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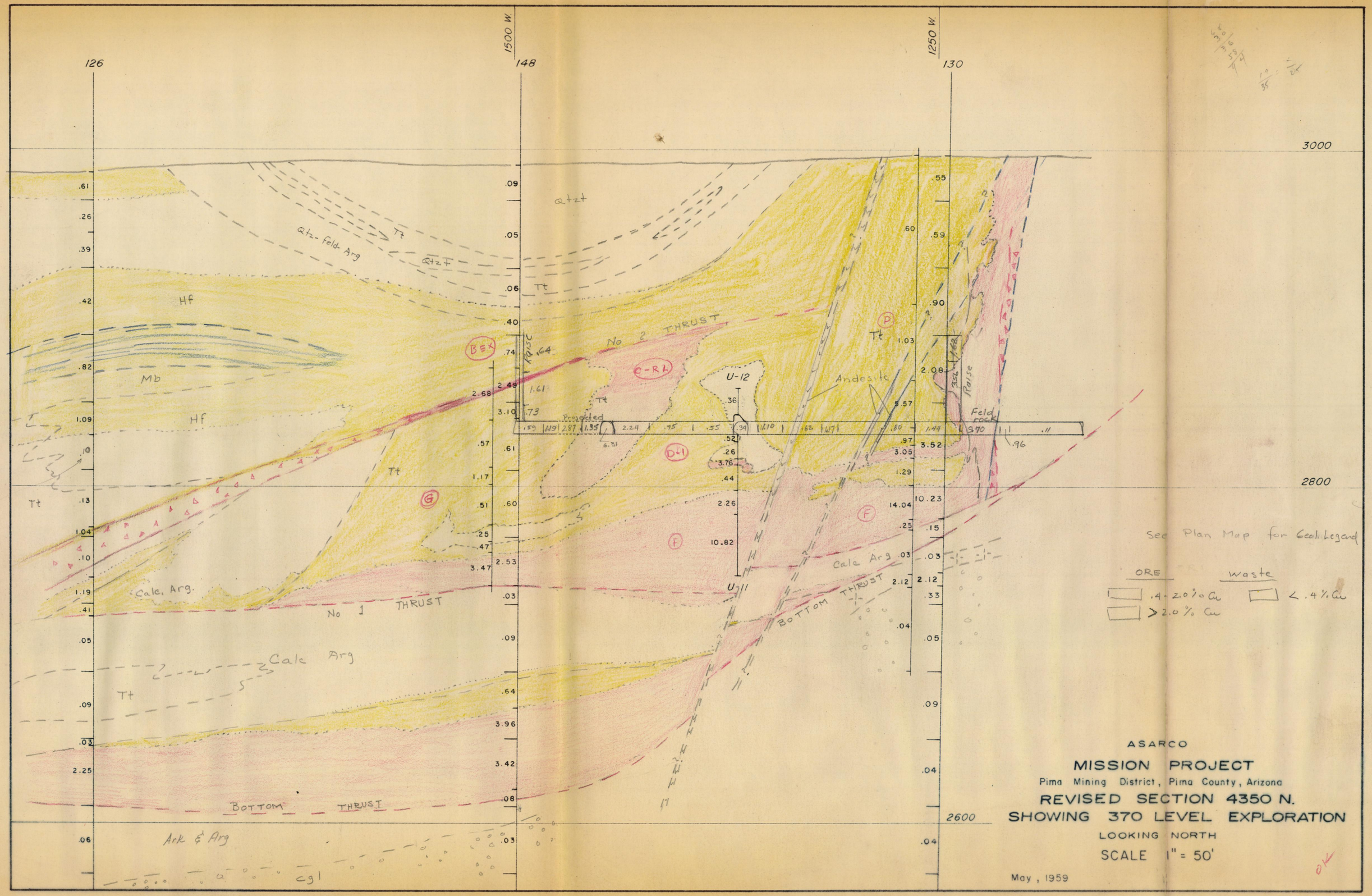
GEOLOGICAL REPORT
MISSION UNDERGROUND WORKINGS

November, 1958

J. E. Kinnison



126
148
130
1500 W.
1250 W.
3000
2800
2600
Qtzt
Qtz-feld-Arg
Tt
Hf
Mb
No 2 THRUST
No 1 THRUST
BOTTOM THRUST
Calc. Arg.
Calc Arg
Ark & Arg
cgl
Andesite
Feld rock
Projected
Raise
U-12
U-11
BEX
C-RL
D-1
G
F
P
See Plan Map for Geol. Legend
ORE
.4-2.0% Cu
>2.0% Cu
Waste
<.4% Cu
ASARCO
MISSION PROJECT
Pima Mining District, Pima County, Arizona
REVISED SECTION 4350 N.
SHOWING 370 LEVEL EXPLORATION
LOOKING NORTH
SCALE 1" = 50'
May, 1959

Section 1500 W

Section through (±) DDH 62

Section through DDH 148

149 — New detailed Ave. — Old Ave.

46 PROJ. 50' W — New detailed Ave. — Old Ave.

151 SHAFT — New detailed Ave. — Old Ave. — Shaft Must Ave.

62 PROJ 10' E — New detailed Ave. — Old Ave.

148 — New detailed Ave. — Old Ave.

3000

2800

Bedrock

Base of Oxidation

Hf

Tt

Qtz-feld-Arg

Qtz-feld

Qtz-feld lenses

Qtz-feld-arg

Calc Arg

Mb

Mb & wall

HF & Tt

No. 2 THRUST

Projected W.

597 TD

A

B

C

C-1

C2

ORE

.4 - 2.0% Cu

2.0% + Cu

Waste

ASARCO

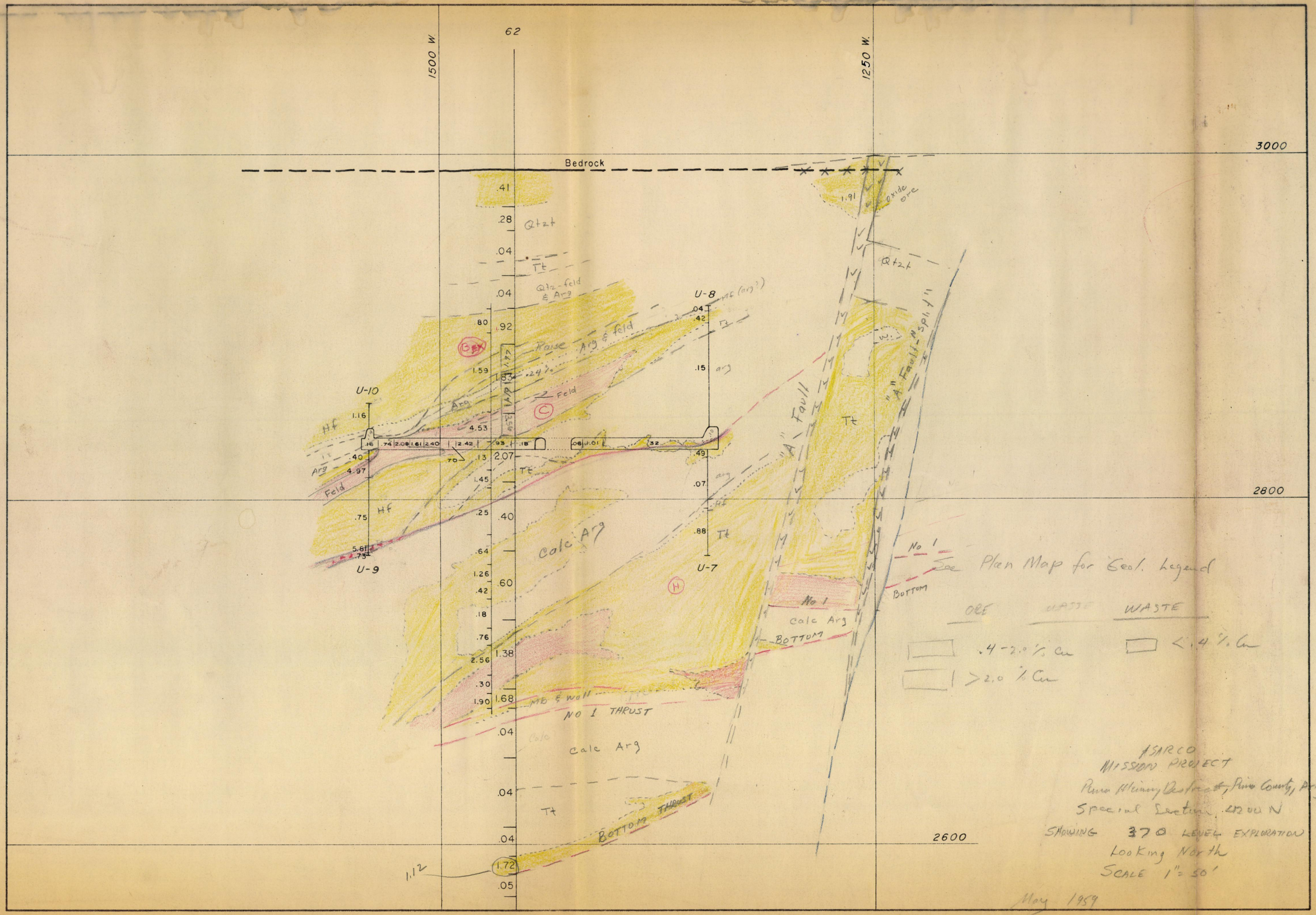
MISSION PROJECT

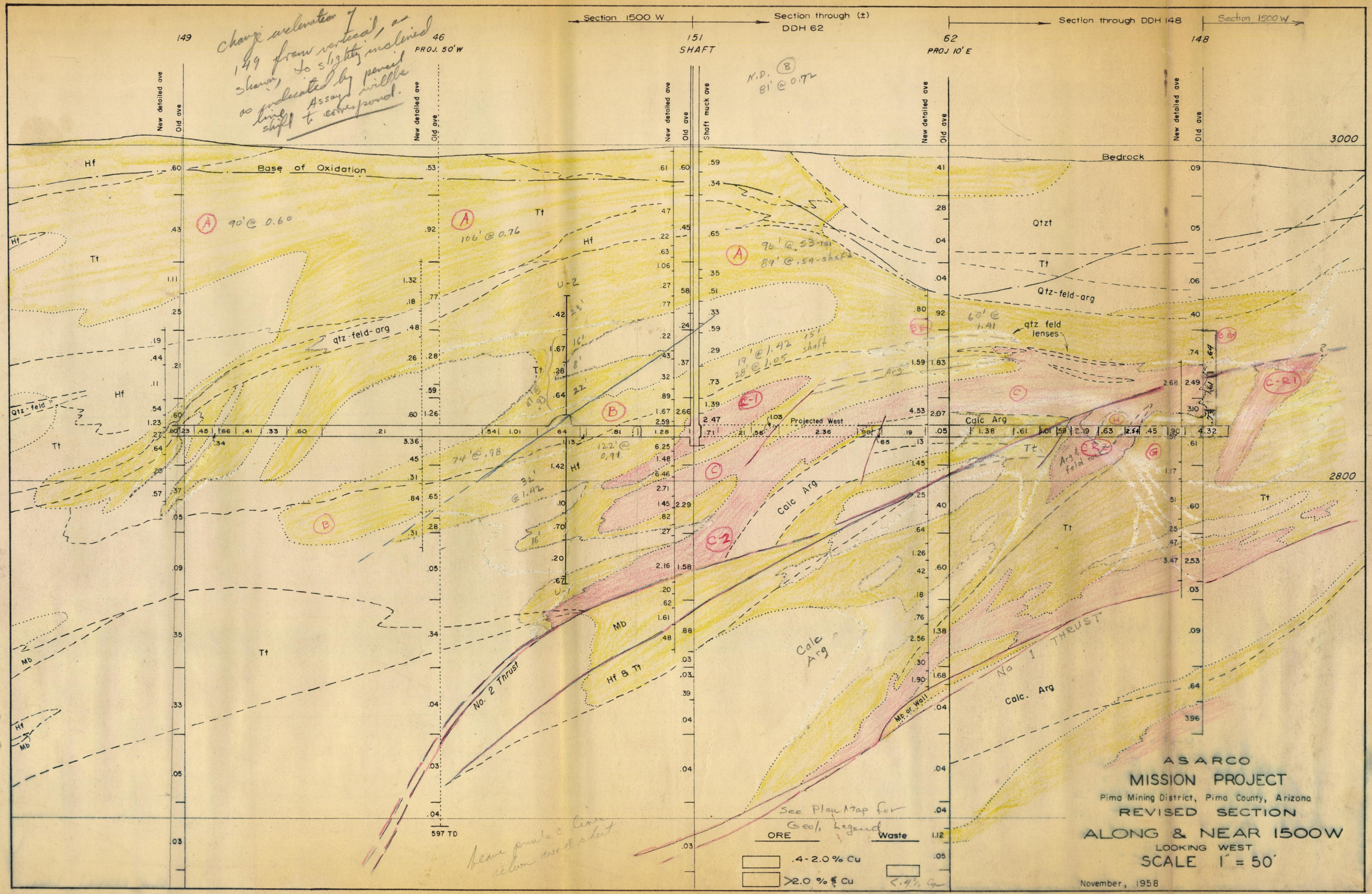
Pima Mining District, Pima County, Arizona

REVISED SECTION
Along & Near 1500 W
Looking West

SCALE 1 = 50

November, 1958


62
1500 W.
1250 W.
3000
2800
2600
Bedrock
Qtzt
Tt
Qtz-feld & Arg
Raise
Arg & feld
Feld
Arg
Hf
Calc Arg
Mb & wall
NO 1 THRUST
BOTTOM THRUST
"A" Fault
"A" Fault-Split
oxide ore
No 1
BOTTOM
U-7
U-8
U-9
U-10
See Plan Map for Geol. Legend
ORE
WASTE
.4-2.0 % Cu
>2.0 % Cu
<.4 % Cu
ASARCO
MISSION PROJECT
Pima Mining District, Pima County, Arizona
Special Section 4200 N
SHOWING 370 LEVEL EXPLORATION
Looking North
SCALE 1" = 50'
May 1959



Change inclination of 149 from vertical, as shown, to slightly inclined as indicated by pencil line. Assays will be shift to correspond.

N.D. (B) 81' @ 0.72

(A) 90' @ 0.60

(A) 106' @ 0.76

(A) 96' @ .53-151 89' @ .54-shaft

60' @ 1.41

19' @ 1.42 15' shaft 28' @ 1.05

74' @ .98

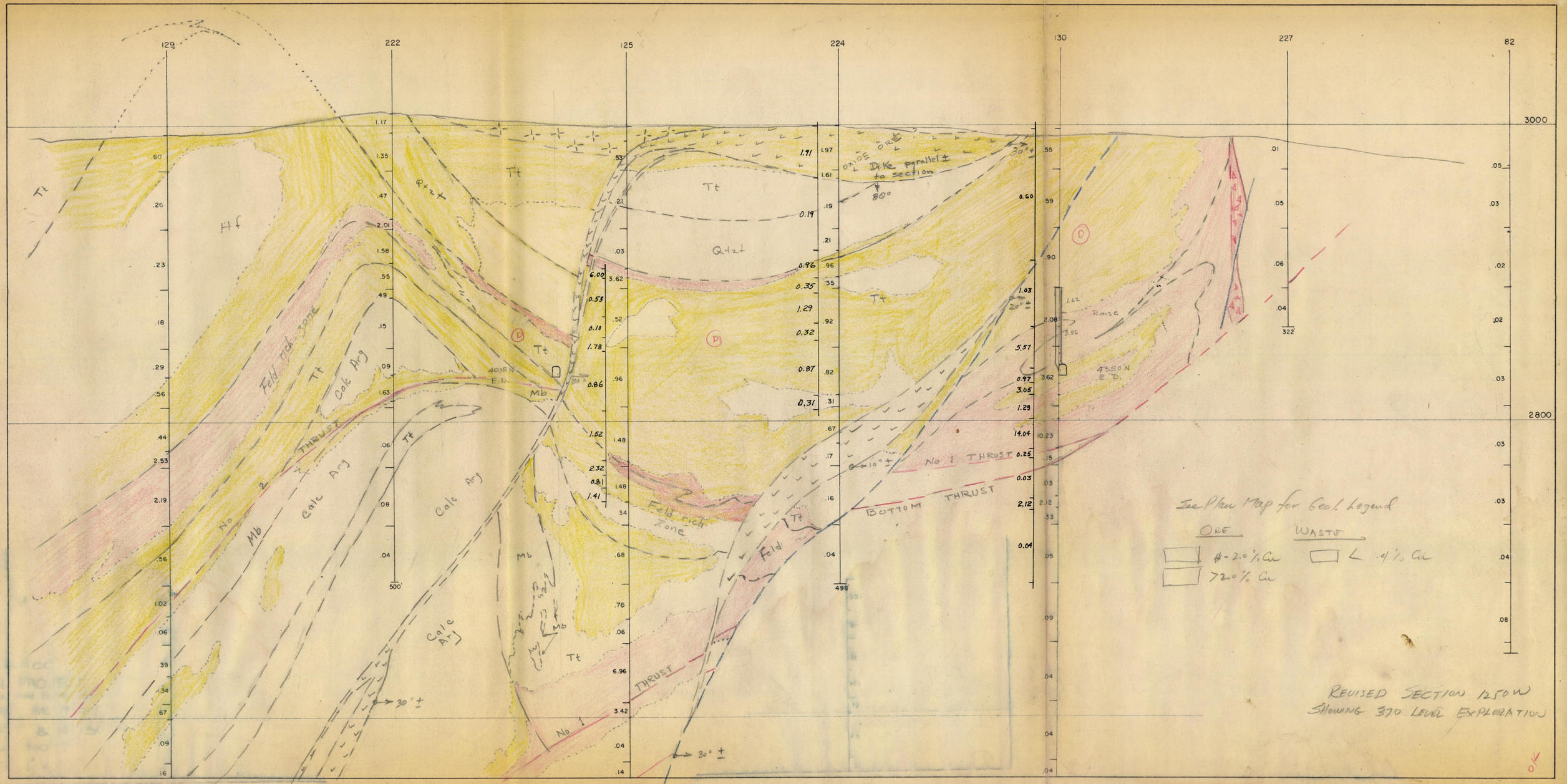
122' @ 0.91

32' @ 1.42

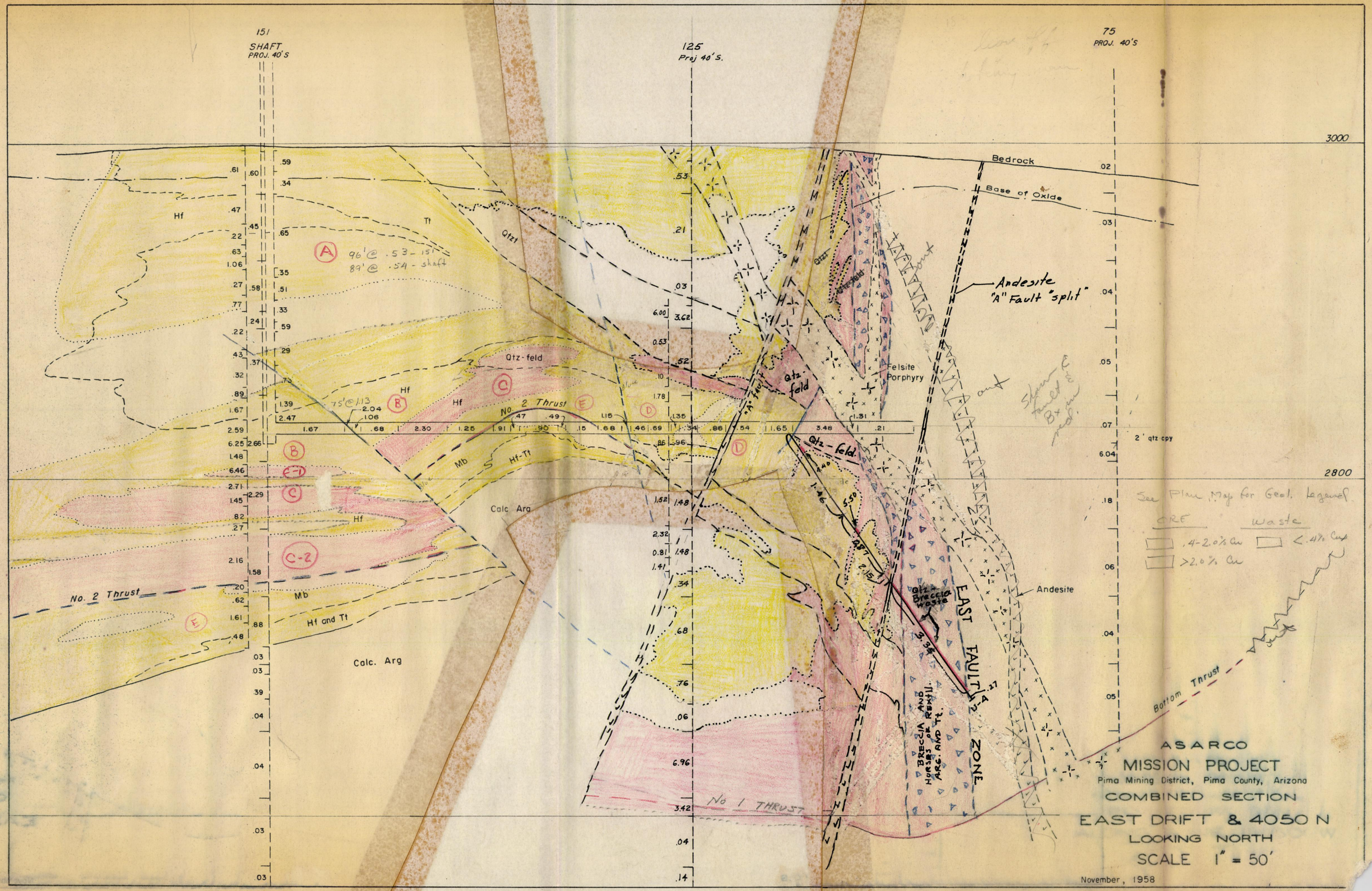
See Plan Map for Geol. Legend

Finished except for ore zone letters

beam prints c linen return wood sheet



129
222
125
224
130
227
82
3000
2800
Tt
Hf
Qtzt
Feld rich zone
Calc Arg
Mb
No 2 THRUST
No 1 THRUST
BOTTOM THRUST
Feld
Dike parallel ± to section
OXIDE ORE
Raise
4015N E.D.
4350N E.D.
See Plan Map for Geol. Legend
ORE
WASTE
4-2.0% Cu
>2.0% Cu
< .4% Cu
REVISED SECTION 1250W
SHOWING 370 LEVEL EXPLORATION


151
SHAFT
PROJ. 40'S
125
Proj 40'S.
75
PROJ. 40'S
3000
2800
Bedrock
Base of Oxide
Andesite
"A" Fault "split"
Felsite
Porphyry
Qtz-feld
Qtz-feld
Qtz-feld
Qtz-feld
Qtz-feld
Hf
Tt
Qtzt
Hf
Hf
Hf
Hf
Hf-Tt
Mb
Mb
Hf and Tt
Calc Arg
Calc. Arg
No. 2 Thrust
No. 2 Thrust
"A" fault
Andesite
EAST FAULT ZONE
Qtz-Breccia waste
BRECCIA AND HORSES OF REXTL. ARG. AND Tt.
No 1 THRUST
Bottom Thrust
2' qtz cpy
96' @ .53 - 151'
89' @ .54 - shaft
75' @ 1.13
See Plan Map for Geol. Legend
ORE
Waste
.4-2.0% Cu
<.4% Cu
>2.0% Cu
ASARCO
MISSION PROJECT
Pima Mining District, Pima County, Arizona
COMBINED SECTION
EAST DRIFT & 4050 N
LOOKING NORTH
SCALE 1" = 50'
November, 1958

J E Kinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 13, 1959

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

GEOLOGICAL REPORT
Mission Underground Workings

Dear Sir:

This report and Mr. Kinnison's attached report with maps and sections together cover all of the underground work completed in the east end of the Mission open pit ore body. These include analyses of various comparisons between geologic and assay data (a) from the ore reserve estimate of March 2, 1959 based on surface drillholes and (b) from the Mission shaft and underground drillholes, drifts and raises.

Practically all of the data and opinions contained in interim reports of November 21 and 25, 1958 by Kinnison and Richard, and in a summary report of April 25, 1959 by Richard and Courtright are repeated herein. This present compilation, then, is complete rather than supplemental.

SUMMARY

The Mission underground workings comprise the following footages:

Shaft	375
Drifts	1,679
Raises (4)	216
Underground diamond drillholes (U-1 through U-12)	881
Total Footage	3,151

These workings expose various geological characteristics of the ore body which, heretofore, were only partially evident from study of surface drillhole cores. Some variations from original interpretations are apparent. Copper values are somewhat more erratic in local distribution than was expected -- that is, the sulphides occasionally exist in clusters and pods with unsystematic trends which, individually, cannot be projected far. The existence and continuity of structures such as the A fault, the No. 2 thrust, and the East fault are verified, although the positions of these locally vary somewhat from predictions. The A fault is comprised of parallel, dike-filled strands rather than a single plane. The East fault consists of an important vein-like concentration of chalcopyrite missed by surface drill holes due to its vertical attitude. These variations from predictions, however, do not

necessitate any revisions of the basic geological interpretations of the ore reserve estimate of March 2, 1959. Most important, those structural concepts which governed much of the detailed geometry of that estimate have been confirmed.

The following tabulation is a summary (1) of assay comparisons of bulk raise and grab shaft samples with core samples, and (2) of polygon-by-polygon "mathematical" comparisons among the various data noted under (a) and (b) in the first paragraph above:

		% Cu	% Variation
(1)			
Shaft Grab Muck vs. Core, Surface Hole			
Average core (weighted)		.81	
Average shaft grab muck (weighted)		.83	+2
Footage	174.7'		
Raise Bulk vs. Core, Surface Holes			
Average core (weighted)		1.93	
Average raise bulk (weighted)		1.57	-19
Footage	215.6'		
Raise Bulk + Shaft Grab Muck vs. Core, Surface Holes			
Average core (weighted)		1.43	
Average raise bulk + shaft grab muck (weighted)		1.24	-13
Footage	390.3'		
(2)			
Core, Underground Holes vs. Grade-Polygons (based on surface drillholes)			
Average polygons (weighted)		1.81	
Average core (weighted)		1.68	-7
Drifts vs. Grade-Polygons			
Average polygons (weighted)		1.78	
Average drifts* (weighted)		1.20	-33

*Includes raises within polygons

As may be noted, the average assay of the total sinking and raising is 13% lower than that of the surface drill holes. However, in the case of the shaft, there is very close agreement. The underground drilling results are in reasonably close agreement with those of the surface drillholes, probably due to the interspaced symmetry of the two. The widest variation occurs between the drift and surface drillhole results.

While mathematical comparisons of data, as above, produce results which can be boiled down to simple ratios, the figures can be misleading unless the following, and other, factors are considered: (1) the horizontal workings penetrate only a small part of the ore body, and the raises check only 1.1% of the

total 14,704' of drillhole in ore; (2) this small part contains a greater range in tenor, up to 15% Cu, than the principal mass of the ore body; (3) individual ore calculation polygons are only intended to approach the true shape and position of ore lenses; and (4) the horizontal workings penetrate few polygons symmetrically. If these conditions are taken into account, a probability range of wide permissible differences is imposed on the "mathematical" comparisons summarized above. It is believed that the differences in the above tabulation are within this range of permissibility.

Within the above-noted limitations, the underground sample data support the validity of the ore reserve estimate.

GENERAL

The underground work originally was laid out primarily to secure bulk metallurgical samples and at the same time to gather some detail on the character and distribution of copper values, structure, and other geological features. The shaft was sunk on diamond drillhole 151 in the eastern portion of the ore body and drifts driven north, south and east on the 370-foot level. This provided material for pilot plant operation on all ore types except the argillite which is confined to the western half of the ore body. Subsequently, the program was expanded to include additional drifting and underground drilling, and four raises on drill holes (Mr. Pope's letter of November 26, 1958 to Mr. Snedden).

It was generally understood that, due to its limited extent, this program of additional underground work was not intended, in the usual sense, to be a "check" of drillhole sample accuracy and ore reserve estimation. If such a check had been considered necessary it would probably have included appreciable interspaced surface drilling, as explained in Richard's report of November 25, 1958 to Mr. Hart, as well as much more underground driving. The reason for doing check work customarily rests on an uncertainty as to the representativeness of drillhole samples. This reason does not exist in the case of the Mission ore body. Core recovery was exceptionally high, 91.2%, and the mineralogical character of the ore is such that the small amount of core lost would not have been either high or low in copper, systematically. This is amplified on page 26 of Richard's Drilling and Sampling Report, October 31, 1958.

Therefore, the additional program of underground drillholes, drifts, and raises should be considered principally as providing more information on the general character of copper distribution and other geological features. Kinnison's attached report goes into these features in detail.

As a secondary benefit, the underground assay data can, within certain reservations, be compared directly with drillholes and polygons of the ore estimate.

The principal uncertainty in any ore reserve estimate revolves about the geometrical and mathematical procedures selected for projecting the continuity of values between drillholes. Due to unusual conditions of structure and mineralization, this problem was particularly critical in the Mission ore

zone. The basic assumption was made that mineralization in general followed bedding horizons with low-angle dips, and this assumption governed part of the geometry of the ore reserve calculation method. This assumption is best checked by interspaced vertical penetrations which cut across the mineralization trend (and normal to the longer axes of the calculation polygons). The vertical underground drillholes satisfy the geometry of this condition, although otherwise they are rather inadequate due to being limited in vertical extent to two or three benches. In contrast to the vertical drillholes, the drifts tend to be situated along rather than across internal mineralization layers and are for the most part unsymmetrically arranged in relation to the calculation polygons. For these reasons the assays of drift samples serve rather poorly as a check of individual polygons.

When viewed as a unit, the underground drifts and drillholes penetrate a relatively small part of the ore body, and grade variations from point to point are considerable -- from a few tenths up to 15% Cu. These workings, then, constitute a "sample" which is small both geometrically and statistically. In comparisons with the ore reserve estimate, this small sample can be expected to show appreciable differences from the grades of the polygons and still be within the range of probability.

The rather small part of the ore body which is presently under consideration is comprised of a number of ore lenses. As explained in Kinnison's attached report, the underground drifts and drillholes now demonstrate that these lenses are somewhat more irregular in shape than was originally pictured; however, most importantly, only minor changes in volume of individual ore lenses are indicated. In respect to copper content of these individual lenses, and disregarding for the moment the awkwardness of the geometry imposed by the polygon ore estimation method, comparisons of assays among surface drillholes and underground drifts and drillholes within individual ore lenses show variations of as much as 40%, but usually within 15%. These variations are entirely within an allowable range. In fact, the correspondence of values within some of the ore lenses is remarkably close, as can be noted in Kinnison's detailed tabulations.

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

MATHEMATICAL COMPARISONS OF ASSAYS

The three tabulations below list (I) shaft and raise muck assays and corresponding diamond drillhole core assays, (II) ore calculation polygon values and underground diamond drillhole core assays within each polygon on various benches, and (III) ore calculation polygon values on the 2810 bench and average muck assays from workings (drift, raise and shaft) in polygons. Plan maps of the 2810 and 2770 bench levels (Atts. D and E) show most of the polygons penetrated and comparative assays in each case. These polygons are those used in the ore reserve estimate of March 29, 1958. Penetrations above and below these two benches may be viewed on Kinnison's geologic sections (Atts. F through J.

Table I

Core vs. Muck Samples	Core Recovery	Length Feet	% Cu
DDH 151 - Core	80%	174.7	0.81
Shaft - Grab muck*		174.7	*0.83
Shaft - Channel		174.7	1.10
DDH 148 - Core	98%	54.6	1.83
Raise - Bulk		54.6	1.03
DDH 130 - Core	97%	51.8	3.13
Raise - Bulk		51.8	2.97
DDH 62 - Core	95%	52.7	2.56
Raise - Bulk		52.7	2.16
DDH 149 - Core	96%	56.5	0.32
Raise - Bulk		56.5	0.25

Combinations of Above	Length	% Cu	% Variation
Total Core	390.3	1.43	
Total Raise bulk + shaft grab muck	390.3	1.24	-13
Core	174.7	.81	
Shaft grab muck	174.7	.83	+2
Core	215.6	1.93	
Raise bulk	215.6	1.57	-19

*Shaft and drift samples are grab samples of muck taken from each bucket at shaft collar. All raise muck was processed in sample plant after grab samples were taken. Results showed that the grab samples are 4% low. Accordingly, the grab assays have been upgraded by 4%.

Table II

Grade-Polygons and Underground Drillhole Samples

Bench	Polygons: Surface Drillholes	Polygons: Grade % Cu	Underground Drillholes: Hole No.	Underground Drillholes: (1) Length (Feet)	Underground Drillholes: (2) Core Assay
2890	151	0.58	U-2	20.9	0.43
2850	(4) 151	0.89	U-2	40.0	0.93
2810	(3) 151	2.66	U-2 & U-1	40.0	1.34
	46	1.19			
2770	(3) 151	2.29	U-1	40.0	0.67
	46	0.65			
2730	(3) 151	1.58	U-1	29.3	0.34
	46	0.05			
2810	125	0.96	U-4	22.8	1.67
2770	125	1.48	U-4	49.3(40)	1.60
2850	(4) 178	6.33	U-6	6.7	5.33
2810	178	1.10	U-6 & U-5	40.0	0.63
2770	178	0.15	U-5	15.3	3.13
2810	224	0.82	U-8 & U-7	40.0	0.20
2770	(3) 62(4)	0.62	U-7	40.0	0.56
	224	0.17			
2850	62	1.83	U-10	5.5	0.78
2810	62	2.07	U-9 & U-10	40.0	1.78
2770	62	0.40	U-9	40.0	1.22
2730	62	0.60	U-9	2.2	0.75
2850	130	2.08	U-12	7.0	0.25
2810	130	3.52	U-11 & U-12	40.0	0.71
2770	130	10.23	U-11	40.0	4.35
2830	130	0.75	U-11	24.3	10.64
Totals (weighted average)		1.81		574.0	1.68 (7% low)

Notes:

(1) Includes short footages of drift and drill station raises where these are along the vertical line of the drillhole pairs.
(2) Includes drift and drill station muck assays, as in Note (1).
(3) Underground drillhole falls in plane between two polygons.
(4) Polygon not penetrated by drillhole, but adjacent to it.

Table III

Grade Polygons and Grab Muck Samples from Workings

2810 Bench

Polygon No.	Polygon Tons	Polygon Grade, % Cu	Workings in Polygon Footage	Workings in Polygon *Grade, % Cu
(1)	56,769	1.10	27.5	.72
(2)	109,133	1.22	201.7	1.83
(3)	34,502	8.00	50.5	.39
(4)	43,678	3.52	239.8	1.89
(5)	58,359	.82	19.5	.44
(6)	106,328	2.07	341.9	.96
(7)	171,668	2.66	420.7	1.22
(8)	111,115	.96	121.0	1.56
(9)	9,166	.03	20.0	.72
(10)	128,719	1.19	122.5	.45
(11)	47,000	.28	58.0	.41
(12)	56,529	.60	62.0	.47
	932,966	1.78	1,685.1	1.20....33% low
(13)		.04	40.0	.11
(14)		.04	29.0	.23

*Grab muck sample assays upgraded 4%

In Table I above, the shaft samples closely agree with the drillhole samples, but the raise samples are consistently lower than the surface drillhole core samples, the average difference in the latter case being 19%. This figure has no particular significance in view of the large degree of irregularity in copper distribution and the small size of the core sample in contrast to that of the bulk sample (a ratio of approximately 1:1000). The detailed raise maps (Atts. O through R) show that the differences are nothing more than chance variations between very small and very large samples. From the statistical standpoint something on the order of 1000', or more, of raising would be required to reach close agreement, assuming 100% accuracy in all types of samples. It should be noted that core recovery is near-perfect (95-98%) in the drillhole segments covered by the raises.

In Table II above grade-polygons are compared to underground drillhole results. As may be noted wide differences exist; but, taken as a group there is reasonably close agreement, the drillhole cores being low in 13 instances and high in 11, with an average of 7% on the low side.

Original plans limited the underground drillholes to the 2810 and 2770 benches. However, to secure additional information on mineralization and structure, some of the holes were extended short distances into benches above and below. For example, hole U-11 was extended 24.3' below the 2770 bench and determined that the high grade zone (10.00% Cu, over 40' in thickness) cut in hole 130 is also present in this area, but it is 20' or more below its position as projected for purposes of ore calculation (Att. H).

In deriving the average grade of the polygons in Table II (1.81% Cu), those with partial rather than full bench penetrations were weighted according to the footage of drill hole -- i.e., 50% of a polygon's tonnage for a 20' drill intercept. In one instance a hole (U-5, 2770 bench) passed outside the ore body at a depth of 15.3' in the bench. The full 40' bench was penetrated, but only the 15.3' segment is included in the tabulation. Additional data, such as the tonnage of each polygon and core recovery for each bench (both surface and underground holes) are included in the appendix (Att. A).

Core recovery in the 527.8' of underground drilling (all AX size) ranged from 63% to 98%, and averaged 79%. Sludge samples were collected whenever available. To save time, holes were not cemented when water circulation was lost. The tabulation of core-sludge assays and recoveries (Att. C) shows an average sludge recovery of only 63%; but there is fairly good correspondence between core and sludge assays, except in hole U-11 where the sludge averages 50% higher than the core. It was considered that the sludge samples were less reliable than the core, therefore core assays only were used in computing the underground drillhole results.

In Table III above grade-polygons are compared to muck samples from workings on the 2810 bench. The grade of the workings in a polygon was derived by weighting each sample according to its length in feet. The tonnages recorded for the polygons are those of the ore reserve calculation, excepting polygon No. 8. In this instance the area (and tonnage) was reduced to conform with the adjusted limit of the ore body as indicated on the 100 scale plan map (Att. D). The results of the channel samples cut in the drifts are included in another detailed tabulation (Att. B).

Yours very truly,

KENYON RICHARD

J. H. COURTRIGHT

Enclosures: Kinnison Report and
Attachments A - U
cc: DJPope - 2 cc w/attns.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 13, 1959

MEMORANDUM FOR K. E. RICHARD

MISSION UNDERGROUND EXPLORATION
Geological Report

Detailed geologic mapping in the underground workings at the Mission property, together with a study of the core from underground diamond drilling, has disclosed certain features of structure and mineralization which were not heretofore completely understood from the study of surface-drill cores. However, these new data do not necessitate any revision of the basic geologic interpretations previously made; on the contrary, further confidence may now be placed in some of the more speculative interpretations plotted on the 100-scale geologic sections (transmitted to L. H. Hart, November 22, 1957) which formed the basis for the ore reserve estimate (March 21, 1959).

Underground work was halted temporarily in September, 1958, and a geologic report on that phase of the program was prepared (transmitted to L. H. Hart, November 25, 1958). Much of the data presented there are incorporated into this report.

List of Attachments

F Revised section, along and near 1500W; 50-scale: shows workings and revised geology and ore outlines.

G Combined section, East drift (4015N) and 4050N; 50-scale: shows workings and revised geology and ore outlines.

H Revised section, 4350N; 50-scale: shows workings and revised geology and ore outlines.

I Revised section, 1250W; 50-scale: shows workings and revised geology and ore outlines.

J Special section, 4200N; 50-scale: shows workings, geology, and ore outlines.

K Section 1500W; 50-scale: Original geologic section with ore outlines, enlarged from 100-scale; to be compared with Attachment F.

L Section 4050N; 50-scale: Original geologic section with ore outlines, enlarged from 100-scale; to be compared with Attachment G.

M Section 4350N; 50-scale: Original geologic section with ore outlines, enlarged from 100-scale; to be compared with Attachment H.

List of Attachments - continued

N Section 1250W; 50-scale; Original geologic section with ore outlines, enlarged from 100-scale; to be compared with Attachment I.

O Raise sections; 5-scale; 4200N, 1450W, DDH 62.

P Raise sections; 5-scale; 3750N, 1500W, DDH 149.

Q Raise sections; 5-scale; 4350N, 1500W, DDH 148.

R Raise sections; 5-scale; 4350N, 1250W, DDH 130.

S 370 Level; 20-scale; underground workings: Ore colored.

T 370 Level; 20-scale; underground workings: Rock type colored.

U Bulk and Channel Sample Assay Map; 1" = 30'.

Geologic Summary

Disseminated copper ore (chalcopyrite with more or less pyrite) occurs without relation to the mineralized fissures which are present, which suggests that remote ore-feeders effected the pervasive sulphide dissemination. The ore solutions were guided locally within the mineralized area by the major thrust faults, and by the East fault. Rock type served in part to influence the intensity of sulphide replacement. Thin mineralized fissures strike generally northeast and locally, as in the south drift, form high-angle northeast ore zones of minor consequence. The "No. 2 thrust," a speculative but important structural feature interpreted from drill cores, is proved to exist. The "A" fault, and a related fault east of it, are proved to exist. The East fault was penetrated by DDH U-4, and is seen to localize high-grade ore. Several post-ore faults of unknown displacements are present.

Ore outlines and geologic contacts as shown on the 100-scale ore reserve sections are correct in a gross way. As was to be expected, the inaccuracies inherent in the projection of ore lenses and structures beyond actual drillhole intercepts have caused the plotted location of such lines to vary from their true locations. For the most part such variations are seen to be small. In a few cases the variations are appreciable. But in all cases these differences are of geometrical aspect only, and in no way negate earlier interpretations. This condition will probably exist throughout the eastern part of the ore body. In the central and western areas, where geologic structure is less complicated, the old sections will probably be more nearly correct.

By visual inspection of the revised cross sections (Atts. F - J), and comparison to the old sections (Atts. K - N) it may be seen that loss of ore tonnage occurs in the vicinity just west of the "A" fault, between 4050N and 4350N. This loss of copper is more than balanced by the addition of ore along the East fault, which was not previously known to be exceptionally well mineralized.

The ore taken for metallurgical testing was described separately for each lot. The rocks tested were soft tactite with admixed diopside, and the soft variety of hornfels, which are representative of the principal ore types in the eastern part of the ore body.

Distribution of Copper

The attached 50-scale sections may be used visually to compare changes in the shape of ore outlines indicated by underground data. Original sections 1250W, 1500W, 4050N, and 4350N, in the vicinity of the workings, are enlarged to 50-scale (Att. F-I), and supplemented by 4 new sections, showing revised geology and ore outlines (Att. K-N), A fifth section, 4200N, is included to show underground exploration on that line (Att. J), although no original section exists for comparison. For demonstrative purposes, the drillhole assays have been recalculated to show on the new sections more details of high-grade (plus 2% Cu) and waste than was practicable on the original sections of smaller scale; the distribution of three classes of material (less than .40% Cu) (.40-2.0% Cu) (plus 2.0% Cu) is shown by white, yellow, and red, respectively. In those places where the drillholes are off section, the data are plotted as if the section plane contained angular bends, either horizontally or vertically, as conditions require; or else the data are plotted by projection along geologic lines to the section plane. With the exception of parts of the 1450W, Drift north, underground exploration data are given priority for about 50 feet above and below drift level, but beyond these limits geology and ore outlines are in most cases merged to conform to surface drillhole data. For example, on section 4050N-4015N Drift E, geology and ore outlines near DDH 125 are based on drift data and geologic projection in that area above 2700'±, but below that elevation the section is bent north to conform to DDH 125. Thus a minor amount of distortion is involved.

Eight principal ore zones, delineated on the basis of structural environment and assay range, and/or direct continuity, have been penetrated both by surface drill holes and by underground workings and/or drillholes. These are labeled A through H on the 50-scale revised sections.

Comparison of surface drill with underground drift and drill penetrations of these zones provides a means of evaluating continuity of grade between the surface holes, but only in a limited way. The underground workings penetrate only a small part of any one ore zone, and do not necessarily penetrate each zone symmetrically. This aspect is discussed more fully by Richard (p. 2, 3) in an earlier section of this report. The muck grab samples are indicated to be about 4% low on the average (Richard, p. 5, this report), but in the following tabulation these assays have not been upgraded. That the 4% factor has been by-passed does not imply any difference of opinion concerning it. The figures used in the tables can, by proper calculation, be up-graded accordingly. But the small difference which would result is within the margin of error imposed by the method of comparison, and the additional calculations required are not considered to be warranted. It may be kept in mind, however, that drift assays in these tables may be 4% low. Were the drift assays up-graded, those underground averages which are lower than corresponding surface hole averages would be in slightly closer agreement.

Table A is a summary of significant comparisons. Details of each zone are given on following pages.

TABLE A

Summary

Significant assay comparisons by zone (weighted averages)

	Penetration		Assay
Zone A			
DDH 151 (Surface drillhole)	96 ft.	@	0.53% Cu
Shaft (on 151)	89	@	0.54
DDH U-2	23	@	0.42
Zone B			
2 Surface drillholes	93 ft.	@	1.07% Cu
Underground Exploration*	385	@	0.97
Zone B Extension			
2 Surface drillholes	97 ft.	@	1.09% Cu
Underground Exploration	70	@	1.12
Zone C, and other related high-grade zones			
5 Surface drillholes	110 ft.	@	3.27% Cu
Underground Exploration	243	@	2.68
Zone D and D-1			
Zone D: 3 Surface drillholes	369 ft.	@	0.77% Cu
Zone D: Underground Exploration	274	@	0.96
Zone D-1: Underground Exploration	202	@	0.58
Average of D & D-1, Underground	476	@	0.80
Zone E (No. 2 thrust)			
DDH 151 (Surface drillhole)	40 ft.	@	0.74% Cu
4015N, Drift E	106	@	0.80
Zone F (Above No. 1 thrust)			
2 Surface DDH's	40 ft.	@	8.76% Cu (20' thick each)
DDH U-11	50	@	8.51
Zone G			
DDH 148 (Surface drillhole)	63 ft.	@	0.65% Cu
Underground Exploration	113	@	0.82
Zone H			
DDH 130 (Surface drillhole)**	28 ft.	@	5.57% Cu
Underground Exploration	154	@	4.36

*"Underground Exploration" is used to designate the combination of all drifts, raises, and drill holes which are applicable in any one zone.

**The only surface drillhole penetration of this zone.

It has been pointed out by Richard (p. 2) that an attempt to reduce all samples to two comparative figures is apt to be misleading. In a limited way, however, the average of surface drill vs. underground exploration, derived from Table A, shows a relationship between the assays in all of the combined zones A-H, and the assays of the underground work in these same zones. For analogy, the underground exploration may be compared to a large number of chip samples, taken without geometrical relationship to a vein; the surface drillholes in this analogy would be represented by channel samples cut across the vein at systematic intervals. These two figures are, at least, worthy of note:

Average of surface penetrations, Table A, 936 ft. @ 1.58% Cu

Average of underground penetrations, Table A, 1718 ft. @ 1.70% Cu.

The following comparison tables show details of ore variation within individual zones, and will be useful (1) to supplement the summary of Table A, and (2) to demonstrate range in values in different parts of individual zones. The 50-scale revised sections should be studied in conjunction with these comparisons. It will be noted that the total footage of underground work is 3151 feet, of which 2270 feet are diggings, and 881 feet are drill holes. The total footage used in the detailed comparisons is 1,858 feet (1,282 diggings and 576 drill holes). The fact that all of the footage of underground exploration is not utilized in no way affects the validity of the comparison. The footage not used consists mainly of large waste block penetrations, some of which are outside the ore body, and to a lesser extent of penetrations which cannot be classified to a specific zone of correlation. The comparative method used here bases upon a comparison of ore in surface drillholes, vs. ore penetrated underground, all segregated into naturally occurring zones of ore continuity. In this respect this method avoids some of the limitations imposed by comparison by operating pit benches and mathematical polygon divisions.

Ore Zones - Detailed

Zone A is a low-grade zone which extends from the shaft south through DDH 149, and lies between bedrock and about 100 below (Att. F).

	DDH 149	DDH 46	DDH 151	Shaft	DDH U-2**
Penetration, feet	90	106	96	89	23
Grade, % Cu*	0.60	0.76	0.53	0.54	0.42

Notes *All assay averages are weighted by length of penetration

**Underground drillholes designated by "U"

As may be noted, the shaft muck grab samples in Zone A agree very closely with the assay of the drillhole (151) on which it was sunk. The other assays serve only to show that Zone A is uniformly low-grade.

Zone B is a medium-grade zone separated from Zone A above it by a band of waste. It has been penetrated by 2 surface drillholes and by several diggings and underground drillholes (Att. F).

	DDH 46	DDH 151	Shaft (on 151)	1500W DriftS	4015N DriftE	1450W DriftN	DDH U-1	DDH U-2
Penetration, feet	74	19	28	122	75	81	32	47
Grade, % Cu	0.98	1.42	1.05	0.92	1.13	0.72	1.42	0.93

Summary, Zone B

Average of 2 surface DDH's	1.07% Cu* - 93 ft.
Average of workings	0.93% Cu - 306 ft.
Average of 2 underground DDH's	1.13% Cu - 79 ft.
Average of underground exploration	0.97% Cu - 385 ft.

*In this and following summaries, where several assay averages are shown, those regarded as most significant and informative are underlined.

Zone B Extension is a zone of variable grade which extends north and east from the shaft (Att. F). Because it occurs above Zone C and the No. 2 thrust, as does Zone B, and appears to be a direct extension of Zone B, it is lettered to show this similarity. Zone B extension does occur in a slightly different geologic environment, however, and for this reason it is discussed individually. Although the grade of penetrations shows in B Extension a wider range than in B, the average grade of both zones is remarkably similar. Zone B extension is penetrated by 2 surface holes and by drifts, raises, and underground drillholes.

	DDH 62	DDH 148	Raise on 62	Raise on 148	4200N DriftW	DDH U-9	DDH U-10
Penetration, feet	60	37	34	22	16	4	14
Grade, % Cu	1.41	0.58	1.41	0.64	0.15	0.40	1.16

Summary, Zone B Extension

Average of 2 surface drillholes	1.09% Cu - 97 ft.
Average of 2 raises	1.11% Cu - 56 ft.
Average of underground exploration*	0.91% Cu - 90 ft.
Average of raises and drillhole U-10**	1.12% Cu - 70 ft.

*Includes the waste section in 4200N, Drift W and .4% Cu in U-9.

**Thus excluding waste and .4% Cu zones. This is the preferable assay average because this waste zone is as large as some that were so separated on the ore reserve 100-scale sections.

It is also interesting to note that the raises, driven along surface holes, yield averages in this zone which correspond very closely to the

respective drillhole averages over the full vertical range of the zones.

DDH 62	1.41% Cu in Zone B Extension
Raise on 62	1.41
DDH 148	0.58
Raise on 148	0.64

Zone C, and others prefixed with "C", are high-grade (plus 2% Cu) ore zones which comprise a semi-continuous zone between the No. 2 thrust and Zones B and B Extension. These zones are traced south, north, and east of the shaft (Att. F, G). Zone C was shown in the first geologic report of November, 1958 to extend north beyond DDH 148. A raise on 148 in Zone C disclosed that the high-grade surface hole intercept was confined to the south wall, and that the raise as a whole contained lower grade ore. I have interpreted this to mean that the north limit, at this point, of Zone C is very near to the south edge of the raise, or about at hole 148. Since the raise penetrates along this boundary, its value for comparison is highly questionable, and so the raise is not used in the following tabulation. The high-grade drill hole intercept, however, is included in the surface-hole average for Zone C.

	DDH 131 (C)	DDH 151 (C-1)	DDH 151 (C-2)	DDH 62 (C)	DDH 148 (C)
Penetration, feet	18	17	27	17	31
Grade, % Cu	4.02	4.08	2.16	4.53	2.68

	Shaft (C-1)	1450W Drift N(C)	4015N Drift E(C)	4200N Drift W(C)	Raise on 62 (C)	DDH U-9
Penetration, feet	19	46	30	48	19	10
Grade, % Cu	2.47	2.36	2.30	2.08	3.56	4.97

Average of 5 surface DDH's	3.27% Cu - 110 ft.
Average of underground exploration	2.57% Cu - 172 ft.

Near DDH 148, two zones of high-grade ore were encountered in the drifts. These pods are isolated, and were not anticipated. Their probable geologic occurrence is shown on Att. F and H. These zones are most nearly related to Zone C, and are marked C-R1 and C-R2 on the sections.

	1450W Drift N and Drift W	4350N	1450W Drift N
Penetration, feet	45		26
Grade, % Cu	3.32		2.31

Average of underground exploration 2.95% Cu - 71 ft.

Summary, all "C" Zones

Average of 2 surface drillholes	3.27% Cu - 110 ft.
Average of underground exploration	2.68% Cu - 243 ft.

Zone D is a vaguely defined zone which lies east and northeast of the shaft (Att. G, H, I). It is partly similar in its geologic location to Zone B, but is treated separately due to its partial separation from Zone B by the folded No. 2 thrust, and the related "ridge" of calcareous argillite. Zone D has been penetrated by 3 surface drillholes, and by diggings and an underground drillhole.

	DDH 125	DDH 130	DDH 224	4015N Drift E		4350N Drift E
Penetration, feet	95	144	130	101		100
Grade, % Cu	0.72	0.76	0.79	0.84	(0.99*)	0.97

	Raise on 130	1375W Drift N		DDH U-4	DDH U-5
Penetration, feet	16	34		97	23
Grade, % Cu	1.62	0.65	(0.77*)	1.21**	0.64

*Assay up-graded to compensate for dilution by andesite dikes occupying a significant portion of the drift. Estimation by volume.

**Near East fault, contains slightly higher grade ore.

Average of 3 surface drillholes	0.77% Cu - 369 ft.
Average of underground exploration, using 2 up-graded assays, excluding U-4	0.96% Cu - 274 ft.
Average of underground exploration, including U-4	1.03% Cu - 371 ft.
Average of underground exploration, all original assays	0.89% Cu - 274 ft.

Zone D-1 occupies a large area on section 4350N (Att. H). This zone is more or less related to Zone D, but is of generally lower grade. No surface holes penetrate it.

	1375W Drift N	4350N Drift E	DDH U-11	DDH U-12
Penetration, feet	70	84	33	15
Grade, % Cu	0.45	0.67	0.74	0.36

Average of underground exploration 0.58% Cu - 202 ft.

Summary, Zones D and D-1

Average of 3 surface drillholes	0.77% Cu - 369 ft.
Average of underground exploration, excluding U-4	0.80% Cu - 476 ft.

Zone E is shown on Att. G, and lies east of the shaft in the No. 2 thrust fault zone. The ore disseminated through this fault zone can be compared only in a general way due to uncertainties in structural interpretation. The penetrations in DDH 151 and in the 4015 Drift E are mineralogically similar and are compared below:

No. 2 thrust zone:

DDH 151	0.74% Cu - 40 ft.
4015 Drift E	0.80% Cu - 106 ft.

Zone F is a high-grade zone above the No. 1 thrust on section 4350N (Att. H). This zone is traceable in other parts of the ore body, but can be compared to underground assays only in this area.

	DDH 130	DDH 148	DDH U-11
Penetration, feet	20	20	50
Grade, % Cu	14.04	3.47	8.51

Average of 2 surface drillholes	8.76% Cu - 40 ft.
DDH U-11	8.51% Cu - 50 ft.

Zone G is a small zone north of the shaft, which lies below the calcareous argillite and the No. 2 thrust. It is penetrated by one surface hole and by drifts and an underground hole.

	DDH 148	4350N Drift W	1450W Drift N	DDH U-7
Penetration, feet	63	44	42	27
Grade, % Cu	0.65	0.98*	0.62	0.88

*Excludes a portion of this drift -- 19' @ 2.87% Cu -- which drives along the contact between Zone G and high-grade Zone C-R1.

Summary, Zone G

Surface DDH 148	0.65% Cu - 63 ft.
Average of workings	0.80% Cu - 86 ft.
Average of underground exploration	0.82% Cu - 113 ft.

Zone H is a vertical zone 20 to 40 feet wide which forms the east margin of the ore body. The ore in this zone is high-grade and forms as massive replacements and as breccia filling in the East fault. The west edge was penetrated by DDH 130, and may have been penetrated by DDH 121, south of the workings. The comparison to the intercept in DDH 130 has little meaning, other than that it substantiates the consistently high-grade nature of this zone. This zone is not reflected in the ore reserve calculation.

	DDH 130	Raise on 130	4015N Drift E	4350N Drift E	DDH U-4*
Penetration, feet	28	32	28	25	101
Grade, % Cu	5.57	3.96	3.48	9.70	3.28

*Angle hole representing about 45' horizontal width; 16' next to east wall averages 7.60% Cu

Average of underground exploration 4.29% Cu - 186 ft.

RAISE-DRILLHOLE COMPARISON

During the expanded underground program, 4 raises were driven on surface drillholes, each raise being more or less 55' above the sill. Each raise was advanced to the 2890' elevation. The muck from each round was processed through a bulk sampling plant.

The geology exposed on the 4 walls of each raise was mapped in detail on a scale of 1" to 5', to show structure, rock type, and the heavier sulphide concentrations (Att. O-R). Low- or average-grade disseminated ore is not shown, by symbol, because this can be easily deduced from the muck assay. The erratic nature of the heavy sulphide concentrations is brought out on these maps much better than can be done by words. The assays of each round and of each drillhole assay-intercept are plotted alongside of the geologic maps. These are further grouped into assay averages which show the variations of copper within the raises and between raises and drillholes.

By comparing the assay variations, between drillhole and raise, to the distribution of heavy sulphides as shown on the geologic maps, it is possible in most instances to determine why these variations occurred. It is obvious from inspection of these maps that a slight shift in the location of the drill hole -- sometimes only a few inches -- would have produced greatly different assay results.

Description of Significant Geological Features

All rocks penetrated by the workings, with the exception of post-ore andesite, are mineralized and contain pyrite and chalcopyrite in varying proportions. All ore-grade rock contains chalcopyrite, with a lesser amount of pyrite, erratically disseminated as grains, pods (up to 3"), and rarely as unoriented stringers up to 3" long. Near the East fault there are large pods -- up to several feet -- of massive chalcopyrite-pyrite. Bornite occurs in very limited quantity. Sphalerite is limited to a few thin veins and very rare disseminated grains, and molybdenite is very sparse. Oxidized ore in the shaft contains copper silicates and brown copper oxides (copper "pitch"). Some blebs of "pitch" contain a chalcopyrite core for about 10' above the base of the oxide zone, which is 20' below the top of bedrock.

Rocks which have served as favorable hosts for sulphide replacement are tactite, hornfels, quartz-feldspar, and some portions of the calcareous argillite and dense feldspar series. Marble is generally below ore grade,

although parts of this rock contain low-grade ore. These rocks are all of the Pima formation (Paleozoic). Intrusive felsite porphyry, most of the calcareous argillite (Pima fm.) and much of the dense feldspar rock (Pima fm.), and argillite of the Kino formation are altered and contain sulphide stringers; but these rocks are not metalized strongly enough to constitute ore. Post-ore andesite is unmineralized, although it contains very rare films of pyrite -- due possibly to a slight re-solution of adjacent sulphides during intrusion.

Ore-waste contacts within the favorable rocks are nearly always gradational, although changes from low- or medium-grade to high-grade ore are frequently sharp. Ore-waste contacts are sharply visible where the change occurs at the contact between favorable and unfavorable rocks.

Drifts were mapped on a scale of 1" to 20'. These maps show rocks, ore, and structure, and present a graphically clear picture of geological features of the Mission ore zone. For convenience, ore is shown in color on one map (Att. S) and geology is colored on another (Att. T); structural data is the same on both maps. Averaged muck assays are shown on these two maps. A separate map (Att. U, 30 scale) shows individual muck and channel assays.

Steeply dipping mineralized fissures and thin veins occur throughout the workings, and nearly all strike northeast. In the 1500W Drift S these fissures are prevalent and closely spaced, and here they locally constitute high-angle ore zones of minor consequence. The mineralized fissures cut disseminated ore with no evident relationship, and conversely, areas of intense fissuring do not necessarily contain disseminated sulphides in ore-grade quantity. The No. 2 thrust is seen to localize high-grade ore, but the relationship of this high-grade band to disseminated ore at a distance is not really known. From the drill cores it is also evident that the No. 1 thrust and the Bottom thrust also localize high-grade ore bands. The East fault, a pre-mineral vertical breccia zone (DDH U-4), and the rocks adjacent for a few tens of feet on the west wall, contain high-grade ore. This fault was known by deduction from the surface drillholes, although the breccia zone was not actually cored by these vertical holes. The extensive and high-grade mineralization which is localized by the East fault was not known previously. It appears, based on limited evidence from the surface drillholes, that the East fault is terminated in depth by the bottom thrust (but this does not imply a post-ore fault offset).

From the foregoing discussion, it appears that the ore of the eastern part of the Mission ore body occurs principally as irregular disseminations, secondarily as high-grade lenses along low-angle thrust faults and the east fault, and to a limited extent in northeast fissure zones which are unrelated to disseminated ore. This suggests that the ultimate feeder(s) is not yet uncovered. However, within the known altered zone, the structures mentioned serve as local ore-concentraters. The bulk of the copper, far removed from even these local ore channels, was emplaced by some process of pervasive dissemination. The host rock type, or unknown features related to it, were the most important factors controlling the intensity of replacement.

The drifts all show the ore zone to be traversed by many faults of various directions of strike and dip. The magnitude of these structures is not known, although most of them probably cause small dislocation. Certain structures of principal importance, however, were originally interpreted from the drill cores, and shown on the geologic 100-scale ore reserve sections. Those structures in the area opened by the workings have been verified. They are (1) the "A" fault and a related fault east of it, now called the "A" fault "split"; (2) the No. 2 thrust; and (3) the East fault. The locations of these structures are now more positively known due to the exposures underground.

The "A" and "A" fault "split" were penetrated in the northeastern part of the level workings; and the "A" fault, where it has an abrupt and previously unknown easterly bend, was found in the 4015N Drift E. The dip is about 75° westerly on the average, and the strike is north-northwest. This fault is filled by post-ore andesite, and the intrusive contacts are tight against post-ore gouge. Despite these indications of dominant post-ore movement, there is a notable association with slightly increased quantities of sulphide immediately adjacent to the dikes. This may indicate that the fracture was initiated prior to ore deposition. However, there is no suggestion that the structure is related to any appreciable amount of disseminated ore.

A highly sheared low-angle folded fault zone brings marble in contact below hornfels in the 4015N Drift E. There is little doubt that this is the No. 2 thrust. The position of the fault on section 4050N required revision on this section near the "A" fault (Att. G), but it is significant that this fault has been verified. In this area the evidence regarding its age relative to ore is unsatisfactory. A sulphide vein which penetrates partly into the fault zone shows that the structure was initiated prior to mineralization -- but there is certainly suggestion of some post-ore movement. In the 1450W Drift N, the No. 2 thrust is also exposed by the diggings. Here the fault crosses rocks different from those in the 4015N Drift E area, and consists of a single zone of gouge and breccia 4" wide. The fault is here clearly pre-ore, and localizes a band of high-grade ore above it. Post-ore movement is also evident. In this vicinity the thrust has been penetrated in an underground drill hole, 4200N Drift E, and by the raise on DDH 148. It cannot be traced north and east beyond these penetrations, and its course is problematical. It is possible, at least, that the fault bounding ore zone C-R2 on the north (Att. F, T) is an overturned segment of the No. 2 thrust, and that it has here merged into a bedding slip.

The East fault breccia was missed by all surface drill holes, and the precise location of this important structure was not known prior to the underground program. A zone cored in DDH 221, containing steeply banded sulphides in a feldspathic gangue, is probably part of this zone. DDH U-4 penetrated a wide pre-ore breccia zone below the 4015N Drift E, which contains high-grade ore with some interspaced waste zones, and this is believed to be the East fault. In two drifts east (4015N and 4350N) high-grade ore was penetrated in a coarse quartz-feldspar matrix. Residual masses of argillite (identified in thin-section) indicate that this is a bedded, recrystallized zone in the Pima formation. This bed has apparently been folded and warped against the East fault prior to metamorphism.

Within the tactite-hornfels units, bedding is not recognized. However, argillite and marble, although structurally distorted, show bedded relations when considered as a unit.

Two northeasterly post-ore faults of considerable strike extent are present, but their direction and magnitude of slip are unknown. One of these causes a large horizontal offset of the No. 2 thrust (Att. T), but the low-angle of the thrust would allow a small, vertical movement to produce large horizontal offset component.

Metallurgical Samples

The ore taken for metallurgical testing was described separately for each lot. Abstracts of these memorandum descriptions appear in Mr. Romney's reports on individual lots (report: Pilot Mill Test of Mission Mine Ore).

The underground samples were of soft diopside hornfels (types B and C -- Memorandum to K. E. Richard 3/10/58, transmitted to N. Weiss, with carbon copies to D. J. Pope and L. H. Hart, 3/13/58) and tactite (refer to same memo) with small to moderate amounts of admixed diopside. These rocks are typical of the principal ore types to be encountered in the eastern part of the ore body. In the central and western parts some tactite is much harder and more compact than the tactite ore tested, but this type is subordinate in amount. The hornfels ore tested is the predominant hornfels type throughout the deposit, particularly in the eastern part of the ore body.

The sample of argillite ore tested from the Pima Mine pit is typical of the hardest variety in the Mission deposit. Some of the argillite in the western Mission area contains more fractures and will probably crush more easily than the Pima sample.

The ore types represented by these test lots constitute about 90% of the eastern part of the ore body and about 70% of the total ore body. Of the types not represented, about 8% (hard, dense type of hornfels, and extremely soft hornfels) may present different metallurgical problems, while the remaining 22% have megascopically similar physical characteristics to the types actually tested.

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JEK/ds
Attachments

ATTACHMENT A
Grade Polygons and Underground Drill Hole Samples

Bench	Polygons: Surface Drill Hole	Core Recovery	Tons	Grade % Cu	Underground Drill Holes: Hole Number	(1) Length (Feet)	Core Rec.%	(2) Core Assay (% Cu)
2850	151	90	122,102	.58	U-2	20.9	65	.43
2850	(4) 151	-	53,343	.89	U-2	40.0	64	.93
2810	(3) 151	95	171,668	2.66	U-1 & U-2	40.0	63	1.34
	(3) 46	70	128,719	1.19				
2770	(3) 151	84	165,657	2.89	U-1	40.0	63	.67
	(3) 46	82	122,836	.65				
2730	(3) 151	96	171,911	1.58	U-1	29.3	87	.34
	(3) 46	72	76,473	.05				
2810	125	95	111,115	.96	U-4	22.8	81	1.67
2770	125	88	119,179	1.48	U-4	49.3(40)	78	1.60
2850	(4) 178	-	82,991	6.33	U-6	6.7	77	5.33
2810	178	-	56,769	1.10	U-6 & U-5	40.0	87	.63
2770	178	-	38,500	.15	U-5	15.3	88	3.13
2810	224	96	58,359	.82	U-8 & U-7	40.0	83	.20
2770	(3) 62 (4)	-	3,670	.62	U-7	40.0	93	.56
	(3) 224	91	70,349	.17				
2850	62	94	136,306	1.83	U-10	5.5	62	.78
2810	62	92	106,388	2.07	U-9 & U-10	40.0	73	1.78
2770	62	97	90,454	.40	U-9	40.0	81	1.22
2730	62	97	81,734	.60	U-9	2.2	96	.75
2850	130	97	48,880	2.08	U-12	7.0	98	.25
2810	130	97	43,678	3.52	U-11 & U-12	40.0	74	.71

Attachment A - Continued

Polygons					Underground Drill Holes			
Bench	Surface Drill Hole	Core Recovery	Tons	Grade $ Cu	Hole Number	(1) Length (Feet)	Core Rec.$	(2) Core Assay ($ Cu)
2770	130	92	76,589	10.23	U-11	40.0	90	4.35
2730	130	98	105,594	.15	U-11	24.3	95	10.64
Totals (Weighted Average)		91	2,282,744	1.81		574.0	79	1.68

Notes:

(1) Includes footage of drift and drill station raise.
(2) Includes drift and drill station muck assays.
(3) Underground drillhole fills in plane between two polygons.
(4) Polygon not penetrated by D.D.H. but adjacent to it.

ATTACHMENT B

Grade Polygons and Grab Muck Samples from Workings
8810 Bench

Polygons					Workings in Polygons		Drifts Only	
				Grade		Grade, $ Cu	Grade, $ Cu	
No.	DDH	Core Rec.	Tons	$ Cu	Footage	Assay(1)	Grab Muck(3)	Channel
1	(2) 178	-	56,769	1.10	875	.72	.72	.72
2	148	99	109,133	1.82	2,017	1.83	1.89	1.89
3	(2) 130	-	34,302	8.00	505	.39	.39	.36
4	130	97	43,678	3.92	2,398	1.89	1.86	1.46
5	284	96	58,359	.82	195	.44	.44	.70
6	62	92	106,388	2.07	3,419	.96	.87	.69
7	151	95	171,668	2.66	4,207	1.82	1.14	.86
8	125	95	111,115	.96	1,210	1.56	1.56	1.10
9	(2)125	-	9,166	.03	80	.72	.72	.38
10	46	70	128,729	1.19	1,225	.45	.45	.71
11	(2) 149	-	47,000	.28	580	.41	.41	.36
12	149	98	56,592	.60	620	.47	.48	.37
Totals (Weighted Average)		93	932,966	1.78	16,851	1.80	1.16	.98

(1) Grab Muck sample assays upgraded 4% (All drift and shaft assays are on grab muck samples. All raise muck run through Sample Plant)
(2) Polygon not penetrated by DDH, but adjacent to it.
(3) Grab muck sample assays upgraded 4%.

ATTACHMENT C

Mission Underground Diamond Drillholes

Hole No.	No. of Samples	Feet	Core Recovery	Core Assay(% Cu)	Sludge Recovery	Sludge Assay(% Cu)
U-11	13	47.9	83	1.73	74	2.64
U-9	14	51.7	79	1.88	39	1.49
U-8	15	66.2	91	.18	90	.20
U-7	13	45.6	90	.34	68	.58
U-5	13	45.9	87	1.00	35	.96
U-2	13	54.4	60	.75	70	.56
U-1	13	64.1	74	.54	88	.53
Total	94	375.8	80	.88	61	.93
U-4	41	152.0	83	1.97	67	2.27
Total	135	527.8	81	1.19	63	1.32

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 25, 1958

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

MISSION UNDERGROUND WORKINGS
Geological Report

Dear Sir:

This will transmit Mr. Kinnison's report with maps and sections giving detailed descriptions and interpretations of geological features exposed in the Mission workings, as well as comparisons of Cu distribution between drill holes and drifts. These data do not include the new work in the North drift. This advance is being reported weekly in a preliminary way.

The comparisons of values which Mr. Kinnison makes between drill hole and drift intercepts of certain ore lenses show differences, but this is about as reasonable a check of the continuity of values along mineralization trends as could be expected. The drift assays are somewhat lower than corresponding drill hole intercepts, but this is more than compensated by the intercept of high grade in the East drift. This zone may have continuity along the East fault, in which case a good deal more Cu will be mined here than was included in our ore estimates. This is an example of the expected compensation described in the second of the quoted paragraphs on page 2 below.

(The plan maps will be trimmed to a standard size only after the final extent and direction of workings is known.)

The underground work originally was planned principally to provide bulk metallurgical samples. Also, it was anticipated that a certain amount of information on the continuity of values between drill holes would be obtained. Due to their small extent, it was not expected that these penetrations would serve to determine either (1) the representativeness of the core samples in general or (2) the correctness throughout the ore body of those geological interpretations of ore outlines and Cu distribution which formed the basis of ore reserve estimates. Furthermore, it was considered that a check of these two factors was not needed, as was pointed out in my letter of October 24, 1957 to Mr. Snedden, which is repeated, in part:

> "Most of those conditions which usually require or justify underground check work do not exist at East Pima. Core recovery has been excellent, and the usual uncertainty as to how to combine core and sludge assays does not exist. The mineralogical texture of the ore types is such that the 10% of core lost to sludge has not had a selective

salting effect, as has been the case with many ore bodies; consequently, the East Pima core samples can be considered as an accurate measure of the copper content of the drill holes.

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

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

It can be pointed out further that the theoretically perfect hole-spacing for measurement of any one disseminated ore body, is a function of its size, uniformity and richness. Since no two ore bodies are the same in all three respects, they cannot be compared precisely in terms of "tons of ore per foot of drill hole in ore". Nevertheless, such a comparison is at least indicative of the relative degree of measurement of ore bodies -- that is, the lower the "tons per foot", the better-measured the ore body. I have this figure for only two other ore bodies, but these indicate the Mission is the best-measured of the three:

Cuajone	8560
Toquepala	7500
Mission	5200

The degree of non-uniformity of Cu distribution in the Mission deposit is greater than in the other two. Closer hole-spacing therefore was required.

The present workings may be viewed as though they are horizontal drill holes which have penetrated five of the polygons of ore set up in our ore reserve calculations. From this arithmetic viewpoint certain comparisons can be made. Although such comparisons ignore mineralization trends and are, in my opinion, of little value, they are included and analyzed here as a matter of viewing the problem from all angles, as follows:

Drill Hole	Ore Reserve Calc. Polygon Tons	Ore Reserve Calc. Polygon Grade	% Avg. Core Rec. in Polygon	Underground Drifts Footage	Underground Drifts Avg. Assays Channel	Underground Drifts Avg. Assays Grab
151	171,668	2.66	95	395*	1.16*	1.23*
46	128,719	1.19	70	125	.71	.42
125	119,420	.96	95	170	.88	1.26
62	106,328	2.07	92	75	.71	.74
149	56,529	.60	98	45	.37	.46
Totals and Averages	582,664	1.68	90	810	.95	1.02

*Includes shaft samples within this polygon

The grade comparisons in the above table should be considered in the light of the three following factors:

(1) The grab and channel samples were taken carefully and with thought toward reduction of mechanical and other extraneous errors. Despite this, both are subject to chance variations in Cu distribution and can give erroneous indication of values at any one location involving up to a dozen or so samples. In sufficiently large numbers, both types of samples give averages which probably approach, say, 90% of the true value of the ground penetrated.

(2) When averaged in large numbers the core samples of the Mission deposit probably approach 100% of the true value of the material around the holes. This is due to the symmetry of the core, the high average core recovery (91.2% in ore), and the textural relationships between chalcopyrite and gangue minerals. In groups of no more than 8 or 10 core samples, which is approximately the number in each of the above polygons, the core sample averages, like any other sample type, are subject to chance variations in Cu distribution. For any one polygon, then, the core averages could be either higher or lower than the true value.

(3) Within any one polygon there are both geometrical and statistical disparities in comparing a few vertical core samples with a larger number of horizontal drift samples.

The five polygons above represent only 0.76% of the total ore body tonnage. From the standpoint of statistical analysis, which would take into account the total ore body tonnage as well as the range in grade of all the polygons, these five polygons represent a very small "sample" of the ore body. The internal checking of this sample, then, can have substantial variation and still be within acceptable limits with respect to the entire ore reserve calculation.

In my opinion the ore body has been penetrated by enough holes; the core samples are representative; the method of ore estimation is sound; and no checking is needed. However, if it is felt that check work should be undertaken, a minimal program of drilling 12 surface holes 600' deep, interspaced at 75' intervals along two section lines is recommended. Six holes would be drilled on each of sections 4050 N and 1500 W which are situated close to and parallel with the East drift and the North-South drifts, respectively. The data from these holes would serve in a general way as a check of our ore reserve interpretations of continuity of ore lenses between holes in the eastern part of the ore body.

This program can be partially accomplished by drilling short vertical holes (50-75') up and down from locations in present underground openings. This is being started now; but core recovery may be poor, in which case the underground drilling should not be continued beyond 3 or 4 holes. Even though the core recovery in underground holes proves to be acceptable, only six of the proposed 12 locations can be reached from underground workings -- four of these proposed locations lie on section 4050 N west of the shaft, and two would be north of the North drift on section 1500 W. These remaining six locations should be drilled from the surface.

It is understood that Mr. Pope has instructed that raises about 40' in length be driven on five drill holes (Nos. 62, 125, 130, 148 and 149). The core assays which could be compared with this 200' of raise assays range within .08 and 8.24% Cu, average 1.83% Cu, and represent 1.37% of the total footage (14,600') of drill hole in ore in the entire ore body. From the standpoint of statistical analysis, this limited amount of data could probably be considered as an acceptable correspondence if the two assay averages are within, say, 20% of each other. In other words, closer correspondence than this would be only a coincidence even if all samples -- core, channel, bulk, grab -- were nearly perfect.

It should also be noted that any raising done on drill holes will not provide data on accuracy of ore reserve tonnage estimates.

Yours very truly,

Original Signed By
K. Richard

KENYON RICHARD

Encl. Kinnison Report w/Maps & Secs.
KR:S
cc: DJPope - w/encl.
NWeiss- w/report, w/o maps

November 28, 1958

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

MISSION UNDERGROUND WORKINGS GEOLOGICAL REPORT

Dear Mr. Richard:

This is to acknowledge your transmittal letter of November 25 with Mr. Kinnison's complete report of the underground work at the Mission Mine. I wish to record that I am in full agreement with the comments which you present in your letter relative to the general interpretation of the results of this program. I also wish to comment that I consider Mr. Kinnison's geological report, excellent.

I believe that Mr. Pope has now suggested additional work which is already underway and I assume the same type of record will be continued. I understand this program includes some raising on drill holes and I believe it would be worth-while building up a record similar to that obtained in the course of check-raising at Toquepala. Mr. Courtright is thoroughly familiar with the details of that program, in which the equivalent of each floor of the raise was channel-sampled about midway to provide a quantitative comparison of metal distribution to be applied against the corresponding bulk sample. This procedure helped to show why a bulk sample for a particular unit of drill hole might be in considerable disagreement. In other words, the drill hole unit might pass through a five-foot section of relatively barren ground, whereas the raise in the corresponding distance may have penetrated several strong bunches of chalcopyrite concentrations. Obviously, the reverse condition could also obtain, but this information together with geological mapping for each floor equivalent permits a very instructive analysis of the nature of the mineral distribution within the ore body.

I do not know exactly what procedure has been agreed upon in connection with this raising, where the drill hole will be carried, etc., or whether some sort of bulk sample is contemplated. I do assume, however, that some kind of bulk sample will be required and you will wish to carry on the same type of detailed mapping which you have applied to the sill work. The channel-sampling mentioned, therefore, may represent the only point which might be in addition to instructions you have received. The Toquepala raises were ten feet long by five feet wide, and to obtain distribution information, the raise was channel-sampled with five-foot cuts on each end and two five-foot cuts on each side.

Very truly yours,

L. N. HART

cc: DJPope
TASnedden N.Weiss JEKinnison

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 21, 1958

MEMORANDUM FOR K. E. RICHARD

MISSION UNDERGROUND WORKINGS
Geological Report

Detailed geologic mapping in the underground workings at the Mission property has disclosed certain features of structure and mineralization which were not heretofore completely understood from the study of drill cores. However, no major revisions of previous geologic interpretations will be necessary in light of this work; on the contrary, further confidence may now be placed in some of the more speculative interpretations plotted on the 100 scale geologic sections (transmitted to L. H. Hart, November 22, 1957) which formed the basis for the ore reserve estimate.

List of Attachments

A - Revised section, along and near 1500W; 50-scale: shows workings and revised geology and ore outlines.

B - Combined section, East drift and 4050N; 50-scale: shows workings and revised geology and ore outlines.

C - Section 1500 West; 50-scale: Original geologic section with ore outlines, enlarged from 100 scale; to be compared with Att. A.

D - Section 4050 North; 50-scale: Original geologic section with ore outlines, enlarged from 100 scale; to be compared with Att. B.

E - Mission Mine Cross Section; 20-scale; through Shaft and South drift: Geology, with ore shown in color.

F - Mission Mine Cross Section; 20-scale; along north wall of East drift: Geology, with ore shown in color.

G - Mission Mine Cross Section; 20-scale; along west wall of North drift: Geology, with ore shown in color.

H - Mission Mine, 370 level; 20-scale; Underground workings: Ore colored.

I - Mission Mine, 370 level; 20-scale; Underground workings: Rock type colored.

J - Mission Mine, Assay Map, 370 level; 20-scale; Underground workings.

Summary

Disseminated copper ore (chalcopyrite with more or less pyrite) occurs without relation to such mineralized fissures as are present, which suggests

that a remote feeder(s) effected pervasive sulphide dissemination, perhaps guided locally by rock type or the major thrust faults. Post-ore faults of unknown displacement are present. The "No. 2 thrust," a previously interpreted structure, is proven to exist. The "A" and "East" faults were not observed because of probable fault and intrusion separations at drift location. Thin, mineralized fissures strike northeast, dip steeply southeast, and form high-angle northeast ore zones of minor consequence, as shown in the south drift. A zone of quartz-feldspar rock with plus 3% Cu forms the east margin of ore exposed in the East drift, and may represent a vertical layer of high-grade along the East fault.

It appears that the gross ore outlines as originally shown on the 100 scale sections need little revision. There is, however, a slight decrease in tonnage of lower grade ore, but a more definite continuity of higher grade ore (plus 2% Cu).

The ore taken for metallurgical testing was described separately for each lot. The rocks tested were soft tactite with admixed diopside, and the soft variety of diopside hornfels, which are representative of the principal ore types of the eastern part of the ore body.

Distribution of Copper

The attached 50 scale sections may be used to visually compare changes in the shape of ore outlines indicated by underground data. Original sections 1500E and 4050N, in the vicinity of the workings, are enlarged to 50 scale (Attachments C and D), and supplemented by two new sections, showing revised ore outlines and geology (Attachments A and B). For demonstrative purposes, the drill hole assays have been recalculated to show on the new sections more details of high-grade (plus 2% Cu) and waste than was practicable on the original sections of smaller scale; the distribution of the three classes of material (less than .40% Cu) (.40 to 2.0% Cu) (plus 2.0% Cu) is shown by white, yellow and red, respectively. In those instances where the drill holes are off section data are plotted as if the section plane contained angular bends, either horizontally or vertically, as conditions require. With the exception of part of the North drift, underground geology and ore distribution is given priority for about 50 feet above and below drift level, but beyond these limits is merged with drill hole data. For instance, the ore intercept in hole 46 is represented by the down dip projection of the upper contact of Zone B, as determined by the shaft and south drift data. The lower contact of Zone B is plotted according to the drill hole data. Thus a minor amount of distortion is involved; Zone B may not pinch going west as it appears, but may simply dip west.

Four principal ore zones, related structurally but not entirely continuous, have been penetrated both in drill holes and in the workings. These are labeled A, B, C, and D on the 50-scale revised sections.

Comparison of drill and drift penetrations of these zones provides a means of evaluating continuity of grade between holes, but only in a very limited way due to the small number of penetrations and the non-uniform distribution of

copper in any one zone. Further, the muck grab samples are of questionable reliability in any short segment of drift, particularly in the high-grade zones where massive, rather than disseminated, chalcopyrite predominates. Of course, the overall average of the muck grab samples is probably within acceptable limits of accuracy. The drill hole samples and muck grab samples within each zone are tabulated below.

Zone A is a low-grade zone, extending from bedrock to about 95 feet below.

	DDH 149	DDH 46	DDH 151	Shaft
Penetration, feet	90	106	96	89
Grade, % Cu	0.60	0.76	0.53	0.54

shaft grab samples in

As may be noted the grade of Zone A agrees very closely with that of the drill hole (151) on which it was sunk.

Zone B is a medium-grade zone separated from Zone A above by a band of waste. It has been directly penetrated in DDH's 46 and 151, the shaft, South, North and East drifts. A zone cored in DDH 62, which occurs under somewhat different geological conditions, is probably a related extension although it contains higher grade ore.

	DDH 46	DDH 151	Shaft	South Drift	East Drift	North Drift	DDH 62
Penetration, feet	74	19	28	122	75	81	60
Grade, % Cu	0.98	1.42	1.05	0.92	1.13	0.72	1.41

Zone B: Average grade of 3 DDH's: 1.20% Cu
Average grade of workings: 0.93% Cu
Average grade of 2 DDH's (excluding DDH 62) : 1.07% Cu

Zone C contains high-grade ore, and is penetrated in DDH's 151 and 62, and in the North and East drifts. A probable extension of this same zone was penetrated in DDH 148. Related high-grade zones, not directly continuous, are marked C-1 and C-2 on the cross sections.

	Zone C DDH 151	Zone C-1 DDH 151	Zone C-2 DDH 151	Zone C DDH 62	Zone C DDH 148
Penetration, feet	18	17	27	17	31
Grade, % Cu	4.02	4.08	2.16	4.53	2.68

	Zone C-1 Shaft	Zone C North Drift	Zone C East Drift
Penetration, feet	19	46	30
Grade, % Cu	2.47	2.36	2.30

High-grade zones (C, C-1, C-2):
Average grade of 5 DDH penetrations: 3.27% Cu
Average grade of workings : 2.36% Cu

Zone D is penetrated only by DDH 125 and the East drift.

DDH 125 : 90' @ 0.73% Cu

East Drift: 101' @ 0.84% Cu

The ore disseminated through the No. 2 thrust fault zone can be compared only in a general way due to uncertainties in structural interpretation. This zone was penetrated in DDH 151, where the thrust zone is mineralogically similar to the exposure in the East drift.

Thrust zone:

DDH 151 : 40' @ 0.74% Cu

East drift: 106' @ 0.80% Cu

The ore zones in the south half of the South drift, controlled by high-angle fissures, cannot be directly compared to any of the drill hole intercepts, but DDH 46 contained numerous quartz fissures, and some of the ore in that hole, which was correlated with Zone A, may be related to the fissure zones of the South drift.

The zone of high-grade ore (plus 3% Cu) in quartz-feldspar rock, near the face of the East drift, may represent a vertical ore zone adjacent to the East fault. Being vertical, no drill holes have penetrated it, except possibly DDH 221. If this zone is localized by the East fault it may contain an appreciable amount of copper, which is not reflected in the ore reserve estimate. It might extend beyond the ultimate pit limits, opening the possibility of eventual underground mining.

Averages of grab and vertical channel sample assays taken in the shaft compare as follows with the weighted average assay of the core of the hole which the shaft followed:

Channel	1.10% Cu
Core	.91
Grab	.80

This demonstrates that the channel and grab were carefully taken.

In summary, results of the underground work definitely indicate continuity of copper mineralization between drill holes; however, the average assay of the drill holes is higher than that of the drifts in two zones (B and C). Considering the wide range of copper content within any one penetration (from sample to sample) and the lack of balance, geometrically, between drill holes and drifts, close agreement in value among a few widely spaced penetrations would be nothing more than a rare coincidence anyway.

Description of significant geologic features

All ~~mineralised~~ ore grade rock contains chalcopyrite, with a lesser amount of pyrite,

erratically disseminated as grains, pods (up to 3"), and rarely as unoriented stringers up to 3" long. All rocks penetrated by the workings, with the exception of post-ore andesite, are mineralized and contain pyrite and chalcopyrite in varying amounts. Sphalerite is limited to a few thin veins and very rare disseminated grains, and molybdenite is very sparse. Oxidized ore in the shaft consists of copper silicates and brown oxides (copper "pitch"). Some blebs of "pitch" contain a chalcopyrite core for about 10 feet above the base of the oxide zone, which is 20 feet below the top of bedrock.

Ore-waste contacts within favorable rocks are gradational, but are sharply visible against unfavorable rocks and post-ore faults. Certain feldspathic rocks which contain higher-grade ore have visibly sharp waste-ore contacts. However, a number of waste-ore contacts are not clearly visible.

High-angle northeast mineralized fissures are prevalent and closely spaced in the South drift, and occur in lesser abundance elsewhere. These fissures cut disseminated ore with no evident relation to it. In the South drift, these fissures are locally spaced close enough together to constitute low-grade ore, and are associated with two northeasterly altered zones containing ore.

High-grade ore (plus 3% Cu) in a coarse quartz-feldspar gangue was penetrated for about 30' adjacent to a felsite porphyry dike in the East drift. The felsite displaces the East fault by crossing it at drift level (Att. B) or perhaps intruding along the fault zone. The felsite itself is pre-ore, but an unfavorable host. The high-grade ore zone is contacted by post-ore faults and the pre-ore intrusive felsite, so nothing can be positively stated concerning its distribution beyond the drift. It may be a bedded recrystallized or metasomatic zone in the Pima formation (Att. B), or it may represent an ore concentration along the East fault. Steeply banded ore in a feldspathic gangue was cored in DDH 221, which lends support to the latter possibility.

A highly sheared low-angle folded fault zone brings marble in contact below hornfels in the East drift. There is little doubt that this is the No. 2 thrust -- a structure based on drill core interpretation and plotted on the 100 scale sections as a pre-ore thrust fault. The position of the fault on section 4050N must be revised near the "A" fault, but it is significant that the thrust interpretation has been verified. Crosscutting veinlets demonstrate that the structure was initiated prior to mineralization, but the evidence regarding post-ore movement is inconclusive. Thin slips seen in the North drift, which may be related to the thrust, appear to localize high-grade ore.

Bedding is not recognized except possibly in the calcareous argillite, and a thin, banded zone in the North drift (which may be a silicified fault zone). Bedding control of ore, then, may not be as well developed in the eastern area as in the central and west parts of the ore body.

The "A" fault, a post-ore high-angle structure striking north-northwest and intruded by andesite, was not definitely penetrated in the East drift. A narrow andesite dike in the East drift may be a part of the "A" fault which locally has an abrupt swing to an easterly strike; or the "A" fault may have been separated at drift location by other faults.

Two northeasterly post-ore faults of considerable strike extent are present, but their displacement is unknown. These displace ore lenses and pre-ore structures, and in the pit will locally form visibly sharp waste-ore contacts. Other similar post-ore faults are undoubtedly present beyond the limits of the underground workings.

Metallurgical Samples

The ore taken for metallurgical testing was described separately for each lot. Abstracts of these memorandum descriptions appear in Mr. Romney's reports on individual lots (report: Pilot Mill Test of Mission Mine Ore).

The underground samples were of soft diopside hornfels (types B and C -- Memorandum to K. E. Richard 3/10/58, transmitted to N. Weiss, with carbon copies to D. J. Pope and L. H. Hart, 3/13/58) and tactite (refer to same memo) with small to moderate amounts of admixed diopside. These rocks are typical of the principal ore types to be encountered in the eastern part of the ore body. In the central and western parts some tactite is much harder and more compact than the tactite ore tested, but this type is subordinate in amount. The hornfels ore tested is the predominant hornfels type throughout the deposit, particularly in the eastern part of the ore body.

The sample of argillite ore tested from the Pima Mine pit is typical of the hardest variety in the Mission deposit. Some of the argillite in the western Mission area contains more fractures and will probably crush more easily than the Pima sample.

The ore types represented by these test lots constitute about 90% of the eastern part of the ore body and about 70% of the total ore body. Of the types not represented, about 8% (hard, dense type of hornfels, and extremely soft hornfels) may present different metallurgical problems, while the remaining 22% have megascopically similar physical characteristics to the types actually tested.

John E. Kinnison

JOHN E. KINNISON

JEK/ds
Attachments A - J

Section 1500 W

Section through (±) DDH 62

Section through DDH 148

149

46 PROJ. 50'W

151 SHAFT

62 PROJ 10' E

148

ATTACHMENT A

New detailed ave | Old ave | Shaft muck ave

3000

Bedrock

Hf

Base of Oxidation

Tt

Qtzt

Qtz-feld-arg

qtz feld lenses

A

B

C

C-1

C-2

Projected West

Calc Arg

Hf & Tt

Mb

Mb or Wall

No. 2 Thrust

2800

597 TD

ORE

.4 - 2.0 % Cu

2.0 % + Cu

Waste

TO ACCOMPANY Report

DATED Nov 21, 1958

BY J.E. Kinnison

ASARCO

MISSION PROJECT

Pima Mining District, Pima County, Arizona

REVISED SECTION

ALONG & NEAR 1500W

LOOKING WEST

SCALE 1" = 50'

November, 1958

ATTACHMENT B

B

151 SHAFT PROJ. 40'S

125 PROJ. 40' S

184 PROJ 40'S

75 PROJ. 40'S

3000

Bedrock

Base of Oxide

Hf

Tt

Qtzt

Qtz-feld

Felsite Porphyry

A

B

C

D

C-2

Mb

Hf-Tt

Hf and Tt

Calc Arg

No. 2 Thrust

No. 1 Thrust

Andesite

Possible qtz-feld zone w/hi-grade

East Fault

2' qtz cpy

Bottom Thrust

2800

ORE

.4 - 2.0% Cu

+2.0 % Cu

WASTE

TO ACCOMPANY Report

DATED Nov. 21, 1958

BY J.E. Kinnison

ASARCO

MISSION PROJECT

Pima Mining District, Pima County, Arizona

COMBINED SECTION

EAST DRIFT & 4050 N

LOOKING NORTH

SCALE 1" = 50'

November, 1958

ATTACHMENT C

C

149 | 46 PROJ. 50' W | 151 SHAFT | 62 PROJ. 50' W | 148

3000

.60 .43 1.11 .25 .21 .60 .37 .05 .09 .35 .33 .05 .03

.53 .92 .77 .28 .59 1.26 .65 .28 .05 .34 .04 .03 .04 597 TD

.60 .45 .58 .24 .37 2.66 2.29 1.58 .88 .03 .03 .39 .04 .04 .03

.41 .28 .04 .04 .92 1.83 2.07 .40 .60 1.38 1.68 .04 .04 .04 1.12 .05

.09 .05 .06 .40 .74 2.49 3.10 .61 .60 2.53 .03 .09 .64 3.96

2800

Hf

Tt

Qtz - Feld - Arg

Qtzt

Qtz - feld - arg

Qtz - Feld (local)

Mb

Calc Arg

No 2 THRUST

Hf & Tt

Axis

Wall of Mb

TO ACCOMPANY Report
DATED Nov 21, 1958
BY J E Kinnison

NOTE: Plus 0.4 % Cu shown in red

ASARCO
MISSION PROJECT

Pima Mining District, Pima County, Arizona

SECTION 1500 WEST

SCALE 1" = 50'

November, 1958

ATTACHMENT D

D

151 Shaft

125

184

75

3000

2800

.60 Base of Oxidation

Hf.

.45

Hf. & Tt.

.58

.24 Tt.

.37

2.66 Hf.

2.29

1.58 No. 2 Thrust

.88

.03

.03

.39

.04

.04

.03

Tt.

Qtzt

.53

.21

.03

3.62

.52

.96

Fault

Feld-rich zone

"A"

1.48

1.48

.34

.68

.76

.06

6.96

3.42

.04

.14

Mb.

Hf & Tt.

Tt

Calc. Arg.

Calc. Arg

Mb

A

Tt.

Tt.

Qtzt

East Fault

.01

.02

.02

.04

.04

.03

2.93

.07

.02

.02

.02

.45

.03

.04

.02

Cgl.

Fp

Bedding ?

.02

.03

.04

.05

.07

6.04

.18

.06

.04

.05

Arg

Bottom Thrust

No. 1 Thrust

TO ACCOMPANY Report
DATED Nov. 21, 1958
BY J.E. Kinnison

NOTE: Plus 0.4 % Cu shown in red

ASARCO

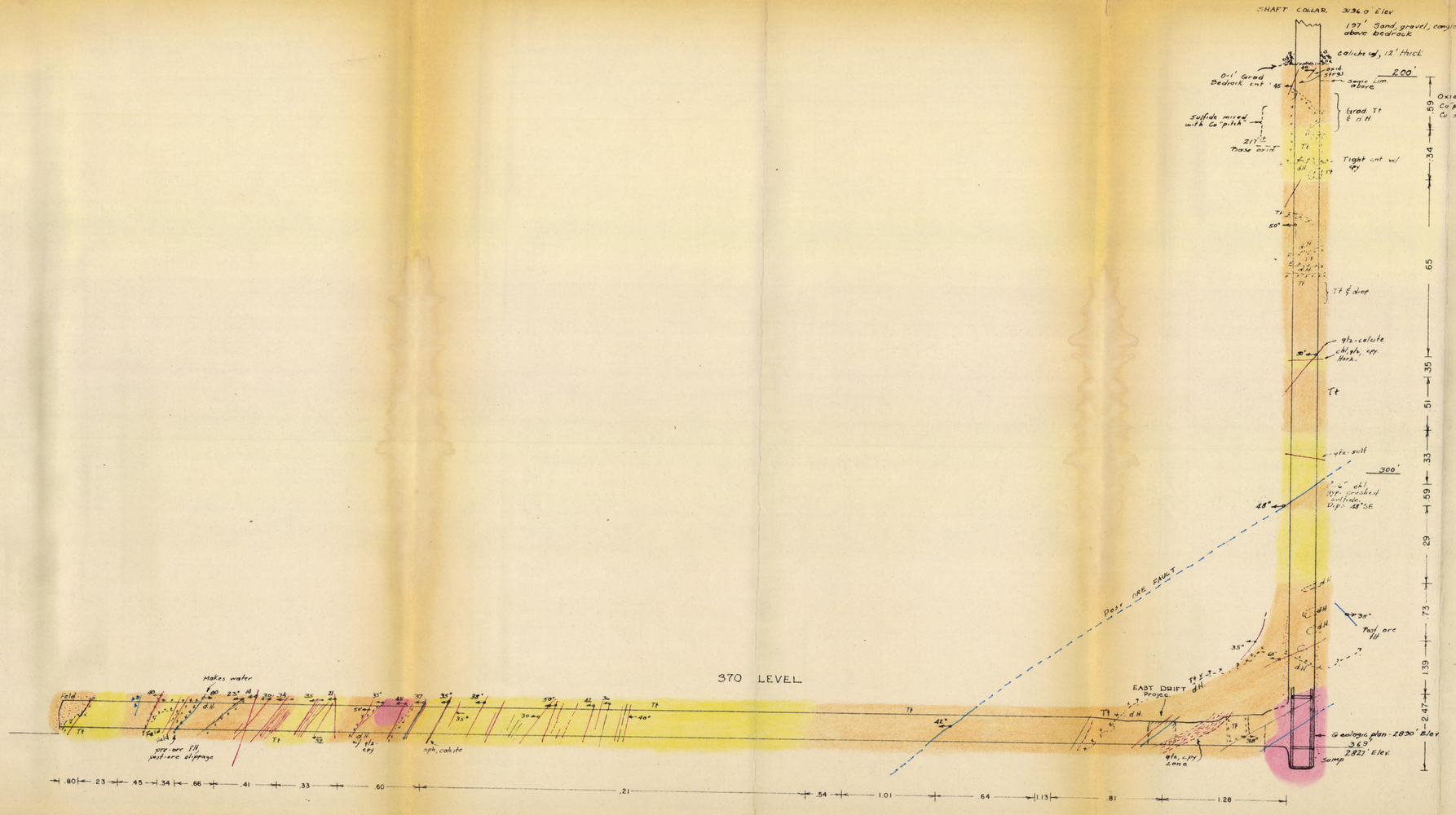
MISSION PROJECT

Pima Mining District, Pima County, Arizona

SECTION 4050 NORTH

SCALE 1" = 50'

NOVEMBER, 1958



ATTACHMENT E

E

See Plan Map for Legend

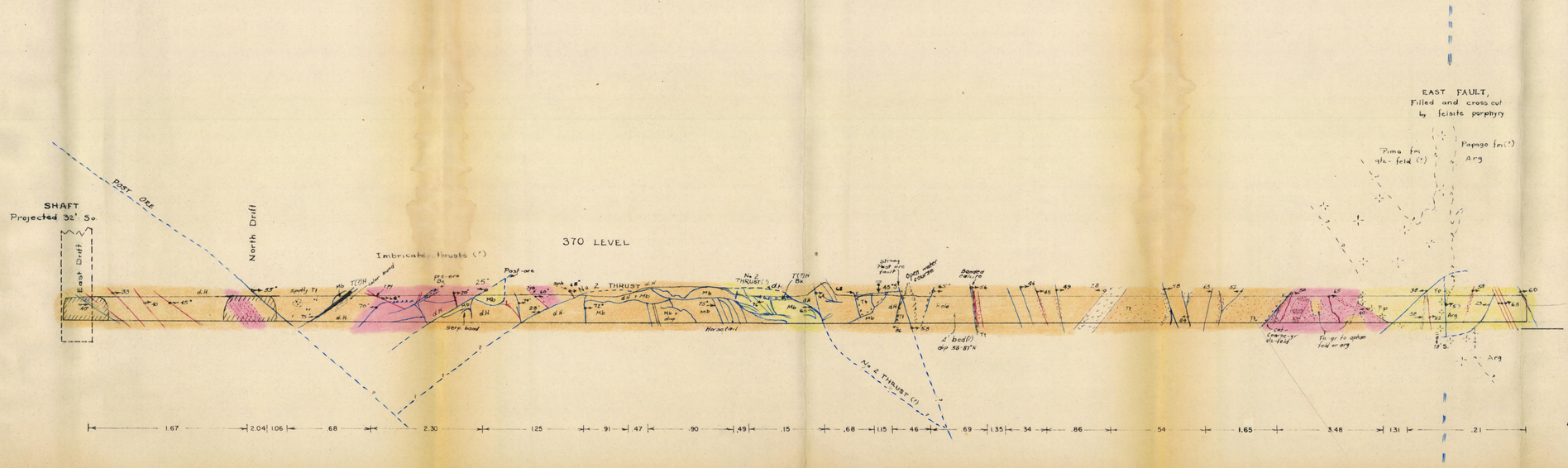
TO ACCOMPANY Report
DATED Nov. 21, 1958
BY J.E. Kinnison

A SARCO
MISSION MINE
CROSS SECTION
Through Shaft and South Drift
LOOKING WEST
Scale 1" = 20'

NOVEMBER, 1958

J.E.K.

ATTACHMENT F



See Plan Map for Legend

TO ACCOMPANY Report
DATED Nov. 21, 1958
BY J.E. Kinnison

ASARCO

MISSION MINE

CROSS SECTION

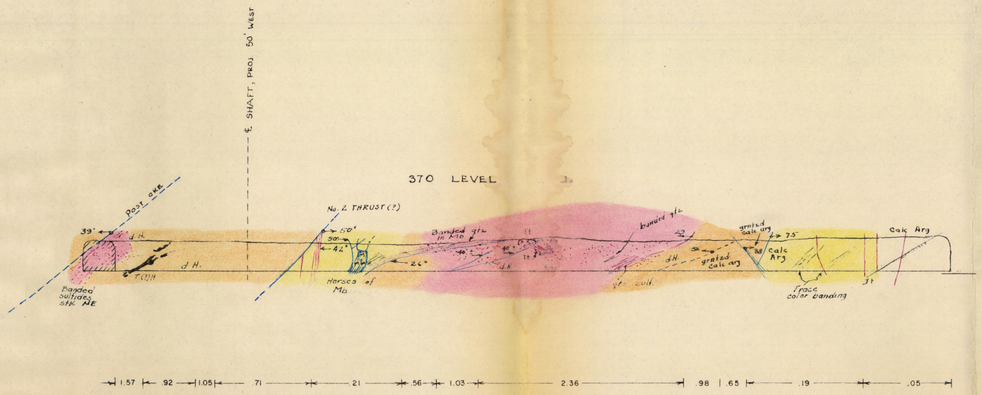
Along North Wall of East Drift

LOOKING NORTH

Scale 1" = 20'

NOVEMBER, 1958 J.E.K.

ATTACHMENT G



See Plan Map for Legend

TO ACCOMPANY Report
DATED Nov. 21, 1958
BY J.E. Kinnison

ASARCO

MISSION MINE

CROSS SECTION

Along West Wall of North Drift

LOOKING WEST

Scale 1" = 20'

NOVEMBER, 1958 J.E.K.

G

ATTACHMENT I

NOTE:

TRANSIT SURVEY JUST COMPLETED SHOWS THAT, FOR TRUE POSITION WITH RESPECT TO COORDINATES AND DRILL HOLES, THE WORKINGS SHOULD BE ROTATED ABOUT THE SHAFT 1°45' COUNTERCLOCKWISE.

11/5/58

EXPLANATION

Meta-sediments of Pima formation

- Tt — Tactite - Symbol shown near contacts
- d.H. — Diopside Hornfels
- Mb — Marble
- Calc Arg — Calcareous Argillite
- Feld — Felspathic rock. (Recrystallized fine-grained or aphanitic, pink colored rock)
- qtz-feld — Recrystallized or metasomatic coarse-grained intergrowth of quartz and feldspar
- T(?)H — Hornfels, probably composed of trem-actinolite minerals Dense, brown-black, altered to chlorite and/or serpentine

Papago formation

- Arg — Argillite and sandy argillite

Igneous

- Fp — Felsite porphyry

Post-ore igneous

- Andesite

Note: With the exception of T(?)H, all rocks are named by visual comparison to types identified by petrographic study of drill cores. Refer to reports by R.L. Dubois, and file memoranda P-10.10.2 /2

Mineralization

- Vein or mineralized fissure
- Strong disseminate ore

Averaged Muck Samples

- 0 - .09 % Cu
- .10 - .39 % Cu
- .40 - 2.0 % Cu
- 2.0 %+ Cu
- 16' at 0.89 % Cu

Structure

- Fault
- Gradational or obscure contact
- Contact
- Joint

American and Smelting Refining Company

MISSION MINE

Geology Colored

370 LEVEL - UNDERGROUND WORKINGS

Pima Mining District, Pima County, Arizona

SCALE 1" = 20'

Survey by Brunton & tape - J. E. K.
Geology by J. E. K. mapped at 2830' elevation
November, 1958

TO ACCOMPANY Report
DATED Nov. 21 1958
BY J. E. Kinnison

I

ATTACHMENT J

766 200 E

766 300 E

766 400 E

766 500 E

766 600 E

362 900 N

362 800 N

362 700 N

362 600 N

362 500 N

362 400 N

DDH 148
1.22

DDH 130
3.52

DDH 62
2.07

DDH 224
0.71

DDH 184
0.04

DDH 125
0.96

370 - 1450 W. NORTH CROSSCUT

DDH 151

Channel Sample

Bulk Sample

370 - 4015 N. EAST DRIFT

370 - 1500W SOUTH CROSSCUT

DDH 46
1.19

DDH 222
0.71

NOTE:
TRANSIT SURVEY JUST COMPLETED SHOWS THAT, FOR TRUE POSITION WITH RESPECT TO COORDINATES AND DRILL HOLES, THE WORKINGS SHOULD BE ROTATED ABOUT THE SHAFT 1°45' COUNTERCLOCKWISE.
11/5/58

DDH 149
0.60

DDH 129
0.43

Bench Assay - % Cu
(20' above and 20' below level)

DDH 60
0.51

TO ACCOMPANY Report
DATED Nov. 21, 1958
BY J.E. Kinnison

American Smelting and Refining Company

MISSION MINE
ASSAY MAP
370 LEVEL - UNDERGROUND WORKINGS

Pima Mining District, Pima County, Arizona

SCALE 1" = 20'

Elevation of Shaft Sill - 2827'

October, 1958

EP-105-2

J