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J. E. K.

MAR 26 1968

SAN XAVIER
DIAMOND DRILL HOLES

	D. D. Hole	Date Started	Date Completed	
Tract I	X-101	9-26-57	9-27-57	
	-102	9-27-57	9-28-57	
	-103	9-30-57	9-30-57	
	-104	10-1-57	11-4-57	
	-105	10-1-57	10-2-57	
	-106	10-2-57	10-5-57	
	-107	10-5-57	10-7-57	
	-108	10-7-57	10-8-57	
	-109	10-8-57	10-9-57	
	-110	10-10-57	10-11-57	
	-111	10-11-57	10-12-57	
	-112	10-14-57	10-14-57	
	-113	11-2-57	11-19-57	
	-114	11-4-57	11-18-57	
	-115	11-16-57	11-18-57	
	-116	11-18-57	11-25-57	
	-117	11-18-57	11-26-57	
	-118	11-19-57	11-26-57	
	-119	11-25-57	5-14-58	(Hole re-entered)
	-120	11-26-57	12-16-57	
	-121	11-29-57	12-9-57	
	-122	12-4-57	12-9-57	
	-123	12-10-57	12-13-57	
	-124	12-10-57	5-14-58	(Hole re-entered)
	-125	12-31-57	1-10-58	
	-126	1-8-58	1-15-58	
	-127	1-10-58	1-18-58	
	-128	1-11-58	1-27-58	
	-129	1-15-58	2-3-58	
	-130	1-18-58	2-4-58	
	-131	1-20-58	1-31-58	
	-132	1-28-58	2-3-58	
	-133	2-13-58	2-24-58	
	-134	2-18-58	2-24-58	
	-135	2-24-58	2-28-58	
	-136	2-28-58	3-18-58	
	-137	3-4-58	4-15-58	
	-138	4-24-58	5-10-58	
	-139	6-9-59	7-30-59	
Tract II	-140	8-1-59	8-5-59	
	-201	9-14-57		
	-202	9-14-57	10-29-57	
	-203	9-16-57	9-17-57	
	-204	9-16-57	4-23-58	(Hole re-entered)
	-205	9-18-57	9-18-57	
	-206	9-18-57	9-19-57	
	-207	9-19-57	9-20-57	
	-208	9-20-57	11-1-57	(Hole re-entered)
	-209	9-20-57	10-11-57	(Hole re-entered)

SE 7

p. 9

SAN XAVIER
Diamond Drill Holes

Tract II, (cont'd)

D. D. Hole	Date Started	Date Completed	
X-210	9-24-57	9-25-57	
-211	10-11-57	11-9-57	
-212	10-24-57	11-23-57	
-213	10-30-57	11-26-57	
-214	11-6-57	11-16-57	
-215	11-9-57	4-22-58	(Hole re-entered)
-216	11-20-57	12-16-57	
-217	11-23-57	1-10-58	
-218	11-26-57	12-9-57	
-219	11-26-57	12-14-57	
-220	12-3-57	12-19-57	
-221	12-10-57	1-10-58	
-222	12-13-57	12-17-57	
-223	12-14-57	1-13-58	
-224	12-18-57	1-17-58	
-225	12-19-57	12-19-57	
-226	12-19-57	12-21-57	
-227	12-21-57	12-31-57	
-228	12-16-57	12-20-57	
-229	12-21-57	12-28-57	
-230	12-28-57	1-4-58	
-231	1-2-58	2-13-58	
-232	1-4-58	1-7-58	
-233	1-11-58	1-25-58	
-234	1-14-58	1-31-58	
-235	1-18-58	2-15-58	
-236	2-1-58	2-8-58	
-237	2-5-58	2-12-58	
-238	2-4-58	2-13-58	
-239	2-4-58	2-18-58	
-240	2-13-58	2-21-58	
-241	2-13-58	3-25-58	
-242	2-15-58	2-26-58	
-243	2-21-58	2-28-58	
-244	2-24-58	3-3-58	
-245	2-27-58	3-19-58	
-246	3-19-58	4-5-58	
-247	3-18-58	3-26-58	
-248	3-19-58	5-15-58	(Hole re-entered)
-249	4-4-58	4-23-58	
-250	4-23-58	5-23-58	
-251	5-21-58	6-9-58	
-252	5-24-58	6-3-58	
-253	6-3-58	6-12-58	
-254	6-5-58	6-19-58	
-255	6-10-58	6-24-58	
-256	6-13-58	7-3-58	
-257	6-20-58	7-14-58	

SAN XAVIER
Diamond Drill Holes

Tract II, (cont'd)

D. D. Hole	Date Started	Date Completed
X-258	7-7-58	7-23-58
-259	7-15-58	8-12-58
-260	7-23-58	8-5-58
-261	8-5-58	8-13-58
-262	8-12-58	8-25-58
-263	8-13-58	8-23-58

Tract III

-301	12-23-57	1-8-58
-302	1-8-58	1-17-58
-303	2-10-58	2-15-58
-304	2-27-58	3-18-58

JEK

J. E. K.

SEP 0 6 1967

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

September 5, 1967

TO: T. A. SNEDDEN

FROM: J. E. KINNISON

SAN XAVIER, TRACT II
DRILL LOGS

The following data are presented in response to Mr. Peel's request for conclusions for the summary drill hole logs on Tract II. I did not provide conclusions originally because I thought that the logs themselves would be self-explanatory in this regard.

The exploration drill holes fall basically into three groups, representing three general objectives:

a) Those drill holes which lie on a direct projection of the Mission altered zone.

b) Those drill holes which are nearby the altered outcrops (described in logs X-101S and X-104), and located generally to the east, northeast, and southeast thereof.

c) Those holes drilled to explore the gap between objectives A) and B) above, and other miscellaneous outlying holes.

I trust the following will satisfy Mr. Peel's need for specific conclusions.

CONCLUSIONS

Of those holes drilled to fulfill the objective of group A above, the following sub-groups apply as indicated:

1) The following drill holes penetrated significant primary copper minerals of ore grade, in relatively shallow altered limestone and argillite:

X-254
X-202
X-211
X-246
X-245
X-215
X-229
X-221
X-233
X-224

CONCLUSIONS (cont'd)

2) The following drill holes penetrated a thin, but significant chalcocite blanket in argillite and porphyry, partly oxidized:

X-242
X-212
X-251
X-255
X-220
X-256
X-213
X-253
X-258

3) The following drill holes penetrated deep ore grade primary copper minerals, principally in altered limestone. The drill holes are widely spaced, and the significance of these intercepts in terms of ore is problematical.

X-213 (also see No. 2 above)
X-217
X-224 (also see No. 1 above)
X-231
X-250

4) The following drill holes penetrated altered pre-ore rocks which contained little or no ore grade copper intercepts. They do, however, represent a part of the Mission altered zone as it extends northerly on to the Reservation.

X-259
X-201
X-218
X-234
X-227
X-257
X-262
X-261
X-219
X-223
X-235
X-241
X-264
X-263
X-252
X-239
X-216
X-260

CONCLUSIONS (cont'd)

5) Drill hole X-236 penetrated essentially unaltered pre-ore rock. It lies beyond the limit of the altered zone and porphyry copper deposit of Mission and its extension into southern Tract II.

Those holes drilled to fulfill the objective of group B above, are readily divisible into the following sub-groups:

1) The following drill holes penetrated leached capping with significant ore grade secondary copper sulphide minerals in the form of a chalcocite blanket, partly oxidized. Some primary sulphide ore grade streaks also were intercepted.

X-238
X-244
X-247
X-237

2) The following drill holes penetrated altered rock which contains principally iron sulphide, and is peripheral to sub-group 1 above:

X-228
X-208
X-229
X-230
X-232
X-247
X-240
X-243
X-209
X-206

3) The following holes penetrated unaltered or very weakly altered pre-ore rock peripheral to sub-group 2 above. These holes lie beyond the porphyry copper deposit delineated by drilling in the central portion of Tracts I and II.

X-205
X-210
X-207

Of those holes drilled to fulfill the objectives listed under group "C" above, the following sub-groups are pertinent:

CONCLUSIONS (cont'd)

1) The following holes penetrated post-ore rocks only, located geographically between exploration objectives as enumerated in A and B above. As a group, and considered with other factors, there is no reason to expect a porphyry copper ore deposit beneath these holes.

X-226
X-204
X-203
X-249
X-248

2) The following two holes penetrated unaltered or very insignificantly altered pre-ore rocks. These are beyond the margin of any porphyry copper deposit:

X-225
X-222

3) Drill hole X-214 penetrated only post-ore rock. Considered with the results from other drill holes, there is no reason to expect an ore deposit beneath this hole.

John E. Kinnison

JEK:mc
cc: JHCourtright
RBMeen
TASnedden - Orig. + 4 extra copies

Drilling exp. Capsule

J. E. K.

AUG 08 1967

6 line Laymans terms
all holes
all tracts

Request by Lawyers Re SX North suit

out in general core (all holes in effect are for this purpose)

X-102S

Purpose: To explore for a porphyry copper deposit.

The drill penetrated alluvium with a rotary bit to 120 feet. A diamond drill cored post-ore conglomerate from 120-126 feet. Bedrock, from 126 feet to total depth of 129 feet, ~~This~~ is arkose, very weakly altered with trace quantities of iron sulfide.

Conclusion: The alteration and trace of disseminated iron sulfide is insignificant. The hole is beyond the margin of any porphyry copper deposit.

background — not labeled as such. Just a ¶ at beginning if needed.

Purpose: There are numerous very small outcrops in section 27 - part pre-ore, part post-ore basalt. The abundance there of oxide of iron suggested a mineral deposit beneath, but other characteristics of a leached capping over disseminated sulfides is lacking.

was tested at the surface — no use - drilling tech term

The hole (was collared) in a pre-ore outcrop, and penetrated by diamond drill pre-ore rocks to 168 feet. From 168-196 feet the drill penetrated the basement fault zone. From 196 feet to total depth of hole at 227 feet the drill penetrated unmineralized pre-mineral rock.

awkward but no objection by Lawyers.

Conclusion: The iron oxide in the scattered outcrops does not overlie sulfides. This vicinity will not contain an ore deposit.

26th Deadline
21 to typist (Monday)
Finished and Mail 18th (Fri)
Today the 9th wed.
Typing currently —
finish for review edit (also currently?)
8 days, leaving all Friday
for any final changes.

General Terms

Geology. I suggest that this term be avoided if possible. Just what is geology? It has to do with everything in the earth from the center to the surface. It is a broad term which leads into ambiguous usage. What, for example, is a geologist? There are many specialities within the profession of geology. I operate as a "mining geologist." Professionally, what does this mean? These are difficult terms to define and I caution against the use of these words where they may be avoided.

See transmittal page & pg 3 ¶ 2, for statement of cost distribution by tract

GEOPHYSICAL DIVISION
3422 South 700 West
Salt Lake City, Utah

August 1, 1966

J. E. K.
MAR 25 1968

Mr. Robert Richter, Assistant Comptroller
New York Office

GEOPHYSICS
SAN XAVIER INDIAN RESERVATION

Dear Sir:

My memorandum of this date, concerning the subject matter relative to the tax write-off, is enclosed. Time and cost accounting was handled by the Tucson office and their figures should be more accurate than any judgment that can be obtained through the percentage figures of survey coverage on property retained. Survey coverage and anomalous features interpreted from the geophysical data are described relative to the federal survey control. The descriptions could have been shortened considerably if they could be illustrated on maps.

done - April 1st '68 R.H.L. San Xavier reservation tracts 1 & 2

I hope that the enclosed will be of some assistance in your study of the problem.

Very truly yours,

R. J. Lacy

R. J. LACY

RJL:ao
Enc.

2 copies of this letter together with the memorandum above-referred to were made in N.Y. Office for Mr. C. P. Pollock.

GEOPHYSICAL DIVISION
3422 South 700 West
Salt Lake City, Utah

August 1, 1966

CONFIDENTIAL

GEOPHYSICS
SAN XAVIER INDIAN RESERVATION

INTRODUCTION:

The Mineral Hill Mine, about one mile south of the San Xavier Indian Reservation and several old mines in the Twin Buttes area six miles to the south, in low outlying foothills of the Sierritta mountains had been operated sporadically for many years. United Geophysical Company discovered the Pima deposit east of the Mineral Hill Mine under 200± feet of gravel and sand valley fill (alluvium) by the application of geophysical methods. ASARCO later discovered a more or less northward extension of the Pima deposit. This ore deposit, called the Mission Mine, is immediately adjacent to the San Xavier Indian Reservation entirely under 200± feet of alluvium. The eastern edge of the deposit was known to extend into the Indian Reservation. The only outcrops on the reservation north of the Mineral Hill, Pima and Mission complex of ore deposits are some small hills of post-mineral volcanic and conglomerate rocks in the southwest corner of Tract 1 and two small, low knobs of altered pre-mineral arkose and monzonite with iron oxides derived from sulphides in the northeast corner of Section 23 in Tract 1. The alluvial cover ranges from .0 to 100 feet or so in the southwest part of Tract 1 and thickens north and east to 200 feet or more.

Prospecting is a matter of elimination of areas that are geologically unfavorable or uneconomic due to physical factors as much as it is evaluating known mineral deposits. When a potential geologically favorable area is covered with alluvium or post-mineral rock, the process of elimination requires extensive drilling or geophysical surveys and less extensive drilling. In the latter case the geophysics indicates targets for drilling to check depths to various horizons and geological information to verify one or the other alternate interpretations of the geophysical results. These cross geological-geophysical correlations build up until the geophysical interpretations are firm and can be extrapolated over large areas with only occasional drilling checks. The point here is that geophysics is not a complete substitute for geological information obtained by drilling and that every hole drilled serves a real purpose in the elimination process involved in exploration in alluvium and post-mineral rock covered areas.

Geophysics can indicate base metal sulphide mineral deposits indirectly through magnetic surveys (sulphides associated with magnetite and pyrrhotite),

gravity surveys (sulphides associated with heavy lime silicates and massive sulphides), electromagnetic surveys (massive sulphides and metallic sulphide veins and veinlet complexes) and induced polarization surveys (metallic sulphides in disseminated, vein or massive replacement forms). They seldom, however, give any indication of grade or detailed geometry unless the former is directly proportional to the density contrast or percent sulphide concentrations by volume (induced polarization). In any case, the development drilling is necessary for purposes of economic evaluation and engineering aspects of the mineral deposit.

The following geophysical methods applied on the San Xavier Indian Reservation are listed below along with survey periods and percent of total coverage that was done on property retained.

Method	Survey Period	% of Survey on Property Retained
Magnetic (Aeromagnetic	July 17-22, 1956	--
(Ground Mag-	September 1957	64%
(netics		
Gravity	Oct.-Dec. 1957	23-2/3%
Electromagnetic	July 1957-Jan. 1958	40%
Induced Polarization	Feb.-March 1958	--

The aeromagnetic survey was very useful in eliminating areas with excessive thickness of alluvium and post-mineral volcanic rock cover wherein deposits could not be mined by open pit methods. The survey was conducted well before the permit date, however, and the area of the three tracts is an infinitely small percentage of total survey coverage which cost about $14,000.00.

Gravity, with a little more drilling necessary to indicate the correlation, served the same purpose of eliminating areas with excessive alluvium and post-mineral volcanic rock cover. It did indicate an additional non-magnetic post-mineral rock (conglomerate) and thus extended the unfavorable areas.

The gravity method also serves to indicate the thickness of the post-mineral rocks better than the magnetic method.

The electromagnetic method served no purpose in eliminating areas and, in the positive sense, did not indicate any metallic sulphide conductors as the sulphide occurrence was geometrically unfavorable to the application of this method.

The induced polarization survey was a test on the Mission property and on the San Xavier Indian Reservation entirely within the boundaries of property retained. This test, even though the results were good, was conducted after drilling had outlined the Mission deposit and its extension into the south edge of the Indian Reservation.

The percentage of survey coverage on property retained is quite accurate, but may not reflect variations in line footage of production per day due to physical problems. Personnel and wage and salary variations are obviously unobtainable from the percentage figures given. The time and cost accounting was handled by the Tucson office and their figures should be more accurate.

MAGNETIC SURVEYS

DESCRIPTION OF METHOD:

The Earth's magnetic field can be described by assuming a bar magnet at a small angle to the axis line between the north and south poles. The magnetic flux lines therefore are horizontal near the equator and have increasing inclinations in the north and south latitudes to 90° at the magnetic north and south poles. The horizontal declination of the earth's magnetic field in the Tucson area is 13° to 14° east of true north; its inclination from the horizontal is 59° north and the total magnetic intensity is approximately 50,800 gammas. The magnetometers used on the San Xavier Indian Reservation surveys can measure to an accuracy of 1 gamma so that on the order of 1 part in 50,000 parts of the earth's field can be measured.

Local deviations in the magnetic field are caused by magnetic susceptibility variations in the earth's crust due to variations of magnetic mineral content. The magnetic mineral of interest in the alluvium and rocks on the San Xavier Indian Reservation is magnetite. Igneous rocks that intruded sedimentary rocks and were extruded on the surface in the form of hot molten magmas and flows, usually contain accessory magnetite on the order of a few percent. The detection of igneous rocks in contrast to most sedimentary rocks with little or no magnetite content is therefore possible through magnetic measurements with sensitive magnetometers. Some types of base metal sulphide deposits are associated with appreciable quantities of magnetite gangue mineral and are thus detectable as well. Thin layers of magnetite in alluvial fans and stream beds can be deposited in sand and gravel valley fill material by erosion of igneous rocks and magnetite deposits from mountains and foothills. As the magnetic field decreases inversely, and exponentially with distance, the effect of these thin layers of magnetite can be minimized by increasing the altitude of the plane of measurement. The effect of massive magnetite deposits and large bodies of igneous rock underlying the alluvium will not decrease as much with distance and may then be more clearly detectable.

SURVEY COVERAGE AND RESULTS:

A request for authorization to conduct airborne geophysical surveys over the San Xavier Indian Reservation, among other areas in the Avra and Santa Cruz valleys, was made on May 31, 1956. Both the airborne magnetic and electromagnetic methods were recommended on the basis of successful ground tests of these methods in the Pima and Silver Bell areas. The request was approved on June 6, 1956. Preliminary tests of the airborne electromagnetic system were negative and this method was eliminated from the contract. The aeromagnetic survey of all areas, including the San Xavier Indian Reservation, was flown during the period July 17-22, 1956. Specifications were 1/4 mile spacing between north-south flight lines at 500 feet mean terrain clearance. Therefore 96 line miles were flown over the three tracts on the San Xavier Indian Reservation.

A preliminary report, dated October 6, 1956, was submitted in which it was stated that interpretation of the aeromagnetic results indicated that most of Tract 3 (excluding Section 28 and the south 1/2 of Section 29) was underlain by post-mineral volcanics at depths exceeding 200 feet and having a thickness exceeding 200 feet. A similar interpretation was made for the south 1/2 of Section 19, the south 1/8 of Section 24, the north 1/2 of Section 30 and a southwest strip diagonally across Section 25 including all but a little less than the NW 1/4 and a strip along the south border. It was concluded that no ore deposit at depths ammenable to open pit mining could exist within these volcanic flow areas.

During the latter half of June 1957, 167,100 line-feet of ground magnetic surveys were run on Tracts 2 and 3, primarily in Section 30, T16S, R13E; Sections 25 and 26, T16S, R12E; and the south 1/4 of Section 24, and southeast 1/4 of the southeast 1/4 of Section 23, T16S, R12E. The part of this survey within the boundaries of ground retained constitutes 64% of the total. Since thin layers of magnetite in the alluvium caused extreme "hash" in the data, the ground surveys were terminated and more reliance was placed on the aeromagnetic survey.

(1) In a report dated August 23, 1957, entitled "Magnetics-Airborne and Ground", it was suggested that the magnetic high trending southeast from the center of Section 25, T16S, R12E through the southwest corner of Section 30 could represent copper mineralization associated with magnetite along the projection of the Mission orebody. A hole was recommended at this location. Holes were recommended at the center of Section 25 in Tract 2 and near the southeast corner of Section 26 in Tract 1 to check the interpretation of and depth to volcanics.

(2) In a similarly titled letter dated September 11, 1957, a magnetic high trending southwest into Sections 13 and 18 in Tract 2 is noted and interpreted as another peninsula of post-mineral volcanic flow underlying the alluvium. A hole was recommended off the southwest nose of this anomaly near the two small outcrops of altered arkose and monzonite in the northeast

part of Section 23. Another hole was recommended about 1,200 feet east of the center of Section 15 in Tract 1 to check a magnetic high that could be interpreted as volcanics or possibly magnetite associated with copper mineralization. The former was drilled as a matter of evaluating mineralization near the two outcrops and the latter was drilled and volcanics verified.

In a memorandum dated December 13, 1957, the following was stated: New theoretical calculations in light of the drill hole data (shallow drilling that verified interpretation of post-mineral volcanics and indicated depth of alluvial cover in the center and southwest corner of Section 25 in Tract 2) suggest a thickness of volcanics of 150 feet near the center of Section 25, of 50-75 feet near the southwest corner of Section 25 and 300 to 400 feet northeast of the center of the section. A hole was suggested in a magnetic low at the northeast corner of the southwest 1/4 of the southwest 1/4 of Section 20 in Tract 3 to test for the possibility of pre-mineral rock windows in the volcanics. Another hole near the center of Section 29 in Tract 3 was recommended to check a southeast trending magnetic high for possible copper mineralization associated with magnetite similar to the condition at the south part of the common Sections 25 and 30 line in Tract 2.

CONCLUSIONS:

The magnetic surveys served to indicate areas underlying the alluvium and the order of magnitude of thickness of these rocks. Some shallow drilling was required to check the interpretation of post-mineral volcanics and the depth of alluvial cover to refine the calculation of thickness of these rocks. Some drilling was necessary to check the alternate interpretations of isolated magnetic highs as volcanics or copper mineralization associated with magnetite and all but one of these were indicated as caused by volcanics. The point is that all of these holes were necessary and served a purpose in a negative sense concerning mineralization, but an impractically large number of holes would have been necessary for this purpose without the magnetic surveys.

GRAVITY SURVEYS

DESCRIPTION OF METHODS:

Gravity meters are used to detect variations in the density of subsurface materials in the earth's crust. They are capable of measuring one part in ten million parts of the earth's gravitational field. Relative gravity contour maps are reduced to a base elevation and this requires elevation survey control within a foot or less at all stations. It is often possible to indicate bedrock topography underlying alluvial cover and distinguish between rock types that have density contrasts. Massive sulphide and magnetite deposits may result in local gravity highs. Heavy lime silicate gangue minerals associated with disseminated and lensy iron and copper sulphide mineralization in the Mission deposit resulted in gravity highs over that deposit.

COVERAGE AND RESULTS:

Gravity surveys were conducted on the San Xavier Indian Reservation during the period October 1957 to January 3, 1958. North-south lines 21,120 feet long, approximately 580 feet apart, were surveyed on approximately 290 foot station intervals on all of Tracts 1 and 2 and the west edge of Tract 3. The thirty-six lines on Tracts 1 and 2 and two lines on Tract 3 constitute a total of 802,560 feet. Five east-west lines 8,300 feet long (totaling 41,500 feet) and 4,000 feet apart were surveyed on approximately 580 foot station intervals on Tract 3. Total footage, then, is 844,060. The line-feet of survey within the property retained is 199,740, constituting 23 2/3% of the total survey.

The following was stated in a preliminary report dated October 17, 1957. A gravity high in the southeast corner of Section 25, Tract 2 is west of the East Boundary Fault (indicated by drilling and gravity results on the Mission Mine property to the south) and could indicate heavy lime silicate gangue minerals associated with copper mineralization. Note that there was also a magnetic high here suggesting copper mineralization associated with magnetite gangue (report dated August 23, 1957, titled "Magnetics-Airborne and Ground"). It was noted that a hole currently being drilled would test this interpretation. The hole later intersected ore grade copper mineralization with heavy lime silicate and magnetite gangue. A gravity high in the southeast 1/4 of the southwest 1/4 of Section 30 in Tract 2 was interpreted as a bedrock hill as it was east of the Boundary fault (there was no magnetic high at this position). A hole drilled to test this interpretation against the alternate interpretation of heavy lime silicate, encountered unmineralized bedrock at 134 feet, rather than the usual ± 200 feet of alluvium. The negative gravity feature in Tract 2 trending southwest and bounded by a fault on the south from the center of Section 30 through a point 2,000 feet west of the common line between Sections 25 and 30 and 1,000 feet north of the south line of Section 25; and by a fault on the northwest side striking southwest from a point 2,100 feet east of the northwest corner of Section 19 through a point 1,200 feet east of the northwest corner of Section 25 corresponds to the magnetic anomaly interpreted as thick post-mineral volcanic flow. The boundaries are steeply dipping, suggesting a volcanic-filled down-faulted block. The area north of this block is interpreted, both from gravity and magnetic surveys, as pre-mineral bedrock with a few bedrock hills and the only two outcrops of pre-mineral rock (the altered and mineralized arkose and monzonite in the northeast corner of Section 23) on the three tracts. Gravity irregularities in the southwest part of Tract 1 were interpreted as due to variations of gravel thickness in a near outcrop environment.

In a letter dated December 19, 1957, titled "Geophysics (Magnetic & Gravity)", a progress report of magnetic interpretations in the light of new evidence, dated December 13 and a progress report concerning the results of the gravity survey, dated December 10, were summarized. Another fault had been interpreted from the gravity results as this survey progressed north. This fault strikes west-southwest from a point about 2,100 feet

north of the south common corner of Sections 18 and 13 to a point about 600 feet north of the south common corner of Sections 14 and 15. The eastern part of this fault corresponds to the south boundary of the northernmost peninsula interpreted from the aeromagnetic survey as post-mineral volcanic flow rocks. Interpretation of the gravity and aeromagnetic surveys, supplemented by a few shallow drill holes, indicated a thickness of at least 600 feet of post-mineral volcanic flow and caliche conglomerate underlying approximately 150 to 200 feet of alluvium north of this fault. A similar thickness was interpreted for the southernmost peninsula of post-mineral volcanics between the fault striking southwest from the northwest corner of Section 19 to the southwest corner of Section 24 and the fault extending from the center of Section 30 through the south central part of Section 25. Besides these, the entire area east of a line about 2,200 feet east of the center of Tract 2 was interpreted as post-mineral volcanics exceeding a thickness of 600 feet under 200± feet of alluvium. This left a 6,000 foot wide strip of pre-mineral bedrock, covered by 0 to 200± feet of alluvium, trending southwest from about the north-central third of Tract 2 through the southwest part of Tract 1. A few possible windows of pre-mineral rock to the east were to be checked by drilling. Small remnants of volcanic flow could be anticipated in the southwest part of Tract 1. Except for a few shallow holes and one or two deep holes to check this interpretation, the drilling could be confined to the north extension of the Mission deposit along the south edge of Section 2[illegible] and southwest corner of Section 30 in Tract 2 and to the relatively shallow pre-mineral rock area described above. A great deal of shallow-hole and some deep-hole drilling would have been necessary to eliminate the area of thick post-mineral rock without the magnetic and gravity surveys. Except for the indication of the heavy lime silicates and magnetite associated with copper mineralization in the south part of Section 25 in Tract 2, the gravity and magnetic surveys did not result in any interpretation related to sulphide mineralization. The mineralization in the east central part of Tract 1 and west central part of Tract 2 is largely disseminated sulphides in arkose and monzonite and therefore there is no density or magnetic contrast between the mineralized and unmineralized pre-mineral rocks.

ELECTROMAGNETIC SURVEYS

DESCRIPTION OF METHOD:

The electromagnetic surveys conducted on the San Xavier Indian Reservation were done with the dip-angle technique. A vertical transmitter coil, with its plane oriented toward the receiving coil produced the primary electromagnetic field. The receiving coil measured the dip-angle of the primary field (horizontal at the receiver station) plus the dip-angle of any secondary field from electrically conductive sub-surface media. Maximum coupling for this system is obtained with steeply dipping planar conductive media and coupling with flat dipping media is minimum. Electrical continuity of the conductive media is necessary over at least one half the transmitter-receiver separation and preferably equal to the separation for adequate correlation of curves between adjacent profile lines. The trans-

mitter-receiver separation should be approximately twice the depth to the top of conductive media. An alluvial cover of 200± plus leached caprock requires a loop separation of at least 500 feet. Conductive media would include massive sulphides, metallic sulphide veins or veinlet complexes; moist fault gouge, graphite and permeable rock contacts.

SURVEY COVERAGE AND RESULTS:

Tracts 1 and 2 were surveyed along north-south lines 1,160 feet apart extending 12,000 feet north from the south edge of the San Xavier Indian Reservation, during the period July 1957 through January 1, 1958. One of these lines was surveyed on the west edge of Tract 3. A few intermediate lines and some east-west lines were surveyed. Power line interference eliminated a 3,000 to 5,000 foot strip trending southwest through the central part of this survey area. Total line footage surveyed at 100 foot stations was 298,000 and 118,000 feet, or approximately 40% was within the property retained. All electromagnetic anomalies indicated could be attributed either to fault zones or to permeable pre-mineral rock contact zones. Although a few holes were recommended on electromagnetic anomalies, the electromagnetic surveys did not contribute positive or negative information to the exploration program on the San Xavier Indian Reservation.

INDUCED POLARIZATION SURVEY

DESCRIPTION OF METHOD:

The induced polarization method used on the San Xavier Indian Reservation involved the introduction of a current pulse (4-8 seconds) between two metal electrodes in the ground and measuring the electrical resistance potential between two porous pot electrodes between the current electrodes. Conductive minerals, such as metallic sulphides, block the electrolytic current paths (carried by ionized ground waters) and a charge is built up on their surfaces. The current is then turned off and the potential of the discharge (decay of the induced polarization) is measured. This measurement is proportional to the aggregate surface volume of the metallic sulphides. The potential electrodes were 400 feet apart and the current electrodes were 400 feet on either side of the potential electrodes, making a total lineal spread of 1,200 feet. This electrode array was traversed along survey lines and measurements were made at 200 foot station intervals.

SURVEY COVERAGE AND RESULTS:

An induced polarization test survey was conducted on the Mission deposit south of the San Xavier Indian Reservation and on its extension into the reservation. A block of ground approximately 7,300 feet long (east-west) and 1,800 feet wide (north-south) was surveyed in Tract 2 along the south edge of the Indian reservation centered at the common line between Sections 25 and 30. This constitutes approximately 50% of the Mission-San Xavier induced polarization test survey. The survey outlined the sulphide concentrations very well, except for an induced polarization lobe extending

east (axis along south boundary of reservation) of the gravity and drilling indicated East Boundary Fault. Sulphide mineralization associated with heavy lime silicates could not exist above a depth of about 700 feet here, so this was interpreted as possibly a pyritic zone in siliceous clastics such as arkose.

Since the drilling on the northern extension of the Mission deposit along the south edge of the reservation had already outlined the deposit, the induced polarization survey did not contribute to the program. A few test lines were run in the mineralized area in Sections 23 and 24, but unusually strong fluctuating natural earth currents interferred with the signal here. Instrumentation and techniques to minimize this problem was developed at a later date.

R. J. Lacy

RJL:ao

R. J. LACY
Chief Geophysicist

WESTERN MINING DEPARTMENT
Salt Lake City, Utah

December 19, 1957

J. E. K

MAR 25 1968

AIR MAIL

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

SAN XAVIER INDIAN RESERVATION
PIMA COUNTY, ARIZONA
GEOPHYSICS (MAGNETICS & GRAVITY)

Dear Mr. Hart:

This is to submit Mr. J. W. Erwin's report of December 13 and comment on it, as well as Mr. Saegart's report of December 10 concerning the results of the gravity survey (latter already distributed). I agree with the conclusions and recommendations in both.

Mr. Erwin's report constitutes a progress report of magnetic interpretations in the light of new evidence. Mr. Erwin, in his first report on Block I of the Avra Valley aeromagnetic project, interpreted an outline of basic volcanics with a general thickness on the order of magnitude of 200 feet or so. This information was submitted prior to the bidding on the reservation tracts and later served definitely to eliminate this area in the shallow drilling program. Subsequent ground magnetic checks, shallow drilling results, and magnetic susceptibility determinations on core samples served to verify an alternate interpretation of volcanics and outlining of these along the west and north parts of the project area. All other basic volcanics intersected are likely to be small remnants. The acid volcanics, phaneritic intrusives (such as latite) and monzonite would not be indicated magnetically, but any of the post mineral igneous rocks in this group are again likely to be of small dimensions, as so far largely confirmed by the drilling to date. Nothing direct, other than the ZZ366 south-trending nose attributed to magnetite associated with sulfide mineralization, is inferred. A hole is recommended at O-368 to protect against a very much more doubtful possibility of this nature. A second hole is recommended at M-372 to protect against a "window" in the basalt flow.

The interpretation as to thickness of basalt flow has been refined to include the variation of thickness and increase the certainty of this postulation. This is a result of the supplemental ground magnetic, magnetic susceptiblity, and shallow hole drilling depth and lithology data.

The gravity map, besides verifying the magnetic outlining of the volcanic flows, confirms the thickness estimate as well where these coincide. In addition the gravity indicates the distribution of the post-mineral red conglomerate (San Xavier formation?). Whatever geologic structure in the pre-mineral rocks controlled the differential erosion pattern of northeast trending valleys, the distribution of the post-mineral volcanics and conglomerates and the order of magnitude of their thickness in these valleys is indicated by the gravity and magnetic surveys. A great deal of shallow-hole, and some deep-hole drilling would have been necessary to accomplish this without geophysics.

Mr. Saegart recommends holes at D-366.0 and UU-376.8 as very doubtful bets as protection against missing a possible heavy silicate zone. Both are primarily interpreted as bedrock hills; the former especially in that it should be in unfavorable clastics in the footwall of the thrust fault indicated by the closely spaced contours along the east edge of the East Pima deposit.

The chances for location of the favorable calcareous Pima formation at relatively shallow depths (within possible economic pit limits) now appear, on the basis of both geological and geophysical evidence, to be rather slim, except where it has been indicated by both as the northwest extension of the East Pima deposit at the south edge of the reservation. There are still a few possibilities to be investigated, however.

Very truly yours,

R. J. LACY

RJL:si
cc:K.E.Richard, w/enc.
W.E.Saegart, "
B.C.Morrison, "

J. E. K.

MAR 25 1968

December 13, 1957

MEMORANDUM TO: Mr. R. J. Lacy

SAN XAVIER INDIAN RESERVATION
Magnetics

SUMMARY AND RECOMMENDATIONS

1. Correlation between igneous rock susceptibilities and the magnetics is good. Lack of indicated magnetics over holes containing basalt can be explained by low susceptibility or by the lack of sufficient mass of basalt to create magnetic anomalies.

2. New theoretical calculations in light of the drill hole data have altered the original calculated thickness of volcanics southwest of WW368. A thickness of 150 feet is indicated at WW368 thinning to 50-75 feet at QQ366. East of WW368 the volcanics appear to thicken to 300-400 feet.

3. To test for the possibility of windows in the volcanics east of A, a shallow hole is recommended at M372.

4. The southeast-trending nose at ZZ366 can be attributed to a tactite-magnetite zone. Correspondingly, a change in the volcanic edge is shown on the revised interpretation sheet.

5. The south-trending nose at 0365-368 should be tested for a possible repetition of the ZZ366 south-trending nose. A drill hole is recommended at 0368.

6. A test magnetometer profile is recommended along 376N from EE to 00 for thickness calculation purposes.

DISCUSSION

Susceptibilities measurements have been made by Mr. B. C. Morrison on all igneous rock encountered in San Xavier drill holes up to November 1, 1957. The following results are taken from Mr. Morrison's letter of November 1, 1957 to you:

Hole No.	Depth	K x 10^6	Character
X-101-S	133	15.2	Pyroclastics, altered
X-105-S	133	114.7	Basalt porphyry
X-106-S	214	107.1	Basalt porphyry, altered
X-107-S	145	14.1	Latite or quartz latite, altered
X-109-S	178	564.7	Basalt
X-110-S	153	715.1	Basalt porphyry, altered
X-111-S	143	14.5	Quartz monzonite, altered
X-203-S	183	298.7	Basalt porphyry
X-204-S	209	430.9	Basic volcanic
X-205-S	159	8.3	Acid volcanic
X-206-S	155	12.7	Pyroclastic
*X-115-S	139	?	Basalt

*-information by phone call.

I believe these data can be grouped according to magnitude of susceptibility as follows:

K x 10^6	Holes	Character
298.7-715.1	X-109-S	Basalt
	X-110-S	Basalt porphyry, altered
	X-203-S	Basalt porphyry
	X-204-S	Basic volcanic
107.1-114.7	X-105-S	Basalt porphyry
	X-106-S	Basalt porphyry, altered
8.3-15.2	X-101-S	Pyroclastic, altered
	X-107-S	Latite or quartz latite, altered
	X-111-S	Quartz monzonite, altered
	X-205-S	Acid volcanic
	X-206-S	Pyroclastic

Accordingly, an evaluation can be made of the magnetic intensity map in light of the above results.

Holes X-109-S(QQ366), X-110-S(MM366), X-203-S(SS368), and X-204-S(WW368) contain igneous rock of high susceptibility (according to the above classification) and with the exception of X-110-S(MM366) correlate with the magnetic high. Ground magnetics did yield an isolated +150 gamma anomaly at MM366 (site of X-110-S). Since isolated anomalous values are usually caused by sources of small size, it is probable that the basalt encountered in X-110-S is a remnant separate from the main mass to the east. Absence of any indication on the airborne intensity map supports the small source contention. In all likelihood other such remnants exist on the Indian ground which might or might not be detected by ground magnetics. Further, interpretation of these small, isolated values is misleading because the source could be within the alluvium. Holes X-105-S and X-106-S encountered basalt with susceptibilities in the lower range of 107.1-114.7 x 10^{-6}. The fact that these values are 3 to 7 times less than the values of susceptibility found in the previous four holes very likely explains the lack of indicated airborne magnetics here. A test profile along 376N from 00 to EE might provide data for thickness calculations. I would recommend that such be done to check against a thickness effect.

It appears that the anomaly at EE378 has been satisfactorily explained by the basalt in hole X-115-S. With this information and the aid of a residual map of the entire block I magnetic map, I have added the interpreted volcanic edges for this general area to the San Xavier Total Intensity Map, etc. 8-57, Revised 12-57. The gentle gradients to the north of 380N indicate increasing depth in that direction, which is probably the case except in the vicinity of the A line and east. The lack of magnetic indications in the region of the remaining holes X-101, 107, 111, 205, and 206-S can, I believe, be adequately explained by the very low susceptibilities of the rock in these holes.

I have made some theoretical calculations on horizontal slabs assumed to approximate the northeast-trending basalt in order to arrive at a calculated thickness. The assumed widths of 1000, 3000, and 6000 feet were through lines QQ, WW and G, respectively.

Assumptions for Horizontal Slab

Width -	1000, 3000, 6000 feet
Depth to top -	200 feet
Flight altitude -	500 feet
Inclination of earth's field -	60°
H.-horz. component -	26,000 γ
V.-vert. component -	43,000 γ

Actual values of ∠Z were taken and susceptibilities were calculated for various assumed thicknesses.

Thickness (feet)	Kx10^6 (ground) Widths 1000'	3000'	6000'	Kx10^6 (air) Widths 1000'	3000'
50	765	1150		790	795
75	380	785		400	460
100	222	570	1150	196	265
200	135	270	590	132	132
300	105	210	400	128	99
400	98	154	230	125	71
500	62	127		113	66
∞	30	12		23	5

The range of measured susceptibilities indicates a thickness of 50 to 75 feet in the vicinity of QQ366 where a 1000-foot width is assumed. However, 75 to 150 feet of thickness is indicated in the vicinity of WW368 where a 3000-foot width is assumed. The conclusion that can be drawn is that there is a thickening eastward. This conclusion can be drawn qualitatively since the magnetic values are of the same order of magnitude over all; hence, the increasing width to the east must be compensated by increasing thickness or increasing susceptibility. No basalt has been found to date with a measured susceptibility greater than that shown in the above tables. Consequently, increasing thickness seems to be the logical conclusion.

It does seem logical to expect the basalt to thin towards its southwest extremity since we now know that this magnetic feature is caused by a flow rather than a dike. Originally, I considered the northeast-trending magnetic high to be very possibly a dike, especially east of line A, rather than a flow. Consequently, my original thickness calculations were based on a vertical dipole assumption which I now believe to be invalid. Therefore, my original calculated thicknesses of 200+feet do not hold for the anomaly west of the WW line. East of line A it appears, by extrapolating the known ground data, that the thickness is greater than 300 feet. This is in line with Mr. Saegart's (Gravity Survey Memo, 12-10-57)

calculations; his westward decrease of gravity resolution of anomalies X-6, X-7, and X-8 could, I would like to submit, be possibly due to a westward thinning of the basalt flow. These altered thickness calculations may offer new exploration possibilities in the volcanic area west of WW and it is recommended that one of the holes in this area be deepened to determine the actual thickness of these basalt flows.

One point should be clear in regard to the volcanics, especially east of line A. The possibility of "windows" in the area of general volcanic sub-outcrop was never intended to be ruled out. This was conveyed to you in my memorandum to you of September 11, 1957. Just as there are remnants such as X-110-S, so there may be "windows." The magnetic low found at L370-372 as well as at G370-372 could well be either due to absence of volcanics or increase in width. To test such a possibility of no volcanics, I recommend a shallow hole at M372 as shown on the revised interpretation sheet of December, 1957.

On the revised interpretation sheet I have shown the south edge of the volcanics cutting through VV367.0 to YY368.0 instead of following the nose to the southeast. As previously stated, two possible explanations existed: (1) associated magnetite, or (2) volcanics. Drilling points to associated magnetite. While in discussion with Mr. Saegart, the possibility of a similar situation with the nose trending south at G365.0-368.0 was brought up. This nose is a portion of a larger feature (see Block I airborne map) which remains in the residual map, whereas the nose at ZZ365.0 is of a local nature and is removed by the regional; all of which is not too encouraging. But I believe a drill hole should be spotted at 0368 to test such a possibility. If the hole proves interesting it might be advisable to conduct some magnetometer profiles to locate closely the nose and tie to the East Pima grid. A correlation between the conductors on claims STA 4 and the magnetics might prove very interesting.

J. W. ERWIN

JWE:si
cc:L.H.Hart
K.E.Richard
B.C.Morrison
W.E.Saegart.

Attachments: San Xavier Total Magnetic Intensity Map
Preliminary Interpretation 12-57

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

October 17, 1957

J. E. K.

MAR 25 1968

MEMORANDUM TO MR. R. J. LACY

PRELIMINARY INTERPRETATION
Gravity Survey
San Xavier Indian Reservation
Pima County, Arizona

The attached map shows the extent of relative gravity reductions completed at this time. Please note the anomaly designation which is used for the Indian Reservation.

Generalized Interpretations

1) The regional gravity gradient observed on the East Pima property is also present within our San Xavier I. R. tracts.

2) The increase in regional gradient on the Indian ground should be attributed to overburden thinning to the west.

3) Anomaly X-1. X-1 is a relative gravity high, located west of the projection of the East Pima bottom thrust fault. The location is favorable - i.e. likelihood of geologically favorable calcareous section. A bedrock hill, as the anomalous source, is unlikely since holes X-201 and X-202 intersected bedrock at 220 and 200 feet respectively. I interpret the source to be heavy silicates developed in calcareous rocks (source of anomalies 1, 2 and 4 - East Pima). Hole X-211 (drilling) should define the anomalous source. If X-211 is an encouraging hole, I suggest another location at ZZ-366.0.

4) Anomaly X-2. This positive anomaly lies east of the projection of the East Pima bottom thrust fault. The source is probably a bedrock hill. One hole is recommended at D-366.0. If bedrock is less than 150 feet, the hole can be stopped. If depth to bedrock is in the order of 200 feet, the hole should be drilled to 400-500 feet.

5) Anomaly X-3. This is a large (areally) negative gravity feature. The boundaries of X-3 correspond closely to the boundaries of the magnetic high which John Erwin interprets as thick volcanics. If the regional gravity influence were removed, the anomaly would exhibit several residual gravity contours, the majority being concentrated along its margins. The source, therefore, should have steeply dipping boundaries. Assuming the source is basalt flow, the gravity results compliment the magnetic interpretation of thick volcanics. Specific gravity tests of the core are now being made to determine if a density contrast exists between the fine grained basalt and adjacent arkose.

6) Anomalies X-3a and X-3b. These gravity high ridges are interpreted as topographic hills on the basalt surface.

7) Anomaly X-4. X-4 is a collective designation of a group of gravity highs. Two maximums are labeled as X-4a and X-4b. A third maximum, which will be designated X-4c, exists within the uncontoured area at 00-374 (the topographic correction has not yet been made for the arkose hill at this location).

The anomalies X-4a and X-4c are associated with bedrock outcrops. A bedrock hill has been demonstrated at UU-374 (depth to bedrock, hole X-209, is 86 feet). This hill provides the source for anomaly X-4b. Gravity high X-4 may be entirely explained by a general thinning of overburden. Using the bedrock depths determined by the shallow hole drilling, I plan to calculate the gravity anomaly (order of magnitude only) that should result from overburden thinning. If the calculated intensities are considerably less than those observed, the area will warrant additional deep drilling.

The possibility that these anomalies are not entirely due to bedrock relief is suggested by the bedrock depth in hole X-208S - 153 feet. The hole is located on the axis of gravity ridge X-4b. This depth may be too great to satisfy the observed gravity anomaly.

A hole at UU-376.8 would allow us to make a better evaluation of anomaly X-4a. I recommend this location.

8) Anomaly X-5. This gravity high is due to a buried bedrock hill; hole X-112S at MM-370.0 reached bedrock at 50± feet.

9) Gravity irregularities in the southwest portion of tract I are due to variations of gravel thickness in an area of near outcrop environment. No further interpretation can be made.

10) Gravity results in the area between DD and II and between 370N and 372N are questionable. Contours will be completed after check results are available.

Conclusions

The anomalys collectively called X-4 represent the only area, within the present coverage, where important concentrations of lime-silicates can exist at moderate depths. This statement excludes anomaly X-1 which would be an extension of the East Pima environment.

It may be significant that the extent of hydrothermal alteration determined by the drilling program is almost entirely within the general area termed X-4.

W. E. SAEGART

WES/ds
Enclosure: 1000 Scale relative gravity contour
map of E. Pima and San Xavier properties
cc - w/encl
LHHart, KERichard, BCMorrison, JLClark, RCribbs

October 6, 1956

MEMORANDUM TO: Mr. R. J. Lacy

J. E. K.

MAR 25 1968

AEROMAGNETIC SURVEY
PIMA-AVRA VALLEY
TWIN BUTTES, ARIZONA
BLOCK 1

The following is my preliminary interpretation of the aeromagnetic contour map of Twin Buttes, Arizona, Block 1. There are features of considerable importance that can be reasonably explained at this time and have been analyzed. Analyses of other anomalies will necessarily have to be field checked before a final interpretation is made.

SUMMARY AND RECOMMENDATIONS

1. A portion of the San Xavier Indian Reservation is underlain by volcanics (see sepia overlay). These volcanics lie at a depth of 100' to 250' and have a thickness in excess of 200'. These volcanics could very likely consist of both flow (TQb) and intrusive (Tbp). From a geophysical standpoint these areas are considered unfavorable.

2. The southern halves of sections 29 and 30 on the Indian ground are favorable in regard to volcanics. This also applies to the southeast corner of section 25, and sections 23, 24, 26, 27.

3. It is obvious that the East Pima ore body would never have been discovered on the basis of this survey. The featureless magnetics of the area it occupies and all other similar magnetics on ground adjoining, including the Indian ground, lead to the conclusion that such ground cannot be considered unfavorable from a geophysical standpoint.

4. The area bounded by the zero contour of the second derivative (see sepia overlay) is interpreted as a deep-seated intrusive at a depth of 1000+' surrounded by sediments and granite. Superimposed upon this anomaly are local, shallow anomalies associated with the mineralization at Pima, Mineral Hill, and the Olivette mine (anomalies 1, 2 and 3 on sepia overlay). These shallow anomalies are interpreted as contact effects due to mineralization. The split between the two portions of the anomaly is interpreted as a fault. On the basis that the mineralization is associated with the inferred deep-seated intrusive, the ground flanking it and not covered by volcanics is considered favorable. Therefore, I recommend geophysical surveys on all lands or portions of stated herein, consistent with land problems and known geology: sections 6, 7, 8, T.17 S., R.13 E; sections 10, 11, 12, 13, 14 and 15, T.17 S., R.12 E. Ground magnetometer work could pinpoint volcanics on sections underlain by them and therefore eliminate such ground.

5. Anomaly 4 on the overlay should be checked because of proximity to the anomaly over the Olivette. This may be due to the contact between the Cretaceous sediments and the andesite within the Silver Bell formation. However, I feel it warrants investigation.

6. Several of the mapped basalt porphyries in T.16 S., R.12 E. do not appear as anomalies on the airborne map. Susceptibility measurements should be made in this area. Such field checks will probably explain the anomalous area at sections 15, 16, 17, 20, 21 and 22 on the Indian ground. These are probably in part volcanics.

7. Investigation of anomaly 5 is recommended as this may have considerable geological significance. A linear feature such as this brings a fault to mind. The gradients indicate shallowness and a theoretical contrast of 300 x 10^{-6} c.g.s. In general, there appears to be a magnetic plateau west of this feature.

8. The magnetic high cutting sections 13 and 14, T.17 S., R.12 E., etc., correlates well with the mapped basalt porphyry and is interpreted as shown on the overlay.

9. The high over Black Mountain is to be expected due to the volcanics present.

10. The northwest portion of the map in T.15 S. shows a broad, featureless magnetic area indicative of considerable depth to bedrock. Further, a positive gradient northward is indicated.

11. The southern portion (T.18 S.) of the map shows a multitude of anomalies. The gradients indicate outcrops and, therefore, these can probably be accounted for by field checks. Variable magnitudes of nearly identical anomalies indicate variable rock types.

GENERAL DISCUSSION

The areas bounded by green on the overlay are interpreted as underlain by volcanics. The outcrops of basalt porphyry at sections 13 and 14, T.17 S., R.12 E. correlate with the northeast trending high at this location, and the anomaly over Black Mountain correlates well with these volcanics. On the basis of trend, similarity of character, magnitude, plus favorable theoretical checks of susceptibility, the areas outlined in green are interpreted as underlain by volcanics. Depth determinations on the anomalies at section 25, T.16 S., R.12 E. and the section within the green boundary in T.16 S., R.13 E. yield depths of 100-250'. Theoretically, their thickness has to be in excess of 200' in order that the susceptibility (approx. 500 x 10^{-6} c.g.s. in this case) be of a reasonable value and still have a depth of 100-250' and magnitude shown. It is possible that the volcanics in this area are both flow (TQb) and intrusive Tbp, thereby creating a combination of finite (200+') and infinite thicknesses. Theoretical susceptibilities of 400-600 x 10^{-6} c.g.s. compare well with field measurements made by Mr. B. C. Morrison on TQb and Tbp.

The second derivative method was applied to the low magnitude anomaly within the dashed line shown on the zero contour of the second derivative. Of course, the zero contour theoretically outlines the anomalous body. This anomaly is interpreted as a deep-seated anomalous body of approximately the dimensions of the zero contour. Vacquier's method yields a depth in excess of 1000' and a

susceptibility of 200 x 10^{-6} c.g.s. A susceptibility of 200 x 10^{-6} c.g.s. is not uncommon for granitic to intermediate rocks. Superimposed upon the broad anomaly are three anomalies numbered 1, 2, and 3 on the accompanying overlay. Anomaly 1 over the Pima ore body has a steep gradient to the north yielding a depth determination of approximately 200'. Anomaly 2 has a more gentle gradient and is probably at a depth of about 500'. Anomaly 3 over the Olivette has gradients yielding depths from outcrop to 200'.

According to Vacquier's method, anomaly 4 lies at about 150-200'. Its theoretical susceptibility is 150 x 10^{-6} c.g.s. There may be some question in regard to the assumptions taken for the dimensions of this body. The n-dimension may be of such magnitude to effect the validity of Vacquier's method in this particular case. Anomaly 5 probably lies within 100' of the surface as indicated by its steep gradient. If semi-infinite planes are assumed, the theoretical contrast necessary to produce anomaly 5 is approximately 300 x 10^{-6} c.g.s.

J. W. ERWIN

JWE:si
cc:L.H.Hart
T.A.Snedden
K.E.Richard
B.C.Morrison

Under separate cover: 2 ozalids 2" - 1 mile mag. & planimetric
1 sepia 2" - 1 mile overlay-interpretation
1 film transparency 1" - 1 mile reduction of magnetics

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

September 11, 1957

J. E. K

MAR 25 1968

MEMORANDUM TO R. J. LACY

SAN XAVIER INDIAN RESERVATION
Magnetics - Airborne and Ground

This memorandum refers to my interpretation of the San Xavier Indian Reservation Airborne Total Magnetic Intensity Map, August, 1957.

The intention of covering the three tracts entirely with ground magnetics is no longer considered advisable. In view of the airborne coverage, I feel that complete ground coverage would be repetitious for the following reasons: (1) Any anomalies that do not appear on the airborne map are either too small physically, too deep, or too low in susceptibility, any of which would make the source unattractive; and (2) any such anomalies would be too small in magnitude to be detected over the alluvial background.

Since the ground location is based on vertical intensity, there is a good probability that the vertical and total intensity positions will differ somewhat. Further, a southward shift is to be expected in either the vertical or total intensity positions. Also, remanent magnetization often found in volcanics can affect the resultant intensity. With these facts in mind, I have shown on the total intensity map my interpretation of these magnetics. The areas indicated as underlain by volcanics(?) are not considered to be necessarily 100% volcanic(?). This is especially true east of the A line; further, there may be basalt of low susceptibility present and not detected by the magnetics, such as found, for example, at CC 366.0 and EE 368.0.

Speaking more specifically, several recommendations can be made on the basis of the ground and airborne magnetics in addition to those made in my memorandum of August 23. A hole is recommended at EE or FF 377.8 -- whichever fits the drilling grid -- to determine the nature of this anomaly. This is probably volcanic, but the shape does not seem typical of this type of rock. The data obtained would also help us interpret the anomalies west of the tract boundary. Since deep holes are planned near the mineralized outcrops at 00 374.0 and 00 376.0, the magnetic closure could be used for spotting one of the holes. Ground work here does not bring out any significant magnetics because of low magnitude versus background variations in the alluvium. However, the fact that we do have an airborne closure may be significant, and data obtained may help us evaluate similar low-magnitude closures as found at 00 378.0. A hole at or near 00 375.2 or 375.4 would be adequate for this magnetic feature.

I have indicated another northeast striking volcanic(?) in the area of A, ZZ, 380.0 etc. which parallels the high to the south. This anomaly is not nearly as strong as the one to the south at 365.0, 366.0 etc. This may be due to the source being at a greater depth, having a lower susceptibility, or being relatively thin. Since the interpreted volcanic(?) covers a large area, it will

undoubtedly be intercepted by proposed drilling program, hence no specific recommendations are made.

Speculating for a moment, after conversation with Mr. R. E. Cribbs, the idea of possible large-scale thrusts in the area presents an interesting possibility. Mentally shifting the southern northeast trending anomaly upon the northern northeast feature brings out some interesting similarities. The implication here is obvious and would make the area of B, C, 374.0 and 376.0 very interesting. If drilling brings out fault relationships this might be food for further thought.

J. W. ERWIN

JE/ds

cc: LHHart
KERichard
Tucson Geophysicists

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

August 23, 1957

MEMORANDUM TO R. J. LACY

SAN XAVIER INDIAN RESERVATION
Magnetics - Airborne & Ground

This memorandum is to accompany the San Xavier Indian Reservation, Airborne Total Magnetic Intensity Map, August, 1957. The map was prepared by enlarging that portion of the airborne map covering the area and matching it to the ground coverage locations.

Of immediate interest is the nose coming off the principal north-east trending magnetic high near ZZ and A 365.0. This magnetic high correlates with the projection of the East Pima orebody and hence may indicate the presence of copper mineralization with associated magnetite. On the other hand, this may be a nose of volcanics off the main north-east trending mass. Since this is in Mr. Richard's area of proposed early holes I would recommend a hole at ZZ365.6 on the basis of detail ground coverage. To determine if we have a flow or dike I would also recommend holes at VV368.0 and QQ366.0. With this information it might be possible to assign the area of the magnetic high as less favorable and concentrate our efforts elsewhere, providing of course the high proves to be a volcanic dike or flow. The area west of the north-east trending high appears favorable because of the featureless magnetics found there. These magnetics seem to indicate sediments, although there could be considerable amounts of basalt in the area which appears to be unusually low in magnetite.

As I mentioned in my memorandum on Block I, October, 1956 there is a possibility of the high being both flow and dike. Further study indicates that east of the A line the high is possibly a flow, whereas west of A it appears more dike-like in nature.

J. W. ERWIN

JWE/ds
cc: LHHart
KERichard

760000 E

770000 E

380000 N

370000 N

TRACT 1

TRACT 2

TWIN BUTTES ROAD

Areas Leased to ASARCO

(Cancelled) PAPAGO TRIBE OF INDIANS, ARIZONA

WATER WELL (DRY)

M-2 High

M-3 High

M-4 High

M-5 Low

M-6 High

G-1

G-2

G-3

G-4

Remove ticks

OUTLINE OF ORE-GRADE COPPER MINERALIZATION

Fault

- magnetic anomalies

- gravity high

T16S, R12E

T16S, R13E

Data derived from descriptions by R.J. Lacy August, 1st 1966

RHL

SAN XAVIER RESERVATION
TRACTS 1 & 2
SCALE 1" = 1000'

1881