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AIME MINING GEOLOGY DIVISION - ARIZONA SECTION

DUVAL SIERRITA - TUCSON, ARIZONA

TUCSON INN CONVENTION CENTER

APRIL 13, 1973

9:00 A.M. - 11:00 A.M.

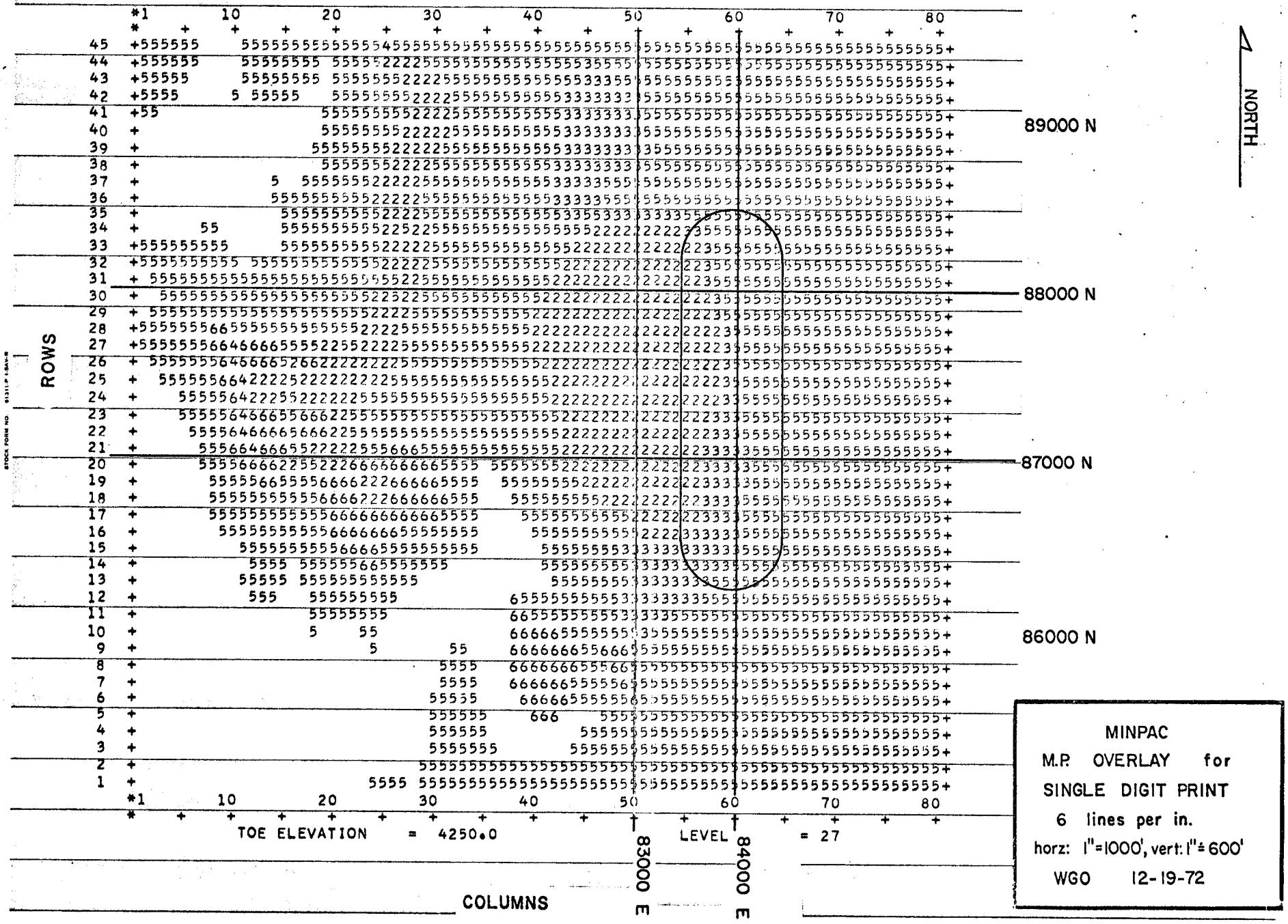
TECHNICAL PROGRAM

Welcoming Address	A. E. Smith Vice President of Operations
Structural Geology of the Sierrita Mountains	Dr. Harald Drewes, Geologist, U. S. Geological Survey
Some Geologic Features of the Sierrita Deposit	Bob Metz, District Geologist (Tucson), Duval
Mineralization Control at the Duval Sierrita Property, Pima County, Arizona	Calvert Iles, Mine Geologist, Duval Sierrita
A Synopsis of Alteration and Mineralization at the Sierrita and Esperanza Mines	Chet Oakley, Geologist, Duval Sierrita
Geologic Data in Mine Planning	Larry Dykers, Assistant Superintendent, Duval Sierrita

Lunch will be served from 11:00 a.m. - 12:00 p.m. Members taking the field trip to the Sierrita Property will board buses at 12:00 p.m.

314 TO CHECK LOADING OF ROCK TYPE CHANGES OF 3/23/73 - AS PER R.T.

TOE ELEVATION = 4250.0 LEVEL NUMBER= 27



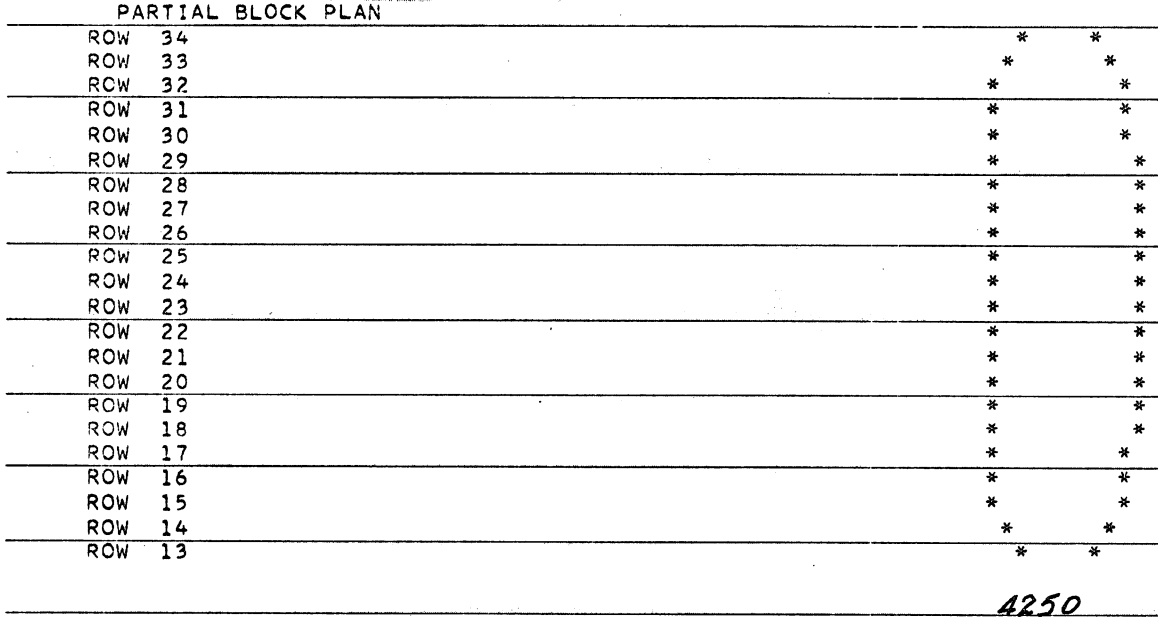
MINPAC
M.P. OVERLAY for
SINGLE DIGIT PRINT
6 lines per in.
horz: 1"=1000', vert: 1"=600'
WGO 12-19-72

The units and grouping should now be as follows:

Printout	Input	Symbol	Unit
	03		Waste Dump
9	04		Leach Dump
	05	Qal	Alluvium
2	25	Kqp	Quartz Porphyry
	26	Kqmp	Quartz Monzonite Porphyry
3	33	Kbqmp	Biotite Quartz Monzonite Porphyry
4	45	Kql	Rhyolite (Quartz Latite)
	46	Kapl	Aplite
	53	pCcbs	Chlorite-Biotite Schist
5	54	pCamp	Amphibolite
	55	pChmd	Harnblende Metadiorite
	56	pCqd	Quartz Diorite
6	65	pCqfg	Quartz-Feldspar Gneiss
	66	pCpeg	Pegmatite

- TEST PIT - 23 MARCH 73

PARTIAL BLOCK PLAN



4250

STOCK FORM NO 6131 PI SAVR

TEST PIT -- 23 MARCH 73
RMO = RECOVERABLE NO. CU EQ = CU - .5ASCU + RMO
ROCK TYPE = 0-UNK, 2-QMP, 3-BQMP, 4-QL, 5-CBS, 6-QFG, 9-QAL.
ORE 1 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU GREATER OR EQUAL TO .35
ORE 2 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU LESS THAN .35 ORE 3 IS CU EQUIV LESS THAN .40 AND CU GREATER OR EQUAL TO .15 BUT LESS THAN .35 --- WASTE IS EQUIV CU LESS THAN .40 AND TOTAL COPPER LESS THAN .15

SEQUENCE NUMBER 34. INCREMENT NUMBER 1

BENCH	KTONS	CU	ASCU	RMO	EQUI	KTONS	CU	ASCU	RMO	EQUI	WASTE KTONS	TOTAL KTONS	S.R.1 S.R.2	S.R.12
	********** ORE 1 **********					********** ORE 2 **********								
	********* ORE 1 + ORE 2 *********					********** ORE 3 **********								
4390	1646.3	0.567	0.084	0.025	0.657	487.1	0.299	0.039	0.044	0.504			2.96	
	2133.5	0.506	0.074	0.030	0.622	1414.2	0.222				2973.0	6520.9	12.38	2.06
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 23	3= 53	4= 0	5= 24	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 60	3= 34	4= 0	5= 6	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 18	3= 21	4= 0	5= 61	6= 0	7= 0	8= 0	9= 0	0= 0
4355	1902.3	0.528	0.084	0.031	0.644	699.9	0.250	0.025	0.054	0.514			2.63	
	2602.3	0.453	0.068	0.037	0.609	901.8	0.226				3407.5	6911.7	8.87	1.66
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 29	3= 50	4= 0	5= 21	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 84	3= 16	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 11	3= 30	4= 0	5= 59	6= 0	7= 0	8= 0	9= 0	0= 0
4320	1350.9	0.566	0.086	0.031	0.685	431.7	0.302	0.052	0.050	0.532			3.70	
	1782.7	0.502	0.078	0.036	0.648	1484.2	0.234				3079.9	6347.0	13.70	2.56
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 31	3= 53	4= 0	5= 16	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 54	3= 46	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 11	3= 28	4= 0	5= 61	6= 0	7= 0	8= 0	9= 0	0= 0
4285	383.5	0.447	0.038	0.037	0.616	553.8	0.273	0.040	0.042	0.468			14.13	
	937.4	0.344	0.039	0.040	0.528	1594.5	0.201				3272.9	5804.9	9.48	5.19
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 78	3= 22	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 44	3= 56	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 10	3= 42	4= 0	5= 48	6= 0	7= 0	8= 0	9= 0	0= 0
4250	252.5	0.450	0.034	0.045	0.663	280.0	0.239	0.021	0.046	0.464			19.87	
	532.5	0.339	0.027	0.046	0.558	1373.1	0.192				3366.1	5271.8	17.83	8.90
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 55	3= 45	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 80	3= 20	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 12	3= 62	4= 0	5= 26	6= 0	7= 0	8= 0	9= 0	0= 0
SUM	5535.8	0.540	0.079	0.030	0.657	2452.7	0.273	0.035	0.048	0.499			4.57	
	7988.6	0.458	0.066	0.036	0.608	6768.1	0.214				16099.6	30856.4	11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 32	3= 49	4= 0	5= 18	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 65	3= 34	4= 0	5= 1	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 12	3= 37	4= 0	5= 50	6= 0	7= 0	8= 0	9= 0	0= 0

TEST PIT -- 23 MARCH 73
RMO = RECOVERABLE MO. CU EQ = CU - .5ASCU + RMO
ROCK TYPE = 0-UNK, 2-QMP, 3-BQMP, 4-QL, 5-CBS, 6-QFG, 9-QAL.
ORE 1 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU GREATER OR EQUAL TO .35
ORE 2 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU LESS THAN .35 ORE 3 IS CU EQUIV LESS THAN .40 AND CU GREATER OR EQUAL TO .15 BUT LESS THAN .35 --- WASTE IS EQUIV CU LESS THAN .40 AND TOTAL COPPER LESS THAN .15

TYPE OF OUTPUT - ACCUMULATIVE BY BENCHES

SUMMARY OF SEQUENCE 34. INCREMENTS 1 TO 1

BENCH	********** ORE 1 ********** / ********** ORE 1 + ORE 2 ********** KTONS	CU	ASCU	RMO	EQUI	********** ORE 2 ********** / ********** ORE 2 + ORE 3 ********** KTONS	CU	ASCU	RMO	EQUI	WASTE KTONS	TOTAL KTONS	S.R.1 / S.R.2	S.R.12
4390	1646.3	0.567	0.084	0.025	0.657	487.1	0.299	0.039	0.044	0.504			2.96	
	2133.5	0.506	0.074	0.029	0.622	1414.2	0.222				2973.0	6520.9	12.38	2.06
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 23 3= 53 4= 0 5= 24 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 60 3= 34 4= 0 5= 6 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 18 3= 21 4= 0 5= 61 6= 0 7= 0 8= 0 9= 0 0= 0													
4355	3548.7	0.546	0.084	0.028	0.650	1187.1	0.270	0.031	0.050	0.510			2.79	
	4735.9	0.477	0.070	0.034	0.615	2316.1	0.223				6380.6	13432.6	10.31	1.84
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 27 3= 51 4= 0 5= 22 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 74 3= 24 4= 0 5= 2 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 15 3= 24 4= 0 5= 60 6= 0 7= 0 8= 0 9= 0 0= 0													
4320	4899.8	0.552	0.084	0.029	0.660	1618.9	0.278	0.036	0.050	0.516			3.04	
	6518.8	0.484	0.072	0.034	0.624	3800.4	0.228				9460.6	19779.8	11.22	2.03
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 28 3= 52 4= 0 5= 20 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 69 3= 29 4= 0 5= 2 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 13 3= 26 4= 0 5= 60 6= 0 7= 0 8= 0 9= 0 0= 0													
4285	5283.4	0.544	0.081	0.029	0.656	2172.7	0.277	0.037	0.048	0.503			3.84	
	7456.2	0.466	0.068	0.035	0.612	5395.0	0.220				12733.5	25584.7	10.78	2.43
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 31 3= 49 4= 0 5= 19 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 62 3= 36 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 12 3= 31 4= 0 5= 57 6= 0 7= 0 8= 0 9= 0 0= 0													
4250	5536.0	0.540	0.079	0.030	0.657	2452.7	0.272	0.035	0.048	0.499			4.57	
	7988.8	0.458	0.065	0.036	0.608	6768.1	0.214				16099.6	30856.6	11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 32 3= 49 4= 0 5= 18 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 64 3= 34 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 12 3= 37 4= 0 5= 50 6= 0 7= 0 8= 0 9= 0 0= 0													
SUM	5536.0	0.540	0.079	0.030	0.657	2452.7	0.273	0.035	0.048	0.499			4.57	
	7988.8	0.458	0.066	0.036	0.608	6768.1	0.214				16099.6	30856.6	11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 32 3= 49 4= 0 5= 18 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 65 3= 34 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 12 3= 37 4= 0 5= 50 6= 0 7= 0 8= 0 9= .0 0= 0													

STOCK FORM NO. 61311 P.1 SAV.R

Form 355

Ⓐ

GEOLOGY EDP DRILL HOLE LOG

HOLE NUMBER	GRID LOCATION	COORDINATES NORTHING	COORDINATES EASTING	COLLAR ELEV.	DEPTH DRILLED	HOLE GEOMETRY AZIMUTH	HOLE GEOMETRY INCL.	METH	DRILL I.D.	DATE START	DATE FINISH	LOG BY	PROPERTY I.D.
1042	40 1055	10360	98200	4053	1200	0	-90	1	02	09-27-72	10-14-72	CAO	004

Ⓑ

CONTINUATION	SAMPLE NUMBER BY DEPTH	ROCK UNIT	EPIDOTE	CHLORITE	CLAY	SERICITE	QTZ. VEINLETS	SILICIFICATION	TOURMALINE	BIOTITE	ORTHOCLASE	HEMATITE	GOETHITE	JAROSITE	ZEOLITES	ANHYDRITE	GYPSUM	CALCITE	OTHER	CU OXIDES	CHALCOCITE	%VOL SULPHIDE	PYRITE	PYRITE TO	CHALCOPYRITE	DISSEMINATED	VEINLETS	FRACTURING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	% CORE RECOVERED	ROCK STRENGTH PSI x 100	R.Q.D. ≥ 4 INCHES	R.Q.D. ≥ 12 INCHES	R.Q.D. ≥ 24 INCHES
	25																																													
		0-25' Rock Bit																																												
	33	3	4	0	0	4	0	2	0	0	0	0	2	5	5	0	0	0	0	0	0	0	1	1	0	1	0	3	7	1												6	1			3	0	0
	43																											F	5	0	1	5	0	1								5	9			4	1	0
		Fit 39-40.5																																												
	53																		1																									7	6			5	0	0
		ox-sulf contact @ 52'																																												
	63	3	4	0	0	4	0	2	0	0	2	3	0	0	0	0	0	2	0	0	0	0	1	3	0	2	0		F		1	0	9	9									7	0			1	0	0
		Flt 62-71																																												
	73																											F		8	0	0	1									5	9			1	0	0
	83																											F		1	0	9	9									7	8			2	0	0
		Flt 82-89																																												
	93																											F		6	0	0	1									7	5			3	0	0
	103	3	4	2	3	2	4	2	0	0	1	4	0	0	0	0	0	2	0	0	0	0	2	3	0	1	0															9	6			6	1	0
	113																																										9	8			4	0	0
	123																											F	3	0	0	7	0	1								9	9			4	0	0
		Flt 117-117.7																																												

Cu Equivalent = Cu + 4 Mo

Ⓒ

SAMPLE ELEV.	Est % Cu	Est % Mo	ASSAYS Cu	ASSAYS Mo		Cu eq.
4028						
4020	.10	.01	.11	.006		.13
4010	.10	.01	.10	.006		.12
4000	.10	.01	.15	.011		.19
3990	.20	.01	.20	.018		.27
3980	?	?	.08	.005		.10
3970	.20	.01	.18	.016		.24
3960	.10	.01	.11	.035		.25
3950	.10	.01	.12	.026		.22
3940	.05	.005	.13	.009		.17
3930	.20	.010	.22	.026		.32

GRAPH: Rx | ORE

EXPLANATION OF "GEOLOGY EDP DRILL HOLE LOG"

PART A

This part of the form is for "header card" information and is completed only once for each drill hole. The column headings are mostly self-explanatory.

HOLE NUMBER, cols. 2 thru 5: Example, Drill Hole No. 861.

GRID LOCATION, cols. 6 thru 13: Development hole grid location is to be reported to the nearest tenth of a unit. Example, Q½; 96½.

COORDINATES, cols. 14 thru 25: Example, 99,000 N; 98,701 E

COLLAR ELEVATION, cols. 26 thru 29: Example, 3,655 ft.

DEPTH DRILLED, cols. 30 thru 33: Example, 1,965 ft.

HOLE GEOMETRY, cols. 34 thru 41: Space has been provided for angle holes. Enter the azimuth in degrees (cols. 34 thru 36) and minutes (cols. 37 thru 38). The inclination is + if upwards, and - if downwards; enter degrees of inclination in cols. 40 thru 41. An example of a vertical hole drilled from the surface is shown on the attached "Example" form.

METH, col. 42: The number designating the drilling method used is selected from the Code Key. Example, diamond core hole.

DRILL I.D., cols. 43 thru 44: The identification of the company that drills the hole is selected from the Code Key. Example, Boyles.

DATE, cols. 45 thru 56: The month, day, and year the drill hole is started and finished is entered numerically. Example, Started January 6, 1970; Finished February 12, 1970.

LOG BY, cols. 57 thru 59: The person logging the core enters his initials here.

PROPERTY I.D., cols. 77 thru 80: The property identification number assigned by the Engineering Dept. is entered here. Example, Sierrita.

contd.

PART B

This part of the form is for describing the geology of the drill hole. One row, or line of boxes, is to be used for each sample interval to be described.

The "blank space" below each row is for remarks and additional information which is not necessary to be keypunched. Each line will be keypunched on a single IBM card. Note that cols. 2 thru 5, HOLE NUMBER, are not shown on this part of the form. The hole number will be entered on each card automatically by the keypunch operator.

CONTINUATION CARD, col. 1: If the additional information mentioned above is to be keypunched, a "1" is entered in column 1 of the "blank space."

SAMPLE NUMBER BY DEPTH, cols, 6 thru 9: The hole number together with the depth of the bottom of the interval sampled will be used for the "sample number". On the attached "Example" form, a rock bit was used from the surface to a depth of 15 feet, and no sample was collected. The first interval sampled was from 15 feet to 25 feet. The sample for assay would be marked 861-25.

ROCK UNIT, cols. 10 thru 11: The appropriate numerical code is selected from the Key and entered here. Example shown (65) is for quartz diorite at Sierrita.

Cols. 12 thru 32: Enter the estimated percent by volume for each mineral by using the appropriate Code Key. It is realized that it is difficult to estimate alteration minerals, but every effort should be made to quantify this information within broad limits. At operating properties, different methods have been used to record the relative amounts of minerals present and it may be necessary to continue with the method being used for future logging.

PYRITE TO CHALCOPYRITE, cols. 33 thru 35: Space is provided for recording the ratio of pyrite to chalcopyrite to the nearest tenth. An entry in col. 35, the tenth, is only necessary where the amount of chalcopyrite exceeds the amount of pyrite. Example, 10% pyrite, 1% chalcopyrite.

DISSEMINATED - VEINLETS, cols. 36 thru 37: It is assumed that the ore minerals are either disseminated or occur in veinlets. Enter in col. 36 the percent, divided by 10, of ore minerals that are disseminated in the rock. Enter in 37 the percent, divided by 10, of the ore minerals that occur in veinlets. Example: 19 is 10% disseminated, 90% veinlets.

FRACTURING, col. 38: Choose a representative foot of core that appears to be the average fracturing intensity for the sample interval. This includes veinlets and mineralized fractures. Count the number of fractures per foot and enter this number in col. 38. If the number is less than 1, enter 0. If the number is 9 or more, enter 9. Example, an average of 5 fractures per foot.

STRUCTURE, cols. 39 thru 59: Space has been provided to record the type, attitude, thickness, and filling material for three structures per sample interval. Notations for the type and filling material are selected from the appropriate Code Keys. The attitude is measured in degrees from the horizontal. Thickness is recorded to the nearest one-tenth of a foot. Example, an unmineralized fault dipping 60 degrees; a vein dipping 80 degrees, 2 feet thick, containing quartz, molybdenite, and pyrite; a fault dipping 75 degrees with 1.5 feet of gouge, unmineralized.

% CORE RECOVERED, cols. 60 thru 61: Example, 99%.

ROCK STRENGTH, PSI x 100, cols. 62 thru 64: Example, 93.

R.Q.D., cols. 65 thru 67: "Rock Quality Determination" - Estimate the percent of broken, loose core in the core box that is four inches or greater in size; 0 is less than 10%, 1 is 10%, 2 is 20%, ..., 9 is 90% or greater. Do the same for the percent of broken core that is equal or greater than 12 inches and 24 inches. The percentage figures recorded with increasing size are cumulative. Example, 30% of the core is $\geq$ 4 inches; 30% is between 4 inches and 12 inches; 40% is between 12 inches and $\geq$ 24 inches.

PART C

This part of the form is similar to the previous core logging form. Record the formula used for computing copper equivalent. The extra boxes formed by the dashed lines in the estimated grade and assays sections can be used to record additional assay data where available.

A SYNOPSIS OF ALTERATION AND MINERALIZATION AT THE SIERRITA AND ESPERANZA MINES

Chester A. Oakley
Geologist
Duval-Sierrita Corp.
February 12, 1973

A SYNOPSIS OF ALTERATION AND MINERALIZATION AT THE SIERRITA AND ESPERANZA MINES

This paper, presented only as a preliminary study, is based almost entirely on field and drill hole data gathered from field mapping and drill logs, then transferred to 50C-scale surface maps, bench maps, and sections. Laboratory work, including preparation and study of thin and polished sections, is necessary to provide definitive conclusions on the subject of mineralization and alteration.

Alteration found at Sierrita-Esperanza is similar to that found at other porphyry copper deposits, and includes potassic, phyllic, and propylitic zones. The alteration and mineralization sequence is far reaching, and must be considered as a large pattern including Sierrita, Esperanza, and mineralization found north of the two pits.

The alteration is characterized by potassium metasomatism with later retrograde propylitization superimposed upon it. Phyllic alteration and to a lesser extent argillic alteration are found only as remnants which were not destroyed by the retrograde alteration. The potassic alteration consists of orthoclase veining, orthoclase envelopes surrounding mineralized and unmineralized quartz veins, orthoclase flooding, and secondary biotite including fracture fillings, veinlets, replacements of hornblende, and pegmatitic masses. The suite of characterizing accessory minerals, especially anhydrite, are also present.

Commonly, secondary orthoclase is found in the quartz monzonite porphyry and Harris Ranch quartz monzonite while secondary biotite is the characteristic potassium mineral found in the quartz diorite-andesite. However, biotite does occur in the quartz monzonite porphyry and Harris Ranch quartz monzonite, and orthoclase in the quartz diorite-andesite. The potassic alteration zone forms a core which includes the northern half of the Sierrita pit, the northwestern

Continued...

half of the Esperanza pit, and an area north of the Sierrita pit.

Phyllic alteration occurs irregularly, outside of the potassic zone. Sericite, quartz, and pyrite are characteristic. Sericitic alteration is found in Esperanza, east of the New Year's Eve shaft, in the southern half of the Sierrita pit, in the Amargosa Extension of the Sierrita pit and in the mineralized area north of the pits. Argillic alteration is scarce, and no well-developed zones are presently recognized.

Two periods of propylitic alteration are recognized. Original propylitic alteration is found up to several thousand feet away from the mine area. The propylitic zone extends for at least 2,000 feet west of the Sierrita pit and 3,000 feet north of the pit. The outer limit of the propylitic zone is not known. Both propylitic facies have the same mineral assemblage of epidote, chlorite, calcite, pyrite, and minor albite.

Retrograde propylitization is found throughout the ore body in varying degrees, although it is most pronounced in the quartz diorite in the northwestern quarter of the Sierrita pit. Possibly unique to the retrograde propylitization is the occurrence of the zeolite stilbite with minor heulandite. The zeolites occur exclusively as fracture fillings and are most abundant in the central portion of the Sierrita pit. Characteristic of the retrograde propylitization are chloritized secondary biotite, epidote and epidote-calcite veins cutting earlier mineralized fractures and veins. The relationship of the retrograde alteration to the regular pattern of hypogene alteration and mineralization is most clearly seen in the potassic zone, where the potassic alteration minerals are well preserved. Orthoclase veins are offset and cut by epidote veins. Epidote veins cut through orthoclase flooded rocks. Biotite filled fractures and veinlets are cut by epidote, and some secondary biotite has been chloritized.

Continued...

The scarcity of phyllic and argillic alteration facies may be explained by the retrograde phenomena, with those facies being destroyed by the epidotization and chloritization, and by the mafic nature of the host rocks which appears to have greatly expanded the stability field, and hence the geographic extent, of biotite with respect to sericite. Some remnants of phyllic and argillic alteration may be seen in thin sections being replaced by propylitic minerals (Laine, 1972). Retrograde propylitization minerals are indistinguishable from the original propylitic suite, but the retrograde propylitic alteration undoubtedly enriches the original propylitized zone.

Ore grade at Sierrita and Esperanza is based upon copper equivalent, currently copper assay plus 4x molybdenum assay, and ore zones therefore do not follow the alteration pattern exactly. However, by using the 0.2% and 0.3% Cu. isograde, a rough correlation between ore mineralization and alteration can be made. Central to the potassic zone, a large area of $<0.2\%$ Cu. exists. This is proposed as a major portion of the barren core of Lowell and Guilbert. The $>0.2\%$ Cu. which surrounds the core includes a large portion of the potassic and phyllic zones, and is proposed as the ore shell. Areas of greater than 0.3% Cu. are usually indicative of shattered zones rather than alteration, although they do occur within the proposed ore shell.

Total sulfide content is low with an overall average from 2% to 3%. The pyrite to chalcopyrite ratio is approximately 1:1 overall. Copper mineralization occurs exclusively as fracture fillings and veinlets in quartz diorite, andesite, and Harris Ranch quartz monzonite. In quartz monzonite porphyry and in the breccia pipe, it occurs as fracture fillings, veinlets, veins, and disseminations. Disseminated chalcopyrite in the quartz monzonite porphyry is found replacing discrete specks of biotite. In the breccia pipe, it occurs as blebs in the biotitic matrix.

Continued...

Molybdenite occurs in fractures as coatings, in crystalline rosettes in open fractures, in quartz veins, and rarely as disseminated grains. Molybdenite mineralization is younger than the copper mineralization with molybdenite veins cutting chalcopyrite bearing veins. The pattern formed by the molybdenite zones roughly follows the copper mineralization trends. Ore deposition must have occurred directly after the intrusion of the quartz monzonite porphyry, and the formation of the breccia pipe.

The alteration-mineralization pattern evolved at the Sierrita-Esperanza deposit differs from the model of a typical porphyry copper deposit of Lowell and Guilbert in the two major respects of shape and retrograde alteration.

Pre-ore shattering and contact effects are the prime factors in the localization of mineralization and alteration at Sierrita-Esperanza. The mineralization-alteration pattern developed in an elliptical northwest-southeast elongated shape, following the contact of the quartz monzonite porphyry with the pre-ore country rock. Mineralized fractures have preferred orientations at NNW and ENE. Ore zones trend NW at Sierrita, and ENE at Esperanza. Shattering is most pronounced in the Harris Ranch quartz monzonite and in the quartz diorite-andesite, and good ore zones exist in those rock types. Shattering in the Harris Ranch quartz monzonite and the quartz diorite-andesite is due to the intrusion of the quartz monzonite porphyry. Shattered zones in the quartz monzonite porphyry located near the breccia pipe appear to have formed with the pipe. Other shattered zones in the quartz monzonite porphyry are found along zones of structural weakness that trend from the breccia pipe into the southwest end of the Esperanza pit. Shattering in the breccia pipe is probably due to cooling and release of pressure within the pipe, and the renewed intrusion of quartz monzonite porphyry. Ore zones are coincident with the shattered areas within these rocks. The Triassic Ox Frame volcanics were resistant to shattering. No hypogene ore occurs within them.

Continued....

SEQUENCE OF MINERALIZATION

The following is proposed as the sequence of mineralization and alteration at Sierrita-Esperanza:

1. Secondary orthoclase, biotite, and sericite, with quartz, pyrite, and chalcopyrite were earliest minerals deposited. Purple anhydrite is also given an early relative age due to its intimate occurrence with the chalcopyrite and pyrite. Original propylitization is contemporaneous with the potassic metasomatism. Molybdenite occurs alone, with quartz, and with pyrite and quartz. Rare fluorite is thought to be associated with the molybdenite. Galena, sphalerite and calcite occur with some chalcopyrite and pyrite in veins found in the eastern portion of Sierrita and scattered throughout Esperanza.

2. Retrograde alteration consisting of epidote, chlorite, K-feldspar, calcite, pyrite, and possibly marcasite occurred after the main mineralizing period. Stilbite can be grouped with the retrograde alteration, but is definitely post retrograde epidote and chlorite. Pink anhydrite and gypsum are post stilbite. The anhydrite is possibly hydrothermal, and gypsum probably represents a supergene environment.

Recommendations for further studies in the area of alteration and mineralization are as follows:

1. A detailed thin and polished section analysis of alteration and ore minerals to delineate specific relationships.

2. A study to define pyrite to chalcopyrite ratios and total sulfide content which will hopefully delineate a pyritic core and halo.

Continued...

SEQUENCE OF MINERALIZATION - Cont'd...

3. An analysis of cross-cutting relationships between mineralized and unmineralized veins. This would give more specific information as to the relative stages of mineralization.

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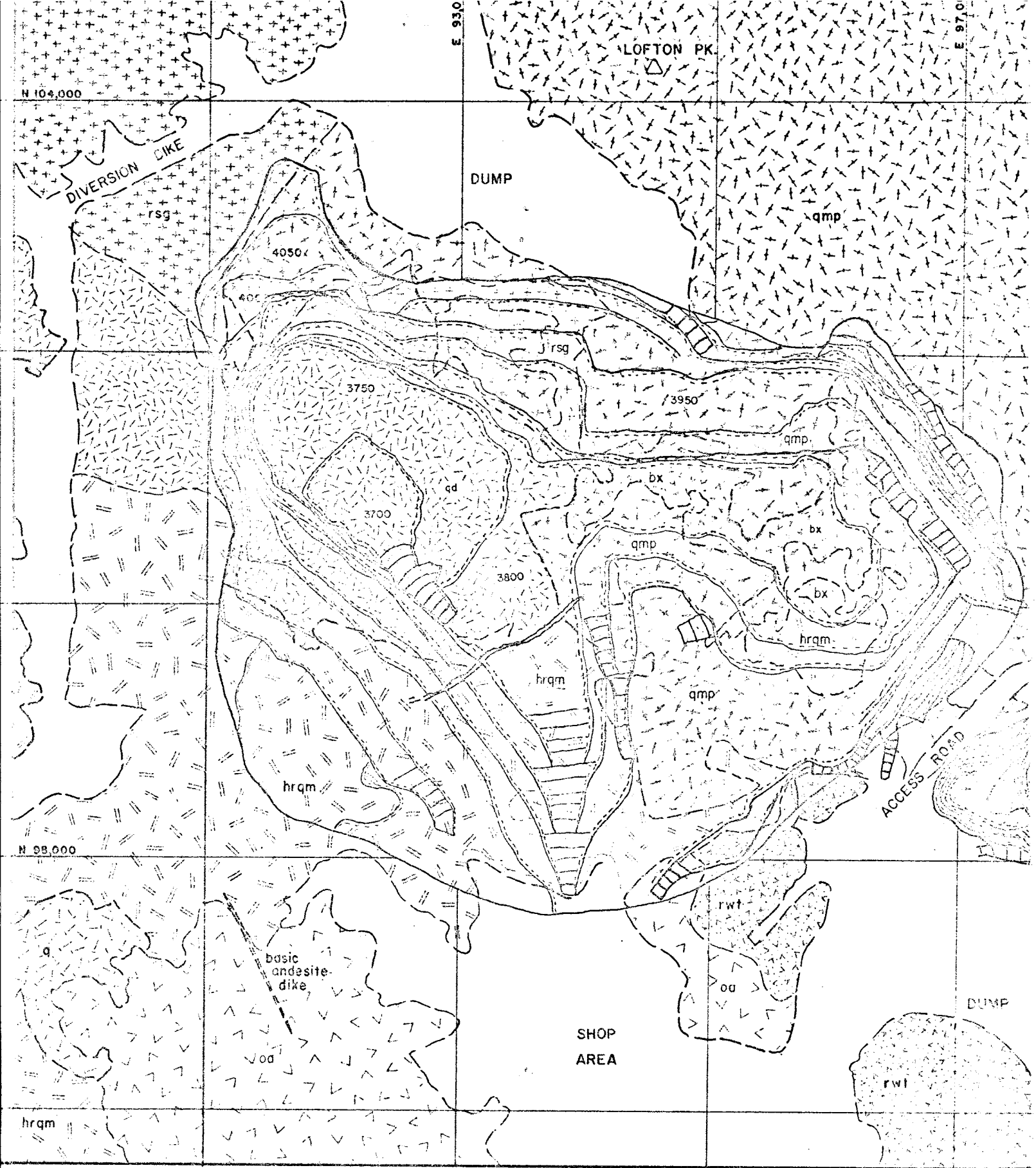

EXPLANATION

- Qal — Alluvium, waste dumps, etc.
- Apl — Aplite
- bx — Breccia Pipe
- qlp — Quartz latite porphyry
- qmp — Quartz monzonite porphyry
- rsg — Ruby Star granodiorite
- oa — Oxframe andesite
- qd — Biotite quartz diorite
- hrqm — Harris Ranch quartz monzonite
- rwf — Oxframe rhyolite welded tuff
- q — Quartzite

DUVAL SIERRITA CORPORATION

SIERRITA PIT GEOLOGY

SCALE : 1" = 1000'

DATE : APRIL 1, 1973

GEOLOGY BY: RAM, AHJ, BLW, DWL, FWM, CAO, CDI

DRAWN BY : RLL, ATD, VHI

MINERALIZATION CONTROL AT THE DUVAL SIERRITA PROPERTY, PIMA COUNTY, ARIZONA

Calvert D. Iles
Mine Geologist
March 6, 1973

MINERALIZATION CONTROL AT THE DUVAL SIERRITA PROPERTY, PIMA COUNTY, ARIZONA

METHOD OF STUDY

Data for the mineralization study was derived from pit geologic mapping, rotary blasthole assays, and development-exploration drillhole geology and assays. Pit mapping data, including rock type, structure, and mineralization occurrence, were plotted on 100-scale bench maps and 200-scale pit progress maps. Blasthole copper and molybdenum assays, spaced at 20-to 50-foot intervals, were plotted on 100-scale bench overlays, contoured, and color-coded for a visual representation of mineralization intensity and distribution. From these overlays, 200-scale pit progress maps were prepared. In addition, 100-scale copper and molybdenum three-bench composite maps were drawn outlining zones $>0.3\%$ copper and $>0.03\%$ molybdenum.

Rock type and copper-molybdenum assay data from development and exploration holes were plotted, contoured, and color-coded on 500-scale maps for alternating benches from the 3800 through the 2000. Hole spacing increased from approximately 250 feet on upper benches to about 500 feet on middle benches, and to greater than 500 feet on lower benches. From the 500 scale maps, a series of copper, molybdenum, and rock-type 200-scale cross-sections were drawn oriented both perpendicular and parallel to major mineralization trends.

GENERAL

The Sierrita-Esperanza orebodies comprise a single Laramide porphyry copper-molybdenum deposit with economic mineral concentrations occurring linearly along the margins of a Laramide quartz monzonite porphyry, both within the quartz monzonite porphyry and adjacent quartz diorite, andesite, breccia, Triassic Ox Frame

Continued ...

GENERAL - Cont'd...

volcanics and Jurassic-Triassic (?) Harris Ranch quartz monzonite. Mineralization zones parallel the contact at Esperanza (northeast) and Sierrita (northwest), forming a V configuration with a < 0.1% copper core, grade increasing again to the north and east in the Lofton Peak and Anglin McGee areas. Both properties reflect the major mineralization trend of the adjacent property through minor zoning.

The predominately hypogene Sierrita orebody is composed of two major parallel mineralization zones striking N40-60W, one of which connects with Esperanza at depth. The west zone occurs primarily in quartz diorite and Harris Ranch quartz monzonite, the east zone in quartz monzonite porphyry and breccia. Significant secondary enrichment occurred only along the east and southeast perimeter in the original West Esperanza area; all secondary ore tonnage has been mined.

The Esperanza orebody consists of a major mineralization zone striking N40-55E, and the southeast end of the east mineralization zone extending from Sierrita. It occurs principally in quartz monzonite porphyry, but with significant tonnages also in andesite and quartz diorite. Mineralization in the volcanics is negligible, with the exception of local secondary enrichment. Orginally a secondary chalcocite-primary molybdenite orebody, most supergene-derived ore has been mined. The remaining portion of the orebody is predominantly hypogene.

Hypogene copper and molybdenum occur in the same general areas, with no obvious zoning relationship.

COPPER-MOLYBDENUM MINERALIZATION

Hypogene ore minerals are chalcopyrite and molybdenite. Mineralization control is

Continued ...

structural-lithological, as indicated by linear zonal geometry paralleling fault trends, contacts, and intrusions; by the association of hypogene mineralization with specific rock types, and by the predominantly fracture-controlled nature of the mineralization, minor disseminations occurring only in breccia and quartz monzonite porphyry. In these two latter rock types, economic mineral concentrations are present only in rock with extensive pre-mineral fracturing. Preference of mineralization for specific rock types was related to higher fracture intensities.

Hypogene copper is present along fractures in the quartz diorite, andesite, volcanics, and Harris Ranch quartz monzonite, occurring as fillings and in quartz veins and veinlets. The same control is present in quartz monzonite porphyry and breccia, but with additional copper present as disseminations and blebs. In the quartz monzonite porphyry chalcopyrite commonly replaces biotite, while in the breccia is present as blebs in the biotitic matrix. Disseminated mineralization is not in itself sufficient to produce ore-grade material unless associated with high molybdenum values.

Hypogene molybdenum occurs in all rock types as fracture fillings, and in quartz veins and veinlets. Disseminations are not common.

Volcanics, Harris Ranch quartz monzonite, quartz diorite, and andesite were in place and fractured prior to mineralization. The quartz monzonite porphyry and breccia may have been lightly mineralized by chalcopyrite during emplacement, followed by later chalcopyrite and molybdenite mineralization after ground preparation by fracturing. There was more than one period of fracturing as indicated by cross-cutting relationships and dissimiliar fracture, veinlet, and vein mineral associations. The most obvious example is a period of late fracturing and subsequent stilbite-anhydrite-gypsum filling which occurred after completion of sulfide mineralization.

Continued ...

COPPER-MOLYBDENUM MINERALIZATION - Cont'd...

A study of the Sierrita pit by W. A. Rehrig and T. L. Heidrick (1972) showed mineralized fractures, veinlets, and veins to be systematic in attitude with a perpendicular pattern of N50-85E and N05-25W. The major mineral zones at Sierrita strike N40-60W, paralleling the contact between quartz monzonite porphyry and the intruded rocks. Secondary zones strike N45-60E, parallel to the major mineralization zone and related contact between quartz monzonite porphyry and intruded rocks at the adjacent Esperanza property. The major structural trend as determined from faults and dikes strikes N60-75E. In summary, the predominant trend of mineralized fractures strikes N50-85E, which parallels the major structural trend. Overall deposit zoning, however, strikes N40-60W paralleling the contact between quartz monzonite porphyry and the intruded rocks. Within this overall deposit zoning, secondary trends strike N45-60E paralleling the major Esperanza zoning trend. The minor trend of mineralized fractures striking N05-25W is not related to any obvious pit features.

COPPER OCCURRENCE AT SIERRITA - DATA FROM MINED BENCHES

General

Hypogene copper $> 0.2\%$ occurs in quartz diorite, along the central quartz diorite-Harris Ranch quartz monzonite - quartz monzonite porphyry contact intersection, and in the breccia pipe. Harris Ranch quartz monzonite and quartz monzonite porphyry in general contain $< 0.2\%$ copper. Secondary chalcocite mineralization was present in significant amounts only along the east and southeast perimeter as part of the original West Esperanza orebody. All secondary ore tonnage has been mined.

Quartz Diorite

Hypogene mineralization in the west and northwest sections of the pit is structurally

Continued ...

Quartz Diorite - Cont'd...

controlled by quartz diorite, which contains a N45W >0.2% copper zone generally paralleling the strike of the quartz diorite intrusion. Scattered areas <0.2% are present in this zone, increasing in frequency to the south. Concentration of mineralizing agents was by ground preparation through extensive stockwork fracturing, probably related in some degree to emplacement of adjacent quartz monzonite porphyry.

The 0.2% zone terminates to the east in quartz diorite along the quartz diorite-quartz monzonite porphyry contact, extends 200 feet into quartz monzonite porphyry on the north, terminates in quartz diorite 500 feet from Harris Ranch quartz monzonite to the northwest and 200 feet from Harris Ranch quartz monzonite to the southwest, and extends 200-500 feet into Harris Ranch quartz monzonite to the south. Overall dimension of the zone is 1200-1700 x 3600 feet.

Within the quartz diorite, a major subtrend is characterized by a series of >0.3% elongated pods striking N45-60E. The strike of these pods becomes more easterly trending to the south. They are not distinguished by large mappable features, but rather by an increase of mineralized fractures, veinlets, and veins. The largest of these zones occurs to the north adjacent to the quartz monzonite porphyry contact, strikes N45E, and measures 300x800 feet. It has been continuous with depth through five benches mined to date, with a vertical or near-vertical dip. To the south, near the center of the quartz diorite, a 50-200 x 600 foot >0.3% zone strikes N50E. Further south, a minor >0.3% zone represented by one to four small pods on each of four benches strikes N60E for approximately 300 feet.

Continued ...

Quartz Diorite - Harris Ranch Quartz Monzonite-Quartz Monzonite Porphyry Intersection

The > 0.2% quartz diorite zone extends 200-500 feet into Harris Ranch quartz monzonite to the south. Within this extension, a structurally controlled > 0.3% hypogene zone 50-100 x 900 feet strikes N65E and dips vertically. It parallels a quartz latite porphyry dike located 50-150 feet to the south, while generally trending along the Harris Ranch quartz monzonite - quartz diorite contact 100-350 feet to the north. To the west are a large number of similar-striking quartz diorite dikes paralleling the predominant structural trend in the pit, indicating a zone of structural activity prior to or during emplacement of the quartz diorite.

On the east, this zone abuts perpendicularly against a second structurally controlled > 0.3% zone to form a T. This latter zone strikes N35W along the Harris Ranch quartz monzonite-quartz monzonite porphyry contact, penetrating into quartz diorite; its extension to the southeast parallels the contact for 700 feet. Farther southeast the contact curves to the south, with the mineralization zone continuing along the original S35E strike into quartz monzonite porphyry characterized by intermixed quartz diorite, Harris Ranch quartz monzonite, and Ruby Star granodiorite. The > 0.3% zone is generally discontinuous, composed of pod-like bodies with an overall dimension of approximately 100 x 1700 feet. Dip is vertical or near-vertical as far as can be determined from available information.

The two zones forming the T are the upper expression of the main portion of the orebody, expanding rapidly in size and increasing in grade with depth.

Breccia Pipe

Hypogene copper mineralization in the east portion of the pit is structurally and

Continued ...

Breccia Pipe

possibly genetically controlled by the breccia pipe. The 0.2% contour closely follows its physical boundaries, generally within 100 and rarely over 200 feet, undulating in and out of breccia along the breccia-quartz monzonite porphyry contact. Scattered areas < 0.2% occur within the breccia. The overall dimension is 300-900 x 2800 feet. Strike is E-W, turning on the east end to S55E which trends toward the west end of the Esperanza orebody. Irregular areas > 0.3% within the 0.2% contour form an elongated zone approximately 200-300 x 1200 feet, with a strike indentical to the > 0.2% zone. A breccia extension on the northeast edge of the pipe is associated with a 300 x 1000 foot > 0.2% zone striking N-S.

COPPER OCCURRENCE AT SIERRITA - DATA FROM DEVELOPMENT DRILLING

General

Hypogene chalcopyrite occurs in two major parallel zones, designated the Sierrita Zone and Amargosa Zone. The Sierrita Zone is more extensively mineralized; the Amargosa Zone extends into and becomes part of the Esperanza orebody. Both zones converge with increasing depth on the northwest end, while to the southeast they are separated by a relatively low-grade area. Their formation may be reasonably ascribed to structural parameters. There is no secondary mineralization below the 3850 bench.

Sierrita Zone

The Sierrita Zone, as delineated by the 0.2% contour, strikes N40-60W. On upper benches it extends from quartz diorite on the northwest through Harris Ranch quartz monzonite, terminating to the southeast in or adjacent to quartz monzonite porphyry. In general, the 0.2% contour parallels the quartz diorite-quartz monzonite porphyry and Harris

Continued ...

Sierrita Zone - Cont'd.

Ranch quartz monzonite-quartz monzonite porphyry contacts, with more intense mineralization in the Harris Ranch quartz monzonite and quartz diorite. Its dimension on the 3800 bench is 600-1800 x 3800 feet. The >0.2% zone increases in intensity and areal extent with depth to merge with the Amargosa Zone on the east, covering most of the pit area.

The Sierrita Zone, as delineated by the 0.3% contour, strikes N40-60W. It increases in length with depth along the zonal strike in the form of an inverted V, plunging 25-30 degrees to the northwest and 25-40 degrees to the southeast.

Measuring 40-100 x 900 feet as presently exposed on the 3800 bench, the >0.3% zone increases to 1000 x 2000 feet by the 3500 bench. Grade increases from 0.3 - 0.4% to 0.3 - 0.8%, becoming essentially constant below the 3500 bench. Size continues to gradually increase to approximately 1400 x 4000 feet on the 2600 bench.

Beginning with the 3300 bench, the northwest end of the Sierrita and Amargosa Zones are connected by an erratically occurring cross-zone striking approximately N45E. The area between the two zones on the south is consistently characterized by low copper content of 0.1 - 0.2%.

The >0.3% zone occurs principally in Harris Ranch quartz monzonite. Its east boundary follows the Harris Ranch quartz monzonite - quartz monzonite porphyry contact, entering only occasionally into quartz monzonite porphyry. There is no contact control for the west edge. The northwest edge generally parallels the Harris Ranch quartz monzonite - quartz diorite contact, plunging 25-30 degrees northwest. Control for the southeast edge, which plunges 25-40 degrees to the southeast, may be related to the overlying Ox Frame Volcanics.

Continued ...

Sierrita Zone - Cont'd.

On upper benches, the > 0.3% zone initially increases in Harris Ranch quartz monzonite along the Harris Ranch quartz monzonite - quartz monzonite porphyry and Harris Ranch quartz monzonite - quartz diorite contacts. These areas correspond to the T intersection described previously. Below the 3600 bench, the zone extends 400-1000 feet into quartz diorite. More intensively mineralized areas of 0.4 to > 0.6% are generally concentrated in the central and northern sections along the Harris Ranch quartz monzonite - quartz diorite contact. Large areas < 0.3% are present in the south half of the zone, apparently plunging about 40 degrees to the southeast.

Within the V-shaped quartz diorite intrusion, the Sierrita Zone is represented by a series of > 0.3% pods which seem to align in a discontinuous zone plunging approximately 25 degrees southeast. This area abuts the > 0.3% zone in the Harris Ranch quartz monzonite to form an essentially tabular zone with a VA configuration, plunging southeast 25-40 degrees.

Secondary trends strike N40-60E, corresponding to those of the major mineralization zone and related quartz monzonite porphyry - intruded rock contact at the adjacent Esperanza property.

Amargosa Zone

The Amargosa Zone, which links the Sierrita and Esperanza orebodies, is incompletely outlined by development drilling. It was originally exploited in the southern end of the Esperanza pit and later in West Esperanza because of high copper values associated with secondary chalcocite enrichment. Most secondary ore tonnage has been mined.

Continued ...

Amargosa Zone

As delineated by the 0.2% contour, the Amargosa Zone strikes N45-60W paralleling the adjacent Sierrita Zone, expanding dimensionally from 400-1400 x 6400 feet on the 3800 bench to at least 2200 x 7400 feet on the 3000 bench where data is insufficient to define exact limits.

The Amargosa Zone extends from quartz monzonite porphyry and breccia on the northwest to andesite and quartz diorite on the southeast, with quartz monzonite porphyry in the center. With few exceptions, the breccia pipe is confined within the 0.2% contour, although it is not the northwest limit to the $>0.2\%$ zone. In this same general region, areas of $>0.3\%$ occur both in quartz monzonite porphyry and breccia with no preferential association.

The breccia pipe itself, as determined from pit mapping, measures 300-900 x 2800 feet. The lowest drillhole intercept is on the 2800 bench, for a continuous minimum vertical depth of 1200 feet. Actual bottom is not known due to wide hole spacing on lower benches. The pipe does, however, decrease in horizontal dimensions with depth.

Generally, areas $>0.3\%$ occurring within the $>0.2\%$ zone are not as large as in the Sierrita Zone, nor as well defined due to the wide hole spacing. A major exception occurs on the southeast end in the Esperanza pit, where a hypogene area measuring 400-800 x 1700 feet on the 3800 bench is zoned by rock type. Geologically, the area consists of a quartz monzonite porphyry core surrounded by andeside-quartz diorite, which in turn is bounded by rhyolite welded tuff. Copper grade decreases from $>0.4\%$ in the andesite-quartz diorite to 0.3-0.4% at the quartz monzonite porphyry contact, and to $<0.3\%$ near the center of the quartz monzonite porphyry. Grade increases to 0.3-0.4% as the opposite

Continued ...

Amargosa Zone - Cont'd.

andesite-quartz diorite contact is approached, becoming > 0.4% upon penetration. Copper content in the rhyolite welded tuff is generally < 0.2%.

Secondary trends in the Amargosa Zone are less common than in the Sierrita Zone. They strike N45-55E where present, corresponding to trends of the major mineralization zone and quartz monzonite porphyry - intruded rock contact at the adjacent Esperanza property.

SUMMARY

The Laramide Sierrita and Esperanza copper-molybdenum porphyry orebodies are components of a single, structurally controlled deposit, occurring along the margins of the quartz monzonite porphyry intrusion. Mineralization is predominantly hypogene chalcopyrite and molybdenite, present economically in zones which parallel the contact between quartz monzonite porphyry and intruded rocks. Both chalcopyrite and molybdenite occur in the same general area, with no apparent zoning relationship.

Copper mineralization in the Sierrita orebody is present in two major parallel zones, the more heavily mineralized Sierrita Zone in quartz diorite - Harris Ranch quartz monzonite and the Amargosa Zone in quartz monzonite porphyry - breccia. The Amargosa Zone links the Esperanza and Sierrita orebodies.

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Memo to: Mr. L. W. Ogryzlo
Dr. J. B. Howkins

from: Philip Eckman

Re: SIERRITA MINE, ARIZONA

Following are some figures regarding the Sierrita mine taken from the Pennzoil Annual Reports and other sources.

	1971			1972		
Tons ore mined	25,727,195 (70,484 per cal. day)			28,304,333 (77,334 per cal. day)		
Tons copper produced	63,049 (Rec. grade 0.245%)			68,940 (Rec. grade 0.244%)		
Tons molybdenum produced				5,836		
Tons Cu delivered to GSA at 38¢/lb.	8,600			16,000		
	Amount (000s)	per ton of ore	per lb Cu	Amount (000s)	per ton of ore	per lb Cu
Net sales	$48,870	$1.90	38.8¢	$78,854	$2.79	57.2¢
Costs (including administration)	31,559	1.22	25.0	58,454	2.07	42.4
Depr., Depl. and Amortization	6,153	0.24	4.9	9,818	0.35	7.1
Taxes (other than Federal income)	6,445	0.25	5.1	8,010	0.28	5.8
Interest	12,696	0.49	10.1	13,717	0.48	9.9
Federal income tax	(3,857)	(0.15)	(3.1)	(4,975)	(0.18)	(3.6)
Totals	$52,996	$2.06	42.1¢	$85,024	$3.00	61.7¢
Net loss	($4,126)			($6,170)		
Cash flow	($1,830)			($1,327)		

The original source of financing was:

Equity	$10,000
GSA loan (repayable by June 30, '79 as 218,400,000 lbs Cu @ 38¢)	83,000,000
Bank loans (currently av. 6.90% interest, repayable by June 30, '82)	48,750,000
Pennzoil loans (av. 7.50% interest, repayable by July 1, '78)	91,620,000
Total debt	$223,371,000

These figures regarding Pennzoil's 1972 operations are of interest:

	000s		
	Total assets	Gross Op. Income	Income as % of assets
Integrated oil & gas operations	$406,507	$66,381	16.3%
Natural gas transmission	457,302	48,201	10.5%
Mining operations of Duval	320,750	17,213	5.4%
Mining operations of Sierrita	236,945	2,552	1.1%

Sierrita is obviously a bad operation, financially, at this time, and with a negative cash flow it will never remove its debt burden. However let us suppose that it were out from under the burden of debt, that the GSA contract was completed, and that the mine was recovering a head grade of 0.3% instead of 0.244% as it will be in a year or two, and let us apply this extra income to the 1972 production and cost figures to arrive at a pro forma cash flow on 1972 results:

1. Added cash flow due to no interest charges	$13,717,000
2. Added cash flow due to sale of 16,000 tons of copper at 50.6¢ per lb (average price in 1972) less 12.0¢ (assumed cost of freight, smelting and refining) 32,000,000 lbs. @ 38.6¢	12,352,000
3. Added cash flow due to increased grade of 6 lbs recoverable copper per ton in place of 4.88 lbs 1.12 lbs x 28,304,333 tons x 38.6¢	12,235,000
Total	$38,304,000

The situation would be made more attractive by the facts that the current tonnage milled is 83,000 per day in place of the 77,384 averaged in 1972, and the price of copper is 10¢ per pound higher, which would produce on the order of $19,000,000 in additional cash flow, or a total of $57,000,000 positive cash flow (less applicable income tax), in place of the $1,327,000 in negative cash flow shown for 1972.

From this I conclude:

1) Sierrita is an inherently sound operation with great profit potential.

2) The GSA contract is a current heavy burden, but involves only 109,200 tons or 7.5% of the total copper reserve of 1,449,000 tons, so it does not place the whole operation in hazard.

3) It is obvious from the Pennzoil Annual Report that the company's main emphasis is in its natural gas and oil operations, that it has great capital demands in that area, and that it can employ capital in that area much more profitably than in its mining division.

4) It seems reasonable to suppose then that Pennzoil might be interested in selling Sierrita, or perhaps half its interest, and that the purchase could be effected at least in part by paying off the bank indebtedness and the debt to Pennzoil, receiving equity in Duval Sierrita in return.

5) The Sierrita mine should be even more profitable if it were shipping to its own smelting-refining or hydrometallurgical facility, and perhaps this could be erected later on as part of the deal. Perhaps Pennzoil would take an interest in such a plant, and could commit all of Duval's copper concentrates (ex Esperanza) to such a plant, totalling about 120,000 tons of copper annually. If the plant were located at a site accessible to ocean freighted concentrates from say Peru or the southwest Pacific, it could be a major installation.

6) It is possible that Essex International, Inc., which fabricates 200,000 tons of copper annually and is seeking its own copper sources, would be interested in sharing in such a deal, and would provide a market for the copper. Such an association could also avoid any anti-trust complications for Anglo-American.

The deal would be very expensive, of course, but probably no more so, perhaps even less, than to find and develop a porphyry copper mine from basic exploration, and it could save ten years or more of lead time.

I believe this is worth looking into.

Tucson, Arizona,
May 18, 1973.

Philip Eckman

SIERRITA 1971 OPERATIONS

TOTAL TONS MINED 25,727,195 (70,484 per. cal. day)

TONS COPPER PRODUCED 63,049 (Rec. Grade 0.245%)

	AMOUNT 000s	per TON	per LB Cu.
NET SALES	$48,870	$1.90	38.8¢
COSTS (Incl. administration)	31,559	1.22	25.0
DEPR. DEPL. AMORTIZATION	6,153	0.24	4.9
TAXES (Other than Federal Income)	6,445	0.25	5.1
INTEREST	12,696	0.49	10.1
FEDERAL INCOME TAX	(3,857)	(0.15	(3.1)
TOTAL	$52,996	$2.06	42.1¢
NET LOSS	($4,126)	($0.16)	3.3¢
CASH FLOW	($1,830)		

OUTSTANDING DEBT

G.S.A. LOAN (218,400,000 lbs Cu @ 38¢ by June 30 '79) $83,000,000

BANK LOANS (av. 6.90% payable by June 30 '82) 48,750,000

ASSOCIATED CO. LOANS (av. 7.50% " " July 1 '78) 91,621,000

TOTAL $223,371,000

SIERRITA 1972 OPERATIONS

TOTAL TONS MILLED. (77,334/cal day) 28,304,333

TONS COPPER PRODUCED (Rec. Grade 0.2442) 68,940

" MOLYBDENUM " 5,836

	AMOUNT 000's	per ton	per lb Cu.
NET SALES	$78,854	$2.79	57.2¢
COSTS (Incl Administration)	58,454	2.07	42.4¢
DEPREC. DEPL. AMORT.	9,818	0.35	7.1¢
TAXES Other than Federal Income	8,010	0.28	5.8¢
INTEREST	13,717	0.48	9.9¢
FEDERAL INCOME TAX	(4,975)	(0.18)	(3.6¢)
TOTALS	$85,024	$3.00	61.7¢
NET LOSS	($6,170)		
CASH FLOW	($1,327)		

Statistics

PENNZOIL COMPANY AND SUBSIDIARIES

	1972	1971	1970	1969	1968
Net Income—In Thousands	$ 58,655	33,280(A)	70,011	65,595	60,143
Earnings Per Share	$ 1.80	1.02(A)	2.16	2.02	1.86
Dividends Per Share On Common Stock	$ .80	.80	.80	.80	.55
Total Assets—In Thousands					
Integrated Oil and Gas Operations	$406,507(B)(C)	395,174(B)	409,455(B)	391,047	354,024
Natural Gas Transmission	457,302	481,436	471,998	432,365	424,344
Mining Operations of Duval	320,750	322,633	302,854	287,114	212,968
Mining Operations of Sierrita	236,945	241,964	217,013	158,378	66,197
Gross Revenues(D)—In Thousands					
Integrated Oil and Gas Operations	$292,130(B)(C)	233,968(B)	218,333(B)	193,043	172,372
Natural Gas Transmission	478,519	459,630	440,444	394,131	359,420
Mining Operations of Duval	89,197	84,121	95,347	82,697	74,947
Mining Operations of Sierrita	78,833	48,870	—	—	—
Gross Operating Income(D)(E)—In Thousands					
Integrated Oil and Gas Operations	$ 66,381(B)(C)	57,128(B)	52,353(B)	47,737	39,905
Natural Gas Transmission	48,201	34,053	42,756	27,461	33,014
Mining Operations of Duval	17,213	14,064	24,237	17,494	18,564
Mining Operations of Sierrita	2,552	4,713	—	—	—
Net Crude Oil and Plant Products					
Produced (Bbls.)	15,547,266	14,794,975	14,891,669	14,200,256	13,433,500
Daily Average	42,479	40,534	40,799	38,905	36,704
Net Natural Gas Produced (Mcf.)	221,396,000	211,390,000	212,150,000	202,749,000	183,508,000
Daily Average	605,000	579,000	581,000	555,000	501,000
Crude Oil and Liquids Processed (Bbls.)	12,114,159	11,640,078	11,816,988	11,678,297	11,449,019
Daily Average	33,099	31,891	32,375	31,995	31,281
Refined Products Produced (Bbls.)					
Lubricating Oils, Waxes and Other	5,307,107	5,135,694	4,806,983	4,817,210	4,608,686
Gasoline and Naptha	5,981,568	5,884,236	6,346,990	6,161,319	6,140,153
Natural Gas Sales (Mcf.)	1,628,098,744	1,775,546,684	1,821,171,425	1,731,532,174	1,569,954,854
Daily Average	4,448,357	4,864,511	4,989,511	4,743,924	4,289,494
Mined Products Sales—In Thousands					
Sulphur—Long Tons	1,400	1,026	614	392	223
Potash—Short Tons	1,109	1,270	1,050	858	675
Copper—Pounds	282,229(F)	193,216(F)	157,985	133,043	132,450
Molybdenum—Pounds	16,596(F)	10,405(F)	5,955	5,702	5,187
Silver—Ounces	1,621(F)	1,348(F)	1,267	1,150	926
Gold—Ounces	13	16	17	18	14
Miles of Natural Gas Pipe Line	10,476	10,551	10,565	10,444	10,300
Number of Employees	9,618	9,631	9,442	11,354	11,068
Payroll and Payments for Account of Employees—In Millions	$ 107.0	99.2	98.4	96.9	86.4

(A) After reduction of $13,900,000 (43¢ per share) applicable to extraordinary item.

(B) Does not include any amounts attributable to POGO.

(C) Does not include any amounts attributable to PLATO.

(D) Without adjustment for certain intercompany transactions.

(E) Net income before interest charges, Federal income tax, minority stockholders' interest, general corporate overhead and extraordinary item in 1971.

(F) Includes Duval Sierrita Corporation which commenced operations on January 1, 1971.

Structural Geology of the Sierrita Mountains, Pima County, Arizona

by

Harald Drewes

U.S. Geological Survey, Denver, Colo. 80225

(Abstract of talk to be given at AIME symposium on Sierrita Mts., April 13, 1973)

The Sierrita Mountains, some 25 miles southwest of Tucson, Ariz., are almost as well known for their complex structures as for their tremendous deposits of copper. Although the area near the mines has been studied in detail, range-wide structural interpretations have been few or have been little publicized, in part because of the difficulty in piecing together many small structurally complex areas that are separated from each other by large stocks or extensive deposits of pediment gravel, and in dating and correlating metamorphosed rocks. The interpretation here offered is based on the detailed map of the Twin Buttes quadrangle by John R. Cooper, augmented by my own detailed work in the Rincon and Santa Rita Mountains and reconnaissance mapping extending from the west flank of the Sierrita Mountains to the borders of Sonora and New Mexico. As a preliminary model of the structural development of a complex range, the interpretation is offered with the expectation that it will be substantially modified as the efforts to find more ore deposits continue.

The Sierrita Mountains contain many faults, both low-angle and high angle, and folds, all of which are now interrupted by large stocks. Most of the strong deformation occurred during the Laramide Orogeny, of Late Cretaceous to Paleocene age (about 90-53 m.y. (million years) ago).

Evidence for pre-Laramide deformation is scanty because it is much obscured by later deformation, whereas evidence for post-Laramide deformation is both widespread and relatively clear.

The sparse record of pre-Laramide rocks and structures in the Sierrita Mountains suggests a sequence of events much like that proposed for the Santa Rita Mountains. During the Precambrian, Pinal Schist was foliated, folded, and intruded by bodies of porphyritic granodiorite which are themselves weakly foliated. In Paleozoic time the sea invaded the area and deposited rocks in a miogeosynclinal environment. During the Triassic through Lower Cretaceous, continental conditions prevailed; from time to time magmatic activity and local relief increased markedly, but the occurrence of faulting during the interval is inferred primarily from the local record of sedimentation and from the structural record in nearby mountains.

During the Laramide Orogeny, the rocks of the area were intruded several times, were strongly compressed and thrust faulted, and were widely metamorphosed and locally mineralized. During this involved period of structural development of the Sierrita Mountains the following major events occurred:

(1) Thrust plates of regional scale were pushed east-northeastward on the Sierrita thrust fault between the times of deposition of the Demetrie Volcanics (upper Upper Cretaceous; ~75 m.y.) and the Red Boy Rhyolite (upper Upper Cretaceous; 72-73 m.y.). Some rocks of the thrust plate were folded, cut by strike-slip faults, thinned, and possibly tectonically metamorphosed. Thrust faults in the Sierrita Mountains, particularly the ones on the west side of the mountains,

resemble those in the northernmost Santa Rita Mountains and in the Rincon Mountains in that several major plates of Paleozoic and Mesozoic rocks and substantial sheets of Precambrian rocks are involved. If the thrust plates in these three mountain ranges are related, then the postulated amount of tectonic transport as suggested by evidence in the Rincons may exceed 10 or perhaps even 20 miles.

(2) Large stocks of Ruby Star Granodiorite were emplaced about 59 m.y. ago, apparently under the influence of northwest-trending pre-Laramide structural grain, also present in some nearby ranges. The widespread thermal metamorphism of the area is probably associated with this magmatic event.

(3) Scattered small stocks of quartz latite porphyry or fine-grained quartz monzonite porphyry (ore porphyry) were intruded about 55 m.y. ago along the east flank of the Sierrita Mountains. Ore fluids, which apparently were associated with or immediately followed this magmatic event, spread along faults and the margins of plutons. From these fluids, metals were deposited in various favorable host rocks close to both the ore porphyry and the available conduits.

Post-Laramide structural features include local high-angle faults and a shallow low-angle fault, as well as some small intrusive bodies. High-angle faulting occurred during several intervals, but in general is datable only as pre-late Oligocene and post-late Oligocene. Some of these faults utilized older high-angle structures, and probably some faulting is

associated with the development of high local relief southeast of the Sierrita Mountains. A plate of rock, perhaps only a few thousand feet thick and a few tens of square miles in extent, is postulated by Cooper to have moved about 7 miles northward from the high area down a gentle gradient on the dish-shaped San Xavier fault. Rocks of this glide plate include some previously thrust-faulted Cretaceous and older rocks, as well as fanglomerate containing intercalated wedges of monolithologic breccia, of landslide origin, and flows of andesite dated at 31 m.y. Rhyodacite dikes 24 m.y. old appear to postdate the gravity gliding and are penecontemporaneous with the youngest volcanic rocks occurring on the flanks of the Sierrita Mountains. The postulated area of high local relief must have been faulted down during the late Tertiary to initiate the basin now occupied by the Santa Cruz River.

DUVAL

The Mining Subsidiary of Pennzoil United, Inc.

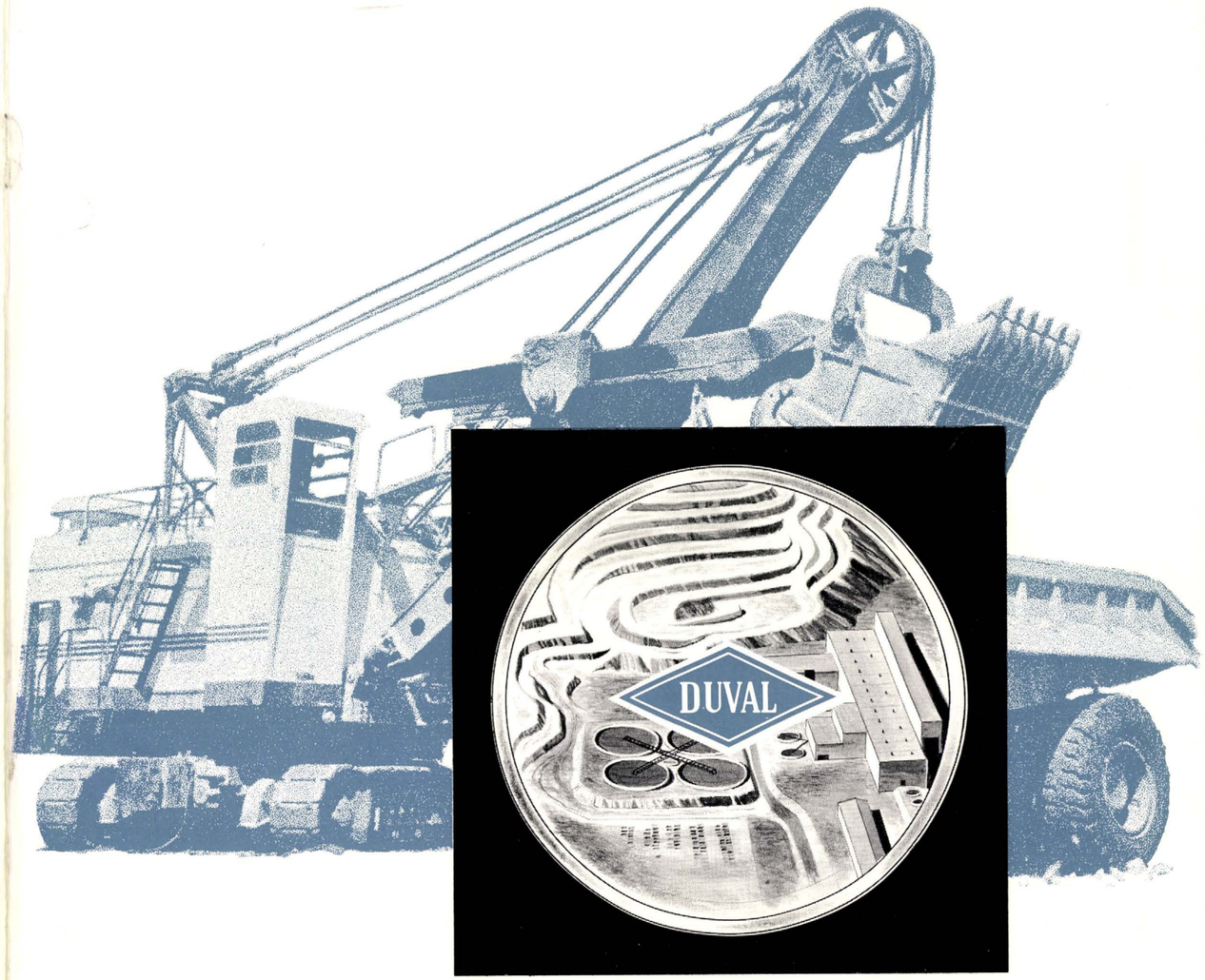
Duval Sierrita Corporation
Sierrita Property
P.O. Box 125
Sahuarita, Arizona 85629

Duval Corporation
4715 East Fort Lowell Road
Tucson, Arizona 85716

Duval Corporation
1906 First City National Bank Building
Houston, Texas 77002

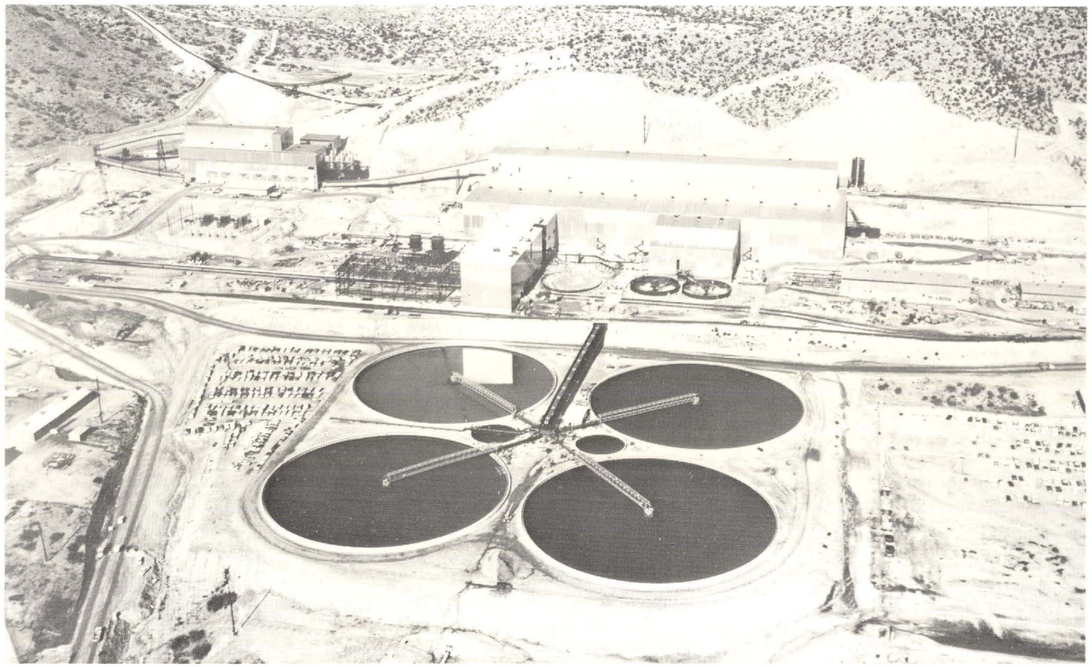
Duval Sales Corporation
300 The Main Building
Houston, Texas 77002

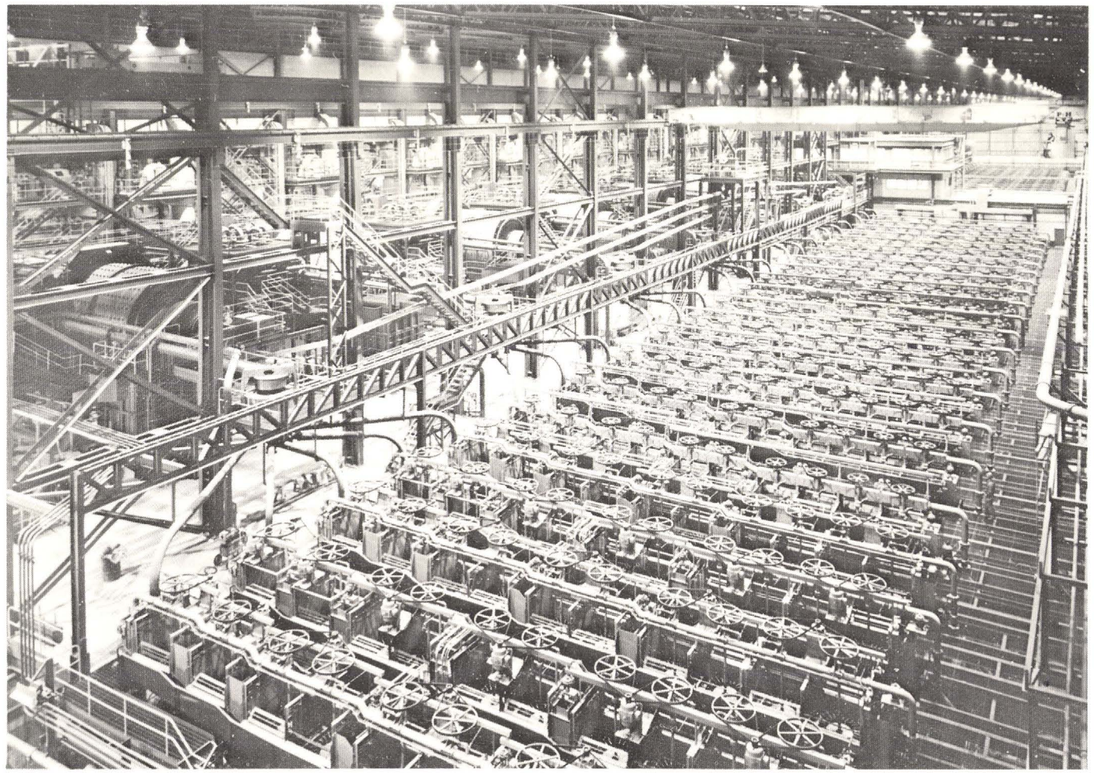
DUVAL SIERRITA CORPORATION



Sierrita Property

Aerial view of Duval Sierrita and Esperanza Properties. Copper-molybdenum ore from the Sierrita pit (upper center) travels two and one-half miles on a 54-inch belt conveyor system to the Sierrita mill (lower center).





Duval Sierrita mill facilities for copper and molybdenum. Four 350-foot diameter rake tailing thickeners in the foreground reclaim water from the slurry for re-use.

process. The concentrate is thickened in 100-foot diameter thickeners.

The combined copper-molybdenum concentrate is then subjected to flotation to separate the two products. The concentrate is steamed and conditioned with reagents before flotation. In the first flotation, the copper minerals are depressed and the molybdenum floated. The copper concentrate is the tailing from this flotation and, after thickening in a 125-foot diameter thickener, is de-watered in four drum filters and loaded in open gondola railroad cars for transporting to the smelter. The molybdenum is further concentrated by cleaning and re-cleaning stages of flotation. The final molybdenum concentrate is filtered, dried and stored for packaging for marketing as molybdenum sulfide or for roasting in two 23½-foot diameter multiple-hearth roasters. The roasted product, molybdenum trioxide, is packaged and marketed as technical molybdic oxide.

Production

Production from the Sierrita Property as originally designed is expected to average 130 million pounds of copper annually during the first five years of operation and 150 million pounds thereafter. In addition, the property will produce approximately 13 million pounds of molybdenum and 500,000 ounces of silver annually. With Sierrita's production, Duval Corporation will rank fourth among United States copper producers and will be the second largest producer of molybdenum in the United States.

Employment

Peak employment during development of the Sierrita Property was 2400. Average employment during production will be 1100.

Utilities

Electric power and natural gas will be supplied by a local utility company. Power requirements are expected to be approximately 60,000 kilowatts or 40 million kilowatt-hours per month. This amount of power would supply a city of 100,000 population.

Natural gas requirements are expected to be some 50 million cubic feet per month with all but a fraction of the gas being used in roasting molybdenum sulphide concentrate into the oxide form.

Concentrator building is nearly as long as three football fields. Final ore grinding takes place in the 14 cylindrical ball mills (left center). The ground copper-molybdenum ore then goes to the 602 flotation machines (foreground) where it is separated mechanically and concentrated.

How the Duval Sierrita Project Came About

In the Sierrita Mountains some 20 miles south of Tucson, Arizona, and about 40 miles north of Nogales, Sonora, Mexico, Duval Corporation, in July, 1964, acquired a large low-grade copper-molybdenum ore body adjacent to its Esperanza Property. The purpose of the acquisition was to provide additional reserves for the Esperanza Property which began operations in 1959.

In May, 1966, the General Services Administration (GSA) announced a program to encourage additional domestic production of copper in the interest of national security. The program, which was authorized by President Johnson in March, 1966, was formulated under authority contained in the Defense Production Act of 1950, as amended. Upon learning of the copper production expansion program, Duval Corporation entered into negotiations with the GSA for development of the Sierrita copper-molybdenum property under the program.

After more than a year and a half of negotiations, Duval Sierrita Corporation, a wholly-owned subsidiary of Duval Corporation, and the GSA signed contracts in November, 1967, for development of the Sierrita Property. Out of the total of $100 million allocated to the program, Duval was assigned $83 million as advances against future delivery of copper to the government at a fixed price of 38 cents per pound. Total cost of the project will exceed $165 million. Additional financing beyond the $83 million is being provided to the extent of $48.75 million by government-guaranteed V-Loans, with the remainder to be provided by Duval.

The $83 million will be repaid by June 30, 1975, through deliveries to GSA of 218.4 million pounds of wirebar copper credited at the rate of 38 cents per pound. During this time, Duval Sierrita Corporation will sell on the open market its molybdenum and silver production plus such of its copper production as may be required to cover cash operating costs, interest and asset replacements.

History of Duval Corporation

Duval Corporation was chartered in Texas on August 18, 1926, under the name of Duval Texas Sulphur Company. The Company acquired its name from the location of its first sulphur property in Duval County, Texas. In 1935, Duval commenced production of sulphur on a portion of Boling Dome in Wharton County, Texas, and this property was successfully operated until 1940. Duval commenced production at its third sulphur property, Orchard Dome in Fort Bend County, Texas, in 1938, and operated the property until 1970.

Duval embarked upon a program of exploration for potash in New Mexico in 1947, and in November of 1951 began mining potash from its Saunders Mine located near Carlsbad. Since then Duval has brought

two other potash mines in the Carlsbad area into operation—the Wills-Weaver Mine in 1961, and the Nash Draw Mine in 1964.

In March, 1959, the Company initiated production at its Esperanza copper-molybdenum property near Tucson, Arizona, and in 1964, brought its second copper-molybdenum property, Mineral Park, near Kingman, Arizona, into production. The Battle Mountain, Nevada, copper-gold-silver property was placed in operation in 1967.

Within a period of 24 months commencing in 1968, Duval brought four additional mining properties into production. These properties, representing an investment in excess of $300 million, were the Fort Stockton, Texas, sulphur property and the Saskatoon, Saskatchewan, Canada, potash property, both brought into production in 1968; the Culberson County, Texas, sulphur property brought into production in 1969; and the Sierrita copper-molybdenum property near Tucson, Arizona, where production commenced in the first quarter of 1970.

In 1950, the Company changed its name to Duval Sulphur & Potash Company and in 1963 to Duval Corporation. In 1930, United Gas Corporation acquired controlling interest in Duval Corporation. In April of 1968, United Gas Corporation merged with the Pennzoil Company to form Pennzoil United, Inc. Duval, now essentially a wholly-owned subsidiary of Pennzoil, continues to operate as a corporate entity.

History of Pennzoil United, Inc.

Pennzoil United, Inc., a large Houston based natural resources company resulting from the consolidation of Pennzoil Company and United Gas Corporation, today lists assets totaling over $1.35 billion. Both companies have histories dating back to the early days of the oil and gas industry.

Pennzoil Company was formed in 1955, by the merger of South Penn Oil Company, leading producer of Pennsylvania Grade crude, and The Pennzoil Company, largest refiner and marketer of Penn Grade products.

South Penn, organized in 1889, had acquired controlling interest in Pennzoil in the early 1920's, and for three decades prior to the merger, the two companies maintained a close relationship as producer-refiner-marketer.

In 1963, Zapata Petroleum and Stetco Petroleum, two West Texas-based companies with substantial oil and gas holdings, merged with South Penn and the corporate name was changed to Pennzoil Company.

As these developments were shaping the course of Pennzoil, similar events in the natural gas industry were paving the way for formation of United Gas.

Principal occurrence in the evolution of this huge, fully integrated natural gas system was the joining together in 1930 of more than 40 gas companies in Texas and Louisiana.

are expected to cost approximately $100 million. This capacity will be greater than that of any single copper-molybdenum concentrator in North America. The construction of plant facilities, as originally designed, will be completed by mid-1970. In May, 1970, an agreement was reached with the GSA for a $12 million expansion at the Sierrita Property. This expansion program, when completed in 1971, is expected to increase significantly the mining and milling capacity at the property.

Crushing

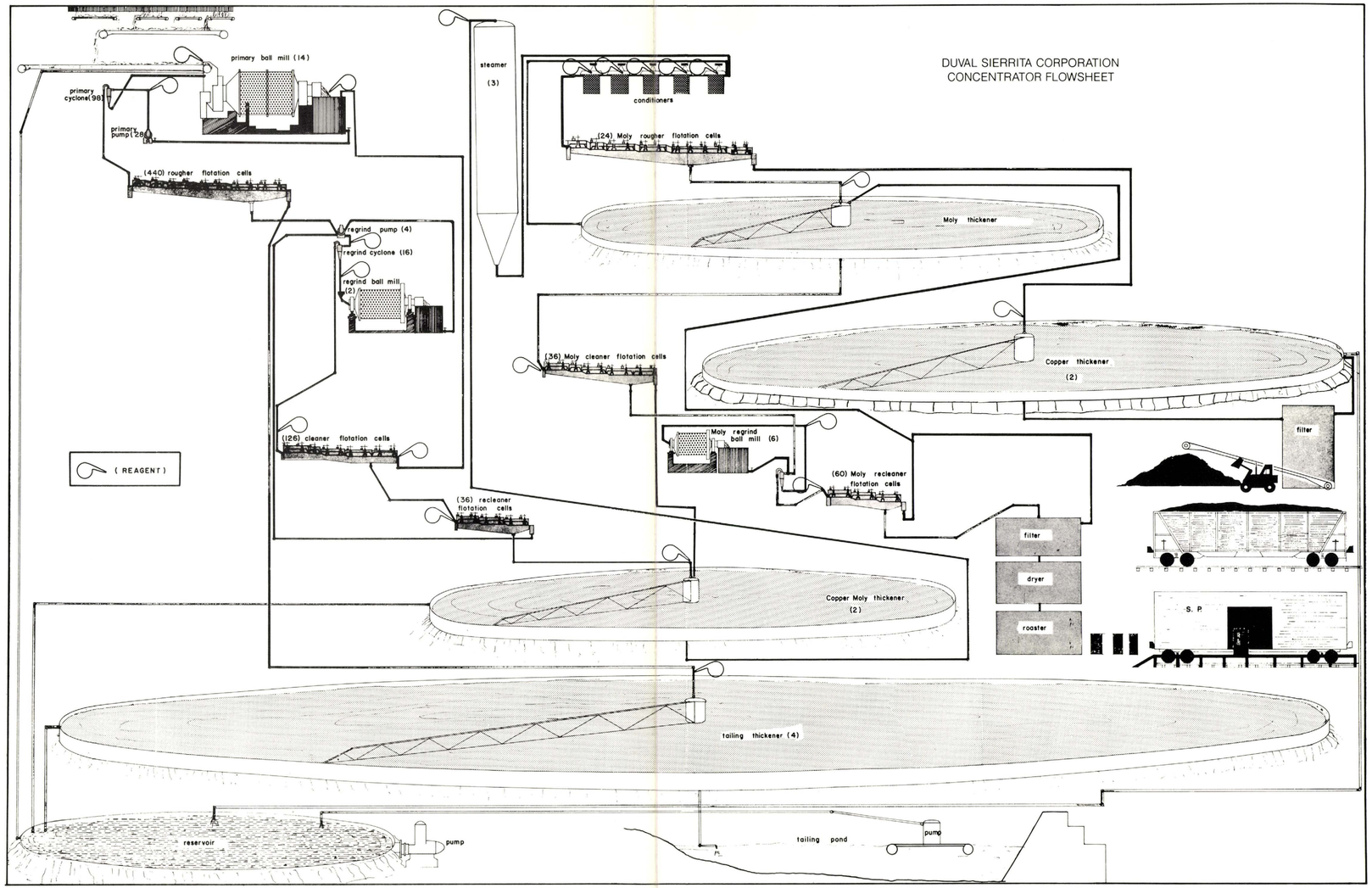
Primary size reduction of the mined ore is achieved by two 60-inch by 89-inch gyratory crushers located near the south perimeter of the Sierrita open pit. The crushers, which reduce the mine ore to about 85 percent minus six-inch, have a total operating capacity of 5000 tons-per-hour. The crushed ore is transported by a 54-inch wide belt conveyor to a 40,000-ton coarse ore open storage—an overland distance of about two and one-half miles.

Feeder belts under the coarse ore pile collect the ore to feed the fine-crushing plant. Ore is first fed to four vibrating double-deck scalping screens ahead of four 84-inch secondary crushers. The secondary crusher product is again screened, and the oversize material is further reduced by eight 84-inch tertiary crushers operating in a closed-circuit system consisting of a 2400-ton surge bin feeding the crushers and vibrating screens. The finished product, essentially all minus half-inch, is transported to a 72,000-ton live capacity fine-ore bin located in the concentrator building.

Concentrating

The process of flotation is used to concentrate the copper and molybdenum minerals. To accomplish this, the crushed ore must be further reduced by grinding to achieve liberation of the mineral particles from the host rock.

The ore from the fine-ore storage is wet-ground in 14 16½-foot diameter by 19-foot-long ball mills driven by 3000 HP motors. The ball mills operate in a closed circuit with cyclone classifiers. The ground ore in an ore-water slurry, after being conditioned with reagents, is introduced into flotation machines which produce a low-grade (rougher) concentrate of copper and molybdenum minerals. The rougher concentrate is then re-ground in two 11-foot diameter by 15-foot-long regrind ball mills that are operated in a closed circuit with cyclone classifiers. The rougher concentrate is floated and re-floated to a final concentrate. A total of 602 flotation machines are used in the copper-molybdenum concentration. The tailing from the flotation process is thickened before disposal in four 350-foot diameter rake thickeners, the water, which is recovered from the slurry, is re-used in the



Power shovel bucket drops approximately 23 tons of copper-molybdenum ore into 1000 HP haul truck. When fully loaded, the haul truck will carry 120 tons of ore. Each truck tire is 48-ply, stands nine feet high and weighs 3000 pounds.

From this nucleus, United Gas ultimately became one of the largest handlers of natural gas in the world, spanning a vast five-state area along a broad arc from Laredo, Texas, to Pensacola, Florida. By 1965, its widespread operations included exploration and production, transmission and distribution of natural gas, refining of gasoline and petroleum by-products, and mining.

Final consolidation of Pennzoil and United Gas occurred on April 1, 1968.

Sierrita Property

The Sierrita Property consists of over 13,000 acres. Included in this total acreage are 143 unpatented mining claims which were purchased by Duval. Approximately 58 percent of the Sierrita ore body was acquired in the purchase of these claims. The remaining 42 percent of the ore body was controlled by patented mining claims owned by Duval. Duval has transferred these patented claims to Sierrita.

Exploration and Preliminary Development

A total of 178 test holes were drilled in order to delineate the Sierrita ore body and to test proposed waste dump areas. Some of the tests were drilled to check certain holes drilled by another mining company which had previously drilled 60 core tests in the area.

Ore Reserves

The exploration and preliminary development program delineated an ore body of 414 million tons with an average copper content of 0.35 percent (seven pounds per ton) and an average molybdenum content of 0.036 percent (0.72 pounds per ton). Engineering pit design indicates that a total of 634 million tons of waste must be handled prior to and during the mining of the 414 million-ton ore reserve. This total of over a billion tons of ore and waste which will be mined, of which 131 million tons were removed during the pre-mine stripping operations, represents more than twice the tonnage excavated in the construction of the Panama Canal.

Mining

It is anticipated that the eventual perimeter of the Sierrita open pit will encompass an area of approximately 460 acres. As presently designed, the pit will ultimately reach a depth of 1850 feet below the highest elevation of the pit area prior to mining. Such an ultimate depth will represent a distance of almost one and one-half times the height of the Empire State Building.

Mining is accomplished by establishing a series of

levels or benches, each bench being approximately 50 feet high. The first step in the mining cycle is the blasting of the various benches. To blast a bench, rotary drills drill holes 59 feet in depth and from nine inches to 12¼ inches in diameter.

Blast holes which contain water are loaded with a gelatin explosive in slurry form. Holes which are dry are loaded with a mixture of ammonium nitrate and fuel oil.

A typical blast consisting of detonation of the explosives in 40 blast holes requires 75,000 pounds of explosives to break 200,000 tons of rock. A blast of this size provides enough broken material to keep one power shovel in production for approximately four days.

Mining Equipment and Facilities

The mining equipment features six power shovels equipped with 15 cubic-yard buckets and 32 haul trucks of 120-ton capacity. These shovels and trucks are among the largest presently used in the copper mining industry. In addition, six rotary blast-hole drills, 12 dozers and numerous other units such as motor patrols, fork lifts, cranes, water trucks, personnel busses and miscellaneous small trucks supplement the operation. Service facilities consist of two modern shops, steam cleaning pad, change room and offices.

Because the power shovels and haul trucks are among the largest used in the industry, some pertinent facts concerning these units are of interest:

Power Shovels

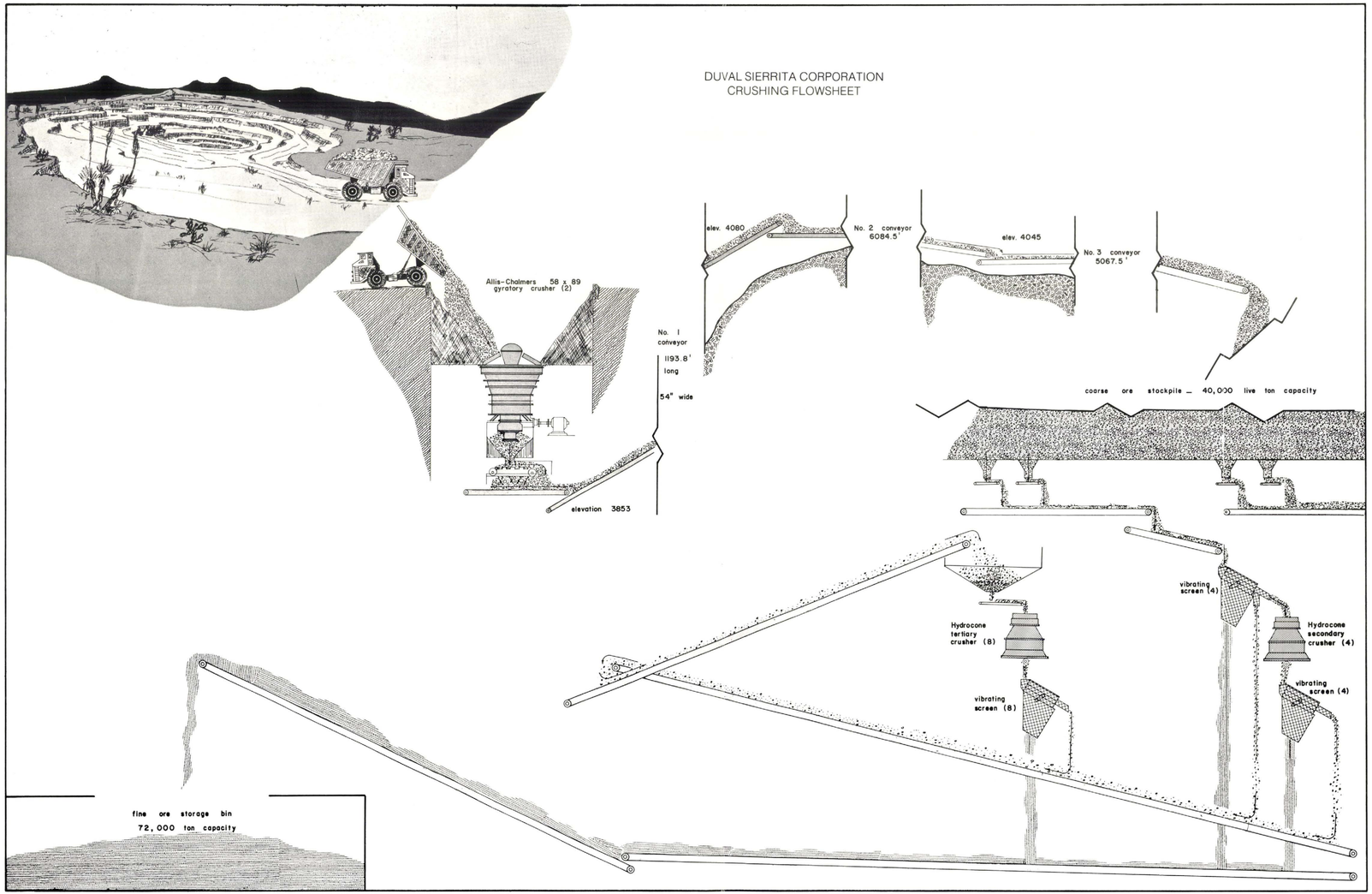
1. The weight of each shovel is approximately 450 tons.
2. Shovels are rated at 750 HP and are electrically powered by 4160-volt alternating current motors.
3. The 15 cubic-yard bucket has a capacity of approximately 23 tons.

Haul Trucks

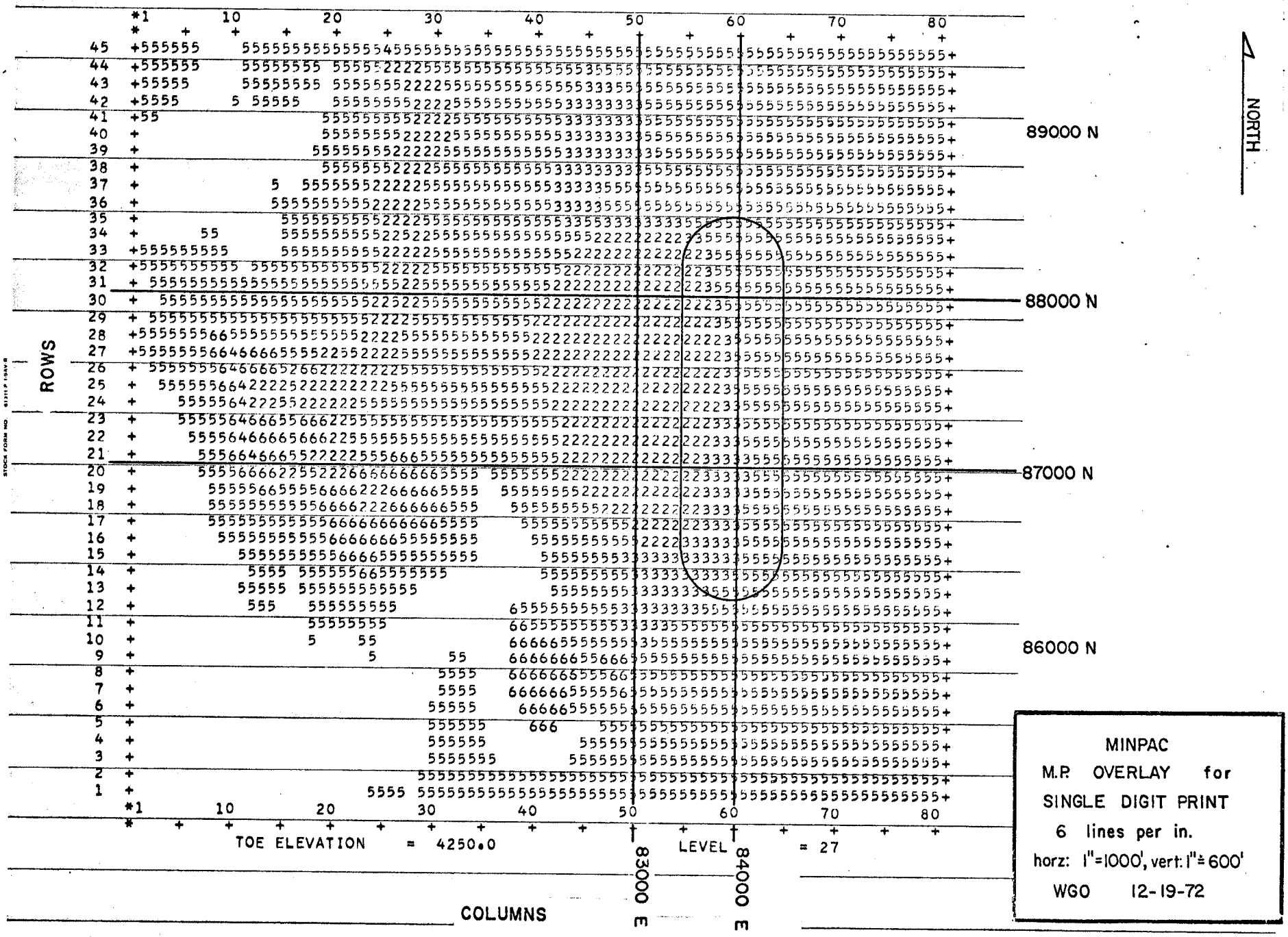
1. The truck engines are 12-cylinder diesels rated at 1000 HP.
2. The truck engine drives a direct current generator, which supplies power to electric motor assemblies in the rear wheels.
3. Trucks have a rated capacity of 120 tons and weigh approximately 75 tons empty.
4. Fuel tanks hold 450 gallons of diesel oil and the engines use one gallon per mile under full-load conditions and level haul.
5. Truck tires are 48-ply, nine feet in diameter and weigh 3000 pounds.
6. The expected life of each truck is five to seven years, after which replacement is anticipated.

Plant Facilities

The concentrator, which has a design capacity of 72,000 tons of ore per day, and its associated facilities



314 TO CHECK LOADING OF ROCK TYPE CHANGES OF 3/23/73 - AS PER R.T.

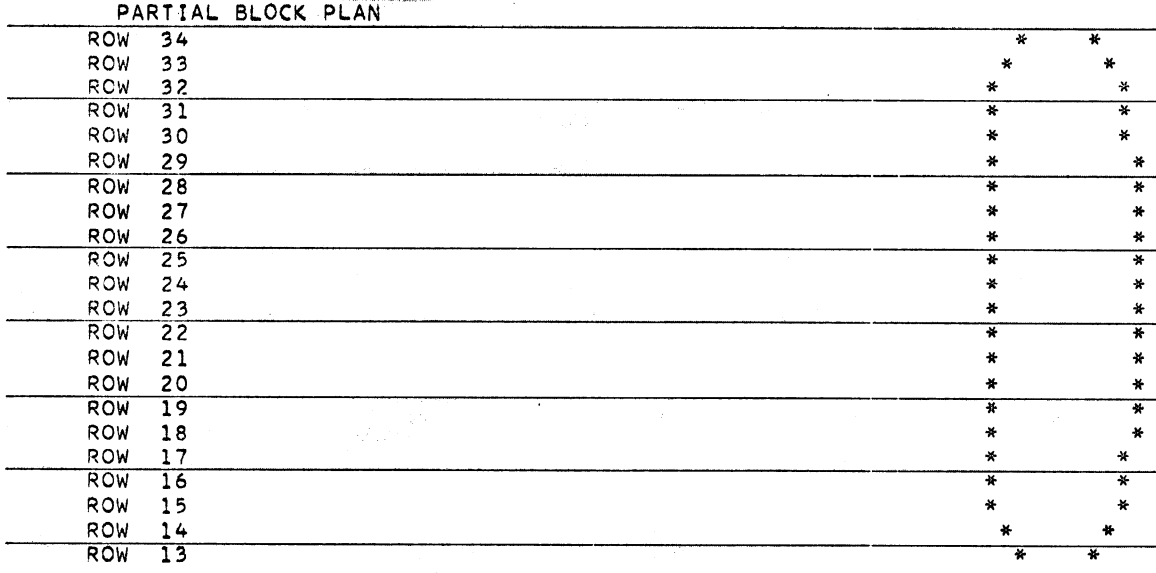


The units and grouping should now be as follows:

Printout	Input	Symbol	Unit
	03		Waste Dump
9	04		Leach Dump
	05	Qal	Alluvium
2	25	Kqp	Quartz Porphyry
	26	Kqmp	Quartz Monzonite Porphyry
3	33	Kbqmp	Biotite Quartz Monzonite Porphyry
4	45	Kql	Rhyolite (Quartz Latite)
	46	Kapl	Aplite
	53	pCcbs	Chlorite-Biotite Schist
5	54	pCamp	Amphibolite
	55	pChmd	Harnblende Metadiorite
	56	pCqd	Quartz Diorite
6	65	pCqfg	Quartz-Feldspar Gneiss
	66	pCpeg	Pegmatite

- TEST PIT - 23 MARCH 73

PARTIAL BLOCK PLAN



4250

STOCK FORM NO 61311-P I SAV-R

TEST PIT -- 23 MARCH 73
RMO = RECOVERABLE MO. CU EQ = CU - .5ASCU + RMO
ROCK TYPE = 0-UNK, 2-QMP, 3-BQMP, 4-QL, 5-CBS, 6-QFG, 9-QAL.
ORE 1 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU GREATER OR EQUAL TO .35
ORE 2 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU LESS THAN .35 ORE 3 IS CU EQUIV LESS THAN .40 AND CU GREATER OR EQUAL TO .15 BUT LESS THAN .35 --- WASTE IS EQUIV CU LESS THAN .40 AND TOTAL COPPER LESS THAN .15

SEQUENCE NUMBER 34. INCREMENT NUMBER 1

BENCH	KTONS	CU	ASCU	RMO	EQUI	KTONS	CU	ASCU	RMO	EQUI	WASTE KTONS	TOTAL KTONS	S.R.1	S.R.12
	********** ORE 1 **********					********** ORE 2 **********								
	********** ORE 1 + ORE 2 **********					********** ORE 3 **********								
4390	1646.3	0.567	0.084	0.025	0.657	487.1	0.299	0.039	0.044	0.504			2.96	
	2133.5	0.506	0.074	0.030	0.622	1414.2	0.222				2973.0	6520.9	12.38	2.06
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 23	3= 53	4= 0	5= 24	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 60	3= 34	4= 0	5= 6	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 18	3= 21	4= 0	5= 61	6= 0	7= 0	8= 0	9= 0	0= 0
4355	1902.3	0.528	0.084	0.031	0.644	699.9	0.250	0.025	0.054	0.514			2.63	
	2602.3	0.453	0.068	0.037	0.609	901.8	0.226				3407.5	6911.7	8.87	1.66
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 29	3= 50	4= 0	5= 21	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 84	3= 16	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 11	3= 30	4= 0	5= 59	6= 0	7= 0	8= 0	9= 0	0= 0
4320	1350.9	0.566	0.086	0.031	0.685	431.7	0.302	0.052	0.050	0.532			3.70	
	1782.7	0.502	0.078	0.036	0.648	1484.2	0.234				3079.9	6347.0	13.70	2.56
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 31	3= 53	4= 0	5= 16	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 54	3= 46	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 11	3= 28	4= 0	5= 61	6= 0	7= 0	8= 0	9= 0	0= 0
4285	383.5	0.447	0.038	0.037	0.616	553.8	0.273	0.040	0.042	0.468			14.13	
	937.4	0.344	0.039	0.040	0.528	1594.5	0.201				3272.9	5804.9	9.48	5.19
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 78	3= 22	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 44	3= 56	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 10	3= 42	4= 0	5= 48	6= 0	7= 0	8= 0	9= 0	0= 0
4250	252.5	0.450	0.034	0.045	0.663	280.0	0.239	0.021	0.046	0.464			19.87	
	532.5	0.339	0.027	0.046	0.558	1373.1	0.192				3366.1	5271.8	17.83	8.90
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 55	3= 45	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 80	3= 20	4= 0	5= 0	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 12	3= 62	4= 0	5= 26	6= 0	7= 0	8= 0	9= 0	0= 0
SUM	5535.8	0.540	0.079	0.030	0.657	2452.7	0.273	0.035	0.048	0.499			4.57	
	7988.6	0.458	0.066	0.036	0.608	6768.1	0.214				16099.6	30856.4	11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE -				1= 0	2= 32	3= 49	4= 0	5= 18	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 2					1= 0	2= 65	3= 34	4= 0	5= 1	6= 0	7= 0	8= 0	9= 0	0= 0
ORE 3					1= 0	2= 12	3= 37	4= 0	5= 50	6= 0	7= 0	8= 0	9= 0	0= 0

STOCK FORM NO. 6331-F (SAV R

TEST PIT -- 23 MARCH 73
RMO = RECOVERABLE MO. CU EQ = CU - .5ASCU + RMO
ROCK TYPE = 0-UNK, 2-QMP, 3-BQMP, 4-QL, 5-CBS, 6-QFG, 9-QAL.
ORE 1 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU GREATER OR EQUAL TO .35
ORE 2 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU LESS THAN .35 ORE 3 IS CU EQUIV LESS THAN .40 AND CU GREATER OR EQUAL TO .15 BUT LESS THAN .35 --- WASTE IS EQUIV CU LESS THAN .40 AND TOTAL COPPER LESS THAN .15

TYPE OF OUTPUT - ACCUMULATIVE BY BENCHES

SUMMARY OF SEQUENCE 34. INCREMENTS 1 TO 1

BENCH	ORE 1 KTONS	CU	ASCU	RMO	EQUI	ORE 2 KTONS	CU	ASCU	RMO	EQUI	WASTE KTONS	TOTAL KTONS	S.R.1 S.R.2	S.R.12
4390	1646.3	0.567	0.084	0.025	0.657	487.1	0.299	0.039	0.044	0.504			2.96	
	2133.5	0.506	0.074	0.029	0.622	1414.2	0.222				2973.0	6520.9	12.38	2.06
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 23 3= 53 4= 0 5= 24 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 60 3= 34 4= 0 5= 6 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 18 3= 21 4= 0 5= 61 6= 0 7= 0 8= 0 9= 0 0= 0													
4355	3548.7	0.546	0.084	0.028	0.650	1187.1	0.270	0.031	0.050	0.510			2.79	
	4735.9	0.477	0.070	0.034	0.615	2316.1	0.223				6380.6	13432.6	10.31	1.84
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 27 3= 51 4= 0 5= 22 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 74 3= 24 4= 0 5= 2 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 15 3= 24 4= 0 5= 60 6= 0 7= 0 8= 0 9= 0 0= 0													
4320	4899.8	0.552	0.084	0.029	0.660	1618.9	0.278	0.036	0.050	0.516			3.04	
	6518.8	0.484	0.072	0.034	0.624	3800.4	0.228				9460.6	19779.8	11.22	2.03
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 28 3= 52 4= 0 5= 20 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 69 3= 29 4= 0 5= 2 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 13 3= 26 4= 0 5= 60 6= 0 7= 0 8= 0 9= 0 0= 0													
4285	5283.4	0.544	0.081	0.029	0.656	2172.7	0.277	0.037	0.048	0.503			3.34	
	7456.2	0.466	0.068	0.035	0.612	5395.0	0.220				12733.5	25584.7	10.78	2.43
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 31 3= 49 4= 0 5= 19 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 62 3= 36 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 12 3= 31 4= 0 5= 57 6= 0 7= 0 8= 0 9= 0 0= 0													
4250	5536.0	0.540	0.079	0.030	0.657	2452.7	0.272	0.035	0.048	0.499			4.57	
	7988.8	0.458	0.065	0.036	0.608	6768.1	0.214				16099.6	30856.6	11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 32 3= 49 4= 0 5= 18 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 64 3= 34 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 12 3= 37 4= 0 5= 50 6= 0 7= 0 8= 0 9= 0 0= 0													
SUM	5536.0	0.540	0.079	0.030	0.657	2452.7	0.273	0.035	0.048	0.499			4.57	
	7988.8	0.458	0.066	0.036	0.608	6768.1	0.214				16099.6	30856.6	11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 32 3= 49 4= 0 5= 18 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 65 3= 34 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 12 3= 37 4= 0 5= 50 6= 0 7= 0 8= 0 9= 0 0= 0													

Form 355

GEOLOGY EDP DRILL HOLE LOG

(A)

HOLE NUMBER	GRID LOCATION	COORDINATES NORTHING	COORDINATES EASTING	COLLAR ELEV.	DEPTH DRILLED	HOLE GEOMETRY AZIMUTH	HOLE GEOMETRY INCL.	METH	DRILL I.D	DATE START	DATE FINISH	LOG BY	PROPERTY I. D.
	1042	60105	51036	00	98200	405	3120	0	-90	1	02	09-27-72	10-14-72	CAO	004

(B)

SAMPLE NUMBER BY DEPTH	ROCK UNIT	EPIDOTE	CHLORITE	CLAY	SERICITE	QTZ. VEINLETS	SILICIFICATION	TOURMALINE	BIOTITE	ORTHOCLASE	HEMATITE	GOETHITE	JAROSITE	ZEOLITES	ANHYDRITE	GYPSUM	CALCITE	OTHER	CU OXIDES	CHALCOCITE	% VOL. SULPHIDE	PYRITE	PYRITE TO CHALCOPYRITE	DISSEMINATED	VEINLETS	FRACTURING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	% CORE RECOVERED	ROCK STRENGTH PSI x 100	R.Q.D. ≥ 4 INCHES	R.Q.D. ≥ 12 INCHES	R.Q.D. ≥ 24 INCHES
25																																										
	0-25' Rock Bit																																										
33	3400402000025500000000110103711																																							61		300		
43																									F	501	501													59		410		
	Flt 39-40.5																																										
53																		1																							76		500		
	ox-sulf contact @ 52'																																										
63	3400402002300000200001302																									F	1099													70		100		
	Flt 62-71																																									
73																									F	8001													59		100		
83																									F	1099													78		200		
	Flt 82-89																																									
93																									F	6001													75		300		
103	3423242001400000020000230																																							96		610		
113																																								98		400		
123																									F	3007	01													99		400		
	Flt 117-117.7																																									

Cu Equivalent = Cu + 4 Mo

(C)

SAMPLE ELEV.	Est % Cu	Est % Mo	ASSAYS Cu	ASSAYS Mo		ASSAYS Cu eq.	GRAPH Rx	GRAPH ORE
4028								
4020	.10	.01	.11	.006		.13		
4010	.10	.01	.10	.006		.12		
4000	.10	.01	.15	.011		.19		
3990	.20	.01	.20	.018		.27		
3980	?	?	.08	.005		.10		
3970	.20	.01	.18	.016		.24		
3960	.10	.01	.11	.035		.25		
3950	.10	.01	.12	.026		.22		
3940	.05	.005	.13	.009		.17		
3930	.20	.010	.22	.026		.32		

EXPLANATION OF "GEOLOGY EDP DRILL HOLE LOG"

PART A

This part of the form is for "header card" information and is completed only once for each drill hole. The column headings are mostly self-explanatory.

HOLE NUMBER, cols. 2 thru 5: Example, Drill Hole No. 861.

GRID LOCATION, cols. 6 thru 13: Development hole grid location is to be reported to the nearest tenth of a unit. Example, Q½; 96½.

COORDINATES, cols. 14 thru 25: Example, 99,000 N; 98,701 E

COLLAR ELEVATION, cols. 26 thru 29: Example, 3,655 ft.

DEPTH DRILLED, cols. 30 thru 33: Example, 1,965 ft.

HOLE GEOMETRY, cols. 34 thru 41: Space has been provided for angle holes. Enter the azimuth in degrees (cols. 34 thru 36) and minutes (cols. 37 thru 38). The inclination is + if upwards, and - if downwards; enter degrees of inclination in cols. 40 thru 41. An example of a vertical hole drilled from the surface is shown on the attached "Example" form.

METH, col. 42: The number designating the drilling method used is selected from the Code Key. Example, diamond core hole.

DRILL I.D., cols. 43 thru 44: The identification of the company that drills the hole is selected from the Code Key. Example, Boyles.

DATE, cols. 45 thru 56: The month, day, and year the drill hole is started and finished is entered numerically. Example, Started January 6, 1970; Finished February 12, 1970.

LOG BY, cols. 57 thru 59: The person logging the core enters his initials here.

PROPERTY I.D., cols. 77 thru 80: The property identification number assigned by the Engineering Dept. is entered here. Example, Sierrita.

contd.

PART B

This part of the form is for describing the geology of the drill hole. One row, or line of boxes, is to be used for each sample interval to be described.

The "blank space" below each row is for remarks and additional information which is not necessary to be keypunched. Each line will be keypunched on a single IBM card. Note that cols. 2 thru 5, HOLE NUMBER, are not shown on this part of the form. The hole number will be entered on each card automatically by the keypunch operator.

CONTINUATION CARD, col. 1: If the additional information mentioned above is to be keypunched, a "1" is entered in column 1 of the "blank space."

SAMPLE NUMBER BY DEPTH, cols, 6 thru 9: The hole number together with the depth of the bottom of the interval sampled will be used for the "sample number". On the attached "Example" form, a rock bit was used from the surface to a depth of 15 feet, and no sample was collected. The first interval sampled was from 15 feet to 25 feet. The sample for assay would be marked 861-25.

ROCK UNIT, cols. 10 thru 11: The appropriate numerical code is selected from the Key and entered here. Example shown (65) is for quartz diorite at Sierrita.

Cols. 12 thru 32: Enter the estimated percent by volume for each mineral by using the appropriate Code Key. It is realized that it is difficult to estimate alteration minerals, but every effort should be made to quantify this information within broad limits. At operating properties, different methods have been used to record the relative amounts of minerals present and it may be necessary to continue with the method being used for future logging.

PYRITE TO CHALCOPYRITE, cols. 33 thru 35: Space is provided for recording the ratio of pyrite to chalcopyrite to the nearest tenth. An entry in col. 35, the tenth, is only necessary where the amount of chalcopyrite exceeds the amount of pyrite. Example, 10% pyrite, 1% chalcopyrite.

DISSEMINATED - VEINLETS, cols. 36 thru 37: It is assumed that the ore minerals are either disseminated or occur in veinlets. Enter in col. 36 the percent, divided by 10, of ore minerals that are disseminated in the rock. Enter in 37 the percent, divided by 10, of the ore minerals that occur in veinlets. Example: 19 is 10% disseminated, 90% veinlets.

FRACTURING, col. 38: Choose a representative foot of core that appears to be the average fracturing intensity for the sample interval. This includes veinlets and mineralized fractures. Count the number of fractures per foot and enter this number in col. 38. If the number is less than 1, enter 0. If the number is 9 or more, enter 9. Example, an average of 5 fractures per foot.

STRUCTURE, cols. 39 thru 59: Space has been provided to record the type, attitude, thickness, and filling material for three structures per sample interval. Notations for the type and filling material are selected from the appropriate Code Keys. The attitude is measured in degrees from the horizontal. Thickness is recorded to the nearest one-tenth of a foot. Example, an unmineralized fault dipping 60 degrees; a vein dipping 80 degrees, 2 feet thick, containing quartz, molybdenite, and pyrite; a fault dipping 75 degrees with 1.5 feet of gouge, unmineralized.

% CORE RECOVERED, cols. 60 thru 61: Example, 99%.

ROCK STRENGTH, PSI x 100, cols. 62 thru 64: Example, 93.

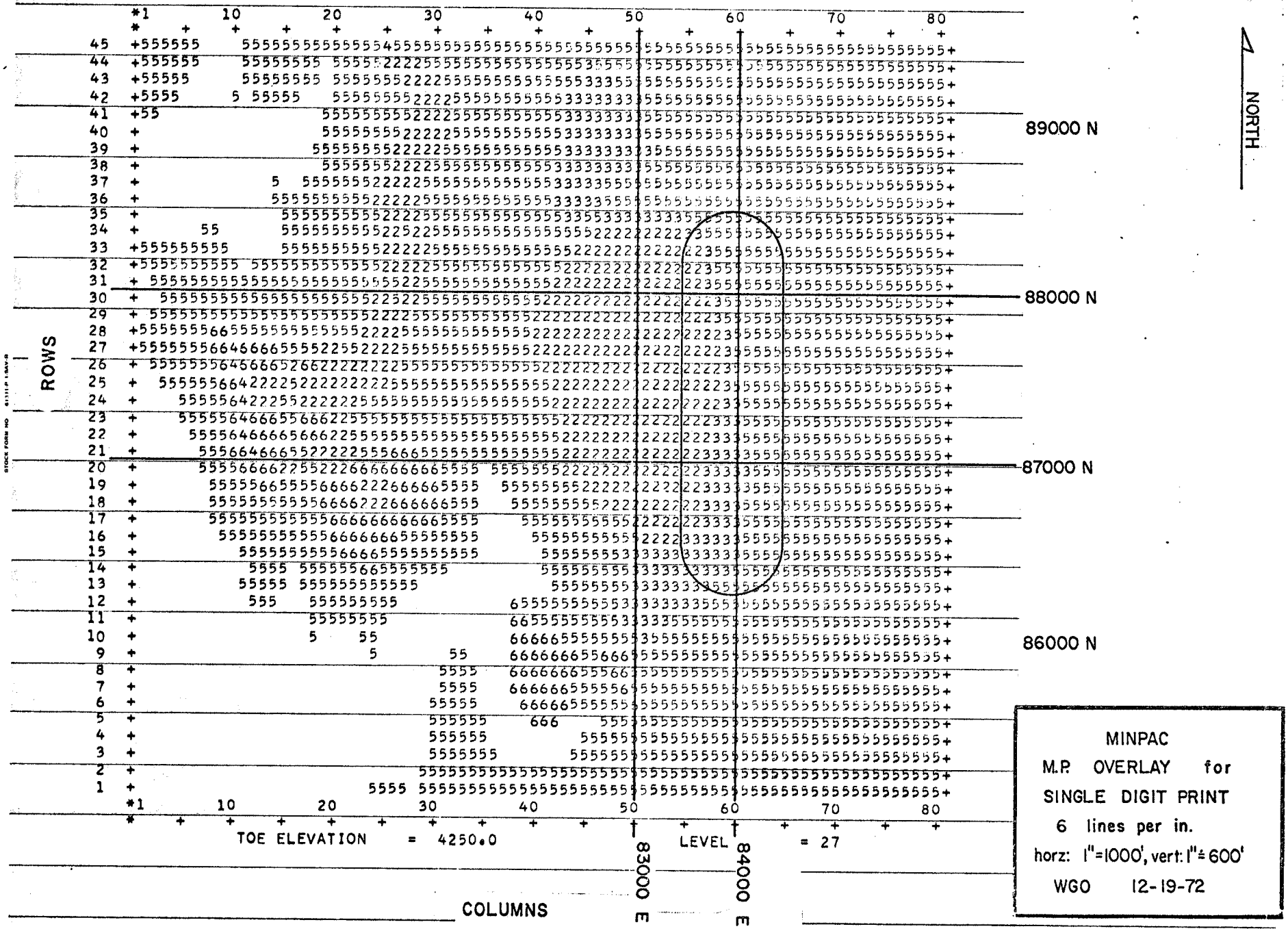
R.Q.D., cols. 65 thru 67: "Rock Quality Determination" - Estimate the percent of broken, loose core in the core box that is four inches or greater in size; 0 is less than 10%, 1 is 10%, 2 is 20%, ..., 9 is 90% or greater. Do the same for the percent of broken core that is equal or greater than 12 inches and 24 inches. The percentage figures recorded with increasing size are cumulative. Example, 30% of the core is $\geq$ 4 inches; 30% is between 4 inches and 12 inches; 40% is between 12 inches and $\geq$ 24 inches.

PART C

This part of the form is similar to the previous core logging form. Record the formula used for computing copper equivalent. The extra boxes formed by the dashed lines in the estimated grade and assays sections can be used to record additional assay data where available.

314 TO CHECK LOADING OF ROCK TYPE CHANGES OF 3/23/73 - AS PER R.T.

TOE ELEVATION = 4250.0 LEVEL NUMBER= 27



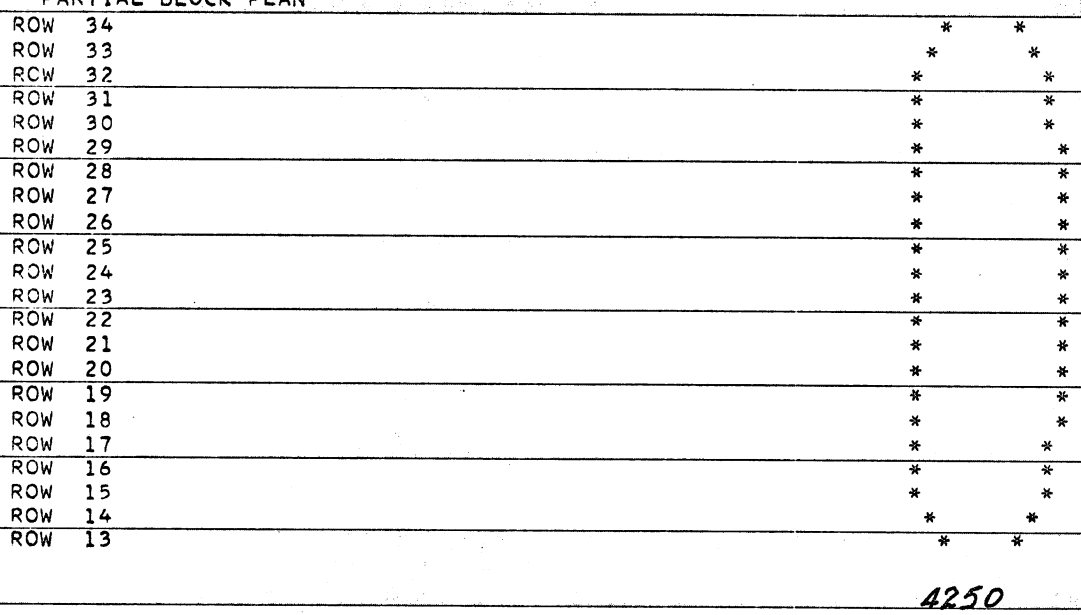
MINPAC
M.P. OVERLAY for
SINGLE DIGIT PRINT
6 lines per in.
horz: 1"=1000', vert: 1"= 600'
WGO 12-19-72

The units and grouping should now be as follows:

Printout	Input	Symbol	Unit
	03		Waste Dump
9	04		Leach Dump
	05	Qal	Alluvium
2	25	Kqp	Quartz Porphyry
	26	Kqmp	Quartz Monzonite Porphyry
3	33	Kbqmp	Biotite Quartz Monzonite Porphyry
4	45	Kql	Rhyolite (Quartz Latite)
	46	Kapl	Aplite
	53	pCcbs	Chlorite-Biotite Schist
5	54	pCamp	Amphibolite
	55	pChmd	Harnblende Metadiorite
	56	pCqd	Quartz Diorite
6	65	pCqfg	Quartz-Feldspar Gneiss
	66	pCpeg	Pegmatite

- TEST PIT - 23 MARCH 73

PARTIAL BLOCK PLAN



4250

STOCK FORM NO 61311 P 1 SAY R

TEST PIT -- 23 MARCH 73
RMO = RECOVERABLE MO. CU EQ = CU - .5ASCU + RMO
ROCK TYPE = 0-UNK, 2-GMP, 3-BGMP, 4-QL, 5-CBS, 6-QFG, 9-QAL.
ORE 1 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU GREATER OR EQUAL TO .35
ORE 2 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU LESS THAN .35 ORE 3 IS CU EQUIV LESS THAN .40 AND CU GREATER OR EQUAL TO .15 BUT LESS THAN .35 --- WASTE IS EQUIV CU LESS THAN .40 AND TOTAL COPPER LESS THAN .15

SEQUENCE NUMBER 34. INCREMENT NUMBER 1

BENCH	KTONS	CU	ASCU	RMO	EQUI	KTONS	CU	ASCU	RMO	EQUI	WASTE KTONS	TOTAL KTONS	S.R.1 S.R.2	S.R.12
	********** ORE 1 **********					********** ORE 2 **********								
	********* ORE 1 + ORE 2 *********					********** ORE 3 **********								
4390	1646.3	0.567	0.084	0.025	0.657	487.1	0.299	0.039	0.044	0.504			2.96	
	2133.5	0.506	0.074	0.030	0.622	1414.2	0.222				2973.0	6520.9	12.38	2.06
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 23 3= 53 4= 0 5= 24 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 60 3= 34 4= 0 5= 6 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 18 3= 21 4= 0 5= 61 6= 0 7= 0 8= 0 9= 0 0= 0													
4355	1902.3	0.528	0.084	0.031	0.644	699.9	0.250	0.025	0.054	0.514			2.63	
	2602.3	0.453	0.068	0.037	0.609	901.8	0.226				3407.5	6911.7	8.87	1.66
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 29 3= 50 4= 0 5= 21 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 84 3= 16 4= 0 5= 0 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 11 3= 30 4= 0 5= 59 6= 0 7= 0 8= 0 9= 0 0= 0													
4320	1350.9	0.566	0.086	0.031	0.685	431.7	0.302	0.052	0.050	0.532			3.70	
	1782.7	0.502	0.078	0.036	0.648	1484.2	0.234				3079.9	6347.0	13.70	2.56
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 31 3= 53 4= 0 5= 16 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 54 3= 46 4= 0 5= 0 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 11 3= 28 4= 0 5= 61 6= 0 7= 0 8= 0 9= 0 0= 0													
4285	383.5	0.447	0.038	0.037	0.616	553.8	0.273	0.040	0.042	0.468			14.13	
	937.4	0.344	0.039	0.040	0.528	1594.5	0.201				3272.9	5804.9	9.48	5.19
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 78 3= 22 4= 0 5= 0 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 44 3= 56 4= 0 5= 0 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 10 3= 42 4= 0 5= 48 6= 0 7= 0 8= 0 9= 0 0= 0													
4250	252.5	0.450	0.034	0.045	0.663	280.0	0.239	0.021	0.046	0.464			19.87	
	532.5	0.339	0.027	0.046	0.558	1373.1	0.192				3366.1	5271.8	17.83	8.90
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 55 3= 45 4= 0 5= 0 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 80 3= 20 4= 0 5= 0 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 12 3= 62 4= 0 5= 26 6= 0 7= 0 8= 0 9= 0 0= 0													
SUM	5535.8	0.540	0.079	0.030	0.657	2452.7	0.273	0.035	0.048	0.499			4.57	
	7988.6	0.458	0.066	0.036	0.608	6768.1	0.214				16099.6	30856.4	11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 32 3= 49 4= 0 5= 18 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 2	1= 0 2= 65 3= 34 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0													
ORE 3	1= 0 2= 12 3= 37 4= 0 5= 50 6= 0 7= 0 8= 0 9= 0 0= 0													

STOCK FORM NO. 61311-F SAY-R

TEST PIT -- 23 MARCH 73
RMO = RECOVERABLE MO. CU EQ = CU - .5ASCU + RMO
ROCK TYPE = 0-UNK, 2-QMP, 3-BQMP, 4-QL, 5-CBS, 6-QFG, 9-QAL.
ORE 1 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU GREATER OR EQUAL TO .35
ORE 2 IS CU EQUIV GREATER OR EQUAL TO .40 AND CU LESS THAN .35 ORE 3 IS CU EQUIV LESS THAN .40 AND CU GREATER OR EQUAL TO .15 BUT LESS THAN .35 --- WASTE IS EQUIV CU LESS THAN .40 AND TOTAL COPPER LESS THAN .15

TYPE OF OUTPUT - ACCUMULATIVE BY BENCHES

SUMMARY OF SEQUENCE 34. INCREMENTS 1 TO 1

BENCH	********** ORE 1 ********** / ********** ORE 1 + ORE 2 ********** KTONS	CU	ASCU	RMO	EQUI	********** ORE 2 ********** / ********** ORE 3 ********** KTONS	CU	ASCU	RMO	EQUI	WASTE KTONS	TOTAL KTONS	S.R.1 / S.R.2	S.R.12
4390	1646.3	0.567	0.084	0.025	0.657	487.1	0.299	0.039	0.044	0.504				2.96	
	2133.5	0.506	0.074	0.029	0.622	1414.2	0.222				2973.0	6520.9		12.38	2.06
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 23 3= 53 4= 0 5= 24 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 2	1= 0 2= 60 3= 34 4= 0 5= 6 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 3	1= 0 2= 18 3= 21 4= 0 5= 61 6= 0 7= 0 8= 0 9= 0 0= 0														
4355	3548.7	0.546	0.084	0.028	0.650	1187.1	0.270	0.031	0.050	0.510				2.79	
	4735.9	0.477	0.070	0.034	0.615	2316.1	0.223				6380.6	13432.6		10.31	1.84
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 27 3= 51 4= 0 5= 22 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 2	1= 0 2= 74 3= 24 4= 0 5= 2 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 3	1= 0 2= 15 3= 24 4= 0 5= 60 6= 0 7= 0 8= 0 9= 0 0= 0														
4320	4899.8	0.552	0.084	0.029	0.660	1618.9	0.278	0.036	0.050	0.516				3.04	
	6518.8	0.484	0.072	0.034	0.624	3800.4	0.228				9460.6	19779.8		11.22	2.03
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 28 3= 52 4= 0 5= 20 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 2	1= 0 2= 69 3= 29 4= 0 5= 2 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 3	1= 0 2= 13 3= 26 4= 0 5= 60 6= 0 7= 0 8= 0 9= 0 0= 0														
4285	5283.4	0.544	0.081	0.029	0.656	2172.7	0.277	0.037	0.048	0.503				3.04	
	7456.2	0.466	0.068	0.035	0.612	5395.0	0.220				12733.5	25584.7		10.78	2.43
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 31 3= 49 4= 0 5= 19 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 2	1= 0 2= 62 3= 36 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 3	1= 0 2= 12 3= 31 4= 0 5= 57 6= 0 7= 0 8= 0 9= 0 0= 0														
4250	5536.0	0.540	0.079	0.030	0.657	2452.7	0.272	0.035	0.048	0.499				4.57	
	7988.8	0.458	0.065	0.036	0.608	6768.1	0.214				16099.6	30856.6		11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 32 3= 49 4= 0 5= 18 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 2	1= 0 2= 64 3= 34 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 3	1= 0 2= 12 3= 37 4= 0 5= 50 6= 0 7= 0 8= 0 9= 0 0= 0														
SUM	5536.0	0.540	0.079	0.030	0.657	2452.7	0.273	0.035	0.048	0.499				4.57	
	7988.8	0.458	0.066	0.036	0.608	6768.1	0.214				16099.6	30856.6		11.58	2.86
ORE 1	PERCENTAGE IN ROCK TYPE - 1= 0 2= 32 3= 49 4= 0 5= 18 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 2	1= 0 2= 65 3= 34 4= 0 5= 1 6= 0 7= 0 8= 0 9= 0 0= 0														
ORE 3	1= 0 2= 12 3= 37 4= 0 5= 50 6= 0 7= 0 8= 0 9= .0 0= 0														

STOCK FORM NO. 81311 P I SAVM

Form 355

GEOLOGY EDP DRILL HOLE LOG

(A)

HOLE NUMBER	GRID LOCATION	COORDINATES NORTHING	COORDINATES EASTING	COLLAR ELEV.	DEPTH DRILLED	HOLE GEOMETRY AZIMUTH	HOLE GEOMETRY INCL.	METH	DRILL I.D.	DATE START	DATE FINISH	LOG BY	PROPERTY I.D.
1042	G01055	103600	98200	4053	1200	0	-90	1	02	09-27-72	10-14-72	CAO	004

(B)

CONTINUATION	SAMPLE NUMBER BY DEPTH	ROCK UNIT	EPIDOTE	CHLORITE	CLAY	SERICITE	QTZ. VEINLETS	SILICIFICATION	TOURMALINE	BIOTITE	ORTHOCLASE	HEMATITE	GOETHITE	JAROSITE	ZEOLITES	ANHYDRITE	GYPSUM	CALCITE	OTHER	CU OXIDES	CHALCOCITE	%VOL SULPHIDE	PYRITE	PYRITE TO	CHALCOPYRITE	DISSEMINATED	VEINLETS	FRACTURING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	STRUCTURE TYPE	STRUCTURE ATTITUDE	STRUCTURE THICK	STRUCTURE FILLING	% CORE RECOVERED	ROCK STRENGTH PSI x 100	R.Q.D. ≥ 4 INCHES	R.Q.D. ≥ 12 INCHES	R.Q.D. ≥ 24 INCHES
	25																																													
		0-25' Rock Bit																																												
	33	3	4	0	0	4	0	2	0	0	0	0	2	5	5	0	0	0	0	0	0	1	1	0	1.0	3	7	1														61		3	0	0
	43																											F	5	0	1.5	0	1									59		4	1	0
		Flt 39-40.5																																												
	53																		1																								76		5	0	0
		ox-sulf contact @ 52'																																												
	63	3	4	0	0	4	0	2	0	0	2	3	0	0	0	0	0	2	0	0	0	0	1	3	0	2	0	F		1	0	9	9									70		1	0	0
		Flt 62-71																																												
	73																											F		8	.0	0	1									59		1	0	0
	83																											F		1	0	9	9									78		2	0	0
		Flt 82-89																																												
	93																											F		6	.0	0	1									75		3	0	0
	103	3	4	2	3	2	4	2	0	0	1	4	0	0	0	0	0	2	0	0	0	2	3	0	1	0																96		6	1	0
	113																																										98		4	0	0
	123																											F	3	0	0.7	0	1									99		4	0	0
		Flt 117-117.7																																												

Cu Equivalent = Cu + 4 Mo

(C)

SAMPLE ELEV.	Est % Cu	Est % Mo	ASSAYS Cu	ASSAYS Mo		ASSAYS Cu eq.	GRAPH Rx	GRAPH ORE
4028								
4020	.10	.01	.11	.006		.13		
4010	.10	.01	.10	.006		.12		
4000	.10	.01	.15	.011		.19		
3990	.20	.01	.20	.018		.27		
3980	?	?	.08	.005		.10		
3970	.20	.01	.18	.016		.24		
3960	.10	.01	.11	.035		.25		
3950	.10	.01	.12	.026		.22		
3940	.05	.005	.13	.009		.17		
3930	.20	.010	.22	.026		.32		

EXPLANATION OF "GEOLOGY EDP DRILL HOLE LOG"

PART A

This part of the form is for "header card" information and is completed only once for each drill hole. The column headings are mostly self-explanatory.

HOLE NUMBER, cols. 2 thru 5: Example, Drill Hole No. 861.

GRID LOCATION, cols. 6 thru 13: Development hole grid location is to be reported to the nearest tenth of a unit. Example, Q½; 96½.

COORDINATES, cols. 14 thru 25: Example, 99,000 N; 98,701 E

COLLAR ELEVATION, cols. 26 thru 29: Example, 3,655 ft.

DEPTH DRILLED, cols. 30 thru 33: Example, 1,965 ft.

HOLE GEOMETRY, cols. 34 thru 41: Space has been provided for angle holes. Enter the azimuth in degrees (cols. 34 thru 36) and minutes (cols. 37 thru 38). The inclination is + if upwards, and - if downwards; enter degrees of inclination in cols. 40 thru 41. An example of a vertical hole drilled from the surface is shown on the attached "Example" form.

METH, col. 42: The number designating the drilling method used is selected from the Code Key. Example, diamond core hole.

DRILL I.D., cols. 43 thru 44: The identification of the company that drills the hole is selected from the Code Key. Example, Boyles.

DATE, cols. 45 thru 56: The month, day, and year the drill hole is started and finished is entered numerically. Example, Started January 6, 1970; Finished February 12, 1970.

LOG BY, cols. 57 thru 59: The person logging the core enters his initials here.

PROPERTY I.D., cols. 77 thru 80: The property identification number assigned by the Engineering Dept. is entered here. Example, Sierrita.

contd.

PART B

This part of the form is for describing the geology of the drill hole. One row, or line of boxes, is to be used for each sample interval to be described.

The "blank space" below each row is for remarks and additional information which is not necessary to be keypunched. Each line will be keypunched on a single IBM card. Note that cols. 2 thru 5, HOLE NUMBER, are not shown on this part of the form. The hole number will be entered on each card automatically by the keypunch operator.

CONTINUATION CARD, col. 1: If the additional information mentioned above is to be keypunched, a "1" is entered in column 1 of the "blank space."

SAMPLE NUMBER BY DEPTH, cols, 6 thru 9: The hole number together with the depth of the bottom of the interval sampled will be used for the "sample number". On the attached "Example" form, a rock bit was used from the surface to a depth of 15 feet, and no sample was collected. The first interval sampled was from 15 feet to 25 feet. The sample for assay would be marked 861-25.

ROCK UNIT, cols. 10 thru 11: The appropriate numerical code is selected from the Key and entered here. Example shown (65) is for quartz diorite at Sierrita.

Cols. 12 thru 32: Enter the estimated percent by volume for each mineral by using the appropriate Code Key. It is realized that it is difficult to estimate alteration minerals, but every effort should be made to quantify this information within broad limits. At operating properties, different methods have been used to record the relative amounts of minerals present and it may be necessary to continue with the method being used for future logging.

PYRITE TO CHALCOPYRITE, cols. 33 thru 35: Space is provided for recording the ratio of pyrite to chalcopyrite to the nearest tenth. An entry in col. 35, the tenth, is only necessary where the amount of chalcopyrite exceeds the amount of pyrite. Example, 10% pyrite, 1% chalcopyrite.

DISSEMINATED - VEINLETS, cols. 36 thru 37: It is assumed that the ore minerals are either disseminated or occur in veinlets. Enter in col. 36 the percent, divided by 10, of ore minerals that are disseminated in the rock. Enter in 37 the percent, divided by 10, of the ore minerals that occur in veinlets. Example: 19 is 10% disseminated, 90% veinlets.

FRACTURING, col. 38: Choose a representative foot of core that appears to be the average fracturing intensity for the sample interval. This includes veinlets and mineralized fractures. Count the number of fractures per foot and enter this number in col. 38. If the number is less than 1, enter 0. If the number is 9 or more, enter 9. Example, an average of 5 fractures per foot.

STRUCTURE, cols. 39 thru 59: Space has been provided to record the type, attitude, thickness, and filling material for three structures per sample interval. Notations for the type and filling material are selected from the appropriate Code Keys. The attitude is measured in degrees from the horizontal. Thickness is recorded to the nearest one-tenth of a foot. Example, an unmineralized fault dipping 60 degrees; a vein dipping 80 degrees, 2 feet thick, containing quartz, molybdenite, and pyrite; a fault dipping 75 degrees with 1.5 feet of gouge, unmineralized.

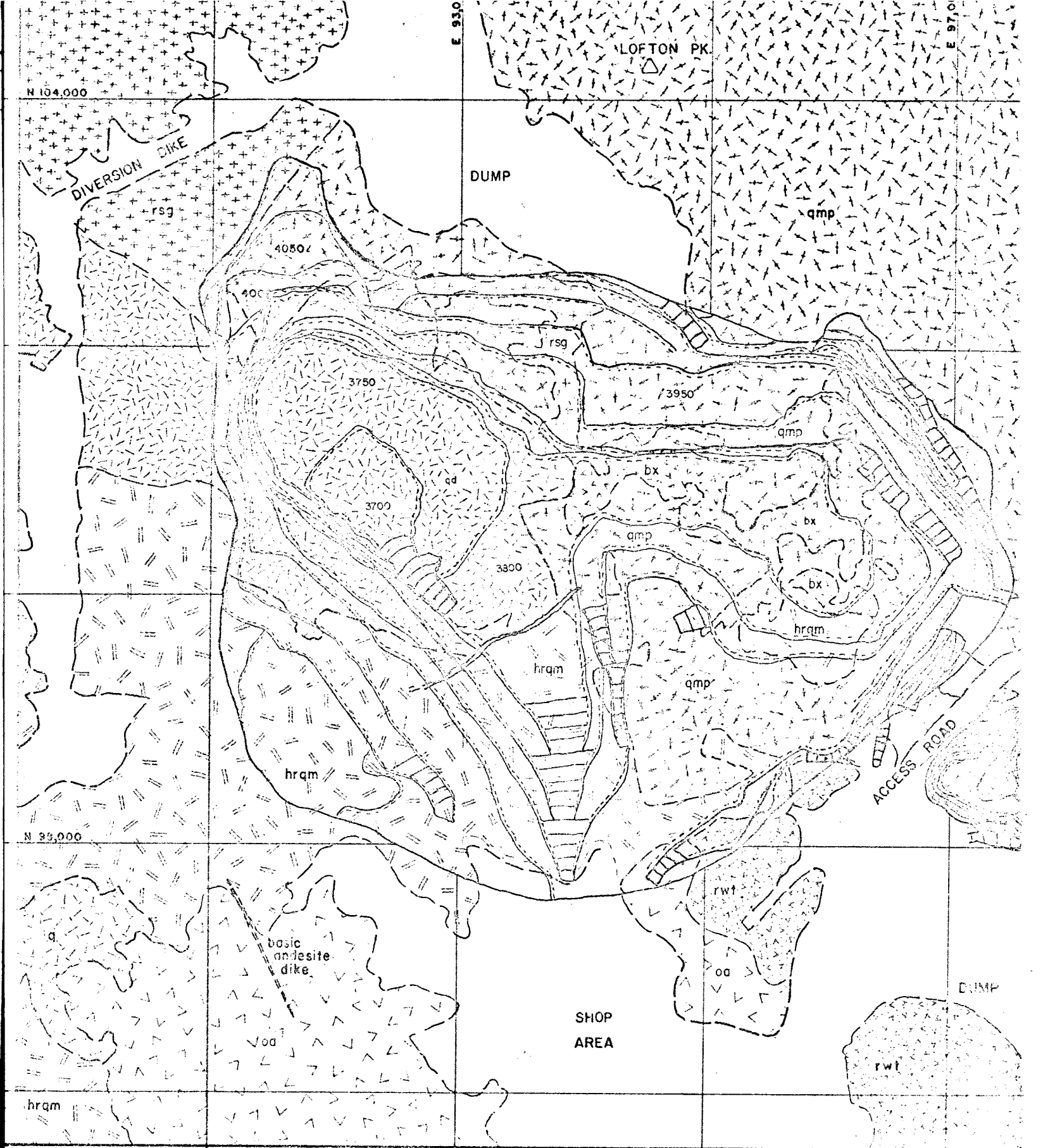
% CORE RECOVERED, cols. 60 thru 61: Example, 99%.

ROCK STRENGTH, PSI x 100, cols. 62 thru 64: Example, 93.

R.Q.D., cols. 65 thru 67: "Rock Quality Determination" - Estimate the percent of broken, loose core in the core box that is four inches or greater in size; 0 is less than 10%, 1 is 10%, 2 is 20%, ..., 9 is 90% or greater. Do the same for the percent of broken core that is equal or greater than 12 inches and 24 inches. The percentage figures recorded with increasing size are cumulative. Example, 30% of the core is $\geq$ 4 inches; 30% is between 4 inches and 12 inches; 40% is between 12 inches and $\geq$ 24 inches.

PART C

This part of the form is similar to the previous core logging form. Record the formula used for computing copper equivalent. The extra boxes formed by the dashed lines in the estimated grade and assays sections can be used to record additional assay data where available.



EXPLANATION

- Qal — Alluvium, waste dumps, etc.
- Aplt — Aplite
- bx — Breccia Pipe
- qlp — Quartz latite porphyry
- qmp — Quartz monzonite porphyry
- rsg — Ruby Star granodiorite
- oa — Oxframe andesite
- qd — Biotite quartz diorite
- hrqm — Harris Ranch quartz monzonite
- rwt — Oxframe rhyolite welded tuff
- q — Quartzite

DUVAL SIERRITA CORPORATION

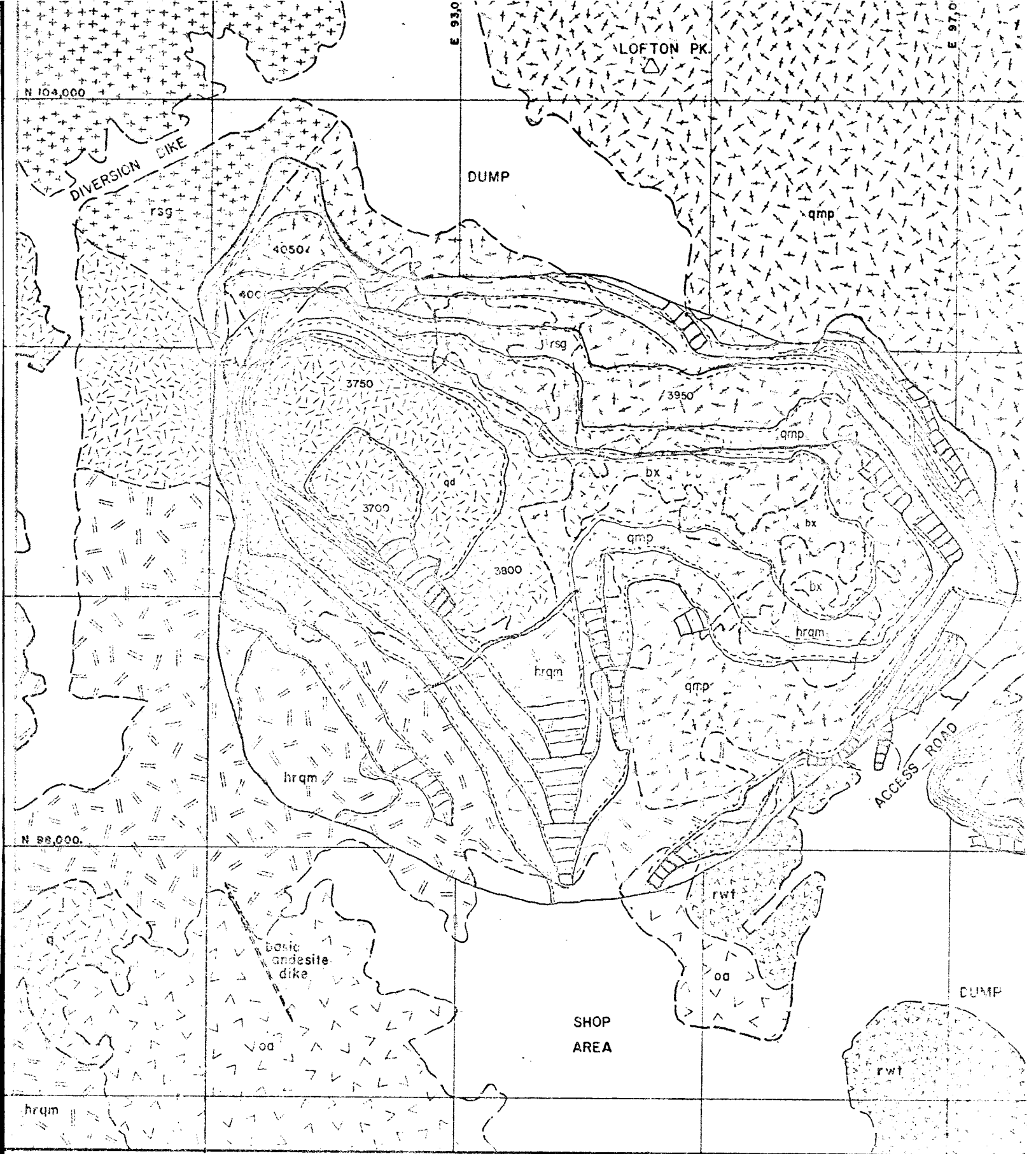
SIERRITA PIT GEOLOGY

SCALE : 1" = 1000'

DATE : APRIL 1, 1973

GEOLOGY BY: RAM, AHJ, BLW, DWL, FWM, CAO, CDI

DRAWN BY : RLL, ATD, VHT



EXPLANATION

- Qal — Alluvium, waste dumps, etc.
- Ap — Aplite
- Lx — Breccia Pipe
- qlp — Quartz latite porphyry
- qmp — Quartz monzonite porphyry
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- q — Quartzite

DUVAL SIERRITA CORPORATION

SIERRITA PIT GEOLOGY

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