 59 and 60 in this area have shown that the possibility of developing open pit ore that would be adversely affected by the existence of a dump on the Kino No. 3 are rather slim. However, the results of holes 63, 64 and 65 now drilling in this area must be in hand before we can be certain whether more holes are needed.

Although it has always been regarded as favorable, the NE corner of the main ore zone has never been drilled out, the reason being that drill information here would not have contributed to our two main problems: (1) forcing Pima to retreat with waste dumps, and (2) making valid mineral discoveries on Federal claims. It now appears that we can put two rigs in this area.

Holes 42 and 50 in the extreme NW corner of our property cut ore which is rather deep but of relatively good grade. If sufficient tonnage exists, this material might support underground mining if it is too deep for open pit mining. Banner's hole offsetting our hole 42 has a better ore column than any of ours. This hole was still drilling in good ore at a depth of 910' when I briefly looked at the core last week. This all makes the area rather attractive, and more information is needed before the present appropriation is expended. At least 4 holes are planned, as shown on the map.

Mr. Courtright and I recently logged the cores of several holes which Pima has recently drilled along the northwest and eastern edges of their property. We are awaiting receipt of assay logs of these holes and will comment in detail at a later date. But it appears in general that mineralization is weak, and we will not need as many holes as originally planned in Pima's tailings pond area in our Mission and [illegible] claims.

Mr. Payne is working on a set of sections which will show practically all of the drill holes. Copies of these will be distributed when they are finished.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

KR/ds
Att: Map
cc: DMage
PVRichard
WHLandwehr
DMay
JHCourtright
RHPayne

w/map

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 10, 1955

MEMORANDUM TO: Mr. Snedden

EAST PIMA
LONGYEAR DRILLING CONTRACT

Yesterday I received a call from Mr. Gleason of the Contract Division of Longyear. He was in receipt of my letter of November 4, in which he was advised that we intended to terminate the contract with them upon completion of their present drill hole.

Mr. Gleason wanted to know if we would permit them to bring in a new drilling crew and drill another hole in an attempt to improve the core recovery with their wire line equipment.

After discussing the matter with you, I advised Mr. Gleason that we had already contracted to bring in the third Joy rig, and due to our limitations of personnel and sample handling equipment, we could not continue to maintain the Longyear rig on the job.

Mr. Gleason said that Mr. Pickard, their General Field Superintendent, would like to visit us in the near future and discuss Longyear's drilling procedures on our job. I told Mr. Gleason that we would like very much to talk with Mr. Pickard and that he should advise us a few days in advance of a visit so that some of our field men could be in the office to participate in the discussion.

Original Signed By
K. Richard

cc: FVRichard
JHCourtright
BSHardie
KGPapke

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

July 26, 1955

MEMORANDUM FOR MR. KENYON RICHARD:

EAST PIMA AREA
Geologic Summary

The following is a resume of the diamond drilling program now being conducted on the Golden West group of claims in the East Pima area, as requested by Mr. L. H. Hart. Possibly you will want to make additional comments upon your return. Due to limited time available, attachments have not been prepared; please refer to the monthly report for June for maps and cross section.

Work in the Golden West area was initiated after an electromagnetic survey had indicated the existence of several roughly east-west trending conductors. Drilling was started on the most northerly anomaly which was considered to give the strongest reaction. Geophysical data suggested that the anomaly was a reflection of a conductor zone of probable steep dip lying at a depth not exceeding 350' to 400'. A detailed ground magnetic survey of the same area gave no anomaly.

Six holes have now been completed in the Golden West area; these total about 2577'. Because of the thick gravel cover in the area and the inability to project structural or stratigraphic detail from distant outcrop areas, initial drilling has beenclosely controlled by the position of the conductor axis. First drilling was along a north-south profile, across the strike of the conductor axis at a point of strongest response. Four holes were drilled along this north-south line (Nos. 16, 17, 18 and 19); in addition, one of the shallow diamond drill holes (No. 7) made a short penetration of bedrock in the same area.

This drilling was necessary in order to gain information with which to intelligently guide additional exploration. It was hoped that drilling results would show a fairly simple relationship between geology and the e.m. anomaly, e.g. an east-west striking mineralized bed with a steep southerly dip. While this simple relationship apparently does not exist -- and in this sense the profile drilling was somewhat disappointing -- the drilling did establish that a broad zone of secondary chalcocite mineralization and some beds containing fairly strong primary mineralization are present in the area. In addition a considerable amount of geological information was obtained; this information will be increasingly helpful as the exploration program progresses.

After completion of the profile drilling, two additional holes were drilled. These were positioned along the main conductor axis to test the continuity of mineralization to the east; while they did not penetrate stratigraphic horizons previously encountered, they nevertheless added to our knowledge of the area. These holes indicated the extension of a zone of secondary enrichment, and one hole (No. 20) penetrated a considerable thickness of metamorphosed siltstone and limestone, some showing rather important primary sulphide mineralization.

Up to this point the anomaly axis has offered the best available control of drill hole locations. Hole No. 22 is being drilled at 46+50 N., profile 50W., on a westerly extension of the conductor axis.

The following is a brief summary of geological information obtained to date. For detailed geologic data, please refer to monthly reports for April, May and June, 1955.

In the Golden West area, bedrock is overlain by a rather uniform thickness of gravel and conglomerate; the thickness varies from 1?2' to 221' in the holes drilled. Most of this material is partly cemented gravel, but a very firmly cemented conglomerate, perhaps 35' thick, is present immediately above bedrock.

Holes drilled along profile 45W. show a number of similarities. Exact correlation of formations can not be made, even among these close-spaced holes. This is due in part to faulting which has apparently caused some omission of beds. Some of the apparent lack of correlation may be due to hydrothermal alteration or metamorphism, which has considerably changed the character of some of the sediments.

Siltstone was encountered in the upper part of all deep holes along profile 45W. It seems probable that these siltstones belong to one formation; the top of this unit has not been located. Included in the siltstone in places are thin units of quartzite, arkose, and a coarse-grained, quartz-feldspar-mica rock. Textural and structural relationships suggest that the latter is a product of recrystallization of a sedimentary rock; this rock has some similarities to the "qfm" material in the Pima mine area (see Kenyon Richard report of September 17, 1954).

In two holes a thin hornfels bed with a dip of approximately 30° underlies the siltstone. The absence of this marker bed in the other two deep holes seems best explained by omission caused by known faults.

The deep holes along the profile were stopped in a thick, rather homogeneous arkosic quartzite. This rock contains non-commercial amounts of primary sulphides; assays generally averaged 0.2 to 0.3% copper. No attempt was made to penetrate below this quartzite in the initial stage of exploration. Where relationships are clearest, the quartzite appears to lie conformably beneath the siltstone and hornfels.

The four holes penetrated an oxidized zone which averages about 35' thick. This zone is leached in the upper portion but often contains abundant native copper, chrysocolla and other copper oxidation products near the base. Underlying the oxidized zone there is a blanket-like mass of secondary chalcocite ranging from 7' to 33' thick. Beneath this zone the siltstone and underlying hornfels show primary metallization with grades comparable to material within the secondary chalcocite zone.

Information obtained from the profile drilling suggests the possibility that the rocks penetrated have a westerly dip of fairly low angle. Hole No. 22 (550' to the west, near the conductor axis) has a secondary purpose of testing this possibility and, if correct, to explore horizons stratigraphically above those penetrated by the profile drilling. Hole No. 22 has not yet reached sufficient depth in bedrock to give this information.

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Holes 21 and 21 were drilled 500' and 1500', respectively, east of the profile line. There is no stratigraphic correlation between these and the previous holes. Hole No. 20 intercepted about 80' of siltstone, arkose and quartzite (not the same quartzite as penetrated by previous holes), underlain by approximately 235' of metamorphosed siltstone and limestone, and bottomed in fresh limestone. This hole cut a secondary zone containing chalcocite, native copper and chrysocolla. In addition, two thick zones showing plus 1% primary copper mineralization were encountered in the metamorphosed rocks. This metamorphic zone needs to be traced and further explored by drilling.

Hole No. 21 went through a thick arkose formation underlain by limestone; the latter appears to have a dip of 35° or 40°. The limestone is lithologically similar to that penetrated in the lower portion of hole No. 20. A secondary enrichment zone about 45' thick is present; in places part of the chalcocite has been converted to native copper. Significant primary metallization was not cut by this hole. In neither hole No. 20 or 21 was any attempt made to drill through the underlying unaltered limestone.

Rocks recognized as igneous have not been penetrated by any hole drilled by the company in the East Pima area. The nearest surface outcrops of intrusive rocks are found on the west side of Mineral Hill about 1-1/4 miles west of the present drilling.

One of the difficulties that now confronts us is the apparent lack of correlation between drill results and the geophysical anomaly. Information obtained rules out the possibility that the anomaly is caused by mineralization along a bed; three holes (Nos. 16, 20 and 21) along the conductor axis penetrated different types of sedimentary rocks. No structural features have been recognized in the core that could be related to the anomaly. The only similarities of mineralization in the three holes are: (1) a flat-lying chalcocite zone and (2) some underlying primary sulphide mineralization as disseminated grains or random veinlets. Magnetite in appreciable amounts occurs only in a few places.

For convenience the intercepts of <u>significant</u> amounts of copper mineralization, either secondary or primary, penetrated by drilling in the Golden West area are summarized below.

From	To	Interval	% Cu. Core (Wgted.)	Remarks
D.D.H. NO. 16				
225'1"	237'3"	12'2"	1.74	Chrysocolla and native copper in siltstone.
237'3"	270'9"	33'6"	.87	Chalcocite and chalcopyrite in siltstone and recrystallized arkose.
270'9"	280'7"	9'10"	1.53	Chalcopyrite with minor chalcocite in veinlets in hornfels.
D.D.H. NO. 17				
207'0	228'3"	21'3"	1.61	Native copper and chrysocolla; mainly in siltstone.
228'3	237'7"	9'4"	.52	Chalcocite in siltstone.
237'7"	265'8"	28'1"	1.22	Chalcopyrite veinlets in siltstone. Weakly mineralized quartzite below 259'.
D.D.H. NO. 18				
233'9"	259'10"	26'1"	1.72	Chalcocite in siltstone. Abundant native copper in upper 10'.
D.D.H. NO. 19				
211.2'	228.3'	17.1'	1.33	Native copper and chrysocolla in arkose and siltstone.
228.3'	260.4'	32.1'	2.05	Chalcocite in upper 7'. Below chalcopyrite veinlets in siltstone and hornfels.
D.D.H. NO. 20				
213.1'	246.3'	33.2'	1.71	Native copper, chrysocolla and chalcocite in siltstone and arkose.
268.6'	335.4'	66.8'	1.07	Chalcopyrite veinlets in hornfels and metamorphosed limestone.
434.0'	445.4'	11.4'	1.53	Chalcopyrite in garnetized limestone. Core assays 4.7% zn; present as sphalerite.
473.9'	511.7'	37.8'	1.50	Chalcopyrite and some bornite in metamorphosed limestone.
D.D.H. NO. 21				
221.0'	266.9'	45.9'	1.64	Chalcocite in arkose. Upper 6' oxidized to native copper; native copper abundant in chalcocite zone.

It appears at the present time that the best exploration possibilities are related to the following:

A) A wide-spread blanket of secondary enrichment, possibly with grade and tonnage improved by adjacent moderately mineralized primary material.

B) A high-grade ore body formed by replacement of limestone or other limey sediments. The metamorphic zone penetrated by Hole No. 20 most closely approaches this condition, although grade of the sulphide zones encountered is rather low.

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