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James Doyle Sell Mining Collection

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File: Mission - Early History

RECEIVED
MAY 20 1974
EXPLORATION DEPT.

IRA B. JORALEMON
168 SOUTHAMPTON AVENUE
BERKELEY, CALIFORNIA 94707

May 15, 1974

J. H. C.
MAY 20 1974

American Smelting and Refining Co.
Exploration Department
Box 5747, Tucson, Ariz., 85703.

Gentlemen:

I am sorry that there has been a misunderstanding as to the propriety of the location of claims that later became your Mission Mine. There was no question as to the legality.

I made several examinations of the Pima Mine, first for United Geophysical and then for Pima Mining Co. Most of my association was with Drex Spaulding and Mr. Pielemier. On one of my earliest trips I told Spaulding that there was a chance of finding a large low grade deposit in addition to the richer ore that was being developed underground. I recommended the location of additional claims and development, mmostly drilling, to prove this theory. The memorandum of November 30th, 1953, copy of which you sent me, shows that Pima was acting on this recommendation on that date; that Asarco geologists were told of the results of the work; and that Mr. Spielmeier asked you to get in touch with Spaulding before locating additional claims.

Both Asarco and Anaconda geologists were at the Pime during one or more of my visits. Neither they nor Drex Spaulding told me that there had been any agreement about locating ground. After Asarco had found ore in ground near that located by Pima I remember that Spaulding was much upset.

In my book "Copper" as quoted by you, I stated that when a company gives another results of exploration, there is a chance that the information will result in injury to the first company. In spite of this I was, and am, sure that free interchange is the best policy.

Formal agreements in such cases are seldom practicable, and might not be legal. Everyone must rely on good will, and misunderstandings are likely. This was apparently true in the Mission-Pima case. I am sorry that Drex is not alive to clear up the affair.

Yours very truly

Ira B. Joralemon

Ira B. Joralemon

AMERICAN SMELTING AND REFINING COMPANY
EXPLORATION DEPARTMENT
P.O. BOX 5747, TUCSON, ARIZONA 85703

J. H. COURTRIGHT
CHIEF GEOLOGIST

1150 NORTH 7TH AVENUE
TELEPHONE 602-792-3010

May 6, 1974

Mr. Ira B. Joralemon
315 Montgomery
San Francisco, California 94104

Dear Sir:

Reference is made to your recently published book entitled "Copper" wherein you comment on acquisition of the Mission property. Excerpts follow (Pages 326, 327):

> "A far more serious loss came from the generosity of Pima in letting engineers of other companies visit their property and even see the drill cores. As the value of the low-grade disseminated deposit east of the richer ore became evident, Pima started to locate a large group of claims out in the desert. But American Smelting and Refining Company engineers had seen the Pima drill cores, and with this knowledge they located for Asarco a great area farther northeast. Much of the low-grade ore extended into the Asarco claims, which were called the Mission Mine."

> "This loss to Pima of one of the great copper mines makes one wonder whether generosity in welcoming visitors is worthwhile. Sixty years ago, due partly to apex lawsuits, all information was carefully guarded. Dr. James Douglas and Dr. Louis D. Ricketts were largely responsible for a more liberal policy, although they realized that now and then someone would take an unfair advantage of the free information. But they were sure that in the long run an interchange of knowledge would benefit everyone, and in most cases they were right. Pima suffered by the policy, but if Pima had not known of the success in mining very low-grade ores at Morenci, it might not have acquired any part of the Twin Buttes District. As in nearly all our endeavors, we must weigh a gain against a possible loss."

Very briefly the facts are:

Following underground development of the Pima deposit, various companies (Anaconda, ASARCO, Eagle Picher, Cerro, Phelps Dodge, Newmont) were invited and most did examine the workings and drill cores with the

understanding that offers to purchase or option would be entertained. Thus, no "generosity" was involved in "allowing" other companies to examine the prospect.

Subsequently, our management advised United Geophysical that ASARCO planned to acquire ground in the vicinity, but would exclude any areas that United Geophysical wished to designate. As evident in the first paragraph of a file memorandum dated 11-30-53 (copy attached) the only area designated was that southeast of Helmet Peak. Shortly thereafter (early December, 1953), we (Richard and Courtright) arranged a meeting with Drex Spaulding, then Pima manager, in his office and informed him personally of our intention to stake claims, but not over any ground that he might select for staking on behalf of his company. He selected an area southeast of Red Hill, and we proceeded to stake elsewhere.

We became aware much later that the fact of our conversation with Spaulding giving him first choice on any of the open ground was never reported by him to his superiors in Los Angeles. Nor, did he ever admit it to any of his local staff.

Furthermore, it was not until after ASARCO had pretty well drilled out the low-grade, large tonnage Mission deposit that Pima began to realize they had a similar very large potential in their own ground. In other words, at the time they did not need any more ground than they already had for what they thought was a small ore body.

Nevertheless, contrary to your statements (quoted above), they (United Geophysical, or Pima Mining Company) were given far more than fair treatment.

Yours very truly,

J. H. Courtright

J. H. Courtright
Then, Assistant Chief Geologist,
Southwestern Department,
ASARCO
Now, Chief Geologist,
ASARCO

Kenyon Richard

Kenyon Richard
Then, Chief Geologist,
Southwestern Department,
ASARCO
Now, Consultant--
Mining Geology

JHC:KR:vmh
Enc. 1
cc: All W/Enc.
J.J. Collins: Exploration Manager, ASARCO
T.A. Snedden: Then, Manager
Southwestern Mining Dept., ASARCO
Now, Vice President,
Mining Dept., ASARCO

P1-1
2-1

T. A. S.

DEC 1 1953

Salt Lake City, Utah
November 30, 1953

FILE MEMORANDUM:

PIMA MINE

Mr. Pielemier of United Geophysical Company called me this afternoon to advise that their company had no objection to our locating claims to the east of their existing claims, also that they were aware of the Nauman and Chilson locations and did not plan to deal with either party and that we were, therefore, free to deal on these claims if we desired. Mr. Pielemier did state, however, that they were running one more electromagnetic line southeast of Helmet Peak, and if we planned on any locations in that direction, he would appreciate if our people would first contact Mr. Spaulding before making any locations as they have not as yet decided whether to locate claims in that area themselves.

Mr. Pielemier stated that they had located 19 additional claims to the east of their previous holdings sometime last month. Judging from the claim map attached to Mr. Kenyon Richard's letter to me of November 25th, this would leave four claims unaccounted for as this map shows only 15 additional locations.

In answer to my request as to the progress that was being made on the exploratory work recommended by Mr. Joralemon, I was advised that one of the two surface holes and one of the two underground holes were completed. The second surface hole which was to go to a depth of 800' has run into trouble at 500'. However, they think there is a chance that the trouble can be corrected and the hole continued. He made no comment on the second underground hole but stated that he thought it would be at least two weeks before any results on this drilling would be available.

ORIGINAL SIGNED BY
F. V. RICHARD
F. V. RICHARD

FVR:bm
cc: C.P.Pollock
D.J.Pope
T.A.Snedden (Conf.)
K.E.Richard (")

Blind note to Messrs. Snedden and Richard: I obtained the above information too late in the afternoon to call New York. However, please do not start locating any claims until I give you clearance as location of claims and dealing with Chilson will depend upon our Company's willingness to do any speculative exploration in this direction.

F.V.R.

Pima

1950 — mag anomaly — discovery

Jan 52 — started shaft —

55 — Cyprus exercised option

Nov. 55 — stripping started

Dec 56 — mill started

Jan 4 54 — KR to TAS — recom acq Hausman claims

Ap 27 54 — LKW to WRL — mentions claims located by ASARCO

July 19 54 — Anaconda making examination ~~ASARCO claim~~

Aug 53 — claim map of ASARCO claim, with letter to Landwehr - with surveying in progress

Dec 21 53

Jan 5. 53 — JHC to TAS — Pima min + expl poss

Nov 5. 53 — anaconda, Eagle P. New mont - examined mine — Am metal, C de P + P.D.

Feb 27, 53 — JHC to TAS — Pima, Sanx, Min Hill

July 20 51 — LWK - WRL — 14 holes completed

Jan 24. 52 — LKW — Alpha shaft 85' deep

June 51 — RFW — Drilling shows 75000 tons ore

Sept — 55 — Drill + claim map incl hole no 24

Nov 19 — 53 — KR to WRL — Proposed acq Hausman + children plus staking of remainder

Dec 4 — 53 KR to WRL — mag with children — pending

Received 11-10-53

Oct 13 53 report claim map Aug 53 ASARCO claims

Pima

Nov 21 - 53 - FVR to CPP - advisability of locating claims now

Nov 30 - File memo - FVR - United Gas gave permission to locate east of Pima ~~etc.~~ also acq of Chilcoat & [illegible]

Sept 8 - 54 - advise that Union Oil had given option to Mudd interests (Cyprus)

T. A. S.

DEC 1 1953

Salt Lake City, Utah
November 30, 1953

FILE MEMORANDUM:

PIMA MINE

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area was of interest to ASARCO

Mr. Pielemier stated that they had located 19 additional claims to the east of their previous holdings sometime last month. Judging from the claim map attached to Mr. Kenyon Richard's letter to me of November 25th, this would leave four claims unaccounted for as this map shows only 15 additional locations.

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ORIGINAL SIGNED BY
F. V. RICHARD
F. V. RICHARD

FVR:bm
cc: C.P.Pollock
D.J.Pope
T.A.Snedden (Conf.)
K.E.Richard (")

Blind note to Messrs. Snedden and Richard: I obtained the above information too late in the afternoon to call New York. However, please do not start locating any claims until I give you clearance as location of claims and dealing with Chilson will depend upon our Company's willingness to do any speculative exploration in this direction.

F.V.R.

the possible ore bodies precludes blind exploratory drilling.

PORPHYRY COPPER EXPLORATION:

Before undertaking exploration of the porphyry copper possibilities we must have control of a large amount of ground. The reason: We have been unable to recognize any pronounced structural trends or other geological conditions which could be projected beneath the gravel cover and which would narrow the field of exploratory interest. Geophysical work might be of some help, as will be discussed farther along. But for the time being it is recommended that we attempt to acquire the area shown on the accompanying claim map, about four square miles. This would include the following groups, as shown on the map:

Pima Mining Company: Though the possibility is rather remote, there is "room" on this property alone for a small porphyry copper orebody. The six holes spotted along the easterly projection of the Pima orebody would shed considerable light on this possibility.

United Geophysical: An attempt should be made to acquire this group separately if negotiations for the Pima Group are unsuccessful.

Chilson Group: The positions of these claims are uncertain. Chilson has done no location work or cornering. He says he has an anomaly running northwesterly through the Kino 6, 7 and 8. This anomaly was obtained with his own electro-magnetic equipment. It may be a valid anomaly, but there is considerable doubt as to its cause. The United Geophysical crew is now running their own electro-magnetic equipment over Chilson's claims. He says that they have a verbal agreement with him to the effect if they can check his anomaly they will option his claims — probably with a monthly payment of about $500.00. His purchase price is $10,000.00 per claim, or a 5% royalty on net smelter return without an upset price. If, after their tests, the Pima people are not interested in his ground, we will be in position to deal with Chilson immediately. He has suggested that he will deal with us on the remainder of his claims if Pima wants part of them. We have objected to this. He says he plans to locate claims covering most of the remainder of Section 31. Also, he mentioned having found an anomaly in the northeast corner of Section 6, and he may locate a few claims there.

Nauman Group: Mr. L. M. Nauman is an electronics expert who does geophysical prospecting for himself as a sideline. He claims to have obtained an electro-magnetic anomaly and has located a group of 10 claims with the intention of drilling this anomaly (trending E-W between his Golden West Nos. 4 and 5). Messrs. Snedden, Richard and Hill have discussed a lease and option with him involving 3% royalty on net smelter returns (this overrides an automatic 5% royalty to the State of Arizona) with minimum royalty payments of $250.00 per month beginning two months after the date of the lease, all to apply on a purchase price of $125,000.00; no work requirements. Mr. Hill is preparing a tentative lease and option on this basis. Of course, we are committed to nothing until New York approves, except that we may give him some help in monumenting his claims to be sure it is done correctly.

Ortiz Group: The position of this group of three claims is uncertain. We have as yet made no attempt to contact the owner, but this group should be optioned if the Chilson ground is acquired.

The remainder of the area of interest is open for location; Sections 5, 32

SILVER BELL, PIMA AND MISSION

In the past twenty years more than a dozen other successful low-grade copper deposits have been found in the United States. In Arizona the Silver Bell ore body of the American Smelting and Refining Company had been known before 1950; it has tens rather than hundreds of millions of tons of ore. The low-grade and the oxidized form of part of the copper delayed production, but the company finally got up its nerve and built a 7,000 ton per day mill. Production started in 1954, a few years after the Clay ore body and the Lavender pit. It has been a real but not an overwhelming success.

Pima Mining Company, twenty miles southwest of Tucson, came in three years after Silver Bell, and geophysical exploration was responsible for the discovery. The United Geophysical Company, under the leadership of Herbert Hoover, Jr., had been successful in exploring for petroleum and thought it could use its knowledge in finding ore. It went about the job with intelligence rather than dramatic vision; so first it searched through technical articles and government publications. The Twin Buttes area southwest of Tucson seemed promising; in this old district small copper and lead-zinc silver deposits had been known for decades. United Geophysical thought there might be larger ore bodies under a thick cover of soil or "desert wash" between the Mineral Hill copper prospect of Banner Mining Company, the San Xavier lead-zinc mine of Eagle-Picher, and the old Twin Buttes limestone replacement lenses. They sent Walter Heinrichs to make a magnetometer survey of the desert area. This found a strong anomaly east of the Mineral Hill property line that was worth drilling.

The first hole cut 3 or 4 per cent copper sulphide ore. Further work showed that the sulphides were in altered limestone and shale, cut by porphyry dikes so highly altered as to be hardly recognizable. Drilling soon developed more than a million tons that averaged 4.5 per cent copper. East and

south of the rich ore, drill holes found disseminated copper sulphides in impure, limy sediments cut by porphyry dikes. The indicated copper content was little more than 0.5 per cent.

The richer ore was worth the cost of preparing for production on a modest scale, but the job was too big for United Geophysical alone. The Cyprus Mines Company, controlled by the Mudd family of Los Angeles, and the Utah Construction and Mining Company of Salt Lake joined in the venture, with Utah as the operator. Because of the "heavy ground" and the irregularity of the richer ore, Utah decided on open-pit mining. It built a 1,000 ton per day mill and started successful production in 1959.

Meanwhile the low-grade "disseminated" ore body east of the richer ore continued to grow. Successive additions were made to the mill, and capacity is now being increased to 53,000 tons of ore per day. Production will be at the rate of 80,000 tons of copper a year. With two hundred million tons of 0.5 per cent copper ore in reserve, Pima is one of the great copper mines.

The chief difficulties met by Pima were due to contests about property ownership. The richer ore extended into the adjoining Mineral Hill property of Banner Mining Company, and the good ore near the property line could not be mined by either company without trespassing on ground of the other. Banner had no great investment in plant, so could afford to wait, and the final agreement was favorable to it. Further trouble came from a contest as to whether State leases, on which much of the ore occurred, were valid. Pima finally got a clear title. The delay was costly but far from fatal.

A far more serious loss came from the generosity of Pima in letting engineers of other companies visit their property and even see the drill cores. As the value of the low-grade disseminated deposit east of the richer ore became evident, Pima started to locate a large group of claims out in the desert. But American Smelting and Refining Company engineers had seen the Pima drill cores, and with this knowledge

they located for Asarco a great area farther northeast. Much of the low-grade ore extended into the Asarco claims, which were called the Mission Mine. Mission built a 20,000 ton per day mill that started full production in 1962; mining is by open pit. The Mission Mine, with a production of 50,000 tons of copper per year, is the most valuable Asarco mine in the United States.

This loss to Pima of one of the great copper mines makes one wonder whether generosity in welcoming visitors is worthwhile. Sixty years ago, due partly to apex lawsuits, all information was carefully guarded. Dr. James Douglas and Dr. Louis D. Ricketts were largely responsible for a more liberal policy, although they realized that now and then someone would take an unfair advantage of the free information. But they were sure that in the long run an interchange of knowledge would benefit everyone, and in most cases they were right. Pima suffered by the policy, but if Pima had not known of the success in mining very low-grade ores at Morenci, it might not have acquired any part of the Twin Buttes District. As in nearly all our endeavors, we must weigh a gain against a possible loss.

After the success of the Mission Mine was assured, Asarco paid more than a million dollars to the Pima Indian tribe for an area adjoining the Mission. Drilling proved that the Mission ore extended into this San Xavier Mine, but it was nearly all oxidized. Asarco is now building a leaching plant to treat this ore. The leaching process will have the additional advantage of using some of the sulphuric acid that must be made from the gases from the Asarco smelter at Hayden, Arizona. The leaching plant will thus reduce pollution by smelter gases.

Two other projects in Arizona will add to the copper production of this great company. The Sacaton Mine near Casa Grande is in a mineralized, steeply dipping fracture zone rather than a typical disseminated deposit. Much of it must be mined underground. A mining and flotation plant with a capacity of

9000 tons of ore per day is under construction. It is estimated that 46,000,000 tons of 0.75 per cent copper ore will be mined.

The last Asarco project in Arizona is in the desert southeast of Florence. Asarco drilled comparatively small outcrops and found a few tens of millions of tons of ore that averages more than half a per cent copper but is too narrow and deep for open-pit mining. It seems an ideal place for testing a process devised by metallurgists of Asarco and Dow Chemical Co. for leaching through drill holes after shattering the ore by introducing water under enormous pressure. If it works, this process also will reduce atmospheric pollution by sulphurous gases.

Poston Butte

"Copper" pub in '73 — check Conoco history

DUVAL MINES

Other low-grade copper deposits that came to production a little before and after 1960 radically changed the copper picture in the United States. They emphasized the fact that two or three top men with vision and judgment can make a company.

A few decades ago the United Gas Company of Houston found a sulphur deposit while hunting for natural gas and turned it over to a subsidiary to operate. This company soon found a good potash mine near Carlsbad, New Mexico. The subsidiary was called Duval Sulphur and Potash Company, later Duval Corporation, and United Gas owned more than seventy per cent of the stock.

The president of Duval, W. P. Morris, and the technical chief, George Atwood, wanted more successes. As they knew little about metal mining, they employed Harrison Schmitt, a consulting geologist from southwestern New Mexico, to help them in their new ventures. Morris and Atwood had the necessary financial and metallurgical knowledge, and Schmitt had the imagination and energy needed to pick the best prospects.

They first turned to southeastern Arizona, at the old Esperanza property, on the other side of Twin Buttes from the Pima. Calumet and Arizona had run some tunnels under the

Ken and Harold:

Enclosed are copies of various letters dealing with Mission. In my letter to Ed Tittmann, transmitting a copy of my letter to Darwin, I stated that I shouldn't be messing into the thing now that I had retired, but that I had gotten so damned mad at the manner in which the geophysicists had filched credit from you two that I finally decided to get something in the files. I told him that I didn't expect to accomplish any more than that.

Anyway, we have somethin on the New York file, and you can put the ones I am sending you in the Tucson file.

Was quite surprised to learn that Ken Wilson had resigned and has started a consulting office in San Francisco, and I really wish him luck. He told me of the deposit somewhere up north that you are drilling or preparing to drill and which, according to Ken, falls"right in one of my northeast zones". Wish you would give me the exact location so that I can spot it on my base map. Can then advise you whether or not it is worth fooling with.

Sincerely

Walt

January 14, 1961

AIR MAIL

Mr. D. J. Pope
American Smelting & Refining Co.
120 Broadway
New York, N. Y.

Dear Darwin:

I appreciated your letter, and the manner in which you accepted mine. I debated quite a long time before I decided to write you for to me there seems nothing more out of line, and in poorer taste, than for someone who has been completely severed from the organization's activities to attempt to criticise current events. But this case struck me as being somewhat different.

But now that I have gotten the matter off my chest, and my opinions in the file, I'm quite willing to drop the whole subject.

In my letter I disregarded the substantial contributions made by others in the Mission project, and there were quite a number, as you state. My particular, and limited, objective was to get into the file the history of the start of the project in order to refute the claims that its discovery resulted largely from the scientific application of geophysics.

As for my part in the matter, all I can lay claim to is that I sent Ken and Harold to Tucson and thereafter merely transmitted their recommendations to New York, and in the case of Mission without much optimism.

I am sending copies of my letter of January 4, your reply, Ed's letter of January 12, and of this letter, to Ken and Harold.

Frank Frost and Ken Wilson called on us yesterday. I was quite surprised to learn that Ken resigned and has opened a consulting office in San Francisco.

Our best regards to both you and Mary.

Sincerely

cc: E. McL. Tittmann
Kenyon Richard, with encls.
Harold Courtright " " "

W. R. Landwehr

Copy of Ed Tittmann's letter of January 12, 1961 to W.R.L.

Dear Walt:

Thanks for sending me a copy of your letter to Darwin regarding the initiation of the Mission project. I also saw Darwin's reply and must say that, in view of what happened since the matter of credit was first publicised, I do not think it is necessary to do anything further. As you know, Hart has left and I do not think there is anyone in the company that does not hold Ken Richard and Harold Courtright in the highest regard not only for the work they did at Mission, but at Toquepala and many other prospects which, while they did not prove to be commercial ore, high-lighted the professional competence of these two men.

I will put your letter in the office files here.

****

Sincerely

E. McL. T.

Copy of D. J.Pope's letter of January 10. 1961 to W.R.L.

Dear Walt:

It was very nice to hear from you and I appreciate the effort which you have taken in writing to me so completely about the history of the discovery of the Mission Unit ore body. I hope that it mines out sufficiently well and that the copper price holds up well enough so that all of the argument about the credit for the discovery will prove to be worth-while. To go back a bit in the history of this, I think the argument started when you wrote and congratulated Messers. Richard and Courtright on their efforts, which I felt at the time was entirely in line and which was not intended to detract from the efforts of anyone else.

To have a successful organization, we must consider the successes or failures of our ventures to be the result of a joint team effort. I have discussed this fully in the past with both Kenyon Richard and Harold Courtright and I am sure that they know and fully realize that in the minds of the rest of us in the company their part of the effort was fully appreciated and that all of us realized that a great deal of credit is due to their initiating this particular project. Aside from that, as far as I am concerned, Walt, I think that you deserve a great deal of credit in the success of the copper exploration in the Southwest because you originally recommended sending Ken Richard in there in the first place, and persisted over considerable opposition in having that recommendation accepted. Along with this, Bud Richard should always be mentioned because he was always an optimist and pushed some of these exploration ventures, plus the support, of course, of the other Company officials clear to the top.

So think it would do more harm than good to the Company and to their future exploration efforts to try to correct, publicly, any possible wrong impression in certain quarters outside the Company because of something published in some magazines which are often not very accurate anyway.

Regardless of all the above, your complete story and analysis is of great interest within the Company. I have discussed it with Mr. Tittmann and I will also show it to Messers. Brown and Pollock. Besides this, I will sound out Ken Richard the next time I see him and make sure that there is no feeling on his part that any one of us now with the Company does not recognize the worth of his work, both with regard to Mission and other ventures. In my own mind I am sure that he understands the situation as I have repeatedly complimented both him and Harold on the excellent work that they have done, including the very good report that Harold wrote on the Trench mine, which enabled us to operate there for several years at a profit, when without his direction we would have given up on trying to find more of the small scattered ore bodies.

If you feel that you wish to write to Ken passing any of this along to him, please feel entirely free to do so, but I do not think we should enter into any future public argument about this matter. I will appreciate your letting me know whether or not you agree and are willing now to let it drop.

Sincerely

cc: Ed Tittmann-Personal

D. J. P.

Menlo Park, Calif.
January 4, 1961

Mr. D. J. Pope
American Smelting & Refining Co.
120 Broadway
New York, N. Y.

Dear Darwin:

The Mission ore body is the major new copper discovery made in the United States in late years, so naturally has aroused a great deal of interest in the mining profession. Not only is it of interest because of its commercial importance but, as it is located in a gravel-covered plain in which there are no outcrops, and within sight of Tucson which has been the hub of mining prospecting and scientifically directed exploration since the arrival of the white man in the area, the manner of its discovery has stirred up a great deal of general curiosity, and particularly professional interest on the part of geologists and geophysicists.

As you well know, the question of credit for the initation of the project and the subsequent discovery of the ore body, has been the subject of considerable comment and discussion within the company for some time, the problem mainly resolving itself into the question of the amount of credit due the geological department of the Southwest, and the geophysical department. You mentioned the matter when you called upon us here in Menlo Park more than a year ago, and I had previously discussed it with Mac when I last saw him, in Salt Lake shortly before I retired. To both of you I expressed the opinion that the geophysicists were claiming, and had gotten, far more credit than was due them.

This, perhaps, would not be too serious were it confined within the company where most of those concerned have at least a fair idea of the facts. But since coming to the Bay area and mingling with more of the general profession, I have been surprised to learn that some, at least, have gotten the impression that the discovery was due almost solely to the successful application of geophysical methods, and that the geologists played only a minor role in the matter. I don't know how widespread this misconception is, but believe it to be somewhat general.

This misunderstanding undoubtedly is largely due to published statements, and in part to oral statements about which I have heard from reliable sources. All have been misleading because they did not clearly state the facts. In some cases the misstatements seem to have been deliberate, in others inadvertent.

I knew of this tendency to claim undeserved credit from its inception but did nothing about it. But after coming here and becoming aware of the erroneous impression gotten by some in the profession, and learning for the the first time of the published statements, I decided to review pertinent letters, reports, and maps and write a summary to you in order to get something in the files, and myself on record. As Ed Tittmann is as vitally inter-

ested in Mission [redacted] anyone, and hence would [redacted] interested in the manner of its discovery, I am sending him a copy.

I want to emphasize that this is my idea. I know that the geologists of the Southwest have been somewhat amused, to put it mildly, over the matter of credit for some time but none have had anything to do with my decision to write this letter, nor its composition other than to furnish me, at my request, some information. Most of the information that I have was brought with me from Salt Lake.

The first published article that came to my attention appeared in the January 1958 issue of Mining World. It states:

> "Geological Discovery of the Year, was the East Pima, Arizona project of American Smelting and Refining Company.... The ore body does not outcrop. Its discovery followed geologic projection of known ore bodies in the nearby Pima Mining Company and Banner Mining Company mines."

In the May 1958 issue of that publication there appears a letter written by Mr. Hart commenting on the foregoing article. The caption of the article in which Mr. Hart's letter appears is: "Pima is Geophysical". Then follows Mr. Hart's letter, from which I will quote.

> Dear Sir:
>
> This refers to your comments regarding the East Pima, Arizona project of the American Smelting and Refining Company. You credit this to be: The Geologic Discovery of the Year: but in the last sentence of the paragraph, you state:
>
> "Its discovery followed geologic projection of known ore bodies in the nearby Pima Mining Company and Banner Mining Company mines."
>
> Obviously, if this statement is correct, the East Pima development would not be a discovery at all, but is instead, only normal development along known ore extensions.
>
> The fact is that East Pima is a new discovery, which is the result of a well coordinated exploration program, to which valuable contributions have been made by our Geological and Geophysical Departments. The principal geological contribution was to select and recommend the area for careful investigation by our Geophysical Department. Information obtained in geophysical surveys pinpointed the important new discovery....
>
> Since our geologists and geophysists have done a commendable job on East Pima, it seems unfair to them to classify their accomplishments as routine "geologic projection of known ore bodies.
>
> L. N. Hart
> Chief Geologist

Then follows this statement by the editor: "Congratulations to ASARCO's staff for making this "Geophysical Discovery of the Year."

It is obvious why the profession has gotten the impression that the discovery of Mission was largely the result of applied geophysics.

Mr. Hart was right in stating that the project was not based upon exploration in search of extensions of known ore bodies. However, his statement that "the principal geological contribution was to select and recommend the area for careful investigation by our Geophysical Department" was a gross misrepresentation of the facts. It implies that the decision on whether the ground would be judged sufficiently promising for exploration rested upon the results of the geophysical survey. And, secondly, it states that successfully applied geophysical methods pinpointed the ore body, which is a similar misrepresentation of the fact, as I shall show in paragraphs which follow.

In the first place Mr. Hart had nothing to do with the initiation of the project so could have no firsthand knowledge of the reasoning upon which the selection of the ground for acquisition and exploration was based. Certainly the geologists had no thought of selecting an area primarily for examination and judgement by the geophysical department. It was acquired recommendations made for drilling without consideration being given to any results that a geophysical survey might disclose. In fact, after recommendations to acquire and drill the ground were made, Richard and Courtright in a letter asked for Mr. Lacy's comments on geophysical methods that might be applicable in exploration. In reply he stated that geophysical surveys were infeasible for he assumed that the United Geophysical Company had already surveyed the area and had found nothing of interest as far as replacement deposits similar to the Pima deposit were concerned, and he had no method that would detect disseminated deposits. But inspite of this the geologists proceeded with property acquisition and exploration. So there is no factual basis for Mr. Hart's statement that the principal contribution of the geologists was to select the ground for geophysical investigation.

In later paragraphs I will show precisely how the geophysicists, after they finally completed a survey, "pinpointed the important new discovery".

A third article, appearing in the August 1960 issue of Mining World, also implies that geophysics played the major role in the selection of the ground. It is entitled:"Fast Start at Mission: American Smelting Now Stripping 2,500,000 Tons a Month". In it is stated:

> "The most important new copper mine in the United States is rapidly being developed 20 miles south of Tucson, Arizona...Alluvium everywhere overlies all bedrock formations. However, earlier geophysical exploration had detected a high anomaly in the area."

To the knowledge of the geologists no geophysical survey that had detected a promising high anomaly had been made prior to our acquisition of the ground. To confirm that this was also the case with the geophysicists I wrote Mr. Lacy last October 17, quoted from the article in Mining World, and asked whether he knew of such a survey. To date I have not received an answer so I assume that he does not.

So again the mining profession was misinformed, in a technical article, and credit given to the geophysicists for Mission.

George Argall, Jr. editor of Mining World, informed me that the was approved in Tucson by Mr. Hall, and in New York by you.

The remainder of this letter contains more of the details of the acquisition and discovery of Mission, and the relative roles played by the geologists and geophysicists in the matter.

It should be kept in mind that two types of deposits can normally be expected in the district. One is the bedded replacement type in sedimentary rocks. The Pima deposit is a replacement of a limestone bed in the arkose series. Because of its high content of magnetite it was particularly susceptible of detection by the magnetic method. The other type the disseminated mineralization of Mission.

The idea that a deposit of disseminated mineralization might be present under the gravel covering east and north of the Pima ore body originated with Courtright who, after a preliminary reconnaissance of the district, wrote a memorandum to Mr. Sneddon on January 5, 1953 in which he called attention to the alteration and mineralization in Red Hill, which is located about half a mile southeast of Pima. In this memorandum he stated:

> "While the hill itself does not appear to hold potentialities, the surrounding gravel may conceal altered intrusive rocks and associated mineralization of possible commercial grade."

Thereafter he further studied the area, prepared a generalized geologic map, and summarized his findings and conclusions in a memorandum to Mr. Sneddon of February 27, 1953. He stated:

> "Deposits comparable to the San Xavier and Pima are not sufficiently large to justify any particularly big risk in exploration, however, these, in combination with a larger objective --- such as a porphyry copper deposit --- offer more favorable odds for an exploration gamble."

As a first step he suggested staking a central block of 90 claims.

Again, in a geological report by Courtright and Hardie dated October 12, 1953 it is stated:

> "If these speculative features are combined with the the two facts, (1) that the Pima ore body is the best and biggest of its type in the district, and (2) the "Red Hill" is the strongest alteration zone, the inference is made that there is a fair chance for the occurance of a gravel-covered porphyry copper ore body. We have recognized no structure or other geological evidence suggesting the position of such a deposit, other than that it would most likely be easterly or northerly from Red Hill." (It actually is northerly and northeasterly.)

Ken Richard in transmitting Courtrught's report, in a letter dated October 12 agreed, stating:

> "Taking all factors into account, the exploration gamble is an attractive one, and the property should be acquired with the expectation of following it up with drilling."

The property to which he referred was that of the Pima Mining Company, but he also recommended the acquisition of the Chilson and Nauman groups, and the location of claims in the open area north and east of Pima's ground, which we did immediately thereafter.

The first mention of the use of geophysics in connection with the project was in a letter by Richard and Courtright dated November 19, 1953 in which Mr. Lacy was asked for comments concerning geophysical methods that might be applicable. Mr. Lacy answered the request in his comprehensive letter to me of November 25, stating:

> "It is felt that the United Geophysical Company covered the area of interest on open land thoroughly with the sulfide replacement type deposit especially in mind. They then staked all of the area on which anomalies possibly indicative of this type of deposit were found. We may then assume that it would be infeasible to duplicate this work."

He then commented at considerable length on whether or not United Geophysical had in mind a disseminated type of deposit when interpreting the results of its surveys and concluded that it did. He then stated that if United Geophysical did not object to our staking ground (which it didn't):

> "we arrive at a conclusion similar to those for sulfide replacement deposits in that it would be infeasible for us to duplicate United Geophysical Company's geophysical surveys."

And under "Conclusions" in the same letter he states:

> "The conclusions to be drawn from the above discussion is that there is no need for us to conduct geophysical surveys in the area covered by the United Geophysical surveys."

The foregoing, then, clearly refutes the implication in Mr. Hart's letter to the Mining World that the geologists were merely looking for something for the geophysicists to survey and judge. Had that been the case we would not have acquired the ground but would have dropped the project upon receipt of Mr. Lacy's letter.

It is equally as interesting and revealing to investigate the manner in which, as stated by Mr. Hart, the geophysicists "pinpointed the important new discovery".

A brief description of the physical structure of the Mission ore body, as determined by drilling, will assist in evaluating the results of the electromagnetic survey that were used in "pinpointing" the ore body.

The Mission body of mineralization consists of three parts, an upper blanket of oxidation and leaching, beneath which is a thin blanket of enriched sulfides, and below that the body of primary mineralization; all of which is characteristic of disseminated copper deposits. The contacts between the three units are roughly horizontal. The top of the blanket of secondary enrichment is remarkably uniform in elevation, varying not more than

50 feet throughout the area of the final pit. The depth below the surface of this blanket is also rather uniform within that area. According to Courtright, probably 95% of the copper occurs as discrete grains and small irregular masses. However, there are bodies of massive sulfides of appreciable size such as those along the East Fault.

During 1954 twelve scout holes were drilled, widely and randomly spaced. These were drilled to shallow depths in a search for for indications of a disseminated type of deposit. No mineralized porphyry was encountered, nor any substantial sulfide mineralization, but the results indicated the existence of a large area of alteration and weak mineralization in the arkosic sediments. These holes were east of the ore body.

Perhaps the discovery of the alteration and mineralization changed the opinion of the geophysicists as to the efficacy of geophysical methods in the problem, for electromagnetic and magnetic surveys were completed in the latter part of that year and recommendations for drilling made by Mr. Saegart to Mr. Lacy on December 30. In turn Mr. Lacy, on February 9, 1955, recommended to me a rather comprehensive drilling program to test the various anomalies determined by the surveys. It should be repeated that the methods used were, according to Mr. Lacy's prior statements, only capable of detecting replacement sulfide bodies of the Pima type.

The electromagnetic survey resulted in about 30 anomalies within the claim area, with the greatest concentration in what is roughly the western third of what is now the pit area. The anomalies were all linear, the majority trending northeasterly and easterly. Mr. Lacy considered them to be caused by possible sulfide replacement deposits, hence recommended rather closely-spaced profile drilling along north-south lines. He believed that the anomalies corresponded roughly with the apexes of the replacement bodies. Anomalies I and II were the initial targets.

Anomaly II was tested first, with four holes ranging in depth from 350 to 550 feet. No replacement deposit was found and, as the anomaly is considerably east of the ore body as we now know it, no encouraging mineralization.

Anomaly I, which was the stronger of the two, was next drilled. The objective again was a replacement deposit to which the anomaly was thought to conform. The objective of the initial series of holes of profile drilling, along profile 45 W, was, according to Mr. Lacy, "to determine the relation of possible mineralization to the positions of the conductor axes to check dips, and to obtain cross-sectional geologic data". If the presence of a replacement deposit were determined then other holes were to be drilled for "a rapid evaluation of strike extensions".

As he stated, Mr. Lacy's interpretation of the anomalies was that they were caused by possible linear replacement deposits similar to Pima, and his drilling recommendations all conformed to that interpretation. In the same letter he stated, relative to disseminated copper sulfide deposits:

"Since the magnetic method was proved inapplicable to this problem in the East Pima area, we have at present no geophysical method that can aid the geologist."

The first hole, No. 16, encountered the first sulfides of commercial grade, as did the other three holes drilled along this profile. However, the positions of the intercepts, and the results of all subsequent drilling in the ore body, proved that the mineralization was not that of a linear replacement deposit with steep dip such as Pima, but was the secondarily enriched blanket-like top of the disseminated deposit. This is shown by the fact that the top of the mineralization in the four holes of the initial series, covering a 300-foot segment of the profile, was at the same elevation in all four holes.

After determining that the holes had encountered a more-or-less horizontal blanket of disseminated mineralization I purposely asked Mr. Lacy whether or not he had a method that could detect such an ore body. He stated that he did not.

There is additional evidence to take into account in evaluating the significance of the anomalies, which were the basis of the geophysicists' claim to a discovery, as indicators of the Mission ore body.

First, in the profile of the discovery Anomaly I, 45 E, in seven holes covering a section length of 1250 feet, the same type of mineralization was encountered at elevations that had an overall variation of not more than 25 feet. There were no anomalies in the vicinity of two of these holes, yet the same type of mineralization was encountered.

Second, is the erratic distribution of the 30 anomalies. The majority are located in roughly the western third of the pit area even though the mineralization is more-or-less continuous throughout that area, and certainly is as abundant in the eastern two-thirds. Some of the anomalies are outside the limits of the ore body.

Third, there are no anomalies corresponding to the abundant sulfides that occur along the East Fault. This is a vertical fault breccia that terminates the ore body on the east. Workings from the East Pima shaft, according to Ken Richard, encountered massive sulfides lying along the fault that in places are 15 to 50 feet in horizontal thickness. The depth of the sulfides is slightly less than the sulfides in the discovery hole. It is precisely the linear sulfide type of deposit that Mr. Lacy envisioned as causing the anomalies, yet there is no corresponding anomaly even though the entire area of the massive sulfides was covered by the surveys.

As linear sulfide replacement bodies correlating with the anomalies were not encountered as expected, other explanations of the anomalies, which attempt to associate them with the type of mineralization that was discovered, have been advanced. These to me seem involved, vague, elusive, and as being advanced in the hope of salvaging whatever remains possible of the basis for the claim of discovery. They strike me as being the product of sub-

jective thinking rather than objective reasoning.

The geophysicists deserve the full amount of credit that is due them for the depth to which the discovery hole was drilled. Had we not followed their recommendations in drilling for the anomaly we might not have drilled to the depth of the ore body, but it is not likely that this would have been the case for we knew of the long intercepts of disseminated mineralisation in arkose that United Geophysics had gotten in the hanging-wall of the Pima ore body, and we had encountered leached capping in arkose in several of the shallow holes drilled prior to the discovery hole. But this really beside the point, for the question that I am discussing is the amount of credit due the geophysicists in the discovery as a result of the scientific application of geophysical methods.

Evaluating, objectively, the results of the geophysical surveys, and the results of all subsequent drilling, the only logical conclusion that can be reached is that the encountering of mineralization in the discovery hole was not due to the successful scientific application of geophysical methods, but rather was purely accidental. Had the hole been drilled anywhere within the limits of the proposed pit, without regards to the positions of the anomalies, a similar discovery would have been made. Yet this is the sole basis for all the credit of discovery claimed by the geophysical department, and reveals the manner in which "the geophical surveys pinpointed the important new discovery" as claimed by Mr. Hart in his published letter.

Because of the importance of Mission the mining profession should be given a true perspective of the manner of its discovery, and the body of geophysical scientists should be set straight. But above all the full recognition of the credit due the geologists of the Southwest should be given not only within the company but also within the general profession.

As the profession has been misinformed through published statements, the only proper way in which to correct the situation is by means of a published comprehensive factual article prepared by a competent and disinterested person who has access to all pertinent data.

Yours very truly,

R. H. Landvehr

cc: E. McN. Tittmann

Menlo Park
October 6, 1960

Dear Ken:

Thanks for your letter of September 8. It corroborated my recollection of the preliminary, or initial is better, steps at Mission. With your remarks, and Harold's, and the data that I have here I'll be able to compose a rather illuminating letter for those in the company who have the idea that geophysics had a mojor role in the discovery and development of the project.

But before I continue with Mission, the dikes at Silver Bell are about what I would expect. I recall that in the Oxide area, and at El Tiro also, the system of mineralized fissures or fractures, have that trend also. I'm studying Arizona now and must get out your paper and see what it contains that I can use.

This project is really more interesting, and may have more scientific potential, than I expected. I began it primarily in a sort of lukewarm try at finding promising areas for exploration but that now has become secondary. I'm now trying to determine whether this trend has a continental-wide meaning, and when considered from that standpoint it leads into all sorts of speculations. So, if I don't lose interest I'll be busy from now on. And I believe it will have practical value also.

But to get back to Mission, the August issue of Mining World whic in effect gave all credit for even the inception of the idea to the geophysical department really touched me off so I decided to see if I could do anything about. So far I have managed to gather some rather convincing evidence, more than I expected, that the geophysicists have deliberately fostered the belief in the profession in general that they deserve all the credit. One of the chief culprits was Hart, as I learned from an article in Mining World that George Argall called to my attention.

It hadn't occured to me that although the geophysists based their first claim of fame upon the discovery, or the linear anamoly, at Hole 16 I believe it was, that the same survey failed to get any indication of the intense mineralization along the easterly end of the ore body. Both you and Harold called that to my attention. I will be able to develop this blow quite well for I have a copy of the map showing the linear anomalies, the first that was compiled I think, as well as sections showing the Basement or Banner thrust that you sent me in 1958. This shows the ore body as finally delineated, and especially the east boundary fault.

In Salt Lake, as soon as I became convinced that the geo's. had convinced themselves of the important role that they had played, and we knew that the principal mineralization lay in somewhat blanket form, I deliberately asked Bob if they had any method that could detect bodies of that form. He said no. I was careful to have a witness present, Owen Evans, when I asked the question although Owen was innocent of my reason for asking the question, but I did explain later. So perhaps it will not be too hard to make a case proving that had no means of detecting any of the mineralization.

(over)

If I go ahead with this thing, and I think I will, I'm not going drag you two into it, as I told Harold. I can't be too optomistic about getting results but at least some of the facts will be on record in the company files.

Will drop you a note from time to time.

Walt

Menlo Park
September 30, 1960

Dear Harold:

I enjoyed your letter of the 20th and to learn about your new home, and that James is developing normally.

Before getting to other matters, I'm interested in the letter that Lacy wrote stating that he could see no reason for doing additional geophysical work in view of what United had already done. I would like a copy of that letter, or at least of that part, if it is possible to get it as it answers a statement made by Hart in a letter to the Mining World. In the January, 1958 issue it was stated that Asarco's discovery was the result of "geologic projection of known ore bodies in the nearby Pima Mining Company and Banner Mining Company mines." You probably saw the article but I was not aware of it until George Argall sent me a copy last week. Hart, rightfully, wrote them calling attention to the fact that the discovery was not the result of projecting known ore bodies. He, however, continued: "The fact is that East Pima is a new discovery, which is the result of a well coordinated exploration program, to which valuable contributions have been made by our Geological and Geophysical Departments. The principal geological contribution was to select and recommend the area for careful investigation by our Geophysical Department. Information obtained in geophysical surveys pinpointed the important new discovery..." So apparently all the Geological Department did was to recommend to the geophysisists that they start working on the area, and that department carried the project through to completion from there.

By the way, neither of you told me whether or not "earlier geophysical exploration had detected a high anomaly in the area" as reported the August issue of Mining World which touched off this crusade of mine. I know of none and yet I faintly recall a survey containing a high which seemed to correspond to a pile of magnetite on one of the old dumps along the east side of Mineral Hill, where at one time there apparently had been a small smelting furnace. I'm sure Asarco made no survey yet the article intimates that we had and that that was what spurred our interest. Incidentlly, Argall said the Article had been cleared by Hall and a man named Pope.

And while were at it I would like to know the approximate date of completion of the gravity survey, and if it is not true that the ore body had been pretty well outlined by that time.

In your letter you stated that the EM survey gave no indication of the massive sulfide at the east end of the ore zone. Would that be the mineralization encounted in holes 134 and 142?

Perhaps I shouldn't be injecting myself into this at this late date but I've been so burned up over the whole mess that the August issue of Mining World touched me off properly. Bob may have been innocently lead into his present position by Hart, but I doubt it. If I write to Pope about this matter after collecting all my evidence, you won't know about it for I don't want to start an inter-company argument. You might hear about it later. Neither will I quote any thing he tells me or you have told me.

I'm pleased that you did so well with Craigmont. I wanted to take advantage of your tip but at that time we knew we were coming down here and didn't want to speculate.

As for my research project, now that I have the time and excellent library facilities are available I'm painstakingly ~~all~~ studing the literature on ore deposits, concentrating on the structure and especially the fissure systems. As you know I have always been obsessed with the idea that the northeast system predominated in western United States and that this fact could be used in finding favorable areas for prospecting, as it has in several instances with which I am familiar. So I started to make charts on which were plotted the strike of all the major fissures. So far the results are very interesting although I've barely gotten started. One trouble ~~that~~ is that the authors of the publications, mostly U.S.G.S., were often not too specific in recording strikes so I'm confronted with such generalities as "the fissures strike northeasterly" or that they dip westerly. That doesn't help much when you're plotting the strikes in 5° segments of arc. But onyway I'm having fun.

I had as my primary object, when I started this project, the discovery of areas favorable for prospecting particularly in the southwest where there is so much alluvial cover, but the thing seems to be developing into a possible problem of scientific interest so I'm placing the discovery of mines as of secondary interest. I judge that it will take me several years to finish the first reading of available literature, then I'll start serious study to determine whether or not there are any worthwhile conclusions.

I'm on a very tight schedule. Get up before six at the latest, or earlier if Sister (the dog) insists, put on the coffee, read the sporting and financial sections while I smoke my first cigarette (king size), shave and dress, cook breakfast and finish the paper by the time it is done, have another cigarette, walk 1.25+miles, water the lawn when I return, then work on my project until noon, have lunch, have a nap, work on the project and shop in between times, at five 0'clock start reading The Wall Street Journal and technical magazines for half an hour, then study mathematics (I'm striving to become a mathematician) until six, mix a highball and listen to the news, more highballs and whatever is on television, dinner at eight, sit in the patio with Sister who insists upon it, then to bed at nine or thereabouts. That only allows a minimum of eight hours for sleeping, not counting the noon nap the purpose of which is to build up my energy for the afternoon. If you think retirement is easy you should try it. Tending David is a sinch compared to this.

We would like to have the specimens from Toquepala, and thanks.

Tell Ken I'll answer his letter in a few days.

Wact

COPY

May 7, 1958

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

GEOPHYSICAL SURVEYS

Dear Sir:

This is to attempt to answer, within our limitations, the questions on the subject of electromagnetic surveys in your letter of April 1, 1958 to me. More concise answers in the past have apparently been ineffective.

First, I wish to apologize for my failure to note and delete the inadvertent reference to "the East Pima discovery anomaly" in the fifth paragraph on page 1 of Mr. F. E. McDonald's memorandum of February 19. Certainly a great deal of geologic data and geologic evaluation preceded the recommendation to drill the discovery hole in Electromagnetic Zone I at the location of D.D. Hole 16. We all know that the facts of the well coordinated exploration procedures indicate that this was a geological-geophysical discovery and not due exclusively to the techniques of either one or the other.

United Geophysical discovered the Pima deposit through a magnetic reconnaissance survey, followed by electromagnetic checking of the magnetic anomalies (note the magnetic and electromagnetic curves in figure 4 on page 200 of the February, 1954 issue of MINING ENGINEERING). While I do not wish to discredit the fine job United did, it was ASARCO's superior knowledge in the mining geology field that enabled it to make a geological-geophysical discovery where United's straight geophysical approach missed the East Pima deposit.

I think discussion to clarify the role and the technical aspects of geophysics in exploration will be on a firmer basis if we both first admit that we do not know of any perfect and infallible exploration method, geological or geophysical. Missing a target or intersecting barren though favorable structures or mineralization trends when drilling in a blind zone on either geological extrapolations or geophysical anomalies is certainly a common experience of geologists and geophysicists alike in the field of mining exploration. Furthermore, geologists must realize that all anomalies for any one geophysical method are not exactly the same. It is apparent that this is the main reason for your misunderstanding of the electromagnetic surveys in the basin and range province of the southwest U.S. Geophysicists claim the same right to interpret, evaluate, classify and rate the anomalous geophysical data as the geologists claim for geologic data. There is one more step in processing geophysical data, and that is correlating the results of the measurements of physical properties with one or more of the geological factors that may produce the anomalous conditions.

As you state (by inference, in paragraph 5, page 1 of your letter), the E.M. Zone I conductor complex may be due to interconnected veinlets which is a structural coincidence. We have postulated this for some time. In paragraph 3 (point 3) on page 2, you state that in this Zone I area there is ... "ordinary disseminated mineralization which drill holes have shown to have no distinctive

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condition of mineralogy or structure to explain the anomaly." This is another case of inadequate data which cannot produce an indisputable correlation. The logs of the holes indicate many veinlets up to 6 inches in width, but many more steeply dipping ones could be missed in the drilling pattern and no one could predict the continuity, or lack of continuity, from the drill cores. Although veinlets, disseminations, and massive sulphide lenses alike are illustrated as >0.4% Cu zones on Mr. Kinnison's sections - and certainly I do not infer criticism of the necessary lack of detail here - major structures are indicated. This is the only basis for postulating the possible trends, the average spatial orientation, and the continuity of the veinlets noted. I have plotted the axes of folds and fault traces at the bottom of the leached zone from Mr. Kinnison's sections on a plan map. The transparent sepia electromagnetic map (copy of which I gave to you last September) placed over this structural plan map indicated a correlation of the east-west and east-northeast striking Zone I conductor axes with corresponding axes of the relatively gently-folded anticlinal structure in that area and the two north and north-northeast striking conductor axes correlate with cross-folding anticlinal axes in those two corresponding directions. It is quite possible that tension fractures related to the anticlinal crests were mineralized and these may constitute the greater part of the conductor complex effect. The east part of the ore body is so complexly faulted that the electrical continuity of these tension structures, if they existed, and other possibly conductive and geometrically favorable mineralized structures may have been destroyed. (Some relatively weak cross-overs and end effects were noted in this area but we did not, and will not now, mark them, as their lack of continuity and their low intensity would not make them reliable indications.) The fact that we apparently cannot detect the faults in the eastern ore area of the East Pima deposit electromagnetically would indicate that the material along the fault planes has low conductivity or it may be discontinuous, more conductive material.

The mineralized tension fractures suggested as the major factor in the E.M. Zone I conductor complex would be related to the anticlinal folds. The ore is not confined to these upwarped areas, but occurs in flat-lying beds and synclinal areas as well. We could not expect, then, to obtain these strong anomalies over the entire areal extent of the deposit. The occurrence of the anticlinal structures within the ore area is again coincidental, although it could be argued that the strong folding and faulting in the general area was one factor in the emplacement of the general pervasive mineralization and of the more concentrated ore mineralization zones. The fact that these anticlinal structures do occur within the ore area, however, would explain why the related tension fractures would be mineralized and therefore highly conductive. The same fractures in an unmineralized area would be weak to poor conductors and would most likely not be detectable electromagnetically at any appreciable depth. Again, the same tension fractures in the pyritized, very much more weakly mineralized, hydrothermal alteration envelope of the more concentrated primary ore zone mineralization would in turn be less completely and more weakly mineralized and therefore productive of correspondingly weaker electromagnetic anomalies. After all, the initial drill holes within the ore zone on the Pima property were located on a magnetic anomaly with an associated strong electromagnetic anomaly. The coincidence must not be so rare, when it is considered that the initial drilling in ore within the only other - though probably related - known buried ore deposit in the district was located on another strong electromagnetic anomaly.

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The above brings up the matter of sulphide concentrations. In the second paragraph (point 2) on page 2 of your letter, you state, in reference to electromagnetic anomalies possibly produced by sulphide veinlets in some manner interconnected: "This may be a function of the abundance of sulphides in general, but the e.m. method makes no distinction between copper and iron sulphides." Since a method of assaying material without obtaining a sample has not yet been devised, I should think that a method of locating drill holes over a possible concentration of sulphides under several hundred feet of overburden would be of value. This indication of a strongly suggested target of metallic sulphides for the location of drilling is all that has ever been claimed for E.M.Zone I on the East Pima property. There has been no claim that we outlined the ore body completely, that we interpreted exact geometry specifically nor as a whole, nor that we eliminated ground through the electromagnetic surveys on the East Pima property (see my letter of September 28, 1955 to you on the subject, "East Pima Area, Geophysics").

....Even though the hydrothermal alteration is pervasive, a primary sulphide deposit of ore grade involves a concentration of sulphides with, at the least, a gradual decrease outward from the ore zones. Newmont's pulse potential work in many places, including Cuajone, Quellaveco and San Jose, indicate decreasing metallic sulphide mineralization outward from the ore zone centers. Our similar induced polarization tests at East Pima indicate that the sulphide concentrations are definitely greater within the ore zones than they are outside of these zones. As you know, induced polarization potentials are proportional to the total aggregate surface area of metallic minerals.

Until our recent development of workable induced polarization equipment, our most direct surface method of indicating possible concentrations of metallic sulphides as drilling targets has been electromagnetics. Both gravity and magnetics are usually used for more indirect indications of rock units, such as the distribution of the post-mineral and pre-mineral rocks on the San Xavier Reservation. Cases of information more directly related to mineral concentrations, like magnetics on the Pima deposit and gravity on the East Pima deposit, are the exception rather than the rule in prospecting for sulphides.

We can recommend electromagnetic anomalies, such as E.M. Zone I at East Pima and those obtained over the mineralized zones on the McMillan project, with a high degree of confidence. When we obtain lower degree (relative to depths), but persistent, anomalous zones, such as the remaining five on East Pima, and those on the San Xavier project, Cocio, Red Hills and Bethlehem, we know that they could well be produced by lesser conductors with favorable geometry. If they fit into possibly favorable geologic conditions, they must be considered as structures indirectly related to mineralization, or to mineralization with largely unfavorable geometry. This is similar to blind drilling on geologically projected favorable structures or mineralization trends, except that the target is defined electromagnetically in the geologically blind area. We do not expect highly favorable probabilities with respect to mineralization in these cases any more than geologists can expect it on long geological projections.

C
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In the interest of improving cooperation between the geologists and geophysicists, rather than to promote dissension and wasteful competition, I have tried to avoid the argumentative attitude in the above discussion and to answer your questions as frankly and factually as possible. Further, in the interest of this cooperation, I have not confined the discussions strictly to electromagnetics. The other geophysical methods applied on your projects have been mentioned as well, as there appears to have been mutual agreement on their contributions. I wish to emphasize these contributions, however. I hope it is realized how good the gravity outline control could be for exploration drilling on the East Pima deposit. The fault boundaries along the east edge are clearly indicated. The graben between the B and D-C faults is indicated. The possibilities trending south into the Pima Mining Company property from our Kino No. 1 area is indicated. We do not have control on the Banner property between our claims and the Reservation so that the gravity picture is not complete here. The only position where possible pit ore is marked gradationally, rather than sharply, is along the southwest edge. This could be expected, as the general, moderate southwest dip would produce a gradual diminution of the gravity effect in this direction.

If the gravity survey had preceded all drilling on the Reservation, we undoubtedly would have correlated the gravity lows with the magnetic interpretation of post-mineral volcanics. The additional area of the gravity lows would have been attributed to non-magnetic volcanics. The shallow drill holes would have been concentrated in the pre-mineral rock areas and advanced into the edges of the post-mineral rock areas. These edge holes, plus a few verification holes within the post-mineral rock area, would have altered the gravity interpretation to include the post-mineral semi-consolidated sediments as well as the volcanics. As it was, the procedure, except in the exact timing, amounted to almost the same end result. I hope everyone realizes that, without the aeromagnetic and gravity outline of the post-mineral rock distribution, a great deal of shallow drilling would have been required, including edge holes on less than the 2000-foot triangular grid spacing, to produce the same complete outline of these rock distributions and the complete coverage to protect against windows of pre-mineral rock.

I would like further to call your attention to the fact that the first shallow drilling program presented for the Reservation project ignored the use of the aeromagnetic outlining of the post-mineral, magnetic volcanics, as well as the possible use of the geophysical surveys to be conducted on the ground. This indicated that the shallow drilling program was placed in direct competition with the geophysics, rather than integrating all methods into a single coordinated program (see your letter of June 1, 1957 to Mr. L. H. Hart on the subject, "San Xavier Reservation, Proposed Exploration"). In other words, there has been a retrogression in the exploration philosophy that resulted in the well coordinated geological-geophysical program that in turn resulted in the discovery of the East Pima ore body. Unless we learn the lessons illustrated by the facts of our own case history, we will lose the geological-geophysical coordination necessary to compete most effectively in the competition of exploration for mineral deposits in covered areas.

Very truly yours,

R. J. LACY

RJL:si

[illegible] GEOLOGICAL SURVEY
[illegible] Arizona

April 1, 195[illegible]

Mr. H. 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 emK-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 emK-1 conductor. The mineralization environment indicated by hole X-13E precludes the possibility that massive sulphides could exist in the immediate area of emK-1. Graphite has never been recognized in the district. Therefore, I believe that the cause of the emK-1 anomaly should be listed as unknown.

In his third paragraph Mr. McDonald suggests that the emK-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 tongs 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-X 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 area (both in and out of the ore body proper), the absence of an anomaly may be due to a lack of mineralogical 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.

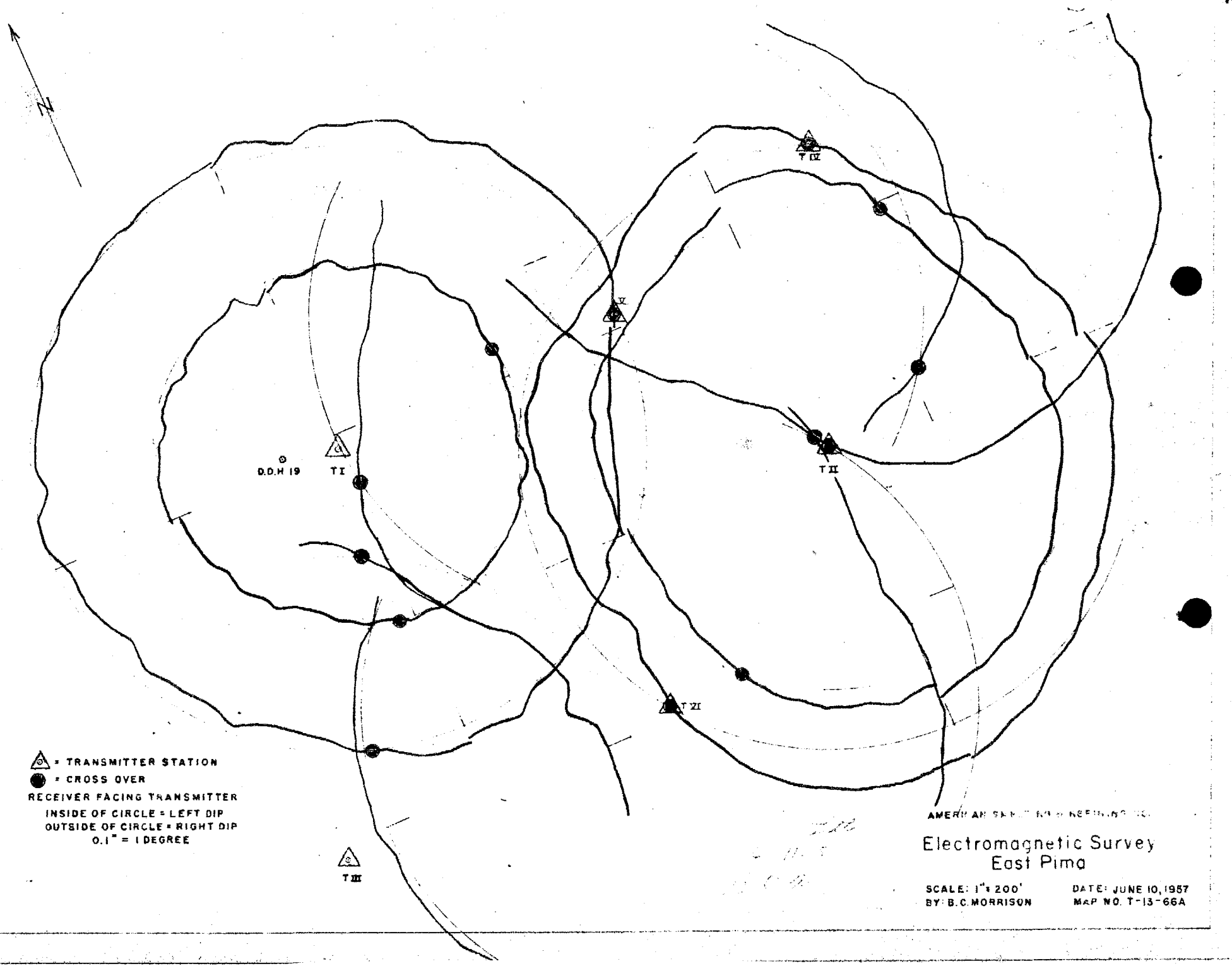
3. As I understand it, the electromagnetic method should be most effective in locating massive sulphide bodies. Yet, massive sulphide lenses in the eastern end of the East Pima ore zone contained the best grade and the shallowest ore but did not produce anomalies; and the so-called discovery anomaly, 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 us 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,

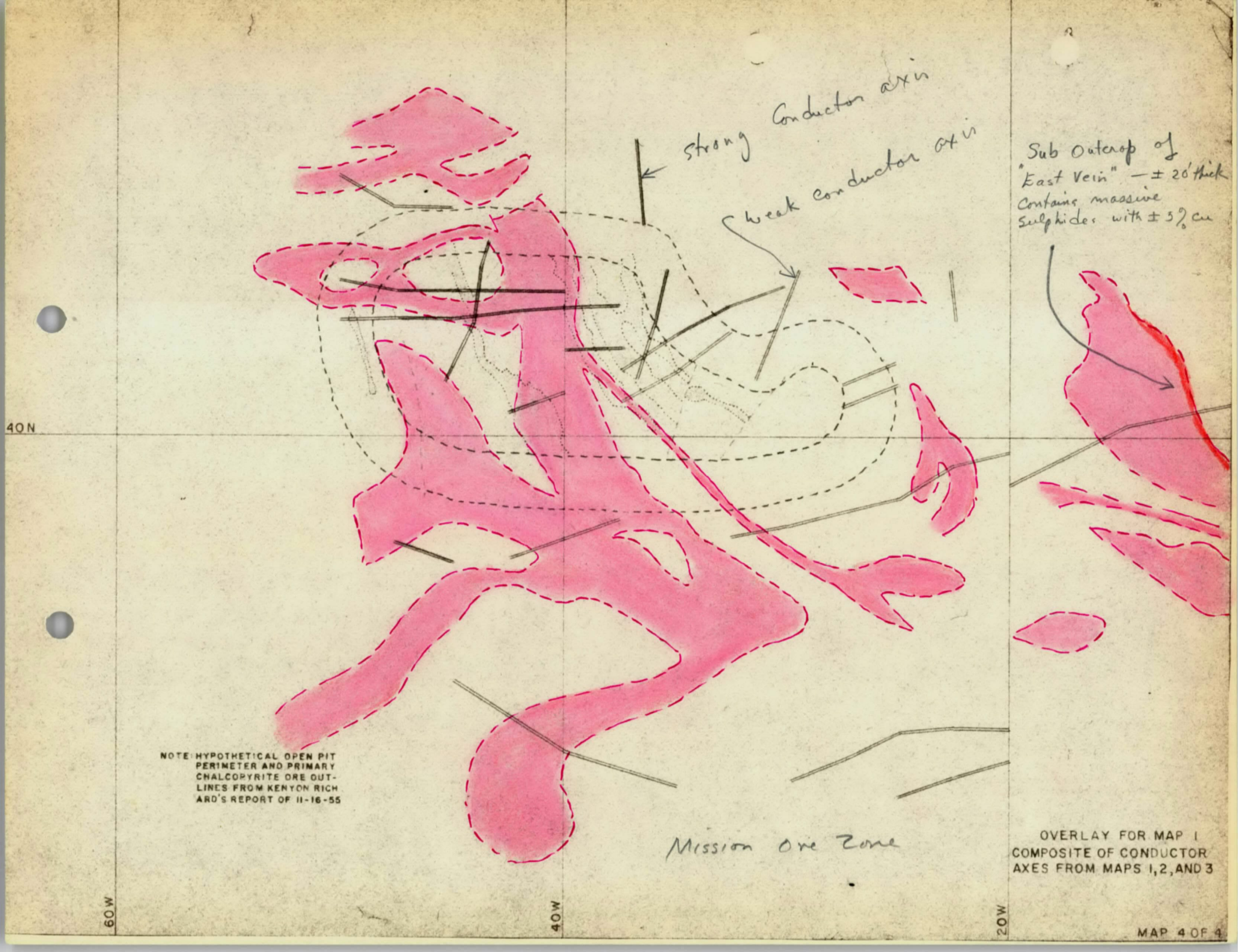
KENYON RICHARD

KR/ds
cc: LEHart
DCMorrison
JHCourtright
FHMcDonald


N
D.D.H 19
T I
T II
T III
T IV
T V
T VI
△ = TRANSMITTER STATION
● = CROSS OVER
RECEIVER FACING TRANSMITTER
INSIDE OF CIRCLE = LEFT DIP
OUTSIDE OF CIRCLE = RIGHT DIP
0.1" = 1 DEGREE
AMERICAN SMELTING AND REFINING CO.
Electromagnetic Survey
East Pima
SCALE: 1" = 200'
BY: B.C. MORRISON
DATE: JUNE 10, 1957
MAP NO. T-13-66A

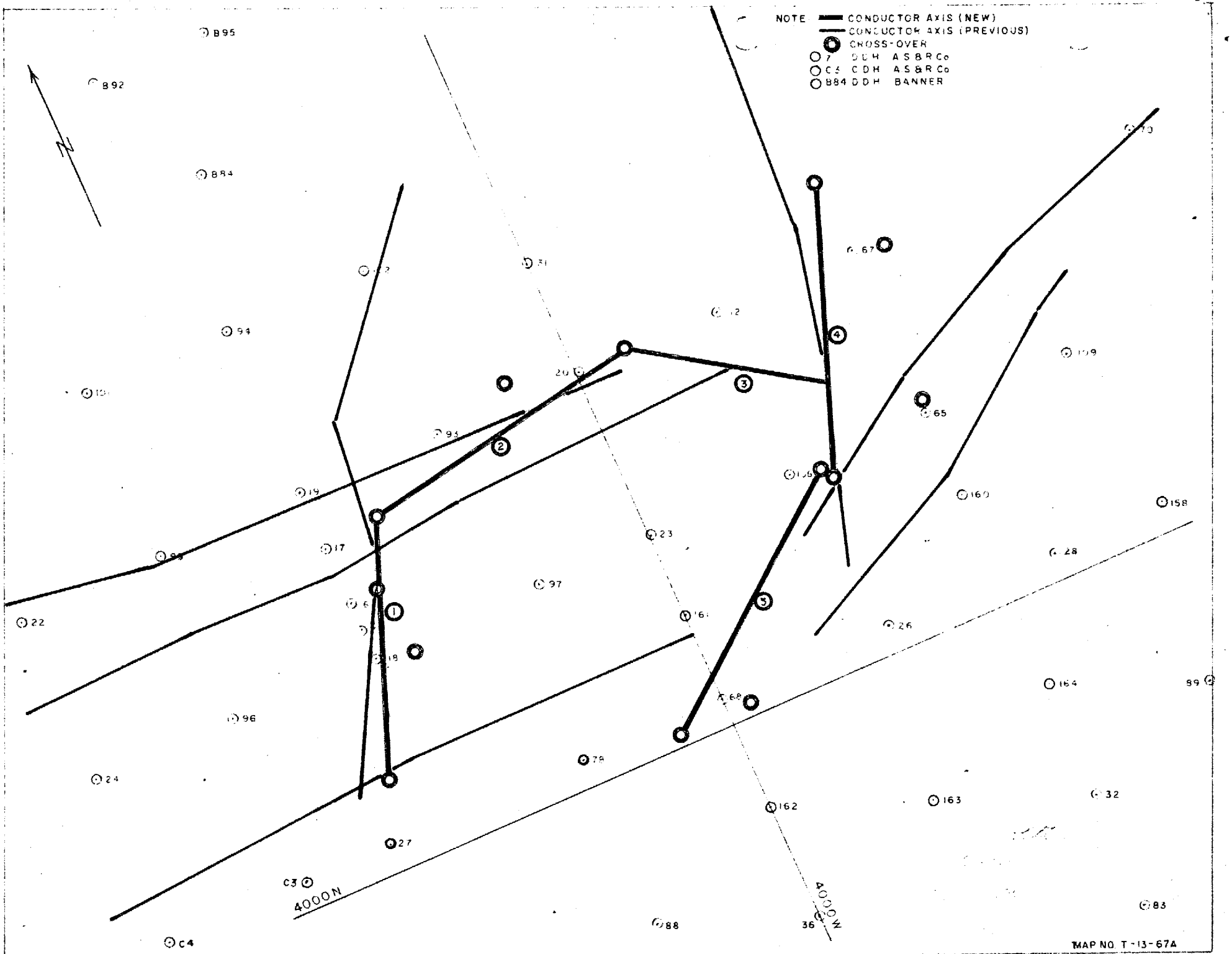
FROM: J. H. COURTRIGHT

To: E M May



NOTE: HYPOTHETICAL OPEN PIT PERIMETER AND PRIMARY CHALCOPYRITE ORE OUTLINES FROM KENYON RICHARD'S REPORT OF 11-16-55

OVERLAY FOR MAP 1
COMPOSITE OF CONDUCTOR AXES FROM MAPS 1, 2, AND 3


NOTE
CONDUCTOR AXIS (NEW)
CONDUCTOR AXIS (PREVIOUS)
CROSS-OVER
DDH A S&R Co
DDH A S&R Co
DDH BANNER
4000N
4000N
MAP NO. T-13-67A

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

June 11, 1957

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

EXPERIMENTAL
ELECTROMAGNETIC SURVEY
EAST PIMA, ARIZONA

Dear Sir:

During the month of May, a series of Electromagnetic Tests was run to find the true orientation of certain conductors at East Pima.

SUMMARY OF CONCLUSIONS

There is a preferred set of orientations of conductor axes in the central part of the ore zone at East Pima. These zone agree in general but not in detail with those found by past surveys. The nature of the conductors is still not understood.

ENCLOSURES

T-13-65A Print showing circles and segments of circles used for bases of the electromagnetic survey.

T-13-66A Overlay showing results of electromagnetic survey on the various circles.

T-13-67A Overlay showing conductor axes indicated by this survey as well as those shown on map No. 12A.

STATEMENT OF PROBLEM

In the past, several electromagnetic surveys have been run across the heart of the ore zone at East Pima using fixed and mobile transmitters. The first extensive survey with mobile transmitter was run along north-south lines, thus designed primarily to indicate east-west conductors. A series of such conductors was found but no north-south conductors were indicated. A second survey was then run, this time along east-west lines. This survey indicated several north-south conductors but no east-west conductors. This could be anticipated in that there will be maximum energization of conductors lying at right angles to the direction of the traverse (parallel to the direction of the plane of the antenna). However, the possibility then arose that, when in the center of a disseminated type deposit, the conductor axes would be found at right angles to the direction of traverse no matter what direction was chosen. This assumes that there will always be a large number of connected particles in the preferred orientation for maximum energization. Thus, it was necessary to determine whether there was a preferred orientation of conductors.

Procedure

The intersections of several conductor axes were selected to test. The transmitter was placed at each of these intersections and the receiver was run in a circle around it using a 500 ft. radius. Readings were taken every five degrees. Thus, the transmitter was always at a constant distance from the receiver. After the first two primary circles were run, circles of smaller radii were shot concentric to the first ones. This gave a general idea of the strike of the indicated conductors. After this preliminary survey, the transmitter was put on the points of cross-over and segments of circles were run. This method gave two points on each of the conductor axes.

The primary circles were centered at 46xN and 44xW and at 43xN and yyyW. In each case this represents the intersection of strong conductors as shown on map number 15A (letter from Lacy to Richard, February 25, 1957).

The coordinates of the centers of the various circles are as follows:

Circle No.	Coordinates North	West	Radius(Ft)
I	46xN	44xW	500
	46xN	44xW	300
II	43xN	yyyW	500
	43xN	yyyW	400
III	xxxN	46xW	500
IV	47xN	39xW	500
V	46xN	39xW	500
VI	xxxN	46xW	500

See sheet number P-13-6A.

Results

A definite set of preferred orientations of conductor axes was found. These, in part, followed the same pattern as shown on map 15A. See P-13-6A.

Conductor Axis 1 follows a previously found trend but does not extend to the north.

Conductor Axis 2 also follows a previously found trend but does not extend to the west nor does it show the double nature.

Conductor Axis 3 is a new one and could well represent the structure striking off axis number 2.

Conductor Axes 4 and 5 are apparently the same one and are in the same direction but of different magnitude than previously known.

It is interesting to note that the changing of radii of the circles changes the apparent strike of the conductors. Also, that when using a 500 foot radii, the primary wave is so much stronger than the secondary that the dip angles are decreased to the same order of magnitude as the instrumental error (1/4 degree).

The breaks in the curves show where it was necessary to change the position of the truck with a resulting deformation of the field.

INTERPRETATION

There are two things these conductor axes may represent. The first is mineralized faults. Structural maps are being made of the East Pima deposit but are not at sufficient stage of completeness to be of help in this study. The second possible explanation is the strike of sub-outcrops of mineralization. This too will have to await the completion of plan maps for validation.

It would be of mutual benefit if those working on the structural problem of East Pima could find a geologic explanation for the conductor axes found.

Very truly yours,

[illegible] C. [illegible]

[illegible]/ds
cc: [illegible] - w/enclosures
bcc:RJLacy - w/enclosures

[illegible] MINING DEPARTMENT
[illegible] Lake [illegible]

February 2[illegible], 1[illegible]

Mr. K. E. Richart, Chief Geologist
Southwestern Mining District
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 [illegible] 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 attitudes, however, would have been covered by the north-south field 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 Base Metal 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 (up to 10,000 cps) or the depth of burial. The response of these conductors would [illegible] with increasing frequency and with increasing depths of burial. These two factors, then, would restrict the list of geological conductors, for low frequency ranges and great depths of burial, especially tending to eliminate the ionic conductors. The frequency of 1,500 cps is comparable to ours at 1000 cps. Their 3500 cps and 7000 cps frequencies are appreciably higher and would miss 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 any 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 intersecting 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.

2

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

Conclusions

Although we wish to encourage conditional 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.Landvehr
T.A.Snedden
B.C.Morrison

February 9, 1955

Mr. W. R. Landauer, Chief Geologist
Western Mining Department
Salt Lake City, Utah

Dear Sir:

Mr. W. E. Sangart's report on the subject matter, dated February 8, 1955, is enclosed. In it he discusses Mr. E. V. Perkins' magnetic surveys over c.m. conductor Zones I and II, and reviews recommendations based on the c.m. surveys (see memorandum dated December 30, 1954).

Magnetite in the gravels causes very erratic magnetic curves and interpretation of magnetic conditions in depth is not possible.

c.m. Zone I

Drilling for possible sulphide replacement deposits should be controlled by the c.m. conductor axes. An initial profile of drilling is recommended on c.m. Zone I to determine the relation of possible mineralization to the positions of the conductor axes to check dips, and to obtain cross-sectional geologic data. The first hole should be located on the conductor axis at station 49 + 50N on profile 45W. The next hole, dependent on data obtained from the first hole, might be drilled at station 44 + 50N on profile 45W. The drilling results would then determine whether location of a third hole should be between the first two holes or south of the second. A fourth hole might then be drilled at 50 to 100 feet north of the first hole.

On the basis of geological data we know that the average dip of the sedimentary formations is south and some of the c.m. curves in the general survey suggest south dip of conductive bodies. This is an assumption, however, and the possibility of vertical or north dip cannot be ruled out. Therefore, the above recommended fourth hole, in the assumed footwall of a possible sulphide replacement deposit, is justified.

This profile drilling will determine the location of single-hole drilling on c.m. profiles 40W and 35W for extension of possible sulphide bodies. These 2 holes, plus the 4 holes recommended on profile 45W, would constitute a minimum test of Zone I. If drilling results are favorable, similar single drill hole locations would be recommended on c.m. profiles 3[illegible] (S. anomaly), 40W (S. anomaly), 30W, 25W, 20W, 15W and 10W for a rapid [illegible]n of strike extension and possible en echelon relations (13 additional

c.m. Zone II

Mr. Sangart recommends a hole on conductor axis II on 7E. D.D.H. #13 is being drilled now at a position 145 feet south of this recommended location. Probably the next hole should be collared 100 feet north of D.D.H. #13 rather than at D.D.H. #11. This north-south line, 7E, determined by diamond drill holes 11 and 13 would constitute the profile drilling position for Zone II and a minimum

of 4 holes along this plane is recommended, including the first two (D.D.H. 13 and at 100 feet north). Location of each hole would be dependent on results obtained in the preceding hole. Holes 3 and 4 might tentatively be recommended at 200 feet north of D.D.H. #13 and at D.D.H. #11.

The 7N profile drilling on Zone II would determine locations of single-hole drilling on profiles 5N and 10N. These 2 holes, plus the 4 holes recommended along 7N, would constitute a minimum test of Zone II. If results of this drilling are favorable, strike extension should be determined by single-hole drilling on profiles 10W, 5W, 0, 15E, 20E and 25E (6 additional holes).

Drilling Estimates

In summary, 6 holes on each e.m. conductor zone (I and II) would constitute a minimum test. Six holes out of the 12 would be located to cut the possible sulphide bodies near the apex (probably roughly coincident with the conductor axis). These might average 250 feet in depth. The other six holes, along the plane of cross-sectional drilling, might average 550 feet. Total footage of the minimum 12-hole drilling program may amount to 4,800 feet, or almost 5,000 feet.

If the results of the minimum drilling program are favorable, 19 additional holes could be recommended to determine strike extent and to establish relations of possible sulphide replacement deposits. These "conductor axis" holes may average 250 feet, so that total footage for the 19 additional holes would amount to 4,750 feet, or again approximately 5,000 feet.

If we assume that each stage yields encouraging results, the presence and strike extent of possible sulphide replacement deposits may be determined through a program involving approximately 10,000 feet of drilling in 31 holes. If all holes can be kept open so that geoelectrical drill hole surveys can test for continuity of mineralization between intersections, possibly 2 down dip holes near each "conductor axis" hole would yield sufficient data for evaluating the step to underground development work.

Disseminated Copper Sulphides

The possibilities for a large disseminated copper sulphide deposit would, of course, have to be evaluated before any underground development work on potential sulphide replacement deposits is considered. Since the magnetic method was proved inapplicable to this problem in the East Plum area, we have at present no geophysical method that can aid the geologist. We expect to have an induced polarization instrument - similar in principle to Newmont's geoelectrical pulse instrument - ready for testing at Silver Bell some time in June. If the test results are satisfactory, we may be able to try it on the East Plum project.

Very truly yours,

R. J. LAST

RJL:ml
cc: L.H.Hart
P.V.Richard
T.A.Hodkin
K.E.Richard

[redacted]
Salt Lake City, Utah

February 8, 1955

MEMORANDUM TO: Mr. R. J. Levy

[redacted]

The results of Mr. Perkins' recent magnetic survey of the Kent Pine area were received last week. The survey consisted of several detailed vertical intensity profiles crossing the electromagnetic conductors of Zone I and II. The relative intensities of these profiles have been plotted on the attached plan map of the Pine district.

Station 15N-10W was selected as the base station and magnetic datum for the profiles across Zone I. Station 15N-40W was used similarly for those stations crossing Zone II. The vertical intensities in the region of Zone I are not relative to those of Zone II as the base stations have not been tied, magnetically.

Mr. Perkins omitted profile 5W because of its proximity to the present drilling operations.

Interpretation of Magnetic Data

A study of the profiles shows that the intensities are highly erratic as you predicted. The irregular distribution of magnetite in the gravels is undoubtedly the cause of these intensity variations. All of the profiles except 15W have station spacings of 50 and 100 feet. Stations on the 15W line are at 25 ft. intervals, resulting in even more erratic intensity variations. Such conditions would be expected if the anomalous sources are shallow within the gravels.

I don't believe much significance can be attached to the high values at 14N and 16N on the 25W profile. There are two reasons for this: first, these are single station anomalies; and second, the extent of the anomalous area and the observed gradients indicate a shallow source, probably no deeper than 100 feet. The high at 11N-20W might be interpreted in a similar manner, although the profile did not extend far enough south to completely define this anomaly.

There is some similarity of magnetic relief between profiles on the 30W, 25W and 20W lines. However, this does not necessarily contradict the interpretation of "magnetite within the gravels," since the prevailing drainage in this area is N-S.

There is no definite correlation of the magnetic profiles with the electromagnetic conductor zones.

East Pima Area
February 8, 1955

Assuming the above interpretations to be reasonable, the magnetic results should not alter our previous drilling recommendations.

Evaluation of Electromagnetic Data

Mr. [illegible] and I have just reviewed my memo to you of December 30, 1954 re Electromagnetic Survey #1. Some slight changes in interpretation - especially as to correlation of conductors between profiles - may be noted by comparing the attached map with the December 30 map. Evaluating the data, we believe that the following are the most favorable drilling locations:

Zone I

Profile 45 W   station 45 + 70N   same as 12/30/54
Profile 40 W   station 46 + 25N   same as 12/30/54
Profile 35 W   station 47N   location shifted 50' S.

Zone II

850' due E of D.D.H. #11 (7E-[illegible])

These locations are plotted on the attached map. They are almost identical to the locations recommended in my memo of December 30.

Probably the first drilling on Zone I should be profile drilling to obtain correlation between possible mineralization and the e.m. curves, as well as geological cross section data. Just as this was proposed along profile 7E for Zone II, it may be recommended for Zone I along profile 45W, with the first hole at 45 + 70N. This data may alter locations for preliminary single-hole extension drilling on the other profiles.

W. E. [illegible]

WES:mk
cc: [illegible]
F.V.Richard
W.R.Landwehr
[illegible]
R.E.Richard

EXERPT FROM Report dated September 17, 1954, entitled:

PIMA MINE
Pima Mining District
Pima County, Arizona

by Kenyon Richard

Under EXPLORATION POSSIBILITIES

"No appreciable thickness of limestone can be expected in the Cretaceous arkose locally; however, the entire Paleozoic limestone series may underlie the gravel which extends several miles to the north, assuming the granite or some other intrusive does not occupy the area. The exploration possibilities here, as well as to the east, are entirely open to conjecture since the limits of disseminated sulphide mineralization are not known."

"Porphyry-type copper possibilities have been discussed at length in previous reports. Pima's exploration during the past year has to some extent strengthened these possibilities by finding commercial grade primary mineralization in the arkose. While most of the arkose carried about 0.30%, 1.17 million tons (within the pit outline) averaged 0.66% copper. The limits of this material were not defined and no controls which might account for its distribution were recognized."

"As previously reported, only minor amounts of chalcocite were found in the sulphides below the base of oxidation. This absence of appreciable secondary enrichment is unusual in strongly altered porphyries and, accordingly, enrichment would be expected in a chemically similar rock, such as the altered arkose. Assays from the oxidized zone show that most of the copper originally present in the sulphides did not migrate downward, but remained behind as oxide in the limonite. This may be due, at least in part, to the impermeable nature of the arkose; strongly shattered zones elsewhere in the same formation might therefore contain substantial enrichment. Just where such zones of sufficient size might occur is conjectural, but the possibility of their occurrence should be taken into account in exploration of the gravel covered area."

"Another factor of possible importance is the occurrence of "igneous appearing rock", described as hydrothermal quartz-feldspar-mica in the arkose. This type of "alteration" is closely associated with intrusive centers in at least two porphyry copper deposits: at Ely, Nevada, and at Bingham Canyon, Utah. Accordingly, its presence at Pima may be of some significance."

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

June 29, 1954

MEMORANDUM FOR:
Mr. T.A.Snedden

EAST PIMA
Pima County, Arizona
Proposed Drilling Program

This will conform with Mr. F.V.Richard's request for an estimate of the cost of drilling, and a map showing the location of proposed holes in the area which lies north and east of the Pima Mining Company claims, and which we hold by claim locations and leases.

The area is entirely gravel-covered, and it is anticipated that gravel depths will range within 200 feet and 400 feet, averaging about 300 feet. The objective in drilling is to find a buried center of stronger alteration-mineralization carrying better disseminated copper sulphide values than are now known in Pima's ground. Also, there is the additional chance of encountering limestone replacement ore like Pima's main ore body. As our information now stands, there are no recognized structures or trends of disseminated mineralization in Pima's ground which can be projected into our ground with any assurance of accuracy. Under this circumstance it would be possible to spend considerable money exploring the sulphide zone in our ground and still miss an ore body.

Pima Mining Company has demonstrated that, by combining mud circulation and oil-well-type rotary rock bits with a conventional diamond drill rig, the gravel beds can be drilled very rapidly and cheaply. Using this system we could obtain information on the character of alteration-mineralization in bedrock over a large area at relatively low cost. The plan would be to obtain only 15 feet or 20 feet of bedrock core in each hole and then abandon it. With this bedrock information from the 10 shallow holes, located as shown on the attached map, 5 additional holes could then be strategically spotted for the main objectives of exploring deep into the sulphide zone. The cheap information gained from the shallow holes would greatly increase the likelihood that the deep, more expensive holes would be positioned so as to provide the best information. It is intended that the first three locations (A, B and C) should be drilled regardless of whether the bedrock

core shows mineralization or not. But these first results may indicate that remaining hole positions should be adjusted.

Following is the estimated cost of these two programs of shallow and deep drilling:

PRELIMINARY SHALLOW DRILLING (10 HOLES):

3000' @ $2/ft.(gravel)	$ 6,000.*
200' @ $6/ft.(bedrock)	1,200.*
Roads	500.**
Sampling and Supervision.....	500.**
T o t a l	$ 8,200.

DEEP DRILLING (5 HOLES):

5000' @ $5/ft	$ 25,000.*
Water haul	2,000.**
Roads	500.**
Sampling and Supervision	5,000.**
T o t a l	$ 32,500.
Total both programs	$ 40,700.
Contingency	4,070.
T o t a l	$ 44,770.

* Contract
** A.S.& R.Co.Acct.

If the results of these two programs indicate mineralization of commercial grade, additional expenditures will be needed.

Attaching map.

KENYON RICHARD

KW:blc

C
O
P
Y

WESTERN MINING DEPARTMENT
Salt Lake City, Utah

January 11, 1954

AIR MAIL

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

ARIZONA, PIMA COUNTY
Pima District
PORPHYRY COPPER EXPLORATION

Dear Sir:

As you know, we have acquired a considerable amount of ground easterly from the Pima mine, by lease and option and by claim location. The enclosed map shows the Chilson ground, upon which we have an acceptable lease and option; the Nauman ground, upon which we have a lease and option the terms of which may not be acceptable; and the claims which we located. The map also shows the ground owned by the Pima Mining Company and the United Geophysical Company.

The acquisition of this ground is based upon the possibility that it may contain a copper deposit of the disseminated type. As the drilling campaign that will be necessary before we can determine whether or not such a deposit exists will cost a considerable amount, I think it is well to summarize the factual basis upon which the project rests.

The possibility that a commercial deposit of disseminated mineralization could exist in the gravel-covered area was first called to our attention by Mr. Courtright in his memorandum to Mr. Snedden of February 27, 1953. His belief that disseminated deposits might exist was based upon the presence of mineralization of that type in arkose outcropping on Pima ground easterly and southeasterly from the Pima ore body. Referring to the existence of deposits, both of the replacement and disseminated types, in the area, he states, "The chances of finding either type of deposit are, however, quite long, being based on geologic permissibility rather than probability." This statement was made before we had access to the records of the Pima Mining Company.

Later, when the Pima Records were made available to us, it was learned that disseminated mineralization in arkose was encountered in several of their surface diamond drill holes in the hanging wall of the Pima ore body and to the east of it. Based upon this added information, Mr. Courtright stated in his report of October 12, 1953 on the Pima mine, "The inference is made that there is a fair chance for the occurrence of a gravel-covered porphyry copper ore body," but pointed out that "we have recognized no structure or other geological evidence suggesting the position of such a deposit other than it would most likely be easterly or northeasterly from Red Hill."

Mr. Kenyon Richard, in his letter of October 12 transmitting Mr. Courtright's

Mr. C. P. Pollock

report, in commenting on the possibilities for disseminated deposits, states, "Taking all factors into account, the exploration gamble is an attractive one, and the property should be acquired with the expectation of following up with drilling." The property referred to is that of Pima Mining Company, but he also recommended acquisition of the Chilson and Nauman ground, and the location of the claims that have since been located by Asarco.

From the foregoing, it can be seen that this proposal is based upon rather definite factual evidence that indicates a possible porphyry copper environment; in other words, there can be a commercial deposit of that type in the gravel-covered area. However, as stated by Courtright, there is no direct evidence of its probable position if it actually exists. We all realize that it is a long-shot gamble, but as such it is worthwhile. However, if we should decide to do some exploratory drilling it is my opinion that we should attempt to acquire more ground to the east.

This project is separate from that of the Pima mine, and our decision should not be influenced by the results of our negotiations for that property. However, no drilling should be started prior to the conclusion of negotiations.

Very truly yours,

WRL:si

/s/ W. R. Landwehr

enc. Map #1185
K. E. Richard's memo Jan. 4, 1954 to T. A. Snedden

cc: D.J. Pope w/map
K.E.Richard w/out map

Copied at Tucson January 23, 1954, for Mr. Courtright.

C
O
P
Y

November 25, 1953

MEMORANDUM TO: Mr. W. R. Landwehr

ARIZONA, PIMA COUNTY
PIMA DISTRICT
GEOPHYSICS

INTRODUCTION

Messrs. K. E. Richard and J. H. Courtright, in their letter of November 19 re the Pima mine, requested my comments concerning geophysical methods that might be applicable. This is a two-phase geophysical problem with respect to two types of deposits, sulphide replacement and porphyry copper. These have been discussed in numerous letters and memoranda in the past, mainly in the following:

Date	From	To	Copies To	Subject
January 13, 1953	R. J. Lacy	D. J. Pope	C.P.P. L.H.H. E.McL.T. W.R.L. F.V.R. T.A.S. R.F.W. L.K.W.	United Geophysical Company's exploration methods in Pima district
June 17, 1953	R. J. Lacy	C.P.Pollock	L.H.H. D.J.P. F.V.R. W.R.L. K.W. T.A.S. M.W.C. K.E.R. L.K.W. J.H.C.	Example completion of Reconnaissance Summary form
June 26, 1953	C.K. Moss	W.R.Landwehr	K.E.R. L.K.W.	Magnetometer test survey for porphyry copper deposits in Pima district.

It is felt that the United Geophysical Company covered the areas of interest on open land thoroughly with the sulphide replacement type of deposit especially in mind. They then staked all of the area on which anomalies possibly indicative of this type of deposit were found. We may then assume that it would be infeasible to duplicate this work.

The United Geophysical Company initially may not have been aware of the porphyry copper possibilities, and so interpreted any broad "basin" of magnetic contours as indicating a topographic low in the basement complex of granite-sedimentary contact. This aspect presents interesting possibilities which are discussed below:

Porphyry Copper Deposits

Mr. C. K. Moss' magnetometer test surveys were conducted mainly south of the presently recommended area of interest. Although the tests were not considered favorable, they were not conclusive for the following reasons:

1. The granite in the granite-sedimentary outcrop area tested in the western part of the district may not be representative of the possible monzonite intrusion postulated in the eastern part of the district.

2. The few profiles run in the southeast area are not considered an adequate test, especially since we do not know whether porphyry copper alteration exists there. There is a magnetic low at the north end of profile 3, where an outcrop of arkose with disseminated sulphides was observed on Red Hill. This may be interpreted either as the fringe of a hydrothermal alteration zone in which accessory magnetite was converted to non-magnetic minerals, or merely the lack of alluvium containing concentrations of magnetite.

3. The erratic readings obtained in the alluvium covered areas undoubtedly result from erratic concentrations of magnetite in the alluvium within a few tens of feet depth. This can be a confusing factor in the interpretation.

The considerations, in relation to the United Geophysical Company and their surveys, are as follows:

1. Their magnetic contour maps may have indicated a broad basin-like anomaly, but

   a. they were not aware of porphyry copper possibilities and interpreted a "topographic low" of the basement complex (granite-sedimentary contact),

   b. they were aware of such possibilities and gravimetric and/or seismic data possibly confirmed the postulation of a "topographic depression" of the granite-sedimentary contact.

   c. or they simply were not prepared as a matter of policy to conduct exploration and development work for porphyry copper deposits.

2. There is no broad basin-like anomaly indicated on their magnetic contour maps, because

   a. the granite-sedimentary contact dips steeply to the east,

   b. the accessory magnetite content of the fresh granite may be unusually low so that there would be no appreciable magnetic susceptibility contrast with hydrothermally altered zones.

   c. or a porphyry copper deposit does not exist in the area surveyed.

If we were able to obtain and study United Geophysical Company's geophysical data and maps, this would be the ideal situation in order to determine which of the above listed conditions, 1 or 2, obtains. This may be possible, if our negotiations for the Pima mine are successfully concluded. However, I would assume that, even though they may not have been aware of porphyry copper

possibilities initially, they are now cognizant of such possibilities. In this case, it is more than likely that separate negotiations would be necessary with regard to the Pima mine property on the one hand and both the United Geophysical property in the recommended area of interest and corresponding geophysical data on the other hand. This may apply if either condition 1a initially obtained or 1c obtains. In the latter case, they would be interested in the sale value of any geophysical data favoring existence of a porphyry copper deposit. Their reaction to our proposal to stake ground in the district, and their activities in staking more property, will be revealing. If they stake more ground, we might assume that their geophysical data are favorable to the postulation of the existence of a porphyry copper deposit in the new areas staked.

If either of the conditions 1b or 2 obtains, they would not object to our staking ground, they would not conduct such activities themselves, and they would not speculate on the sale value of their geophysical data. In that case, we arrive at conclusions similar to those for sulphide replacement deposits in that it would be infeasible for us to duplicate United Geophysical Company's geophysical surveys. One possibility still exists, however. That is the postulation 2b that there may not be a sufficiently high concentration of accessory magnetite in the granite to afford a magnetic susceptibility contrast with hydrothermally altered zones. This places the burden entirely on the sparse geological indications, and favors staking the recommended area and drilling the reconnaissance holes for porphyry copper exploration.

Conclusions

The conclusion to be drawn from the above discussions is that there is no need for us to conduct geophysical surveys in the area covered by the United Geophysical Company surveys. Their staking activities will reveal whether or not their re-interpretation of the geophysical data favors the postulation of a porphyry copper type of deposit. If they do acquire more property now, we may judge from the size and locations of such land acquisitions whether or not they are interested in porphyry copper exploration or the sale value of such geophysical data and newly acquired properties. We then have no alternative but to negotiate separately for such data and property if we are interested in dealing on this basis. This is so because the inference that the geophysical data confirms a reasonably shallow granite-sedimentary contact and sufficient accessory magnetite in fresh granite to allow for interpretable variations would be strengthened.

If the United Geophysical Company does not object to our staking the recommended area and does not acquire new property themselves, we may reasonably assume the geophysical data are not favorable. We may then postulate the one chance if geophysical data are not favorable. That is that an unusually low accessory magnetite content in the fresh granite does not afford sufficient contrast of magnetic susceptibility with hydrothermally altered zones. The recommended claim staking and reconnaissance drilling on the basis of the geological indications then may be considered.

/s/ R. J. LACY

RJL:si
cc: CPPollock
FVRichard
TASnedden
KERichard
JHCourtright

November 6, 1953

MEMORANDUM TO: Mr. F. V. Richard

ARIZONA, PIMA COUNTY
PIMA DISTRICT
PIMA MINE

I have studied the geological report of October 12, 1953 on the Pima mine by Courtright and Hardie, and have the following comments:

The report is well prepared and it is evident that it is the result of careful assembling and analyzing all pertinent data.

The estimate of measured and indicated ore is based upon good geological and engineering practices. The results of our spot-check of a number of ore blocks was very close to the tonnages used in the report. The method used in delimiting the various blocks introduces a factor of safety, but it is not deliberately unreasonable.

We similarly checked the average grade of a number of ore blocks, and in all cases our result was higher than that of the report, the difference being due no doubt to less knowledge of details on our part.

The estimate of inferred ore down to the 800 level also seems reasonable in view of the diminution in the grade of the mineralization between the 500 and 600 levels between coordinates 4600 E. and 4800 E.

As brought out in the report, the possibilities for additional ore of the replacement type are in down-dip extensions of the ore zone as presently developed, and in the easterly extension of the zone. There is also an indication that another mineralized zone may exist a short distance in the footwall of the Pima zone.

Mineralization of the Pima type, although often erratic in the distribution of the valuable content, should persist to a considerable depth. The Pima mineralization probably extends for a considerable depth below the elevation of the 800 level unless an unfavorable structure exists such as the granite in the San Xavier mine.

The eastward extent of the mineralized zone has not been determined. Undoubtedly the eastern limit of Pima's surface drilling marks the limit of the geophysical anomaly that resulted in the discovery of the ore body, but, for reasons given on page 15 of the report, this may not necessarily mark the limits of mineralization. From the evidence on hand, I am of the opinion that chances for additional appreciable amounts of ore to the east are good.

There is a possibility of another mineralized bed a short distance in the footwall of the Pima bed.

As emphasized in the report, and also by Mr. Richard in his covering letter, the Pima body may be peripheral to commercial porphyry-type copper mineralization in monzonite. The positive indications are sufficient to make this an attractive exploration possibility and one that should be taken into consideration in evaluating the Pima mine. It should be considered separately even though we do not acquire that property.

We should make every reasonable effort to acquire the Pima property.

ORIGINAL SIGNED BY
W. R. LANDWEHR

W. R. LANDWEHR

WRL:sl
cc:K.E.Richard

EXERPT------from Geological Report dated October 12, 1953, entitled:

PIMA MINE
Pima Mining District
Pima County, Arizona---------by J. H. Courtright and
B. S. Hardie

Under section EXPLORATION POSSIBILITIES, pages 15 and 16

"Aside from possible extensions of the Pima ore zone discussed above, the widespread alteration and disseminated sulphide mineralization in the arkosic sandstone to the east and southeast are regarded as probable associates of a nearby igneous intrusive mass and/or breccia pipes. Relatively small patches of the same type alteration occur two miles southwest near the New Olivette and Helmet Peak mines (in arkose and volcanics) and are localized near small breccia pipes containing pyritic mineralization. Since no appreciable alteration is found within or along the fringes of the main granite mass on the west, it is considered likely that the alteration in the Pima area is related to a later Laramide intrusive such as the monzonite (or diorite) which occurs about 9 miles south of the Pima mine in the Esperanza area. Here, an altered zone contains a small porphyry copper prospect."

. . . .

"If these speculative features are combined with the two facts, (1) that the Pima ore body is the best and biggest of its type in the district, and (2) the "Red Hill" is the strongest alteration zone, the inference is made that there is a fair chance for the occurrence of a gravel-covered porphyry copper ore body. We have recognized no structure or other geological evidence suggesting the position of such a deposit, other than that it would most likely be easterly or northerly from Red Hill."

EXERPT FROM: Memorandum to Mr. W. R. Landwehr dated June 26, 1953, from Mr. C. K. Moss

Under Conclusions

"From the results of the brief magnetometer work, it seems that any information which would be gained by more detailed work would be too weakly diagnostic in itself to justify the cost of obtaining the information. It does not seem that magnetic information could give conclusive enough results to initiate a drilling program at Pima; however, magnetic work might be helpful in tracing alteration, if drilling were begun on the basis of more positive indications of a different nature and alteration were found in granite."

Aa-16.16.0

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

March 10, 1953

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

PIMA DISTRICT
Area east of San Xavier

Dear Sir:

Reference is made to Mr. Courtright's memo of February 27th and Mr. Wilson's letter of March 10th.

It is my opinion that the magnetometer work, as outlined by Mr. Wilson, should be done first. It may be possible for Mr. Moss to do this work without detection by the companies in the district; and in any event it may be possible for him to avoid identification with this Company.

The decision of whether or not to stake a large number of claims as suggested by Mr. Courtright is a critical one. The magnetometer work is not expected to provide important answers to the problems involved, but information of some interest may result.

There should be emphasis of Mr. Courtright's statement that chances for finding either replacement or disseminated ore are based on geologic permissibility rather than probability.

If the magnetometer work is approved, Mr. Courtright and I will line out Mr. Moss in the field and at that time I will plan to make a reconnaissance of certain parts of the area, particularly the southern slope of "Arkose Hill" if that seems feasible.

Yours very truly,

KR

KENYON RICHARD

KR:ar

cc: DJPope
TASnedden
LKWilson
JHCourtright
RJLacy
Aa-0.0.16

Arizona

February 27, 1953

PIMA MINING DISTRICT
PIMA COUNTY, ARIZ.
(Area East of San Xavier)

Memorandum to Mr. T. A. Snedden

INTRODUCTION

In a recent memo (Jan. 5th) concerning the Pima Mining Company's copper deposit mention was made of pyritic alteration observed in a small hill of arkosic sand[illegible] mineralizing [illegible] the gravels one-half mile southeast of the Alpha Shaft.

Some further study of the area has been made and a generalized geologic map prepared, showing the principal elements of structure and mineralization. The following contains a brief review of features to be considered in attempting evaluation of exploration possibilities beneath the gravel cover.

GEOLOGY

The district is situated about 20 miles south of Tucson in an area of low relief broken by a few small knobs of more resistant (chiefly limestones) sedimentary rocks rising abruptly from the alluvial slopes on the west side of the Santa Cruz Valley.

The principal rock units are:

Gravels	- Recent	(Post-mineral)
Volcanics (Chiefly flows)	- Tertiary (?)	(Pre-mineral)
Shales, Arkosic sandstones	- Cretaceous	(ditto)
Limestone and quartzite	- Paleozoic	(ditto)
Granite - intrusive	- Laramide	(ditto)

A complex structural history is evidenced by the random arrangement of certain recognizable rock units. The predominating trend of the major faults ---Mineral Hill, San Xavier and South Helmet Peak---is easterly. The principal ore deposits, lead-zinc and copper, occur as replacement bodies in limestone in or near these faults (excepting south Helmet Peak) along the east fringe of the intrusive granite mass. Granite contacts at depth are reported in the Mineral Hill and San Xavier mines.

Pyritic alteration with minor amounts of copper is confined for the most part to two areas: (1) in the southern portion of the district where it is associated with the lead-silver veins, and (2) in the low hill one-half mile southeast of the Alpha Shaft. This hill, composed of pale reddish-brown colored, east-dipping arkose and conglomerate beds, is completely surrounded by valley fill. Minor amounts of limonite after chalcocite are present in the leached outcrops. Occasional chalcocite, coating disseminated pyrite grains in sericitized arkose is visible on two small prospect dumps located on the southeast edge of the hill where mineralization is relatively strong. A sample of the pyritic material (no visible chalcocite) assayed .6 oz. Ag and .02% Cu. indicating extremely low values in primary copper.

Oxidation is shallow, extending twenty or thirty feet beneath the outcrops.

One mile southwest of the arkose hill (on the lower northeast slope of Helmet Peak) a zone of metamorphosed shale outcrops along the edge of the valley fill. Copper mineralization in the form of silicates and oxides is scattered throughout. This and the mineralized limestone gossan on the east end of San Xavier hill are probably related to an eastward continuation of the San Xavier structure as noted on the accompanying map.

The narrow lead-silver veins and associated alteration appear to die out southwest of Helmet Peak, however, possible continuity of the structure is indicated by the easterly displacement of limestone beds at the south tip of Helmet Peak.

Small outcrops of unaltered sandstone and conglomerate are shown in the southeast corner of the accompanying map. These quite likely represent more resistant spots in a very broad mountain pediment. Within this pediment area---over three miles wide---the average thickness of gravel cover should not be great, possibly less than 500 feet.

MINES OF THE DISTRICT

A brief summary of file information on the more important of the known ore occurrences follows:

Mineral Hill Mine

Located on the south edge of Mineral Hill and owned by the Banner Mining Company, the mine has produced something over 50,000 tons of oxidized copper ore and is credited with sulphide reserves of 500,000 tons of 2.5% copper. Minor values in tungsten and molybdenum are associated with the copper which occurs in a south-dipping zone of garnetized limestone. Development, which extends to the 700 level, is in progress, but there is no current production.

Pima Mine

This deposit, concealed by over 200 feet of gravel cover, bears a close resemblance structurally and mineralogically to the Mineral Hill deposit, situated some 4000 feet to the west. The grade of the copper ore in the Pima Mine is considerably higher, however.

The drill exploration, which made the discovery, was reportedly based on a magnetic anomaly obtained in surveys conducted within the past three years by the United Geophysical Company. Development to a depth of 600 feet has indicated a reserve of 500,000 tons of 5% copper sulphide ore. Exploration possibilities appear promising along strike and down dip.

San Xavier Mine

The deposit is a lead-zinc-copper replacement of limestone, which has been developed to a depth of 900 feet by Eagle Picher. Past production amounted to something over 500,000 tons of crude ore. The mine is idle at present.

PROPERTY

The eastern limits of Pima and Eagle Picher Mining Company properties

held under location, taken from a property map compiled by Mr. L. K. Wilson, are shown on the attached map. Mr. Wilson has also advised that no mining claims have been recorded (as of Feb. 20, 1953) on the State and Federal land continuing easterly for over three miles from the present mining locations, and has secured the numbers and locations of several grazing patents in the area. Except for possible unrecorded locations which might exist, all ground east of the present known property limits appears to be open for location.

CONCLUSIONS

Exploration possibilities beneath the gravel cover depend essentially on projection of the known ore-bearing structures into a large area which may contain an extensive zone of alteration; at least, the limits of alteration are not visible in the only existing outcrop (Arkose hill). There appears to be little chance of commercial grades of copper ore in the hill itself, but it could be part of an extensive alteration zone within which stronger copper mineralization of the disseminated type might occur, particularly if granitic intrusives are present.

Deposits comparable to the San Xavier and Pima are not sufficiently large to justify any particularly big risk in exploration, however, these, in combination with a larger objective---such as a porphyry copper deposit ---offer more favorable odds for an exploration gamble. The chances of finding either type of deposit are, however, quite long, being based on geologic permissibility rather than probability.

United Geophysical has tested at least part, if not all, of the gravel covered pediment, using various methods including seismic for depth-to-bedrock determinations. Apparently, they found nothing of interest east of their present claim boundaries. However, as pointed out in the above mentioned memorandum (Jan. 5th), since a positive magnetic anomaly reportedly led to discovery of the magnetite bearing Pima deposit, no significance may have been attached to negative anomalies which may indicate disseminated sulphide mineralization where the magnetite content is lower than normal due to alteration effects.

In considering action that might be taken, it is not likely that the Company could conduct geophysical surveys in the area without attracting attention which might result in serious competition in property acquisitions. Since the area of possible interest involves several sections of land, covering it completely with mining claim locations would be a sizeable undertaking. As a first step, we might consider staking a central block consisting of Sec. 7 and the open portions of Sections 1, 6 and 12, plus the south half of 31. This coverage would require about 90 claims, 600' x 1500' each.

A factor to be taken into account is the effect that competitive action by the Company might have on relations with the Pima Mining Company in connection with negotiations for their property. A decision on this aspect of the case is needed at this time.

J. H. COURTRIGHT

JHC:ms
cc: DJPope with map
WRLandwehr "
KRRichard "
LKWilson "
[redacted] "

Aa-16.16.20A

J.H.C.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

January 5, 1953

MEMORANDUM TO:
Mr. T.A. Snedden

PIMA MINING COMPANY
Pima County, Arizona

The following notes are based on observations during our visit to the Pima Mining Company's property on December 30,1952. The history of this recent discovery and data available concerning the deposit have been recorded in file memos by Messrs. Welch, Richard and Wilson at various times during the past year. We were able to examine a small amount of new development, but otherwise were not provided with much information in addition to that previously obtained.

Present development extends 300 feet east and 400 feet west of the shaft -- about 300 feet from the Banner property on the west. A short stub drift has been cut on the 500, and sinking to the 600 is in progress (See attached section).

As observed on the 300 and 400 levels, copper values occur as chalcopyrite in a somewhat irregular zone of garnet, chlorite and clay. The higher grade portions (plus 5% Cu) show considerable massive chalcopyrite; the copper in the lower grade (from 1 to 5%) is present mainly as small grains and stringers of chalcopyrite. Minor amounts of magnetite and very minor amounts of pyrite were visible.

Fresh or slightly altered limestone was observed in both the foot and hanging wall on the 400 level; much chloritized limestone occurs within the ore zone as well as on the fringes. Although members of the local University staff have reportedly examined all the drill cores, and determined the ore to occur in an arkose (coarse feldspathic sandstone) formation, I did not recognize any of this type of rock in unaltered areas on either level. It is entirely possible that some of the strongly mineralized portions were formed in sandstone, but identity of such would necessarily require microscopic study. Without having had an opportunity to examine the drill cores, my impression is that the Alpha deposit is mineralogically and geologically comparable to the Banner lying to the west of Mineral Hill. Both deposits appear to occur within an east-west trending, south dipping, zone of faulting. The grade in the Banner is lower (500,000 tons at 2.6% Cu).

The strongest fault structures roughly parallel the zone of ore mineralization both in strike and dip.

Total shipments of direct smelting ore from development through the period May to December of 1952 averaged as follows: (Reported by Mr. Welch)

Dry Tons	Ag	Cu	Ins	Fe	CaO	Zn	S	Al_2O_3
12,243	.86	6.70	36.8	18.3	21.2	.8	8.6	9.7

This analysis shows very little pyrite to be present. Part of the excess iron (above that in the chalcopyrite) is present in the ferromagnesian minerals which have replaced the sediments. The balance of the iron is probably oxide, indicating about 5% as the megnetite content of the ore. Small amounts of molybdenite and scheelite accompany the copper values.

Indicated ore reserves, according to Mr. Drex Spaulding, Manager, are:

From a depth of 220' to 350'

A block 500' long, 130' deep, 70' wide = 455,000 tons @ 3.00%Cu. (10 cu. ft. per ton).

From 350' to 450'

A block 500' long, 100' deep, 25' wide = 125,000 tons @ 5.00% Cu. (10 cu. ft. per ton).

Some underground drilling has encountered ore between the 500 and 600 levels. In view of this and the extent of ore demonstrated on the 400 level, continuity to the 600 may reasonably be expected.

Classed as inferred ore:

From 450' to 600'

A block 500' long, 150' deep, 25' wide = 187,500 tons @ 5.00% Cu.

Total (Indicated and inferred) = 767,500 tons @ 3.8% Cu.

Assuming selective mining of the higher grade in the block above the 350 level, 500,000 tons @ 5.0% Cu appears to be a reasonable expectancy at the present stage of development. The chances appear

fairly good for continuity of structure, and ore, down dip below the 600 level. Surface drilling reportedly did not extend below the 400.

The operators expect to continue development laterially beyond the present limits, indicating that surface drilling has found at least some ore in these areas.

Although for the most part the development drifts have required no timber support, the ground is not particularly firm due to the presence of numerous fractures and slips at all angles. Except in areas of massive garnet, clay alteration has produced a rather soft friable condition in the ore. This effect is probably supergene, consequently it should not persist very far below the present development.

Currently the mine is making about 350 g.p.m. of water.

SURFACE RECONNAISSANCE:

Other than the limestone, quartzite and granite on Mineral Hill, the only outcrop in the vicinity is on a low hill about one-half mile S. 60° E. of the Alpha Shaft. This hill, about one-third of a mile in length, is composed entirely of east-dipping arkose sandstone. The most interesting feature observed was the presence of alteration and the evidence of previously existing disseminated sulphide mineralization throughout. Minor amounts of limonite after chalcocite were noted. On the southeast edge of the hill where mineralization is somewhat stronger, the dumps of two old prospect shafts show that disseminated pyrite was reached at about 25 feet below the leached outcrops. Minor amounts of chalcocite were visible in some specimens.

It is possible that mineralization and alteration in this hill are related to the Alpha zone which projects through about one-fourth mile to the north, however, a few scattered outcrops of sandstone extending to within a few hundred feet of an easterly projection of the Alpha, showed no particular increase in the intensity of mineralization. There is also the possibility that the disseminated mineralization in this isolated outcrop is part of a larger zone extending beneath the gravel cover to the south and east. The nearest outcrops in these two directions are about four miles distant. As yet I have not examined these.

While the hill itself does not appear to hold potentialities, the surrounding gravel may conceal altered intrusive rocks and associated mineralization of possible commercial grade.

United Geophysical has conducted surveys over this covered area and apparently found nothing of interest between Twin Buttes and the Alpha. This may be of little significance however, since their success

in finding the Alpha presumably was due to a positive magnetic anomaly produced by magnetite associated with contact-type mineralization, while anomalies over porphyry-type copper deposits are more apt to be negative due to the loss of accessory and other magnetite through conversion to pyrite during hydrothermal alteration.

Pima Mining Company claims cover the arkose hill but apparently do not extend east of a line running due south.

A further investigation of the surface and of property status in the area is planned in the near future.

J. H. COURTRIGHT