016948

EXCERPTS FROM :

CYPRUS ANVIL MINING CORPORATION LTD.
GRUM DEPOSIT
PHASE TWO GEOTECHNICAL STUDIES
DRAFT REPORT

December 1979

Montreal Engineering Co. Ltd.
1199 West Pender Street
Vancouver, B.C.
V6E 2R1

SECTIONS :

PART 2 - GEOLOGY AND HYDROGEOLOGY
2.3 Surface Water and Groundwater

APPENDIX A - LITHOLOGIC LOG
ROCK CORE LOG

On a regional basis, important faults include the Tintina trench system, some 11 km to the south. On a smaller scale, the Doal Lake fault is an important feature some 1 km north of Doal Lake. Fault orientations within the pit area are discussed in greater detail in section 3.2 and in Appendix "C".

2.3 Surface Water and Groundwater

Doal Lake is the only significant surface water body within the proposed pit area. Surface drainage is generally northwest into Nose Creek or southeast into Vangorda Creek, however, there are no well established drainage courses within the site proper.

Currently available information indicates that the Pelly River valley southwest of the site represents a regional discharge zone. Recharge areas may include the site as well as terrain to the northeast. More groundwater information is required for the assessment of mine area position relative to regional groundwater system.

It is apparent that groundwater movement within the rock mass is governed by permeability of major discontinuities (i.e. faults, shear zones and joints). Consequently, the overall transmissibility and storage capacity of the rock mass within the pit area should be low.

Local groundwater conditions have been investigated by means of four P100 piezometers (manufactured by Petur Instruments Ltd.) installed at approximately 100 m depths in holes DL-1 to DL-4. Cyprus Anvil Corporation plans to install an additional four piezometers at shallower depths in the holes. Readings from the four piezometers installed to date are shown in Table I. Locations of the drill holes are shown in Plate 1. In the case of DL-1, the equivalent phreatic surface is above the ground surface (i.e. artesian condition) while in the other three holes, the surface is some 5 to 10 m below existing ground surface. It is expected that slightly higher readings might occur at other times of year.

Seepages observed during mining of the decline occurred largely within the ore zone from faults and fractures. Currently, the decline is flooded to the edge of

TABLE I

Pneumatic Piezometer Readings

Date	Hole No.	Elevation of Piezometer[3] (m)	(ft.)	Reading p.s.i.	Equivalent Groundwater Elevation above Piezometer (m)	(ft.)
Oct. 25/79	DOAL LAKE[2] 1	73.8	242	108.5	76.4	250.6
Nov. 3/79	DOAL LAKE 1	73.8	242	106.5	75.0	246.0
	DOAL LAKE 2	56.8[1]	186.5[1]	64.0	45.0	147.8
	DOAL LAKE 3	97.5	320	123.5	87.0	285.3
	DOAL LAKE 4	59.1	194	75.0	52.8	173.3
Nov. 13/79	DOAL LAKE 1	73.8	242	110.0	77.4	254.1
	DOAL LAKE 2	56.8	186.5	64.0	45.0	147.8
	DOAL LAKE 3	97.5	320	125.0	88.0	288.8
	DOAL LAKE 4	59.1	194	77.0	54.2	177.9

1 60.5 m (198.5 ft.) down hole inclined 20°

2 Abbreviated elsewhere as DL-1

3 Relative to ground surface

the steel liner and water is overflowing (October, 1979) at a rate of some 0.5 l/sec. Installation of the shallow piezometers should give a clearer picture of local groundwater flow.

On the basis of current information it may be conjectured that through going discontinuities (faults, joints, etc.) have sufficient permeability and cross connections to reduce large piezometric pressure differences across the site. This is encouraging with regard to dewatering.

APPENDIX A

LOGS

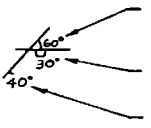
LEGEND

Samples

B1	Bag sample 1
S1	Shear sample 1
M4	Density sample 4
G1	Gouge sample 1

Symbols

F2:38° Angle between S_2 foliation and core axis is 38°



- angle between strike of foliation and joint strike looking down core
- foliation attitude assuming hole vertical
- joint attitude assuming hole vertical

I_{S50} Point load test perpendicular to foliation

I_{S50} Point load test parallel to foliation

LITHOLOGICAL CODE USED BY CYPRUS ANVIL MINING CORPORATION

5A Variably calcareous graphitic phyllite

5B Calcareous muscovite chlorite ± biotite phyllite

5C Metabasite

5D Laminarly banded, variably calcareous, chloritc phyllite, tuffaceous

1	Siliceous
2	Carbonaceous
3	Calcareous (white mica envelope)
4	Altered pyritic (white mica envelope)
5	Banded/laminated
6	Non-calcareous
7	Tuffaceous
8	Chloritic
9	Sulfide bearing
0	Normal

0Q0 Bull Quartz

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PROJECT: GRUM DEPOSIT

LITHOLOGIC LOG

Borehole	DL-1	Date of Drilling	Oct./79
Job No.	02160-002		
Location	66W, 13.2N, East of Doal L.		
Surface Elevation		Top of Casing Elevation	
Drilling Contractor		Rig	Longyear 38 D.D.

DEPTH metres	SOIL SYMBOL	DESCRIPTION	DRILLING AND INSTRUMENTATION
? to 127'		? to 127' TILL, very hard, numerous pebbles to 4 cm, boulder to 10 cm (Granodiorite), some clay, silt and sand. 5.6 ft of core.	123-124' sample B-1
267 -304		3 Runs - 12.5 ft of core 267-296.5' SILT, slightly clayey, few rusty zones, powdery	267-269 sample B-2
		296.5.2966 CLAY, grey, hard, laminated, dry, low plastic	296.5-296.6 sample B-3
		296.6-304 SILT, as above with 17 cm boulder at 303.5'	
? to 315'		? to 315' SILT, as above	
315 -321		315-321' TILL, hard, numerous pebbles, frozen, occassional specks of ice.	
321 -326		321-326' Only weathered chunks of granodiorite recovered	
		NOTE: All core is frozen but this may have occurred after recovery. No segregated ice was seen except 315-321'.	

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ROCK CORE LOG

PROJECT GRUM DEPOSIT

HOLE LOCATION SECTION 80W BETWEEN A 104 and A 20, HOLE INCLINED 20° FROM VERT TO GRID 230°

LOGGED BY DSC/JM | CHECKED DSC | DATE OF INVESTIGATION Oct. 29-30, 79 | JOB NUMBER 02160 | HOLE DL-2

CORE RECOVERY
R. Q. D.
PERCENT 20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
2					0 - 4.4 m Triconed: 0 - 2.3 m Glacial overburden 2.3 - 4.4 m Vangorda fm.	
4			MW		5D3 Phyllite, tuffaceous, calcareous, chloritic, banded	F2: 38 to 85° 5m: I_{s50} = 0 I_{s50} = 8.5 MPa
6			FW		5B0 Phyllite, calcareous, chloritic, some muscovite, locally interbedded 5D0	6m: $I_{s50//}$ = 1.45 MPa $I_{s50\perp}$ = 4.5 MPa F2: 56°
8						F2 = 62° 9m: $I_{s50\perp}$ = 1.05 MPa
10						F2: 65°
12						F2: 80° M7: 13.9 m
14						
16						

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ROCK CORE LOG

PROJECT: GRUM DEPOSIT

HOLE LOCATION: SECTION 80W BETWEEN A 104 and A 20, HOLE INCLINED 20° FROM VERT TO GRID 230°

LOGGED BY	CHECKED	DATE OF INVESTIGATION	JOB NUMBER	HOLE
DSC /JM	DSC	Oct. 29-30, 79	02160	DL-2

CORE RECOVERY ——— R. Q. D. - - - - - - - -
PERCENT 20 40 60 80 100

DEPTH	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
16					As Above	16.5 m: $I_{s50\perp}$ = 1.45 MPa
18					5D3 Phyllite, tuffaceous, calcareous, chloritic, banded. Locally 5B0, few thin quartz veins.	F2: 62-65°
20					5B0 Phyllite, calcareous, chloritic, some muscovite, minor interbedded 5D3	F2: 70-73° 21m: $I_{s50\perp}$ = 6.8 MPa
22					5D3 Phyllite, tuffaceous, calcareous, chloritic, banded	F2: 46-57°
24					5B0 As above 40% interbedded 5D3	23.8m: Sample S1 F2: 49° 25.35m Sample S2 F2: 60°
26						Foliation Strongly developed. Some powdery sericite on surfaces. F2: 50-55°
					GOUGE	
28					5D3 As above. Local quartz stringers	28.4m: Sample S3 F2: 65°
30						
32					See following page	

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ROCK CORE LOG

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HOLE LOCATION SECTION 80W BETWEEN A 104 and A 20. HOLE INCLINED 20° FROM VERT TO GRID 230°

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CORE RECOVERY
R. Q. D.
PERCENT 20 40 60 80 100

DEPTH	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
33					5D0 Phyllite, laminarly banded, tuffaceous chloritic, calcareous	F2: 58°
34						
36						36.2 m: $I_{s50\perp}$ = 10.5 MPa Foliation poorly defined, some folding. F2: 46-50°
38						38.6 m: $I_{s50\perp}$ = 5.9 MPa Foliation better defined, some powdery sericite.
40					OQO Quartz	F2: 64°
					5B0 Phyllite, as 20m	
42					5D3 Phyllite, as at 22 m	
					Gouge and sand, disturbed during drilling.	
44					5D3 Phyllite as above. Badly shattered.	F2: 64°
					Gouge and sand	
46					5D3 Phyllite as above. Broken.	
48					Gouge and sand. Some core apparently ground during drilling.	G1: Intact sample of fault gouge. G2: Sand, probably ground in barrel.

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ROCK CORE LOG

PROJECT: GRUM DEPOSIT

HOLE LOCATION: SECTION 80W BETWEEN A 104 and A 20, HOLE INCLINED 20° FROM VERT TO GRID 230°

LOGGED BY DSC/JM | CHECKED DSC | DATE OF INVESTIGATION Oct. 29-30, 79 | JOB NUMBER 02160 | HOLE DL-2

CORE RECOVERY ——— R. Q. D. - - - - - -
PERCENT 20 40 60 80 100

DEPTH	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
48					As above	
					5A9 Phyllite, graphitic, calcareous, sulphide bearing.	F2: 50°
					Quartz	
					5A9 as above	F2: Variable 0-60° Sheared and folded
					Quartz	49.6m: Sample S4
50					5A9: Phyllite, graphitic, calcareous, sulphide bearing.	51.7m: Joint, planar, rough, SW
52					5D3: Phyllite, tuffaceous. calcareous, chloritic, banded.	
54					5B2: Phyllite, calcareous, graphitic, with muscovite and chlorite	54.25m: S5, slightly graphitic foliation. F2: 65°
56						55.7-55.9 m; Clay and gouge on foliation. Point loads as follows: 54.4m: $I_{s50\perp}$ = 5.8 MPa; 55.1m: $I_{s50\perp}$ =2.7 MPa; 55.3m: $I_{s50\perp}$ =2.6 MPa; 57.0m: $I_{s50\perp}$ = 3.2 MPa; 58.4m: S-6
58						
					Quartz	
					5B2 As above	Thin gouge at 59.8 m and 60 m
60					5D3 Phyllite, tuffaceous, calcareous, chloritic, banded	61.7 to 62.8 m: Badly fragmented, split parrallel foliation. F2: 70°
62					5B0: Phyllite, calcareous with muscovite and chlorite	
64					5D0 Some 5B0. Only chips recovered.	F2: 64° Some graphitic partings

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CORE RECOVERY
R. Q. D.
PERCENT 20 40 60 80 100

DEPTH (m)	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
64					As above	
66					SAND. Core ground in barrel.	
					5B/5D/000 Chips, lithology not known	
68					5D0 Only chips recovered	
70					Sand. Ground core	71.4m: $I_{s50\perp} \approx 3.7$ MPa
72					5B0 Phyllite, calcareous, chlorite, with muscovite 5D0 Phyllite, laminarly banded, tuffaceous, chloritic. calcareous	Broken core 73.5m: M3 74.35m: S8 74.4 m: S7 F2: 80° 75.2m: M4
74						
76					Ground Core.	
					5B0 as above	77.7m: S9 serricitic foliation F2: 85°
78					000 Quartz	
80					5B0 as Above	80.65m: $I_{s50\perp}$ =5.5 MPa 80.7 m: G3: Not long enough for intact test.

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DEPTH	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
80					As above	
					Gouge	
82						
					5B0 As above	
84						83.8m: $I_{s50\perp}$ = 0.9 MPa
			FW - MW		5D0 Phyllite, laminarly banded, tuffaceous, chloritic, calcareous	85.4m: G4, Mod. weath. sheared phyllite G4A Intact G4B Disturbed 87.6 m: $I_{s50\perp}$ = 7.2 MPa
86						
			FW		5B0 Phyllite, calcareous, chloritic, some muscovite, few gouge zones	87.7m JNT, Planar, rough, faintly weath. 10°/70°
					Gouge	86.7m G5 Sheared phyllite 87.1m G6 and G7 Good samples of gouge.
88						89.3m: $I_{s50\perp}$ = 6.5 MPa
					5D0 As above 89.3m: s11 Serricitic Foliation 91.5m: s12 Serricitic Foliation 90.9m: G8 Good Gouge Sample Foliation varies from 55 to 90°	90.9m: G9
90						
					Gouge	
					5D0 Phyllite, banded, tuffaceous, grey	88.3m: $I_{s50\perp}$ = 3.8 MPa F2: 60°
92						92.4m: $I_{s50\perp}$ = 4.8 MPa 95.3m: M1 95.5m: S13 Serricitic Foliation 97.5m: S15 97.7m: $I_{s50\perp}$ = 5.9 MPa
94						98.2M: $I_{s50\perp}$ = 6.8 MPa 99.6m: Rusty coating on foliation surface F2: 40°
96						

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ROCK CORE LOG

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HOLE LOCATION SECTION 80W BETWEEN A 104 and A 20, HOLE INCLINED 20° FROM VERT TO GRID 230°

LOGGED BY DSC/JM | CHECKED DSC | DATE OF INVESTIGATION OCT. 29-30, 1979 | JOB NUMBER 02160 | HOLE DL-2

CORE RECOVERY
R. Q. D.
PERCENT 20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
96					5D0 con't	99.5m: M5 99.6m: S16 Serricite Foliation 100.7m: Joint rough, angle to axis = 90°, calcite filled 102.3 - 102.7m Joint, rough, angle to core axis = 90° 102.3m: $I_{s50\perp}$ = 0.41MPa (poor break) 104.2m: $I_{s50\perp}$ = 5.8 MPa 104.5m: M6 F2 = 70°
98						
100						
102						
104						F2 = 65°
106						109.0m: G9 Good sample 109.9m: Gouge, angle to core = 70° 111.3m: Joint, slickensided, foliation variable, joint crosscuts foliation, angle to core = 50° Sample S17 111.5m: M8
108						
110					NOTE: Lithology logged by Jim Mustard of Cypruss Anvil.	
112		POH				

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ROCK CORE LOG

PROJECT: GRUM DEPOSIT

HOLE LOCATION: 3.1S, 78W

LOGGED BY: DSC | CHECKED: DSC | DATE OF INVESTIGATION: Oct. 1979 | JOB NUMBER: 02160 | HOLE: DL-3

CORE RECOVERY
R. Q. D.
PERCENT
20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
					This hole was logged for lithology by Jim Mustard of Cyprus Anvil. Selected intervals were logged geotechnically.	
2					0 - 6.9 m Triconed	
4						
6					Scale Change	
6						
8					5B2	
					5D3	
10					5B0, interbedded 5D0	
					5C0	
12					5B0, Fuschite: 12.3 - 12.5 m	
14						

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ROCK CORE LOG

PROJECT GRUM DEPOSIT

HOLE LOCATION 1.1S, 70W

LOGGED BY DSC | CHECKED | DATE OF INVESTIGATION Oct./79 | JOB NUMBER Q2160 | HOLE DL-3

CORE RECOVERY
R. Q. D.
PERCENT 20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
14						
16						
					SCO	
					SBO Phyllite, calcareous, graphitic with muscovite	
18						18.3 m: $I_{s50\perp}$ = 21.8 MPa
20						
22						
						23.4 m: U2O
24						
26						
28						28.5 m: $I_{s50\perp}$ = 13.2 MPa 28.5 m: $I_{s50\perp}$ = 22.4 MPa F2 = 90° 28.9 m: joint, calcite filled, angle to core = 45°
30						

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ROCK CORE LOG

PROJECT GRUM DEPOSIT

HOLE LOCATION 3.1S, 78W

LOGGED BY DSC | CHECKED | DATE OF INVESTIGATION Oct./79 | JOB NUMBER Q2160 | HOLE DL-3

CORE RECOVERY
R. Q. D.
PERCENT 20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
30					SBO as above	30.1 m: U21 30.2 m: U22 30.7 m: U23
32						
34						
36						
38						37.2 m: $I_{s50\perp}$ = 23.9MPA
40						
42						44.9 m: joint planar rough, assuming hole vertical: 
44						45 m: $I_{s50\perp}$ = 7.1MPa 45 m: $I_{s50\perp}$ = 29.9MPa
46						

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HOLE LOCATION

LOGGED BY DSC | CHECKED | DATE OF INVESTIGATION Oct./79 | JOB NUMBER Q2160 | HOLE DL-3

CORE RECOVERY ——— R.Q.D. - - - - - -
PERCENT 20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
46					SB0 as above	45.1 m : U24
48						
50						
52						
54					SA0, locally SB4, phyllite, calcareous, very graphitic	55.0 m: U25
56						
58						
60					SB0 as above	Shiny graphitic partings 60.0 m: $I_{s50\perp}$ = 12.3 MPa 62.0 m: $I_{s50\perp}$ = 27.9 MPa
62						

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PROJECT GRUM DEPOSIT

HOLE LOCATION 3.1S, 78W

LOGGED BY DSC | CHECKED | DATE OF INVESTIGATION Oct./79 | JOB NUMBER 02160 | HOLE DL-3

CORE RECOVERY
R. Q. D.
PERCENT 20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
62					5B0 as above	
						63.0 m: $I_{s50\perp}$ = 44.8
64						
66						
						67.6 m: U26 67.9 m: U27 67.8 m: U28
68						
70						70.55 m: $I_{s50\perp}$ = 10 MPa
						71.8 m: $I_{s50\perp}$ = 17.6 MPa
72						
74						
76						
78					5A0 phyllite, calcareous graphitic, quartz veins. Local interbeds of 5D3 and 5B2.	

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ROCK CORE LOG

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HOLE LOCATION

LOGGED BY DSC | CHECKED | DATE OF INVESTIGATION Oct./79 | JOB NUMBER Q2160 | HOLE DL-3

CORE RECOVERY
R. Q. D.
PERCENT 20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
78					5A0 as above	
80						
82						81.8 m: $I_{s50\perp}$ = 8.5 MPa
					5D1 phyllite, laminarly banded, calcareous, chloritic, tuffaceous, siliceous	82.4 m: $I_{s50\perp}$ = 21.8 MPa.
						82.7 m: $I_{s50\perp}$ = 23.7 MPa
						82.75-82.95 m: joint, irregular, calcite and epidote filled, angle to CA = 0°.
84					5A0 phyllite, calcareous, graphitic, locally 5B2, some pyrite in S1 fold hinges.	
86						
88						87.8 m: U29
90						F2 = 90°
						90.6: joint, planar rough, angle to CA = 48°
						92.8: joint, planar rough, 1 mm calcite infilling, angle to core axis = 0°
92						90.6 m: $I_{s50\perp}$ = 6.9 MPa
						91.0 m: $I_{s50\perp}$ = 10.7 MPa
						92.0 m: $I_{s50\perp}$ = 9.2 MPa
						93.4 m: $I_{s50\perp}$ = 23.9 MPa
94						

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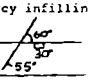
ROCK CORE LOG

PROJECT GRUM DEPOSIT

HOLE LOCATION 3.1S, 78W

LOGGED BY DSC | CHECKED | DATE OF INVESTIGATION Oct./79 | JOB NUMBER 02160 | HOLE DI

CORE RECOVERY ——— R.Q.D. - - - - - - - PERCENT 20 40 60 80 100

DEPTH m	SOIL SYMBOL	CORE RUN	WEATHERING (W)	STRENGTH (S)	DESCRIPTION	REMARKS
94					5A0 as above	
					Gouge in 5A	U30A Gouge U30B Gouge U30C Gouge U30D Gouge
96					5B6 phyllite, muscovite and chlorite	
98					5D6 phyllite, laminarly banded, chloritic, tuffaceous	
					5D1, phyllite, as above, calcareous, siliceous	98.5-98.75: joints (? to foliation, planar smooth, some serrici chlorite, some powd (<1 mm) angle to CA 30°
					5C0 metabasite	
100					5D6 as above	98.5 $I_{s50\perp}$ = 17.9 M
					5C0 metabasite, some interbedded 5D	98.8: joint, planar some talcy infillin 
102					5B6 as above	
					End of Hole at 102.7 m	
104						