

BEAR CREEK MINING COMPANY

Geophysics Division

516 Acoma Street

Denver 4, Colorado

October 28, 1955.

TO: Mr. Ralph C. Holmer
FROM: George R. Rogers
SUBJECT: Test Geophysical Survey at the Pima Mine, Arizona

During the interval October 11 through 14, a test geophysical survey was conducted over the Pima Mine southwest of Tucson. Messrs. Ringel, Bowman, Holland, Madden and Rogers of the Geophysics Division participated. The work was possible due to arrangements made by the Southwest District.

The Pima Mine is a valuable test locality. There is known to be almost exactly 200 feet of post mineral cover (alluvium) over the sub-outcrop. The ore is said to be mainly chalcopyrite with some bornite, chalcocite, magnetite, and pyrrhotite. The deposit is contact-metamorphic with mineralization occurring in favorable limestone formations. A major thrust fault parallels the ore zone and was, undoubtedly, an important ore control. The mine was originally discovered by geophysical work.¹ The Pima ore body consists of a dipping conductive sheet of sulfides in a non-conductive country rock. There is 200 feet of alluvium overburden which is somewhat conductive.

The Southwest District sub-office at Tucson had already laid out a grid and collected geochemical soil samples. The results of this phase of the work will be reported on separately by them. Plate 1 is a base map prepared by the Tucson Office showing

- (a) Approximate topography and culture
- (b) Approximate ore outlines on the 300' level. The grade establishing this outline is not known. Since the ore body dips 45° to the south and bedrock is at the 200' level, the true sub-outcrop must be shifted about 100 feet north of this projection.
- (c) Location of geochemical samples
- (d) Location of geophysical test lines E and F.

¹ R. E. Thomson, W. E. Heinrichs, Jr., E. D. Spaulding, "Geophysical Discovery and Development of the Pima Mine, Pima County, Arizona," Mining Engineering, Vol. 6, No. 2, February, 1954, p. 197-202.

Three electrical geophysical methods were tried--two electromagnetic schemes and an induced polarization technique.

The first EM method tried was a dual horizontal coil arrangement with energization supplied by a 3 watt vacuum tube oscillator driving one of the coils. This method did not give interpretable results as our energizing field was too weak at the coil separation needed to work beyond 200 feet of depth. There was a great deal of 60 cycle noise and harmonics in the area and our signal was simply too weak under these conditions.

The second EM method tried was a vertical energizing coil-dip angle technique such as is commonly used in Canada. The "dip" of the electromagnetic field from a vertical transmitter coil is normally zero or horizontal. If a conductor is present, angles other than zero will be observed; and an abrupt shift in direction of dip from one side of horizontal to the other, known as a crossover, is considered to indicate the axis of a conductor. The transmitter location and lines runage shown on Plate 1. The dip angles read are shown on Plate 2. Two frequencies, 1N or 1 kilocycle and 5N or 5 kilocycle, were employed. Considerable power line noise was noted with this method also but our primary signal was sufficiently strong to permit readings to Station 5 or 10 South. Small but definite angles with well-established crossovers were observed. As is normally the case, larger angles were observed on the line furthest from the transmitter. The crossovers were located approximately over the sulfides--at station zero on line F and at station 1N on line E. Some indication of further electrical disturbance to the south is observed but this could not be reliably segregated from power line interference.

While the above seems quite favorable, it should be pointed out that the transmitter was located in an optimum position with respect to the ore body. Further, in areas of more severe topography, moderately conductive overburden, such as alluvium, could give rise to terrain anomalies.

Since we were having so much difficulty with 60 cycle noise from nearby power lines, it was decided to try the philosophy, "If you can't whip 'em, join 'em." Dip angles were taken on the existing 60 cycle field and results are shown as Figure 2C of Plate 2. Angles varied from about 30° to 65°, and averaged near 40°. Over ground of uniform and poor conductivity the field would be almost vertical--90° dips--and the dip would change very slowly with distance. Irregularities in the direction of the field were observed as shown but the results have not been adequately studied.

The Induced Polarization measurements were made with a two frequency technique devised by T. R. Madden, of the Massachusetts Institute of Technology. Essentially, the resistivity or impedance of the ground is measured

R A. A. Brant, "The Role of Geophysical Methods in Modern Exploration Programs," Engineering and Mining Journal, Mid-March Review Issue, 1955, p. 25-32.

at two, very low, frequencies. A decrease in apparent impedance with increasing frequency is interpreted as due to increasing importance of metallic or electronic type conduction. Plate 3 shows resistivity values in units of $\rho/2\pi$ ohm feet. Superscripts indicate the percent frequency effect. Plate 4 shows the so-called metal factor values which are frequency effects normalized by accounting for apparent resistivity. The higher the metal factor, the greater the importance of metallic type conduction. The resistivity is remarkably uniform over the area, being only slightly higher to the north. The metal factors increase over the ore zone to approximately 200. To the north they drop off to less than 50, but to the south the values do not drop off so rapidly. If a more extensive survey of the region would establish that values over 50 are significant, the sulfide zone would definitely have been detected. In fact, the suggestion is there that the sulfides exist to the south but not to the north of Station 1 North.

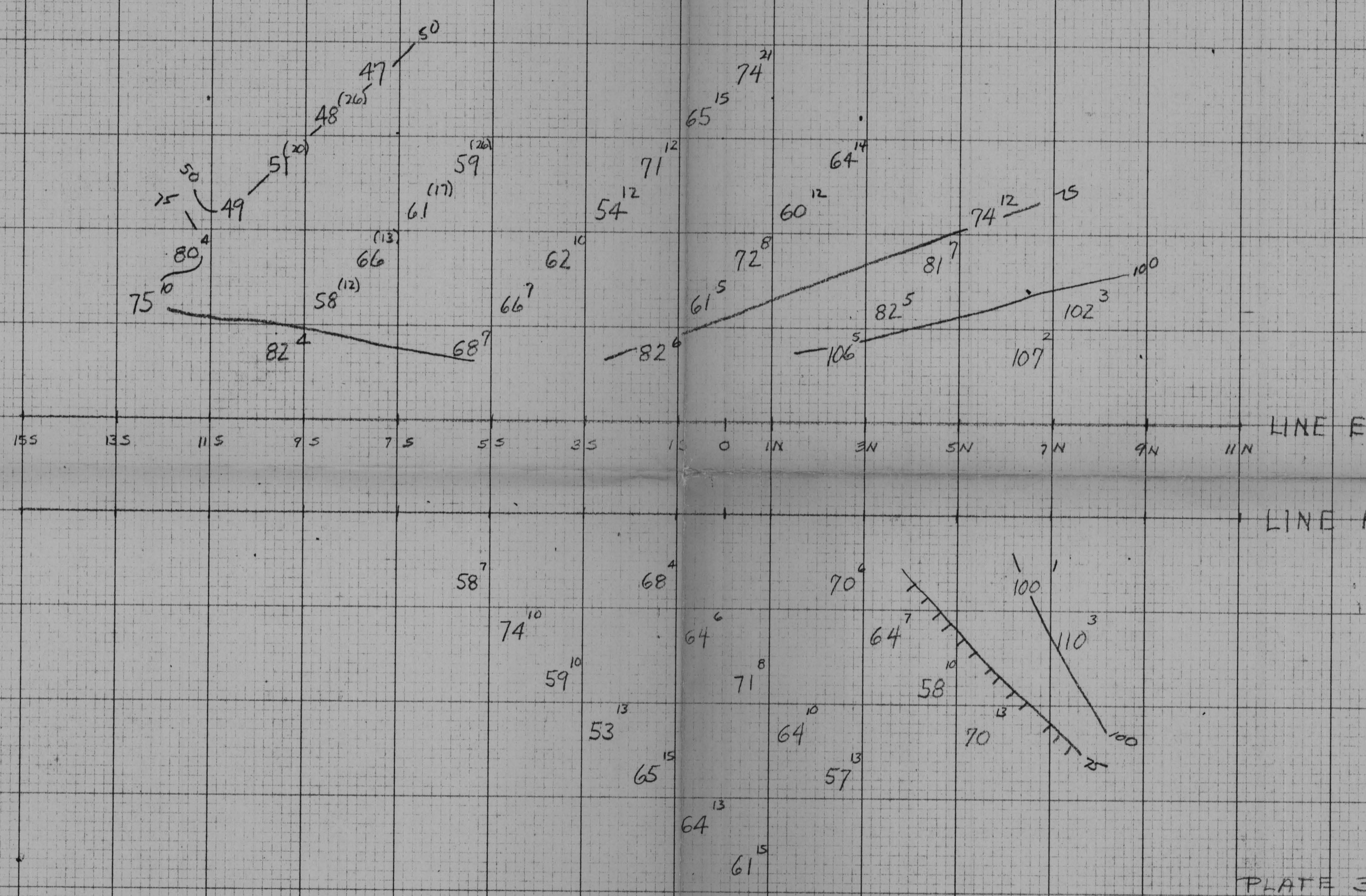
In conclusion, it may be stated that a deposit of the Pima type could probably be detected by two of the three methods we employed. However, in each case, very careful work is necessary as there is no question that the deposit is very near the limits of detectability. Much detail work is necessary in such an area in order to utilize the maximum effectiveness of each method. The existence of actual mineralization to the west combined with a fault zone striking toward the anomalies would be of tremendous importance in selecting such anomalies to be drilled.

Thanks and appreciation are due Mr. Amman Cook, Ray Robinson, Keith Martin, Al Stone, and Don Maltzahn, of the Southwest District of Bear Creek, for arranging the survey, organizing the geologic information, and assisting with the actual work. All hands were willing and anxious to help us in any way possible and it was a real pleasure to work in the Southwest District.

GEORGE R. ROGERS
Geophysics Division

GHR/el

cc - Amman Cook (1)
Ray Robinson (2)
T. R. Madden (1)
File (1)
Author (1)



GEOPHYSICS DIVISION
BEAR CREEK MINING COMPANY

INDUCED POLARIZATION SURVEY, PIMA AREA
RESISTIVITY VALUES

SCALE: 1" = 200' DATA BY: TRM DATE: OCT 1955
CONTOUR INTERVAL: LOGARITHMIC REVISIONS:

DRAWN BY: GRR DRAWING NO.: SW-2,502(1)

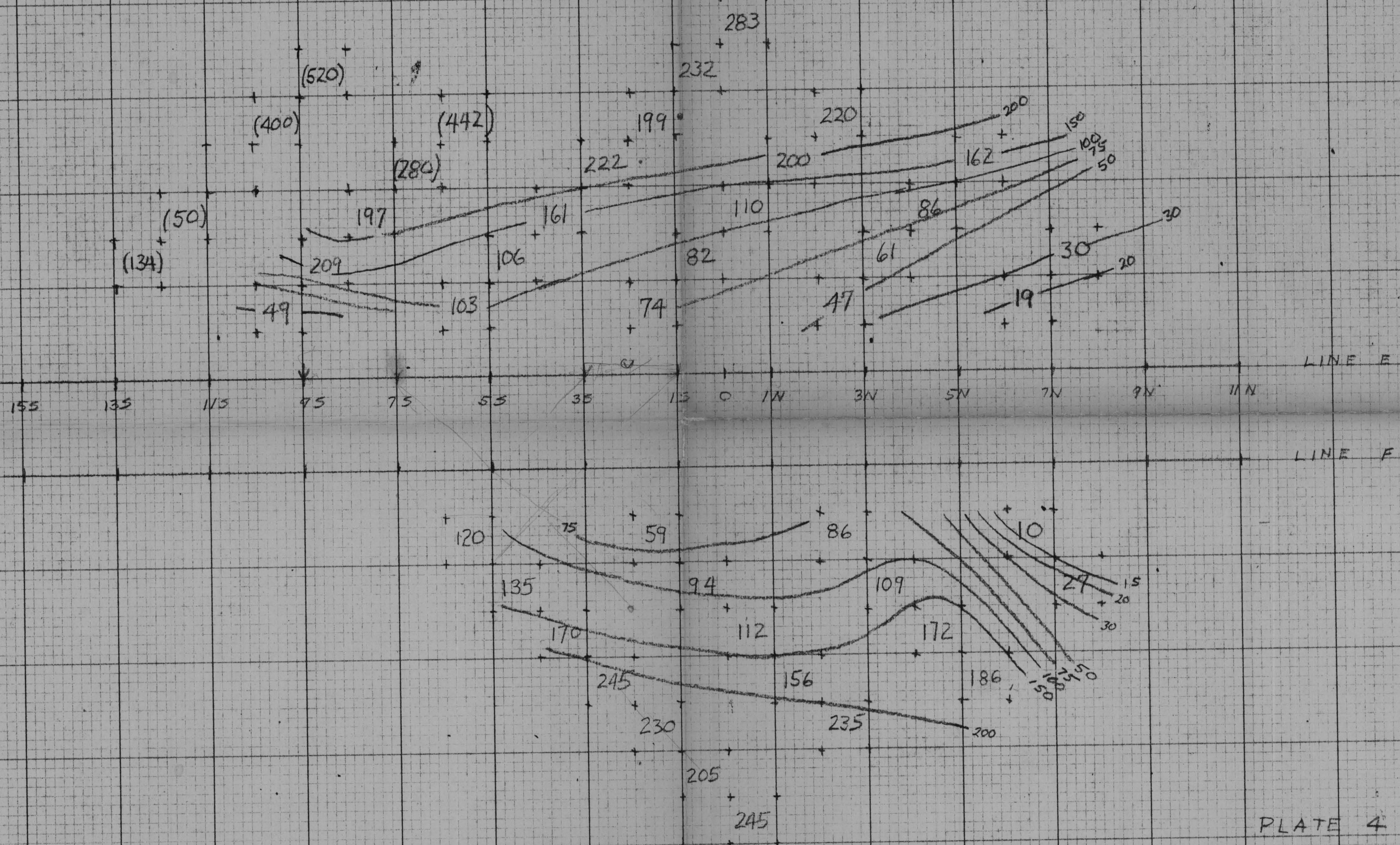


PLATE 4

**GEOPHYSICS DIVISION
BEAR CREEK MINING COMPANY**

**INDUCED POLARIZATION SURVEY, PIMA AREA
METAL FACTOR VALUES**

SCALE: 1"=200' DATA BY: TRM DATE: OCT 1955
 CONTOUR INTERVAL: LOGARITHMIC REVISIONS:

DRAWN BY: GRR DRAWING NO.: SW-2.502(2)

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"PERFECT" CROSS SECTION
100% CO. ONE INCH
EUGENE DIETZGEN CO.

STARPAT CO. WHITESTONE, N.Y. U.S.A.

IK/SK EM 1" = 10°; 200'

XMTR 400'
EAST OF F+00

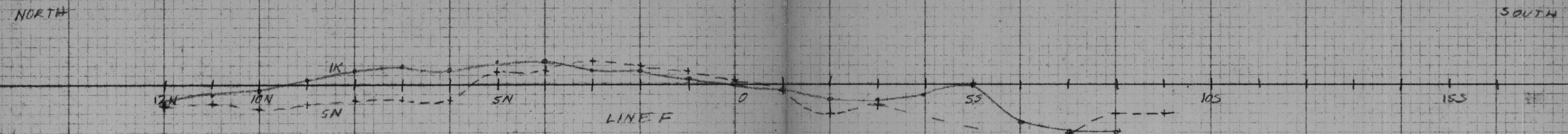


FIG. 2A

IK/SK EM 1" = 10°; 200'

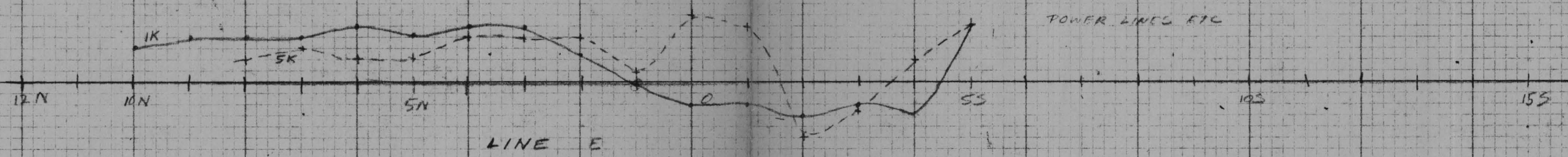


FIG. 2B

60 EM (POWER LINE)
ALL STRIKES SW 1" = 20°; 200'

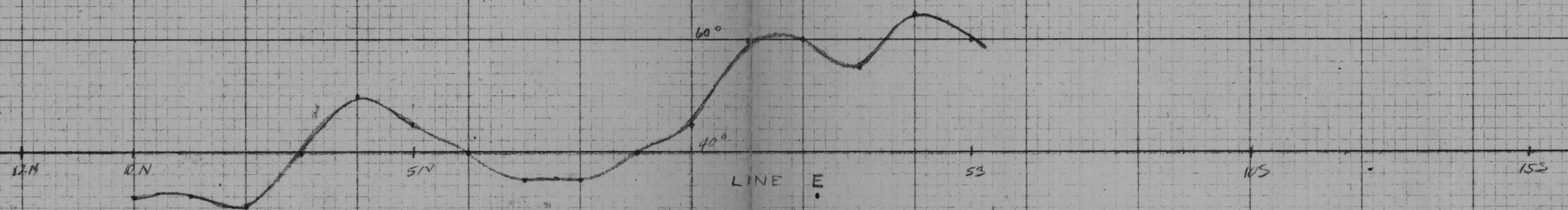
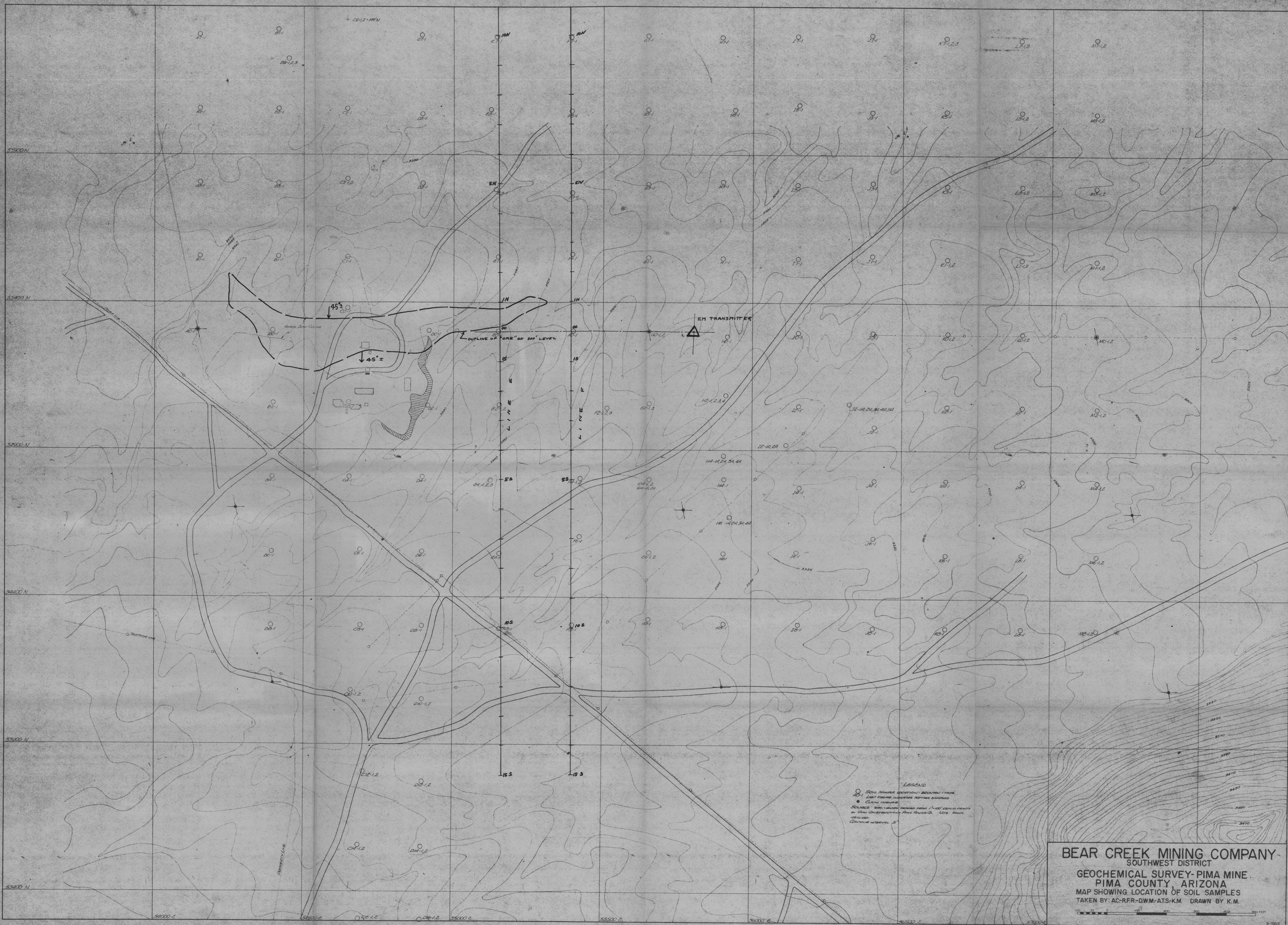


FIG. 2C

PLATE 2
PIMA MINE TEST

SW-2.501

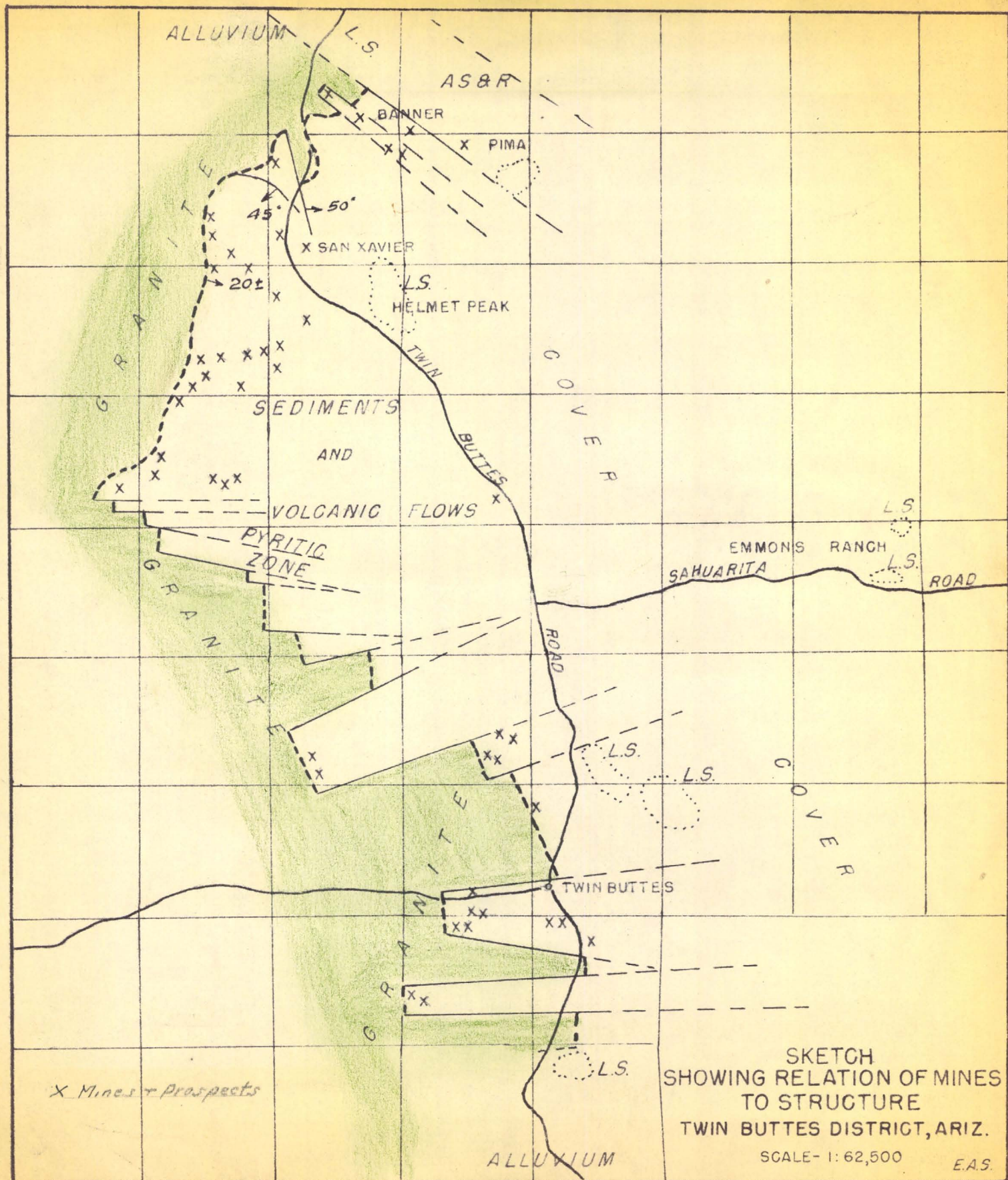


LEGEND
 ○ SOIL SAMPLE LOCATION - BEAUTIFUL - TREE
 △ EM TRANSMITTER
 ● CLIMATE CONTROL
 SOURCE: THIS MAP WAS PREPARED FROM 1:25000 SCALE MAPS
 OF THE U.S. GEOLOGICAL SURVEY. NOTE: ROAD
 WIDTHS
 CONTOUR INTERVAL 5'

BEAR CREEK MINING COMPANY
 SOUTHWEST DISTRICT
GEOCHEMICAL SURVEY-PIMA MINE
 PIMA COUNTY, ARIZONA
 MAP SHOWING LOCATION OF SOIL SAMPLES
 TAKEN BY AC-RFR-DWM-ATS-KM. DRAWN BY K.M.

0 100 200 300 400 500 600 700 800 900 1000 FEET

PLATE 1
 SW-2, 901



COPY

MINUTES OF SPECIAL MEETING
OF BOARD OF DIRECTORS
OF
PIMA MINING COMPANY

A Special Meeting of the Board of Directors of Pima Mining Company was held at 1200 South Waringo Avenue, Pasadena 5, California, at the hour of 10:00 o'clock A.M. on December 7, 1951, pursuant to the following Consent and Waiver of Notice:

WRITTEN CONSENT AND WAIVER
OF NOTICE OF SPECIAL MEETING
OF BOARD OF DIRECTORS OF
PIMA MINING COMPANY

We, the undersigned, being all of the Directors of Pima Mining Company, and desiring to hold a Special Meeting of the Board of Directors of said corporation, hereby give our written consent to the holding of said meeting at 1200 South Waringo Avenue, Pasadena, California, at the hour of 10:00 o'clock A.M. on December 7, 1951, for the purpose of authorizing the form of seal of the corporation, adopting the form of stock certificate to be used by the corporation, establishing the principal office of the corporation,

electing officers of the corporation, establishing a bank account for the corporation, authorizing qualification of the corporation to do business as a foreign corporation in the State of Arizona, authorizing application to the Commissioner of Corporations for permission to issue securities of the corporation, and for the purpose of transacting any and all other business which may come before the meeting.

We, and each of us, do hereby expressly waive any and all notice of the time, place, and purpose of said meeting.

WITNESS our hands this 7th day of December, 1951.

Herbert Hoover, Jr. (s)
Herbert Hoover, Jr.

H. G. Edwards (s)

H. G. Edwards

E. B. Spaulding (s)
E. B. Spaulding

Edw. G. Schenpf (s)
Edward G. Schenpf

E. A. Pielmeier (s)

There were present at the Special Meeting of the Board of Directors of Pima Mining Company, held at the time and place set forth in the aforesaid Consent and Waiver of Notice to said meeting, the following Directors:

Herbert Hoover, Jr.

W. G. Edwards

Edward G. Schenck

H. D. Spaulding

E. A. Pielessier

Directors absent:

None

Herbert Hoover, Jr. was requested to act as Temporary Chairman of the meeting and W. W. Cairns as Temporary Secretary.

The Chairman stated that the purposes of the meeting were as set forth in the foregoing Written Consent and Waiver of Notice.

The Chairman then stated that a seal had been obtained for the corporation, and submitted it to the Directors. Upon motion duly made, seconded, and unanimously carried, the following resolution was adopted:

BE IT RESOLVED, that the seal of this corporation, which has been presented at this meeting, be, and it is hereby adopted as the seal of this corporation, and that an impression of the same be placed in the margin of the minutes opposite this resolution.

The Secretary then presented to the meeting a suggested form of stock certificate for adoption by the corporation. Thereupon, on motion duly made, seconded, and unanimously carried, the following resolution was adopted:

BE IT RESOLVED, that the form of common stock certificate of this corporation, which form has been presented and read to the Board of Directors at this meeting, be approved and adopted, and that the Secretary of the corporation be instructed to insert a specimen of said certificate in the Minutes of this meeting.

The Chairman then stated that the Board of Directors should designate a principal office for the corporation. He suggested that 1200 South Marengo Avenue, Pasadena, California, be selected as such office. Thereupon, on motion duly made, seconded, and unanimously carried, the following resolution was adopted:

BE IT RESOLVED, that the principal office of this corporation be established and maintained at 1200 South Marengo Avenue, Pasadena, California, and that meetings of the shareholders and Board of Directors be held at that address, or elsewhere, as the Board of Directors may from time to time order by appropriate resolution.

The Chairman then stated that it was in order for the Board to elect officers for the corporation. After some discussion on the matter, on motion duly made, seconded and unanimously carried, the following persons were elected to the following corporate offices:

President	Herbert Hoover, Jr.
Vice President	W. G. Edwards
Secretary	E. W. Cairns
Treasurer	W. G. Noble
Assistant Secretary	D. H. Trempier
Assistant Treasurer	E. D. Spaulding

The Chairman then stated that bank accounts should be established for the corporation and suggested that such accounts be established in Pasadena, California and in Tucson, Arizona. Thereupon, on motion duly made, seconded, and unanimously carried, the following resolution was adopted:

BE IT RESOLVED, that this corporation establish in its name one or more deposit accounts with the First Trust and Savings Bank of Pasadena, upon such terms and conditions as may be agreed upon with said bank and that the Vice-President and Secretary of this corporation be, and they are hereby authorized, to establish such an account.

FURTHER RESOLVED, that E. A. Pielaszier, Director, and/or Edward G. Schempf, Director, and/or W. G. Noble, Director, and/or E. W. Cairns, Secretary, any two jointly, be, and they are hereby authorized, to withdraw funds of this corporation from the said account upon checks of this corporation, signed as provided herein with signatures duly certified to said bank by the Secretary of this corporation and said bank is hereby authorized to honor and pay any and all checks so signed, including those drawn to the individual order of any officer or other person authorized to sign the same.

After discussion of various banks in Tucson, Arizona, on motion duly made, seconded and unanimously

carried, the following resolution was adopted:

RESOLVED, that E. B. Spaulding, and/or W. E. Heinrichs, Jr., and/or Robert E. Thurmond, and/or E. H. Tremper, and/or H. G. Noble, Treasurer of this corporation, any two to sign jointly, be, and they are, hereby authorized to execute checks and other items for and on behalf of this corporation and that each of them, be, and he is, hereby authorized to withdraw checks and other items payable to this corporation for deposit.

RESOLVED, that this corporation establish in its any one or more deposit accounts with the Valley National Bank of Tucson, Arizona, upon such terms and conditions as may be agreed upon with said bank, and that the Vice-President and Secretary of this corporation be, and they are hereby, authorized to establish such an account.

RESOLVED FURTHER, that this corporation hereby agrees to the conditions printed in the bank book issued in connection with its account with the Valley National Bank, and to the By-Laws and rules of said bank, as to all deposits and withdrawals made on said account and as to other transactions with said bank.

The Chairman then stated that it would be necessary and advisable for the corporation to qualify to do business in the State of Arizona as a foreign corporation. After some discussion on the matter, on motion duly made, seconded, and unanimously carried, the following resolution was adopted:

BE IT RESOLVED, that the proper officer or officers of this corporation, be, and they hereby are, authorized and directed to take whatever steps they deem necessary or advisable in order to qualify this corporation to do business in the State of Arizona as a foreign corporation, including, but not limited to, the publication of the Articles of Incorporation of this corporation, the payment