Open File Envelope No. 625

SML 96

MOUNT GUNSON

PROGRESS REPORTS TO LICENCE EXPIRY/RENEWAL, FOR THE PERIOD 1/1/1965 TO 30/11/1966

Submitted by
Chapman, Wood, Griswold and Evans Pty Ltd
1966

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Minerals and Energy Resources
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Telephone: (08) 8463 3000
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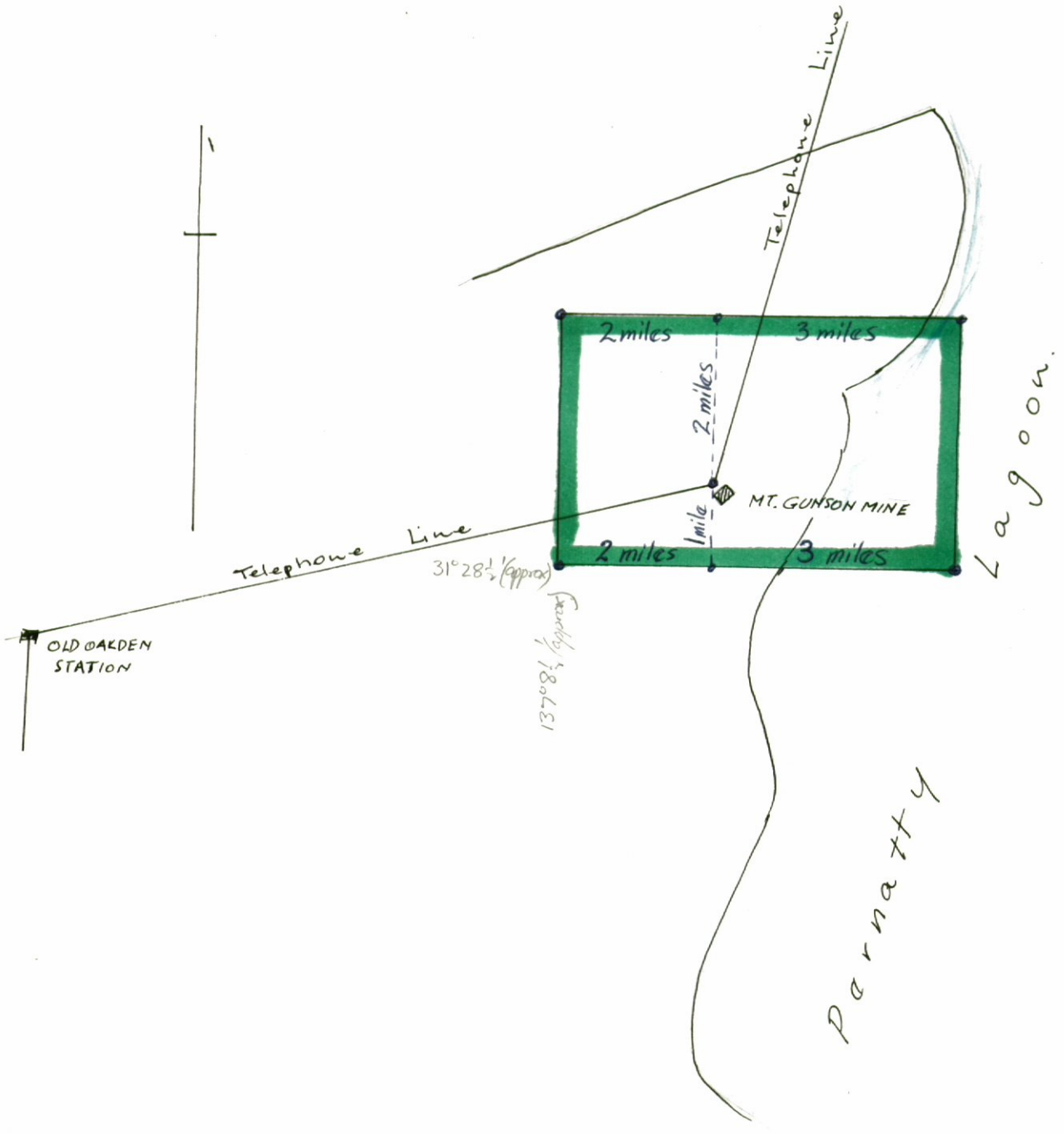
Government of South Australia
Department for Manufacturing, Innovation, Trade, Resources and Energy



AUSTMINEX PTY. LTD.

D.M. 1141/65 S.M.L. 96

CONTENTS ENVELOPE 625

TENEMENT: S.M.L. 121, 138 - Mt. Gunson.

TENEMENT HOLDER: Austminex Pty. Ltd.

Env. 625.
2A

CSR LIMITED

MT. GUNSON - STUART SHELF TENEMENTS

SML 96 (A)
Env. 625, 674
39 sq. km.
1.12.65 - 30.11.66

SML 121 (A)
Env. 674
508 sq. km.
1.8.66 - 30.11.66

SML 139 (A)
Env. 868, 906
629 sq. km.
1.12.66 - 30.11.68

SML 139 A (A, M, P)
Env. 1101, 1399, 1490
699 sq. km.
1.12.68 - 30.11.70

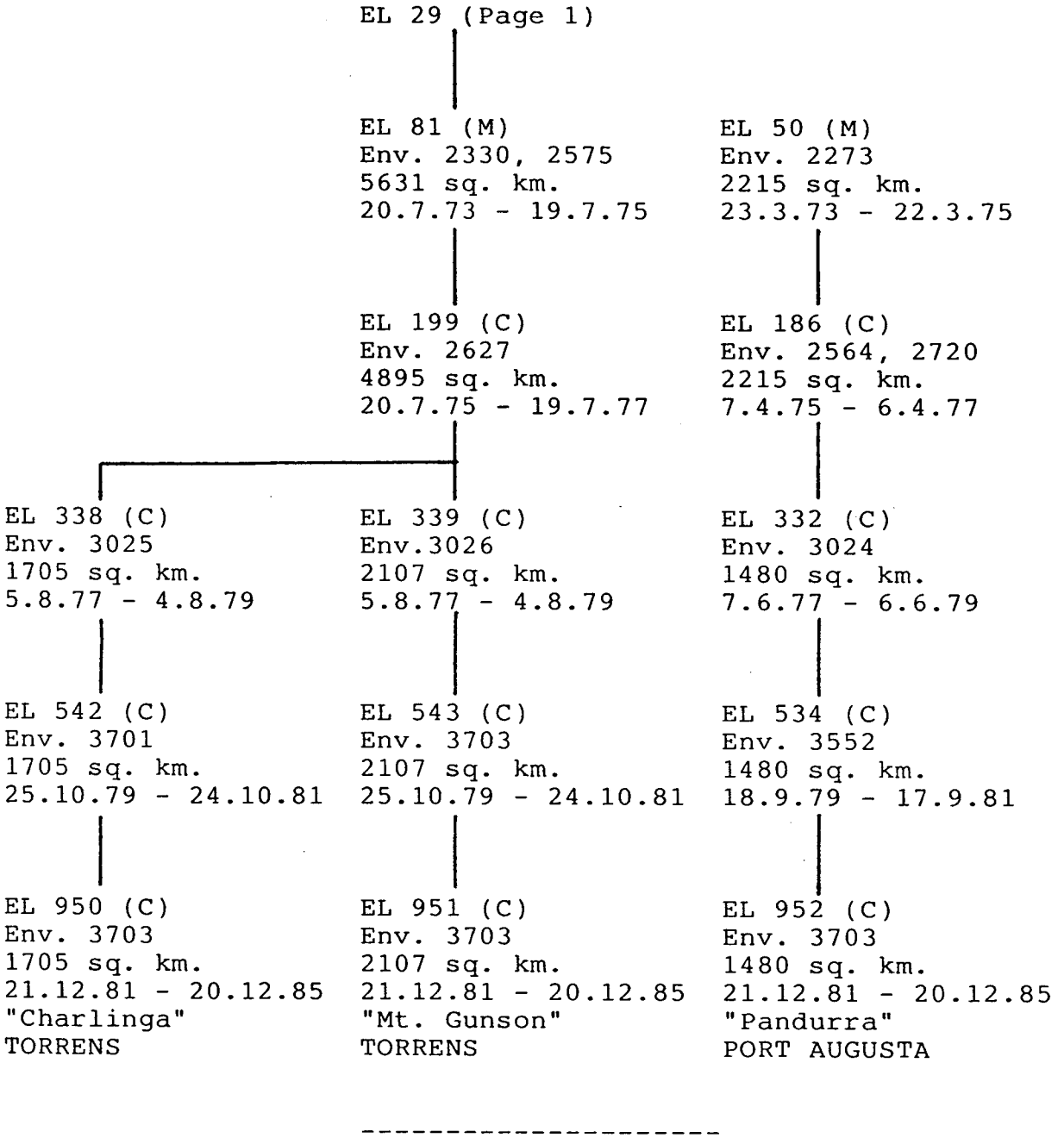
SML 494 (P, U)
Env. 1523
2461 sq. km.
5.11.70 - 4.11.71

SML 527 (P, U)
Env. 1563
699 sq. km.
3.12.70 - 2.12.71

SML 641 (P)
Env. 1855
1067 sq. km.
4.11.71 - 3.11.72

EL 29 (P)
Env. 2187
1067 sq. km.
7.12.72 - 19.7.73

EL 81 (Page 2)



Legend

1. Tenement No. (Company)
2. Env. No.
3. Area of tenement
4. Period of tenure
5. Tenement Name
6. 1:250 000 Sheet

Company abbreviations

A	Austminex Pty. Ltd.
P	Pacminex Pty. Ltd.
M	Mount Gunson Mines Pty. Ltd.
U	United Uranium N.L.
C	CSR Limited

Env. 625
2C

Data relating to exploration described in this Envelope may be included in some of the Envelopes here listed.

DATA AND REPORTS

RECEIVED FROM

CSR LTD., 1986

- 'MT. GUNSON area'

D.J. Flint

ENVELOPE	CLASSIFICATION	CONTENTS
6591	Open	Index (to be prepared)
6593	Open	Cattlegrid: Geology.
6594	"	" Drilling summary data & Drilling logs.
6595	"	" Plans. (Includes flotation tests and concentrate grades)
6596	"	" Mine Period Reports.
6597	"	" Mill " "
6598	"	" Shipping Data.
		Reports.
6604	Open	Lagoon: A) Reserves - East Lagoon & West Lagoon orebodies.
		B) Geophysical Surveys on East Lagoon orebody (Larson, 1970).
		C) Plans (face geology, geology, grade control, mining).
6605	"	MG14 Deposit: Metallurgy
6606	"	Main Open Cut: "
6607	"	Cattlegrid: Metallurgy & Mineragraphy (1973 & 1974 studies).
6608	"	" 1975 Mineragraphy of Mill products & feed.
6609	"	" Flotation testing of diamond drillholes.
6610	"	" Mineragraphy of mill products 1975-1983 by Pontifex & Associates.
6611	"	PETROGRAPHIC STUDIES: Includes Cattlegrid, Main Open Cut, Lagoon Workings, Powerline Embayment, Pandurra Formation, MG14, Gully
6612	"	DRILL LOGS: Main Open Cut Sheet and Main Open Cut deposit
		A) ABC GRID SERIES
		B) BGC (Biogeochem) GRID SERIES
		C) 3-4-XD series (9 holes)
		3-13-XP series (Plateau area)
		MX GRID SERIES

D) Rod E. Jones XXX/XXX SERIES, 1981/1982.
E) 3-4-XP SERIES, 1971/1972 where X=1 to 325.
F) Notes/memos on exploration and drilling at Main Open Cut deposit.

6613 Open

DRILL LOGS:
A) HOUSE SHEET: ABC GRID SERIES
'R' SERIES
MAIN OPEN CUT SHEET:
'N' to 'L' series
(AUSTMINEX, 1966)
B) HOUSE SHEET: 3-3-XP SERIES.
(Mt. Gunson Mines Pty. Ltd., 1971/1972).
C) BGC GRID SERIES for:
HOUSE SHEET, Lines 4S to 30S South of TOWNSHEET.
(Austminex, 1967).
D) HOUSE SHEET - MN GRID
(Austminex, 1967/1968).
E) HOUSE TO MAIN SHEETS, Rod E. Jones XXX/XXX SERIES
of 800-770
to 870-540 (1981/1982).
F) MAIN OPEN CUT TO HOUSE SHEETS.
3-7-XP SERIES
(Mt. Gunson Mines, 1970-1972).
3-7-1P to
3-7-173P.

6614 "

DRILL LOGS - GUNYOT SHEET.
A) 1) Percussion drilling by Austminex, 1966-1967.
Millsite area.
2) ABC Grid (1966).
3) BGC Grid (1967) from lines 94N to 22N.
4) RAMSAY No. 1.
5) WATERHOLE No. 1.
B) Percussion drilling by Mt. Gunson Mines, 1971-72.
3-5-XP series
where X=1 to 32.

6615 "

GUNYAH LAKE SHEET:
Vol. 1) Report: Geochemical Test Survey, Gunyah Lake
(PMR Report 7/73, K.J. Maiden 1973).
Plans : Location of drillholes & I.P.
traverses.
: Location of drillholes - East
Lagoon & eastern area.
: IP surveys: proposed program.
: Bedrock Lithology.

6616 "

GUNYAH LAKE SHEET - DRILL LOGS:
Vol. 1A) MYSTERY AREA (1971).
3-6-XD series where X=1 to 7.
B) GUNYAH LAKE (1971-1972).
3-8-XD series where X=1 to 8.
Vol. 2A) MYSTERY AREA (1970-1972).
3-6-XP series where X-1 to 65.
Note: Both GUNYAH Sheet & HOUSE Sheet.
B) 3-12-XP series, (1971-1972)
where X=1 to 12.
South of HOUSE WORKINGS.

6617	Open	EAST LAGOON - DRILL LOGS: MT. GUNSON MINES PTY. LTD., 1970. 3-1-XP series where X=1 to 262.
6618	"	WEST LAGOON - DRILL LOGS: Mt. GUNSON MINES PTY. LTD., 1970-1972. 3-2-XP series where X=1 to 323.
6619	"	LAGOON AREA - DRILL LOGS: AUSTMINEX (1968) Diamond drillholes.
6620	"	LAGOON AREA - DRILL LOGS: AUSTMINEX (1966-1968) Auger drillholes. On grid: 6,520,000 to 6,521,000 mN and 707,000 to 709,000 mE.
6621	"	LAGOON AREA - DRILL LOGS: AUSTMINEX (1968). Vol. 1) Drilled on grid: 6,520,000 to 6,521,000 mN and all eastings up to 707,000 mE. Vol. 2) Drilled on grid: 6,521,000 to 6,522,000 mN and all eastings.
6622	"	LAGOON AREA - DRILL LOGS: AUSTMINEX (1967). Assorted drillholes.
6623	"	MAGAZINE HILL CLAY DEPOSIT: PACMINEX PTY. LTD., 1973-1974.
6624	"	PERNATTY LAGOON - DRILL LOGS: Western edge of Pernatty Lagoon. Regional Scout drilling by Pacminex in 1972, *5XX-XP series where *=F to L 5XX=505 to 520.
6625	"	MANGANESE WORKINGS (PERNATTY LAGOON): A) MT. GUNSON MINES PTY. LTD. memos of 1977. B) PACMINEX (1971-1972) percussion drilling of 3-10-XP series where X=1 to 20.
6626	"	WOOCALLA, IRONSTONE LAGOON, FAIR NELL MINE, SWEET NELL MINE, MONALENA: A) Geological plans and cross-sections. B) Pacminex, 1970. Drill logs - Sweet Nell Mine Fair Nell Mine 3-9-XP series where X=1 to 22. C) Pacminex, 1971. Drill logs - Woocalla area. 3-11-XP series where X=1 to 9. D) Pacminex, 1972. Drill logs - Monalena area (Woocalla). MONA XP series where X=1 to 16.

6627	Open	MG14 DEPOSIT: GEOLOGY AND DRILL LOGS, with plans and cross-sections. A) Pacminex (1973-1977) rotary percussion/hammer drilling of MG 1 to 21 29 to 41 82 to 100 B) Pacminex (1973-1975) rotary & diamond drilling of MG 14D to 93D (not inclusive). C) Pacminex (1983) drilling of MG501 to MG511. D) Relog of Woomera Bore and LY3.
6628	"	GULLY PROSPECT: Drilling and evaluation of copper resource. Drill logs of: GY1 to GY16 (1975) 3-7-127P to 3-7-129P 3-7-160P to 3-7-162P 3-7-165P 3-7-172P 3-7-173P.
6629	"	OAKDEN HILLS AND SELBY DAM: Pacminex (1973-1980). A) Regional rotary percussion, OK X series, i.e. OK1 to OK157. B) Geochemical drilling at: 1) OK3 Grid i.e. OK3-1 to OK3-86. 2) Selby Dam Grid i.e. holes 1 to 114. C) Diamond drilling - OK XD series i.e. OK36D "109-111D "113D "115D "119D.
6630	"	WINNIE PINNIE AREA: EL199 Pacminex (1976-1977). A) Interpretation of Input data. B) 1976 Rotary percussion drilling of 'input' anomalies, WP series, i.e. WP31 to WP88. C) Drill logs WP31 to WP88.
6631	"	LAKE WINDABOUT: EL199 Pacminex (1976). A) Drill testing of input targets in Lake Windabout district.. B) LW Series, Gamma ray logs. " " drillhole " .
6632	"	LAKE WINDABOUT: A) Drill logs - LW series, i.e. LW1 to LW97. B) Detailed diamond drill logs for: LW52,58,60-66 inclusive.
6633	"	LUCAS HILL: (=WEST LAKE WINDABOUT) Geophysical and Geological Logs.

6634	Open	POWERLINE EMBAYMENT: A) 1975 Summary report of exploration. B) 1977 Geophysical logging of PL32.
6635	"	POWERLINE EMBAYMENT: Drill logs, PL SERIES, i.e. PL1 to PL47 inclusive.
6636	"	BOOKALOO-LAKE DUTTON: Geophysical logging of drillholes, LD series BK series.
6637	"	BOOKALOO-LAKE DUTTON-LAKE MACFARLANE: Drill logs: Bookaloo BK1-BK22 Lake Dutton LD8-LD38 Lake MacFarlane MF1-MF13.
6638	"	LY SERIES DRILLING: A) LY2 (Cattlegrid) 1974 Geophysical logs. B) LY4-LY11 and 83/108 (East of Cattlegrid), 1983 Geological logs.
6639	"	BIOGEOCHEMISTRY: A) CATTLEGRID & MG14 AREAS (Pacminex 1978). B) PERNATTY LAGOON (Austminex, 1966).
6640	"	GROUNDWATER GEOCHEMISTRY - Stuart Shelf: Pacminex (1978) - Report PMR90/78.

6663	"	MT. WHYALLA BARITE DEPOSIT: Pacminex (1974) report - PMR 57/74.
6664	"	GEOLOGICAL MAPPING: Report: Elizabeth Creek area (Chisholm, 1974) Plans: Pernatty Lagoon Mt. Gunson Mines area Elizabeth Area Canegrass Dam area Wirrappa area.

6666 Open

DRILL LOGS - ELIZABETH CREEK & CANEGRASS AREAS:
EC23-EC54 (Elizabeth Creek)
TOC1-TOC4
SP1-SP19 (Snakepit)
3-14-19P to 3-14-41P (Canegrass Dam area)
3-14-1P to 3-14-46P (Canegrass field logs).

6667 "

DRILL LOGS-PANDURRA AREA (EL405):
Vol. 1. EX1-EX157
2. EX158-EX163 & YD1-YD15
3. EX164-EX184.
4.

Area	1:100 000	Drillholes
	6332	J12-J24
Roopena	"	P1-P4
"	"	J1-J11
"	"	I1
Cultana	6432	Q1, Q2
Cariewerloo	6333	Y1-Y6
"	"	T1-T5
"	"	X1-X3

6668 "

DRILL LOGS-WATER BORES in the MT. GUNSON area.

6669 "

DRILLING SUMMARIES:
3-1-X to 3-14-X series.

6670 "

DRILL LOGS-LAKE TORRENS AREA:
(see also ENV. 3769)
BDH1-BDH4
SLT101-SLT107
YAD1.

6674 "

ELECTROMAGNETIC SURVEYS:
A) Gunyah Lake, 1971 hand-held survey (1 plan only)
B) Cattlegrid & MG14 areas, airborne EM INPUT Test Survey by Geoterrex, 1973.
C) Winnie Pinnie area & Yudnapinna area, airborne electromagnetic survey, Barringer INPUT system, 1975. Geoterrex report 83-253 PMR Report 144/75.
D) Stuart Shelf (EL186, EL199), airborne EM INPUT survey by Geoterrex, 1975.
E) Mount Gunson Pulse Electromagnetic Test, 1977. (Ground Survey) PMR Report 58/77.
Cattlegrid anomaly & Anomaly 'J' (margin of Pernatty Lagoon).
F) Pandurra & Cariewerloo, airborne EM INPUT Survey by Geoterrex, 1977.

6675 "

REFRACTION SURVEYS:
A) Austral Exploration (1967)
Refraction Test Survey at Main Open Cut; West Lagoon; East Lagoon.
B) Austral Exploration (1973)
Reconnaissance Seismic Refraction Survey - Mt. Gunson area.

6676 Open

GRAVITY SURVEYS:

A) Gravity survey - Pandurra area, EL186. Survey by Solo Geophysics, PMR114/77.

B) Gravity anomaly 'A' - Site for drillhole LH1. Notes (1978).

C) Magnetic & gravity survey with levelling at Illeroo Grid (Pandurra area, EL534. Report by Solo Geophysics (1979), PMR87/79.

D) Gravity Survey with barometric levelling at Yudnapinna Reconnaissance Line, EL534. Report by Solo Geophysics (1979), PMR88/79.

E) Interpretation of Geophysics, Illeroo area, EL534. Report by Langron (1980) PMR10/80.

F) Gravity survey - Pernatty Lagoon area, EL543. Survey by Solo Geophysics (1980).

G) Gravity survey - Mt. Gunson area, 'Blue Mag' anomaly 1981.

6677 "

AEROMAGNETIC SURVEYS:

A) Report on stage 1 on the interpretation of results of airborne magnetometer survey covering SML139, 152.

B) Report on an aeromagnetic interpretation, Torrens map sheet, S.A. PMR80/75.

C) Plan, EL186, April 1977. Magnetic Profiles.

D) Geoex (1978) Survey.
Plans of: Aeromagnetic total intensity
: Profiles.

E) Report on airborne magnetic surveys over an area East of Lake Dutton (Pernatty & Bookaloo 1:63 360 sheets). PMR10/78.

6678 "

RESISTIVITY SURVEYS:

A) Resistivity Survey at Pandurra near Port Augusta for Pacminex Pty. Ltd. EL186. Report No. 265 by Murdoch Geophysics, 1977. PMR60/77.

B) A resistivity survey at Mt. Gunson, S.A. for Pacminex. (Survey in June 1976) EL199. Report No. 266 by Murdoch Geophysics, 1977. PMR142/76.

C) Evaluation of a resistivity survey at Mt. Gunson, June 1976. PMR173/76, EL199.
(Localities: Cattlegrid; Oakden Hills; MG14).

D) Geophysical Survey at Cattlegrid, July 1973. Survey by CGG; PMR report 133/73.

6679 "

MISCELLANEOUS GEOPHYSICAL SURVEYS - MT. GUNSON AREA:

A) Report on a combined Induced Polarisation, Seismic and EM survey in the Mt. Gunson area. MacPhar Geophysics (1973).

B) Gravity and magnetic surveys on the North Pernatty Grid.
Lines 6,530,000N to 6,540,000N.
Solo Geophysics (1981).

C) Magnetic surveys of 'Blind Dyke', 1982-1983. Un-compiled plans and notes. Includes data of Solo Geophysics (1982).

2 K

6680 "

GEOPHYSICAL LOGGING OF DRILLHOLES-STUART SHELF:

A) Geophysical Logging of Drillhole PL32, Gunson area (i.e. Powerline Embayment). PMR138/77.

B) Geophysical logging of drillholes in the Mt. Gunson and Pandurra areas. PMR59/78.
i.e. OK117-OK120
OK128-OK129
WPB2-WPB4
WPB6
WOB10-WOB13
LW34, LW38, LW40
PL34
MG-11-3
PANDURRA AREA:
J12, J15, J16, J20, J21.

C) Geophysical logging of percussion drillholes, June-August 1978. PMR89/78. (EL332,338,339),
i.e. EC5
PL40
LD31
BK10-BK12
EX158-EX163

D) Geophysical logging in the lake Windabout, Powerline and Oakden Hills areas, EL339,
i.e. LW61-LW75
PL42-PL44
OK132-OK135
PMR Report 36/79.

F) Gamma logs - assorted drillholes.

6681 "

INDUCED POLARISATION SURVEYS:

1) IP Survey by Geoscience (1965) for Austminex, SML55.

2) IP and test resistivity survey by MacPhar Geophysics (1967-1968) for Austminex.

3) IP survey by Austral Exploration, 1971-1972, at: Main Open Cut
Gunyah Lake
East Lagoon
West Lagoon
Mystery
Sweet Nell areas.

4) Multi-mode I.P. survey by McPhar Geophysics, 1974 at: - Cattlegrid
- Gunyah Lake
PMR report 75/74.

6682 "

INDUCED POLARISATION SURVEY:
by SOLO GEOPHYSICS, 1983.
CATTLEGRID - MAIN OPEN CUT AREAS,
Includes: 'Haul Road' anomaly
'Dyke" anomaly.

6683	OPEN	'MOUNT GUNSON area' - regional plans and reports. Includes: A) Austminex (1966-1968) reports for SML 96, 121 and 139 - Pernatty Lagoon area. B) SADME articles on Mt. Gunson - extracted from Mining Reviews.
6714	"	MAIN OPEN CUT - plans
6715	"	CATTLEGRID - cross-sections.
6718	OPEN	HOUSE WORKINGS and GUNYOT workings. Plans only - sections, ore reserves, grade control and hole locations. Austminex Pty Ltd and Mount Gunson Mines Pty. Ltd.
6721	OPEN	CATTLEGRID: Surveying and engineering plans, pit development 1974-1986. Includes 1977 aerial survey.
6722	"	TOWN, CARAVAN PARK, SERVICES & TAILINGS DAM - surveying and engineering plans.
6723	"	CATTLEGRID - grade control for areas C2, C3 and Area IV. Predominantly plans - blasthole layout, top-of-ore, grade control plans and cross-sections.
6724	"	EAST LAGOON OREBODY - plans
6725	"	NORANDA AUSTRALIA Ltd (1967). Plans - Main Open Cut, House Workings, West Lagoon, East Lagoon, Mystery.
6726	OEPN	MAIN OPEN CUT - Cross-sections by Austminex Pty Ltd (1967-1968).
6727	"	WEST LAGOON - plans by Mount Gunson Mines and Austminex Pty Ltd. (Grade control, block plans, face geology, drillholes, cross-sections etc.)
6728	"	CATTLEGRID - Grade control plans for areas B2, B3 and B4 (east-northeast Cattlegrid). Plans of bottom-of-ore, top-of-ore, diamond drill-holes, diamond drilling influence areas as well as pit - and grade control - cross-sections.
6729	"	CATTLEGRID - End-of-period Survey Plans (1980-1982).

TOTAL: - 73 open file

Rept. Bk. No. 62/117
G.S. No. 3461
D.M. 552/66
HYD. No. 1786

0003

DEPARTMENT OF MINES
SOUTH AUSTRALIA

REPORT ON GROUNDWATER PROSPECTS

Special Mining Lease 96

Mount Gunson - Pernatty Lagoon

- Austminex Pty. Ltd. -

The area surrounding the Mount Gunson Mines was inspected on the 5th May, 1966.

REQUIREMENTS

Advice is sought on the prospects of obtaining water for the treatment of copper ore. A supply of 4,000 to 6,000 gallons per hour is required. The salinity of the water is not important provided it is low in carbonates.

LOCATION AND TOPOGRAPHY

Located about 80 miles northwest of Port Augusta and about 9 miles northeast of the Port Augusta to Woomera road, the Mount Gunson Mines are on the western shore of Pernatty Lagoon. This is an arid region of relatively low relief with a number of low hills being the remnants of a former land surface. The low hills adjoining Pernatty Lagoon have been dissected by a number of creeks which drain into the lagoon; a flat usually dry salina. Westerly the low hills give way to sand dunes and clay pans.

Rainfall is about eight or nine inches with high seasonal variations.

HYDROGEOLOGY

The Torrens 4-mile geological sheet (S.A. Geological Atlas Series Sheet 853-16 Zone 5) is taken as reference for this survey. The geology of the Mount Gunson Mines and environs is discussed in previous reports.

Shallow groundwater occurs beneath the saline crust of Pernatty Lagoon. Trenching across the surface of the lake may be a simple method of collecting shallow waters. A test trench is warranted to determine the rate of inflow. This system would have limited use because, if extended into a number of trenches, a large area could be dewatered to the level of the base of the trenches over a period of time. A bore on the lake could be a more satisfactory alternative for testing the groundwater potential of the unconsolidated sediments. Rainfall could not be relied on to replenish the shallow groundwaters.

Sturtian Series (Adelaide System) rocks form the low hills along the western shore of Pernatty Lagoon. These are the Umberatana Group equivalents. The upper member, the Pernatty Grit, comprises a sequence of torrent bedded grits, arkoses, sandstones, quartzites and pebbly quartzites.

The grits and associated rocks are not good aquifers. They are hard, non-porous rocks and do not contain groundwater. However, due to tectonic movements a joint system has developed and where the joints and cracks are partially open groundwater is stored. The grits near the mines appear to be closely jointed.

Many bores have been drilled in the grits and stock supplies have been obtained. However, drilling in the grits with a percussion plant is hard and slow and most bores have not penetrated more than a few feet below the groundwater table. Therefore it is difficult to assess the groundwater potential of a deep bore in the grits.

Drilling of a test bore to a depth of 250 to 300 feet, possibly more is warranted. The hole should be large enough, at

least 6" in diameter, so that a prolonged pump test could be run on completion.

Recharge of groundwater by the downward percolation of surface waters must be small due to the low intermittent rainfall. Along the larger creeks recharge is probably better than elsewhere but continuous pumping could be expected to deplete the groundwater reservoir.

The Woolcalla Dolomite member outcrops along the west shore of Pernatty Lagoon southerly from Mount Gunson homestead. Dolomites in other areas are sometimes good aquifers as the joints and cracks tend to remain open, or sometimes to enlarge through solution, and allow the storage of groundwater. The dolomite has not been tested as a source of groundwater and its potential in this low rainfall area is not known. Therefore test drilling to a depth of 250 to 300 feet and pump testing is warranted.

CONCLUSIONS AND RECOMMENDATIONS

Mount Gunson is in an arid area and the low intermittent rainfall is expected to be the limiting factor for any development of groundwater. Previous drilling on station properties has been to obtain stock quality water and quantitative testing at depth of potential aquifers has not been carried out.

Three localities near the mines with varying geological conditions are considered worthy of further investigation by drilling.

Shallow trenching across the surface of the lake is warranted to determine whether water can be effectively collected in this way. Dewatering of the shallow sediments could be expected over a period of time. Drilling in the unconsolidated sediments beneath the lake may be a more satisfactory alternative to trenching. The lagoon is extensive and if one area was depleted a new bore could be sunk elsewhere.

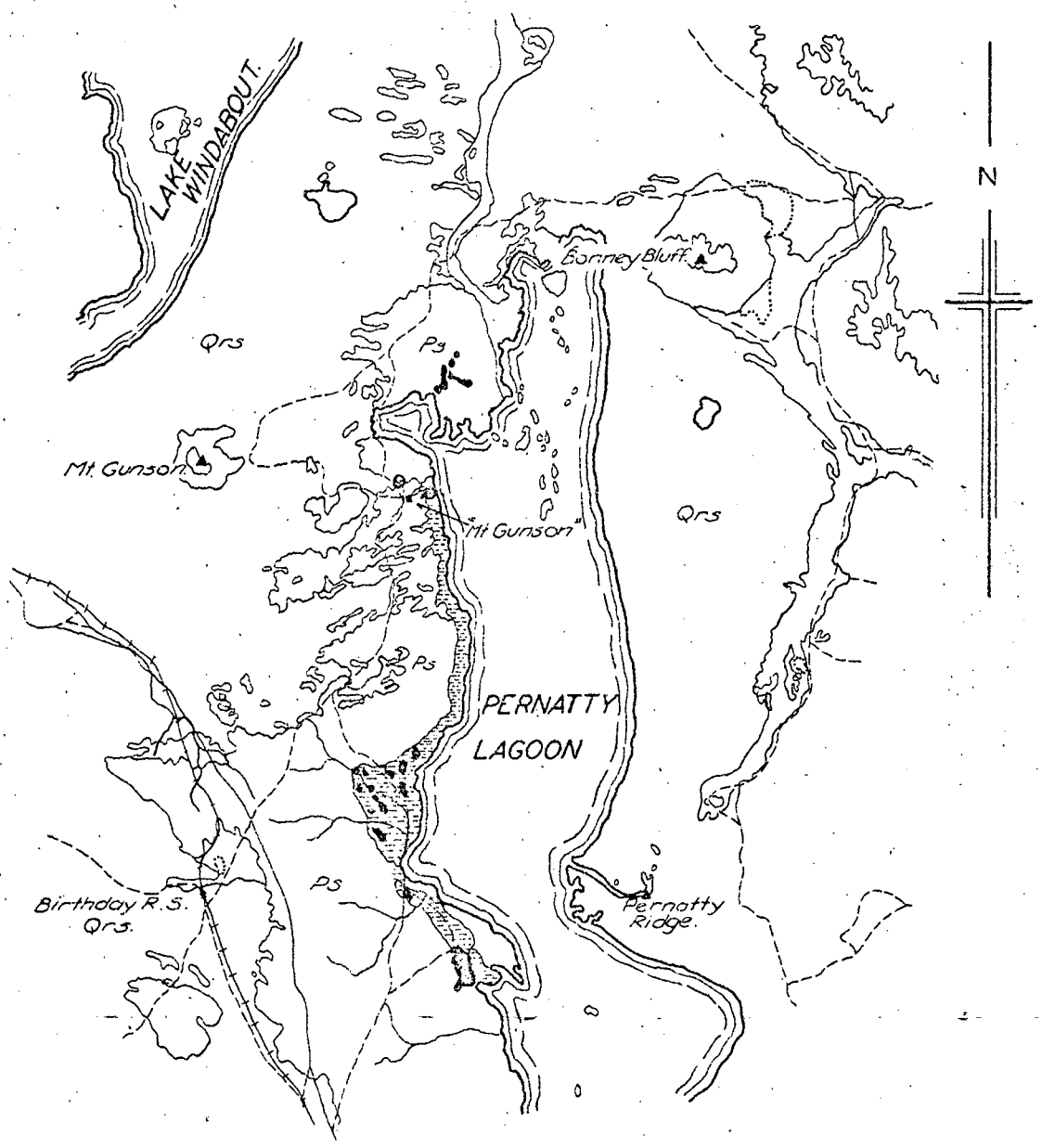
The Pernatty grits are jointed and are known to store groundwater. Test drilling to a depth of 250 to 300 ft. in the grits is recommended. The hole should be large enough, say 6 inches, so that a prolonged pump test could be run on completion.

The Woolcalla Dolomite has not been tested as a source of groundwater. Drilling of a 6" diameter hole to a depth of 250 to 300 ft. and pump testing is recommended.

Two suggested bore sites along one of the larger drainage channels and close to the mines are shown on the accompanying plan.

E. R. Hillwood
Geologist
HYDROGEOLOGY SECTION

ERH:AGK
31/5/66



Quaternary

Qrs. Sand plains: Sand dunes with claypans.

Adelaide System – Marinoan

Ps. Pernatty Grit: Torrent bedded grit, arkoses, sandstone, quartzites, pebbly quartzites.

Woocalla Dolomite Member. "Collenia" reef.

Ironstone; Massive limonite, haematite, ferruginous gravels.

⊙ Suggested bore site.

Geology from Torrens 4 mile map. R.K. Johns.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

	Drn. E.R.H.	UNDERGROUND WATER SURVEY.	SCALE: 1" = 4 mile.
	Tcd. A.M.D.	SPECIAL MINING LEASE No. 96.	S5187 Eb.
	Ckd. L.K.W.	MT GUNSON – PERNATTY LAGOON	
	Exd.	AUSTMINEX PTY. LTD.	

Appendix No.4

T.A.P.G. VENTURE NO.1.

MOUNT GUNSON CU DEPOSIT SOUTH AUSTRALIA

AREA FILE SH 53.16

PROGRESS REPORT FOR THE PERIOD 1 JANUARY - 31 MARCH, 1965

Dated at Melbourne
26 April, 1965

Prepared by: J.H. Evans.
Chapman, Wood, Griswold & Evans P/Ltd

T.A.P.G. VENTURE NO.1

INTRODUCTION

A shallow secondary Cu deposit amenable to open pit mining and considered to be genetically similar to the "Red Bed" Cu deposits of South West U.S.A. is located near Mount Gunson, South Central South Australia within 10 miles of the Trans Australia Railroad and the Trans Australia Highway. The deposit was examined and studied during the period Jan-March, 1965.

FINDINGS

1. Evaluation studies show that 1,000,000 tons of 1.5% Cu at Mount Gunson would meet the Austminex profitability yardstick.

2. The geologic environment is present at Mount Gunson for the possible occurrence of 1,000,000 tons of 1.5% Cu.

3. The present owner of the potential area is amenable to negotiation on terms acceptable to Austminex.

4. A drilling program to test the potential area would cost $18,000.

RECOMMENDATION

It is recommended that the property be optioned by Austminex in accord with the conditions set out in this report and the $18,000 drilling program undertaken.

LOCATION

Topographic Grid SH 53.16. Approximately 90 miles North West from Port Augusta, a small seaport at the head of Spencer Gulf, South Australia.

ACCESS

13 miles of poor road from Birthday Siding on Trans Australia Railway. The all weather dirt and gravel Trans Australia Highway parallels the railroad from Port Augusta to Birthday Siding.

POWER & WATER

The high tension power line from Port Augusta to the Woomera Rocket Range runs within 6 miles of the property. The availability of power from this supply is not known.

A 12" dia. water supply line parallels this power line. The availability of water from this supply is not known.

Subterranian highly saline water is present in Pernatty Lagoon, an extensive salt pan, adjacent to the known Mt. Gunson deposit.

The quantity of water available from this source is not established.

TOPOGRAPHY

Desert peneplain - say ¼ wind blown sand up to 50 ft. in thickness - ¼ gibber plain - ¼ bedrock - ¼ salt lakes, with occassional monadnocks eg. Mt. Gunson, rising some 400 ft above the plain. In the immediate vicinity of the property the maximum relief is approx. 130 ft. over a 1 square mile area.

CLIMATE CONDITION

Arid - Annual rainfall, less than 10 inches. Summer temperatures up to 125° F; Winter temperatures - minimum say 28°F.

REGIONAL GEOLOGY

The deposits of Cu and Mn occur in the eastern side of the stable Stuart Shelf which marks the eastern flank of the Australian Pre-Cambrian Shield.

LOCAL GEOLOGY

Oxide Cu and Mn occur in flat lying sandstone and dolomite beds which are classified as Precambrian in age. The deposits are shallow, flat, irregular and tabular, and are exposed where recent streams have cut through the tableland. The origin and age of the deposits are unknown. No evidence of sulphide mineralization was found in the field examination, although published literature refers to the presence of sulphide minerals.

Three acid leach tests conducted since 1935 report that Cu digestion was consistantly approaching 100%, which suggests the total absence of Cu sulphides.

Copper mineralization is known to occur on two horizons:-

The upper horizon being a sandstone where copper carbonates cement rounded quartz grains.

The lower horizon being a dolomite showed, in two exposures examined, widely dispersed, narrow (less than ¼") copper carbonate filled fissures.

The upper horizon (sandstone) workings are concentrated in an area 3,500 ft. by 350 ft. on the flank of a drainage channel. These workings consist of several shallow shafts from which short drifts have been driven and two small (100 ft. x 200 ft) shallow (up to 40 ft. in depth), open pits excavated.

The lower horizon (dolomite) workings lie on the shore of, and within Pernatty Lagoon. The lagoon workings are filled and no rock exposures were seen in these workings.

One authority draws a parallel between the Mount Gunson deposits and the "Red Bed" deposits of South Western U.S.A.

PAST PRODUCTION

The Cu deposits were discovered before 1900 and were worked intermittently and unsuccessfully until 1937. In this interval abortive attempts were made to operate a reverbatory smelter and later a leaching plant. The reported production in this period is 3,000 tons of 8% - 14% Cu.

Zinc Corporation optioned the property in 1937, at the instigation of two staff members. (Presently these two men are the chief executive officers of Mount Isa Mines and Con Zinc Rio-Tinto). At this time the presumed reserve, based on meagre sampling of the upper horizon (sandstone) workings, was 400,000 tons of 3% Cu.

In the period 1941 - 43, 31,260 tons of 3.5% Cu was mined from surface as a wartime measure and fed to the Port Pirie Pb smelter. The smelting charge was equivalent to 15 cents per lb. Cu and the minimum acceptable grade was 2.5% Cu. Operations were suspended when this grade could n ot be maintained.

In 1950, the property was re-assessed by Zinc Corporation, with the present Chief Geologist of Con Zinc Rio Tinto (C.R.A) directing the re-assessment.

The upper horizon (sandstone) was estimated to contain 135,000 tons of 2.77% Cu. This estimate was based on sampling of old U/G workings as follows:-

Location	Length	Thickness	Average Grade % Cu
Baker Shaft drift	160 ft.	49 inches	3.3
Tableland Shaft drift.	20 ft.	44 inches	1.6
	100 ft.	59 inches	3.2
Arnold Shaft drift	80 ft.	51 inches	3.5
No.4.Shaft	-	72 inches	1.8
No.7.Shaft	40 ft.	?	+ 4%

The lower horizon (dolomite) workings located in Pernatty Lagoon and sloughed in were not sampled and the 203,000 tons of 2.86% Cu reserve estimated by a Government Geologist prior to 1920 was conditionally accepted.

The possible occurrence of a shallow open pit Cu deposit was recognised, and a widely spaced drilling grid to test the continuity of the deposit over a 5,000 ft. x 5,000 ft. area was proposed.

(The property was discussed with the C.R.A. Chief Geologist in February, 1965. He reported that he considers the Mount Gunson Cu deposits to be secondary enrichments which could well have been transported a considerable distance, but that the mode of redeposition, whether in a lake and yielding a wide spread distribution or in streams and yielding concentrations in definite channels is unknown. The drilling program he prepared in 1950 was designed to answer this query).

In 1951 - 52 Zinc Corporation partially completed the proposed exploration program. Nine churn holes were drilled along a N.S. line at 400 to 800 ft. spacing starting at the main open cut, drilling 1,000 ft. at a cost of $25 per foot. Only one hole, located 100 ft. northerly from the pit, intersected significant numeralization - interval 5-17 ft. assaying 0.95% Cu. The program was then discontinued.

In 1962 Jervois Sulphates (N.T) Limited, a small copper leaching company operating in the Northern Territory staked 2 claims covering the major portion of the presently known upper horizon and has unsuccessfully attempted to produce Cu SO4 product from heap leaching.

In 1964, Geo Science Inc., a U.S.A. sponsored group principally engaged in selling geophysical equipment was granted exploration rights to a 100 square mile area surrounding the Jervois Mount Gunson claims.

Geo Science conducted a geophysical survey(I.P) over the area with negative results and is reported to have no further interest in the area. This company's exploration rights expire on 31 July, 1965.

In January, 1965, after establishing contact with Jervois, Austminex examined the property.

ECONOMIC ASSESSMENT

1. Possible Reserve:-

The attached plan and cross section, showing the disposition of workings in the Mount Gunson area were obtained from the South Australian Mines Department .

The churn drilling done by Zinc Corporation in 1951 - 52 is assumed to preclude the existence of Cu mineralization as a continuous tabular deposit extending over the whole area.

The following Cu deposits, shown on the attached plan are excluded from consideration of economic assessment at this time:-

Ramsay Workings

Gunyot Deposit

Bornite Workings

Lagoon Deposit

Dolomite Workings

Brennan's Shaft

Gun Workings

The area covered by Brennan's Workings and the Mount Gunson Workings is considered, and it is assumed to represent stream deposition with limits as shown on the plan attached .

Taking No.10 Shaft 1 ft. of 2.0% Cu

No. 9 Shaft 10 ft. of 0.5% Cu

Baker Shaft 1 ft. of 0.8% Cu

Tableland Shaft 4 ft. of 4.2% Cu

Arnold Shaft 14 ft of 4.5% Cu

No.7 Shaft 3ft of 5.4% Cu

Average is 5½ ft. of 3.1% Cu over an area 1,330,000 square ft., say 600,000 tons of 3% Cu.

2. Estimated Capital Expenditure:-

(a) Mining

Assuming an open pit operation with an ore mining horizon 10 ft. in thickness, a mining reserve of 1,200,000 tons of 1.5% Cu is indicated with an overall stripping ratio of less than 2:1 waste: ore.

Thus the preliminary assessment is made presuming a shallow open pit operation containing 1,000,000 tons of 1.5% Cu at a 2:1 stripping ratio.

On the basis that the milling rate is 500 T.P.D. on a 2.1 stripping ratio, 2,100 tons of material would need to be moved in the pit per shift on a 5 day per week mining schedule.

The estimated capital cost of mining equipment is $420,000 with a direct mining cost of $1.05 per ton of ore.

It is presumed that contract mining would be $1.50 per ton of ore. Hence for 1,000,000 tons of ore contract mining would be preferred.

(b) Treatment

Published data on Cu leaching operations has been studied. A sample taken during the field examination was submitted for confirmation of tests made in 1937. The result of the laboratory test conducted by the Commonwealth Scientific & Industrial Research Organization confirmed that high Cu extraction can be expected (say 97% into solution at - ¼" ore feed) with an acid consumption equal to theoretical plus 53 lbs H_2SO_4 per ton of ore feed.

Flow sheets for two leaching processes, one batch heap, the other continuous agitation, have been developed (see attached flow sheets) and capital cost estimates made for both plants at 500 T.P.D. capacity.

The estimated capital cost for continuous agitation was found to be the lesser, as follows:-

.1 Unit = $1,000

	H.P. Installed	Installed Cost	Spares	Total Cost
Grizzly & Feeder	5	8	1	9
Primary Crusher	150	84	8	92
Screens	25	6	2	8
Secondary Crusher	300	118	10	128
Conveyors	40	34	6	40
Agitation Tanks	40	34	4	38
Thickening(C.C.D)	70	169	13	182
Acid Storage		15		15
Water Storage		12		12
Precipitation Tanks		20		20
Concentrate Drying	5	42		42
Piping & Valves		36	4	40
Water Supply	20	22		22
Power Supply		100		100
Assay & Office		25		25
Total	655	725	48	773

Subsequent to the preparation of the flow sheets, discussions were held during the Mining Congress with Dr. Bhappu of the New Mexico State Bureau of Mines. Bhappu who is knowledgeable on Cu leaching , offered process ideas which would drastically reduce the capital and operating costs of the assumed treatment plant.

Basically Bhappu's ideas are:-

1. Consider autogenous grinding.

2. Follow grinding with the introduction of acid and scrap iron into a ceramic or rubber lined rotating mill. In this mill Cu S04 will be produced and immediately precipitated on the iron. The tumbling action in the mill will scrub the Cu precipitate from the iron presenting a fresh iron surface.

3. The effluent from the rotating mill is then passed through a flotation cell floating a high grade cement Cu concentrate.

Such an approach is novel and would require pilot plant study.

Bhappu has advised that he is developing these ideas and will advise Austminex.

For the purposes of the present economic assessment the capital and operating cost estimates developed for agitation leaching are taken as being applicable.

(c) Ancillary Capital Expenditures

Housing: It is realized that to develop Mount Gunson, housing would be required, presumably established at Birthday Siding on Trans Australia Railway & Highway.

	Assume 12 units @ $10,000 =	$120,000
Vehicles	3 @ $4,000	12,000
Access Road	9 miles @ $5,000/mile	45,000
	Total	$177,000

(d) Pre-Production Expense

(a) Initial program to establish that the minimum economic reserve is present say 1,000,000 tons of + 1.5% Cu.

Percussion drill on 200 ft. grid around Mount Gunson deposit:-

54 holes at 50 ft. depth = 2,700 ft. at $2.50 per ft. =	$6,800
Assaying 2,700 ft. at $1.00 per foot	2,700
C.W.G & E Assessment 1 month at $5,000	5,000
Lab. testing of cuttings	1,500
Contingencies	2,000
Total Initial Program	$ 18,000

(e) Follow up program - Definition of ore zone & plant design

Percussion drill on 50 ft. grid throughout ore zone to 50 ft depth

25,000 ft. @ $1.25 per foot	$31,000
Assaying 25,000 ft @ $0.75 per foot	19,000
C.W.G & E Assessment 3 months	15,000
Plant Design & Metallurgical Testing	42,000
Total	$107,000

Recapitulation of Capital Cost Estimate

1.	Mining - by contractor.		
2.	Treatment Plant	$773,000	
3.	Ancillary Plant	177,000	
4.	Pre-Production Expense		
	(a) Initial Program	18,000	
	(b) Follow up	107,000	
	Sub total		1,075,000
5.	Contingencies		150,000
6.	Working Capital - 3 months operating at $5 per ton		200,000
	Total Estimated Capital Expenditure for 500 T.P.D operation		$1,425,000

3. Estimated Operating Cost - 500 T.P.D. Agitation Leaching Operation

Basis
Possible Mining Reserve - 1,000,000 tons of 1.5% Cu.

Acid Consumption - From C.S.I.R.O Reports No's 45 & 53
and C.S.I.R.O. Test of 16 February, 1965.

Assume acid consumption is (Theoretical + 53 lbs) per ton of ore @ 1.5% Cu require (30 x 1.55) + 53 = 100 lbs per short ton.

Iron Precipitation. No sulphides are evident hence assume theoretical consumption 26 lbs of Fe for 29 lbs of Cu, say 1 lb Fe per 1.1b of Cu.

(a) Estimated Mining Operating Cost

Contractor operations - 500,000 tons moved per year, assume
at 50¢ per ton handled.
at 2:1 Stripping Ratio = $1.50/ton milled.

(b) Estimated Crushing and Conveying Operating Cost

Labour - 2 men @ $25 per shift crushing 700 tons
Labour = 7 ¢ per ton
Supplies 6 ¢ " "

Crushing and Conveying $0.13/ ton milled

(c) Estimated Treatment Plant Operating Cost

Labour - 2 men on leaching 3 shifts 7 days per week = 42
3 men on precipitation 1 shift 5 days per wk = 15
1 mechanic 1 shift 5 days per week = 5
1 electrician 1 shift 5 days per week = 5

Total labour per week 67

Labour @ $25/shift = $\frac{25.00 \times 67}{500 \times 7}$ $0.46/ ton

Supplies: Acid, available at Port Pirie Pb Smelter
@ $20/ton + 150 miles @ 5 ¢/ton mile + $2.50 handling
= $30 per ton F.O.B. Mine 1.50/ton
Iron, say $30 per ton F.O.B. Mine 0.45/ton
Incidental Supplies say 0.19/ton

Total Treatment Plant Operating Cost $2.60/ton milled

(d) Electric Power at say 15 mills

Power consumption:
Crushing & Conveying 500 H.P. @ 70% load 40 hrs/wk = 3.0 Kwhrs/ton.

Process Plant 135 H.P. @ 80% load 168 hrs/wk= 5.2 "

Total Power Cost at 15 mills = $0.13/ton milled

(e) Estimated Administration & Supervision

Manager (Metallurgist)	$1,000/ mo
Engineer	700 "
Accountant	600 "
Assayer	450 "
Office Help	350 "
Office Supplies	200 "
Total	$3,300/mo

Admin. & Supervision = $\frac{3,300 \times 100 \times 12}{47 \times 3,500}$ = $0.22/ton milled

(f) Recapitulation of Estimated Operating Cost @ 500 T.P.D.

	$per ton milled.
Mining-by Contractor @ 50 ¢ per ton	1.50
Crushing & Conveying	0.13
Treatment	2.60
Power	0.13
Admin. & Supervision	0.22
Total Estimated Operating Cost	$4.58 per ton milled

Operating Cost per Year
500 tons per day 7 days per wk. 47 weeks per year
= 164,500 tons @ $4.58 = $750,000

4. Assumed Recoveries

(a) Assuming all ore is crushed to - ¼", then leach extraction is taken to be 97%.

(b) On the basis of four stages of counter current decantation theoretical Cu SO4 recovery to precipitation plant is 97.5%.

(c) On the basis of existing precipitation plants the recovery is assumed to be 99%.

Thus overall plant recovery is 97% x 97.5% x 99% = 93.6%

Assumed overall recovery say 93.0%

On 1.5% Cu head, Cu recovery = 28 lbs per ton milled.

Taking 164,500 tons treated per year at 1.5% Cu head produce 4,600,000 lbs Cu per year.

5. Assumed Freight & Smelter Deductions

Assumptions:

(a) Freight Mt. Gunson - Port Pirie 5 ¢ per ton mile for 150 miles = 0.375 ¢ lb. Cu

(b) Loading Charge say $5 per ton — 0.25

(c) Ocean Freight say $10 per ton — 0.50

(d) Smelting Charge say $12 per ton paying for Cu content less 1.S.T.U. @ E.M.J. price less 3.5 ¢ per lb.

Smelting Charge	0.635
Price Deduction	3.5
Total Deduction on above basis	5.26 ¢ per lb
Say	5.25 ¢ per lb Cu Shipped.

6. Acquisition of Mount Gunson property

Following field examination economic assessment of the property, and discussion with J.A. Wood, the following proposal was presented to I.G. Sykes, director of Jervois on 10 March, 1965.

On the basis that Jervois holds Mineral Claims No's 4476 and 4368 outright, and free of any encumberance and that the claims are in good standing and cover portion (approx 80 acres) of the Mount Gunson copper deposit, South Australia; Austminex Pty.Limited, is desirous of acquiring these mineral claims (below referred to as "the property"), on the following arrangement:-

1. Austminex to be given a free option on the property until 1 January, 1966 within which time Austminex will technically assess the property; principally by drilling to establish the degree and limits of copper mineralization present.

   It is the intention of Austminex to do no field work on the property until the exploration lease held by others on the adjoining ground is either relinquished or renewed (presumably in May, 1965).

   Should Austminex relinquish its option copies of all data pertaining to the property will be offered to Jervois.

2. Austminex will earn ownership in the property at a rate of 1% per £1,000 it spends on the property in technical assessment and it incurs in capital expenditure required to bring the property into production.

3. Once Austminex has spent £100,000 as above it owns the property outright contingent on paying Jervois a royalty to a maximum of £500,000 calculated at the greater of:-

   (a) 4% per annum of the total expenditure made to bring the property into production.

   (b) ½ pence per pound of copper produced from the property. But not less than £10,000 per year commencing 1 January, 1967.

   If Austminex defaults in any payment Jervois re-acquires ownership of the property at a rate of 1% per £1,000 defaulted.

4. Jervois agrees that any mineral rights it presently holds or acquires prior to 1 January, 1967 within 10 miles of the property are included in this agreement.

5. Should Austminex decide prior to 1 January, 1967 to relinquish mineral claims it has staked within 10 miles of the property it will, prior to relinquishment, offer such mineral claims to Jervois at £5 per claim.

6. Both Jervois and Austminex agree that the above is binding to their agents, assigns, successors and nominees.

The following counter proposal was received from Jervois on 22nd March, 1965:-

" 1. Delete clause 2 so property passes to Austminex when it decides to spend capital expenditure on plant.

This I feel is quite satisfactory to us, and, I imagine, more so for Austminex.

2. Jervois rights.

I suggest no maximum limit applies. It seems to me your limit is not likely to be reached, and if it were exceeded both parties would not really be sorry.

Payment times have been defined as not less than annually and within a month of the preceding period.

3. The agreement is made to cover the Gunson area (10 miles from the property) and the new clause 4 is changed as claims are not all inclusive.

New Clauses

4. 5. is added to allay any potential fears of Jervois or its property being acquired by Austminex.

5. A Carbonate-Sulphate clause is added.

6. Clause 7 suggests, if a public listed company be contemplated (15% shares must be held publically to list) we have a right to subscribe or take 15% of the capital. If we, or our shareholders, could not take these up, then your interests would not be possibly hurt.

Notes on other Matters

As indicated to you, about 2 years ago, Jervois applied for the whole Gunson area, and there was a confusion which resulted in

a subsequent application obtaining most of the area. This would put us in a good position to apply either -

1. On trust for Austminex.

or

2. Directly, subject to Austminex having a firm agreement or a letter from our Board of intent."

Original signed by IAN G.SYKES

On 31 March, 1965, Mr.Sykes was advised that Austminex could not accept two points in the Jervois counter proposal namely:-

(a) Austminex must have an upper limit on any royalty payable to Jervois of £500,000.

(b) Austminex would not be prepared to give Jervois a carte blanche agreement concerning all copper sulphate it may produce, but would be prepared to enter into an agreement per Jervois clause 6 for copper sulphate produced from the Mount Gunson deposit.

Sykes expressed his agreement to the two points above.

The following report on Jervois Sulphates(N.T) Ltd., appears in the Jobson's Mining Year Book for 1965.

" Jervois Sulphates(N.T) Limited

(Copper sulphate mining company)

Directors: K.G.Johannsen, M.J.Whitbread, F.C.A., I.G.Sykes, B.Sc B.Com.

Secretary: M. J.Whitbread F.C.A. Registered Office and Share Register: c/o Wilson, Bishop & Henderson, 8th Floor, Shell House, 170 North Terrace, Adelaide, South Australia. Victorian Agent and Registered Office: J.B.Hutchins, c/- , Wilson, Bishop & Henderson, 167 Queen St., Melbourne. Transfers: Common. Shares Quoted: Adelaide and Melbourne.

Auditors: A.L.Slade & Co. Bankers: Australia and New Zealand Bank Ltd., Solicitors: Murray, Cudmore, Worth & Isaachsen.

Capital: Authorised, £250,000. Issued, £125,000 in 140,000 5/- deferred ordinary shares and 360,000 5/- ordinary shares, all fully paid. (The deferred ordinary shares are deferred as to return of capital in the event of liquidation for a period of three years from

date of allotment.
Accounts: Made up to June, 30, submitted in October.

HISTORY

The company was incorporated in South Australia on October, 25, 1962. On April, 17, 1963, it agreed to purchase from Jervois Mines Ltd., mining rights, plant, buildings and development on the Jervois mineral field some 230 miles north-east of Alice Springs. Consideration of £98,300 comprised £15,000 cash, £35,000 in fully paid 5/- ordinary shares, deferred as to return of capital, and £48,300 by acceptance of liabilities as at February, 28, 1963.

A prospectus dated May 23, 1963 offered for public subscription 360,000 5/- ordinary shares at par payable in full on application, including a first and final call of 4/6. Directors reported that ore reserves of 100,000 tons of oxidised material containing 5.5 per cent copper, had been measured. They added that it was reasonable to expect that further reserves will subsequently be proved. As one ton of copper is required to produce four tons of copper sulphate, measured reserves would allow for nine years of production at the rate of 2,250 tons of copper sulphate per annum.

In February, 1964, directors stated that a test run of the plant disclosed troubles in excess of normal teething ones, and the company's future will depend on a report by a firm of mining consultants.

In October, 1964, directors reported that the future of the company was in serious jeopardy. Owing to treatment problems, operations had not commenced, but pilot plant testing of new processes was being developed to try to overcome these. At June, 30, 1964, liabilities totalled £47,422, while current assets of £6,504 included £6,356 of ore stocks, which would be virtually worthless if operations did not commence. Application has been made to the Supreme Court to call a meeting of creditors to obtain a moratorium for twelve months. Accumulated losses to June 30, 1964, totalled £97,151.

Share Prices: 1963 - High 5/-, Low 4/-;
1964 - High 2/3, Low - 3½d. "

The above extract from Jobson's Mining Year Book shows that Jervois is in financial and technical difficulties.

Austminex has not examined the secondary Cu property Jervois holds on the Jervois mineral field referred to by the Jobson Mining Year Book. The logistics in operating 230 miles easterly from Alice Springs are adverse. Should negotiations with Jervois prosper in the Mount Gunson deposit, then consideration could be given to the Jervois mineral field.

It is proposed that Austminex will commence the initial phase of the preproduction expense proposed for Mount Gunson i.e. percussion drill on a 200 ft. grid at an estimated cost of $18,000, once the following conditions are met:-

1. T.A.P.G. participants approve the proposed program.

2. An agreement is signed with Jervois.

3. Austminex acquires exploration rights to the area surrounding the Jervois claims at Mount Gunson.

7. Cash Flow Projections 500 T.P.D. Agitation Leaching

Basis:

(a) Overall Cu recovery 93%

(b) Royalty payment to vendor 1 ¢ per lb. Cu produced.

(c) Mining by contractor at 50 ¢ per ton handled. Stripping Ratio 2:1.

(d) Capital Outlay.

Plant	$1,100,000
Pre-Production	125,000
Working Capital	200,000
Total	$1,425,000

(e) Operating Costs

Mining	$1.50 per ton milled
Crushing	0.13
Treatment	2.60 at 1.5% Cu * ($2.83 @ 2.0% Cu, $2.37 @ 1.0% Cu) * Depending on acid & Fe consumed.
Power	0.13
Admin	0.22
Total Operating Cost	$ 4.58 per ton milled

(f) Net Smelter Return - EMJ Cu price less 5.25 ¢ / lb Cu.

(g) Taxation - assume 1st year deduct sufficient to yield nil taxable return, remaining years straight line depreciation. Tax rate 42½% on 80% of taxable profit.

(h) Charge for refurbishment of plant and/or exploration - $50,000 per year.

(i) Required return on investment is 10% compound interest over investment life.

(j) No residual value and working capital returned at end of life.

Cash Flow Projections prepared at various fixed conditions yielded the following results:-

Condition A. Assumed reserve 1,000,000 tons; life 6 years.

% Cu Mill Head	2.0	2.0	1.5	1.5	1.0	1.0
E.M.J. Cu Price ¢/lb	25	30	30	35	40	45
Net Cash Flow $1,000	1,765	2,996	1,712	2,625	1,555	2,160
Present Value $1,000	1,268	2,184	1,228	1,910	1,009	1,560

Under this condition the required return on $1,425,000 capital outlay is obtained when:-

(a) Reserve is 1,000,000 tons of 2.0% Cu. & EMJ Cu price is 25.9 ¢ / lb

(b) Reserve is 1,000,000 tons of 1.5% Cu & EMJ Cu price is 31.4 ¢ / lb

(c) Reserve is 1,000,000 tons of 1.0% Cu & EMJ Cu price is 43.8 ¢ / lb

Condition B Assumed reserve is 500,000 tons; life 3 years.

% Cu Mill Head	2.0	2.0	1.5	1.5	1.0	1.0
EMJ Cu price ¢ lb	28	30	35	40	45	55
Net Cash Flow $1,000	1,525	1,767	1,586	2,042	1,354	1,962
Present Value $1,000	1,257	1,463	1,309	1,696	1,112	1,629

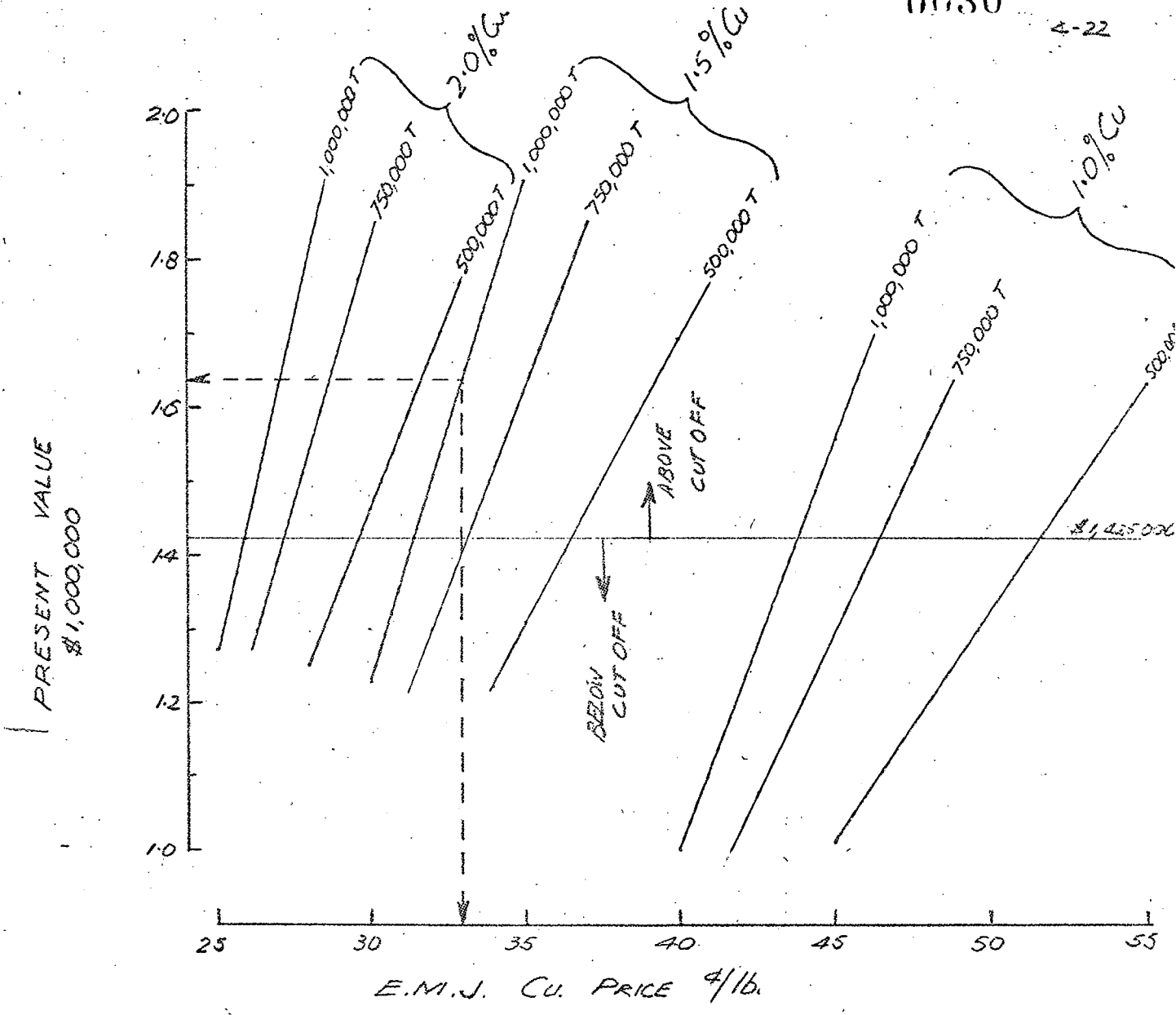
Under this condition the required return on $1,425,000 capital outlay is obtained when:-

(a) Reserve is 500,000 tons of 2.0% Cu & EMJ Cu price is 29.6 ¢ per lb

(b) Reserve is 500,000 tons of 1.5% Cu & EMJ Cu price is 36.5 ¢ per lb

(c) Reserve is 500,000 tons of 1.0% Cu & EMJ Cu price is 51.1 ¢ per lb

The relationship between Present Value, EMJ Cu price, Reserve Grade and tonnage is presented on the attached graph. Graph 1.



EXAMPLE: PRESENT VALUE AT COMMENCEMENT OF OPERATIONS OF 1,000,000 TONS OF 1.5% Cu. AT 33¢ Cu PRICE IS $1,640,000

RELATIONSHIP PRESENT VALUE, COPPER PRICE, RESERVE GRADE AND TONNAGE VENTURE NO 1 MOUNT GUNSON COPPER DEPOSIT

GRAPH No 1

T.A.P.G. PROGRESS REPORT NO. 7
Period 1 April - 30 June, 1966

Appendix No. 1

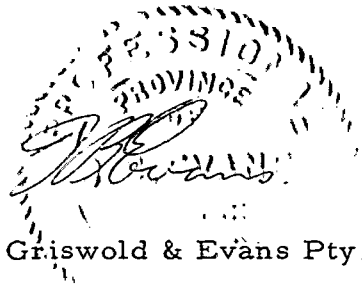
T.A.P.G. Venture No. 1

Mount Gunson, South Australia

Area File SH 53.16

Dated in Melbourne
25 July, 1966

Submitted by



Chapman, Wood, Griswold & Evans Pty. Ltd.

T.A.P.G. VENTURE NO.1

PROGRESS REPORT FOR PERIOD 1 APRIL - 30 JUNE, 1966

Appendix No.1 - Mount Gunson, South Australia

TABLE OF CONTENTS

Attachments

C.S.I.R.O. Ore Dressing Investigation Report No.663.
Dept. of Mines South Australia, Hydrological Report.DM552/66.
C.W.G & E Plan G.P.I. - Gunson - Lease Drilling Plan.
Austminex Plan G.P.5 - Gunson - Main Open Cut - Drill Hole Location and Assay Plan.
Austminex Plan G.P.6 - Venture No.1 - Gunson - Pernatty Lagoon Area - Drill Hole Location and Assay Plan.
Austminex Plan G.P.7 - Venture No.1 - Gunson - Gunyot Area - Drill Hole Location and Assay Plan.

ABSTRACT

The T.A.P.G. Venture No.1 Mount Gunson Copper Deposit, South Australia which commenced with the initial field examination in Jan., 1965 and was then followed by the preparation of a minimum target reserve analysis, yielded two optioned Mineral Claims enclosed in a 15 square mile Special Mining Lease by December, 1965.

Stage 1 Exploration involving 1,000 ft. of percussion drilling in portion of a known mineralized zone was completed in January, 1966 to indicate the presence of +500,000 Tons of better than 1% Cu near surface, within the area tested. Notice was served on the Mineral Claim holder that the option was being exercised in February 1966.

Stage 2 Exploration involving geological mapping, geochemical prospecting and an additional 10,000 ft. of percussion drilling with on site assaying was completed in June, 1966. In three areas of quartzite host rock where "oxide" copper and secondary copper sulphides occur within 60 ft. from surface the Stage 1 and Stage 2 Exploration drilling is assessed to have yielded a combined Drill Measured and Drill Indicated Reserve of 1.8 million tons of 1.2% Cu with a computed overall waste: ore stripping ratio of 1.7:1.

The availability of process water is not as yet established; however indications are favourable that process water can be obtained at reasonable cost.

Metallurgical tests on representative samples submitted to C.S.I.R.O. Ore Dressing Division indicate that the mineralization is amenable to sulphuric acid leaching and also to Leach, Precipitate, Flotation concentration with an indicated acid consumption of 2.3 lbs of acid per lb Cu recovered yielding a 90% recovery of contained Cu.

Preliminary enquiries reveal that a healthy marketing situation exists.

Total expenditure to 30 June, 1966 on the project is $Au47,418 ($US 53,107).

It is proposed that Stages 1 & 2 Exploration have yielded in excess of the assumed required minimum reserve necessary to substantiate at least a 500 T.P.D. operation.

A program of Stage 3 Exploration is recommended to be completed in November, 1966, at which time it is anticipated that sufficient data will be available to formulate pre production decisions for a suggested production target date, July 1967.

The anticipated Stage 3 Exploration expenditure is estimated to be $Au. 79,300 ($US 88,900), with the following field work undertaken:-

1. A 16 man field camp suitable for permanent occupancy will be established on site.

2. A representative 500 ton bulk sample will be mined and metallurgically tested.

3. Exploration rights to additional ground will be acquired and initial exploration of this area will be completed.

4. A test of the availability of process water from one possible source will be completed.

REVIEW OF WORK PRIOR TO 1 APRIL, 1966

The Gunson area was field examined in January, 1965, following study of published data. A sample cut during the field examination was submitted to the Ore Dressing Division, C.S.I.R.O for comparison with earlier tests of Cu digestion by sulphuric acid leaching and acid consumption as previously reported by C.S.I.R.O Reports No's 40 and 47 following tests in 1937.

On the basis of the metallurgical test results, a feasibility study designed to relate the required minimum ore reserve with profitability was made (see T.A.P.G. Progress Report No.2, Appendix No.4).

An application was made to the Mines Department South Australia in July 1965 for a Special Mining Lease to embrace 15 square miles of the Mount Gunson Copper deposit.

In August 1965 two Mineral Claims covering the Gunson "Main Open Cut Workings" were optioned.

In December, 1965 Austminex was granted Special Mining Lease No.96 covering the 15 square milessurrounding the two optioned Mineral Claims.

In January, 1966 Stage 1 Exploration was undertaken with the objective of drilling approximately 1/3rd of the then known Main Open Cut Workings. This program involving 1,014 ft. of percussion drilling to indicate the presence of better than 500,000 tons of + 1% Cu mineralization as "oxide copper" within the area tested.

The summary report of Stage 1 Exploration recommending that the option to purchase the two Mineral Claims be exercised and that Stage 2 Exploration be undertaken was presented to T.A.P.G. participants under a C.W.G & E letter dated 18th February, 1966.

Advice that the recommendations were accepted was received on 23rd February, 1966, the vendor was advised that the option to the two Mineral Claims was being exercised and Stage 2 Exploration commenced in March, 1966.

By 31 March, 1966 Stage 2 geological mapping and geochemical sampling had progressed to show the presence of a weak geochemical anomaly in the region of the old "Gunyot Workings". Geochemical sampling of the "Lagoon Workings" in the dry salt lake, Pernatty Lagoon, showed that geochemical sampling in that environment is not a suitable prospecting technique.

PROGRESS ACHIEVED 2ND QUARTER, 1966

1. FIELD WORK

A. Drilling.

Following the establishment of a field camp and an on site assay office, and having completed a ground survey control grid, Stage 2 drilling by a contractor equipped with a Gardner Denver PR-133 percussion, track mounted, rig and a 900 cfm compressor commenced on 29th April.

In the period 29 April - 4 June, 9,597 ft. of percussion drilling and 300 ft. of auger drilling were completed in 3 areas of known, outcropping Cu mineralized quartzite.

The attached plans show the area drilled:-

C.W.G & E Plan G.P.I - Gunson - Lease Locality Plan - shows the area drilled in Stage 1 Exploration i.e. Portion of the "Main Open Cut Workings" and the location of the various known Cu deposits.

Austminex Plan G.P.5 - Gunson - Main Open Cut - Drill Hole Location. and Assay Plan - shows the location of holes drilled and assay results obtained in Stages 1 & 2 Exploration in the "Main Open Cut Workings" area.

Austminex Plan G.P.6 - Venture No.1 - Gunson - Pernatty Lagoon Area - Drill Hole Location and Assay Plan - shows the location of holes drilled and assay results obtained in Stage 2 Exploration in the "Lagoon Workings" and "Bornite Workings" area.

Austminex Plan G.P.7 - Venture No.1 - Gunson - Gunyot Area - Drill Hole Location and Assay Plan shows the location of holes drilled and assay results obtained in Stage 2 Exploration in the "Gunyot Workings" area.

In summary the Stage 2 Exploration drilling was as follows:-

(a) Percussion drilling 3" dia holes.

*Main Open Cut	100 holes drilled for 4,960 ft. - average 50 ft. per hole
+Lagoon	48 holes drilled for 2,085 ft. - average 43 ft. per hole
Gunyot	66 holes drilled for 2,552 ft. - average 39 ft. per hole
Total	214 holes drilled for 9,597 ft. - average 45 ft. per hole

(b) Auger drilling 4½" dia holes

Main Open Cut	1 hole drilled for 42 ft.
Lagoon	27 holes drilled for 228 ft - average 8 ft. per hole
Gunyot	1 hole drilled for 30 ft.
Total	29 holes drilled for 300 ft.- average 10 ft. per hole

Notes *One hole drilled to 180 ft. without encountering any further zones of mineralization.

+ One hole drilled to 98 ft without encountering any further zones of

B. Sample Collection

Each 5 ft run of percussion drill cuttings was recovered using the Questa type venturi drill collar casing arrangement and dust collector at the drill site. The collected cuttings of each 5 ft. run were weighed, logged and split a sufficient number of times to yield two representative samples of approx. 2 lbs each, at the drill site by C.W.G & E staff. One sample being required for submission to the Mines Department, and the other for assay assessment.

C. Sample Bucking

Each nominal 2 lb sample of drill cuttings suspected to contain Cu and nominally 100% - 10 mesh was firstly dried when necessary prior to being split to approx. ¼ - ½ lb. wt. The reject being kept for reference.

The ¼ - ½ lb fraction was then ground to 100% - 80 mesh. split, coned and quartered to yield + 1 grm of sample pulp - reject being kept for reference and repeat assaying.

D. Assaying Procedure - Iodiometric Copper Determination

1 grm of sample (-80 mesh) is brought into solution by treatment with hot nitric acid to oxidize all elements present to their highest valencies. Possible interference by iron being prevented by transforming it into complex ferric fluoride by the addition of ammonium bi-fluoride. The addition of potassium iodide to the dilute acidic solution causes the copper ions present to react with the iodide to liberate iodine. This reaction is quantitative, thus by titrating with sodium thio-sulphate to form sodium tetrathionate from the liberated iodine present the quantity of sodium thio-sulphate added to obtain an end point is directly proportional to the copper content present.

The limit of detection by this method using 1 gram of sample is considered to be 0.01% Cu.

Periodic repeat assays and comparisons to prepared standards were carried out regularly throughout the assaying program.

Assays submitted to a custom assayer using atomic absorption methods gave the following comparison.

Sample No.	C.W.G & E Field Iodometric Assay % Cu	Minex Atomic Absorption Assay % Cu
1000	1.35	1.35
1005	0.60	0.75
1019	1.12	1.25
1037	2.28	2.20
1051	1.54	1.75
1069	1.08	1.20
1086	0.87	0.90
1100	0.52	0.55
1101	0.35	0.30
1102	2.45	2.75
1115	1.67	1.35
1116	2.30	3.00
1149	3.84	3.20
2129	0.97	1.00
2130	1.20	1.25
2131	1.07	1.10
Total	23.21	23.90
Arith.Mean	1.45	1.49

E. Recording of Assays and Drill Log Data.

All drill hole locations were surveyed and collar elevations obtained. The drill hole data and assay value of each 5 ft. intercept of copper bearing sample were recorded on vertical sections drawn on 40 ft. horizonal and 10 ft. vertical to 1 inch scale, as assay data was obtained, nominally within 48 hours of drilling. These vertical sections were then used to direct subsequent drill hole locations.

11. OFFICE ASSESSMENT OF FIELD DATA

A. Assessment of Assay Data and Compilation of Reserves

The following controls have been assumed:-

1. Rock Density - S.G = 2.44 by measurement.
   assume 13.2 cub.ft = 1 short ton.

2. C.W.G & E on site assays are applicable.

3. Cut off Grades.
   0.40% Cu over 10 ft. when no overburden is involved.
   0.60% Cu over 10 ft. when overburden removal is required.

4. Limits of Influence of Assays.
   (a) Lagoon Workings - 30 ft. in North-South direction, unless continuity is established.
   50 ft. in East-West direction, unless continuity is established.

   (b) Gunyot Workings - 25 ft. in all directions, unless continuity is established.

   (c) Main Open Cut Workings - polygons within the zone of mineralization.
   - on extremities, governed by geologic interpretation but nominally 25 ft.

5. Pit Configuration - As the maximum pit depth is approx.60 ft. below surface, and the wall rocks are considered to be highly competent, an overall wall slope of 1 ft. horizontally to 2 ft. vertically is assumed to apply.
   Bench interval - 10 ft.
   Internal roads - minimum width 25 ft.
   Maximum slope 1 in 10.

Possible open pit layouts assuming the above controls have been prepared on 10 ft. bench intervals for the Main Open Cut Workings and the Gunyot Workings.
For the Lagoon Workings it is considered that insufficient detail is presently available i.e drill density is insufficient, from which firm pit layouts can be prepared, hence in this area only a general pit lay out has been prepared.

It is believed that full definitions of appropriate ore reserve categories are not required at the present time. With the assumed controls listed above applying it is considered that the category "Drill Measured" can be used for the Main Open Cut and Gunyot areas and "Drill Indicated" for the Lagoon area as follows:-

Presently known Ore Reserves

Category	Location	Ore Short Tons	Grade % Cu	Stripping Ratio Waste: Ore
Drill Measured Hole Spacing 200' x 75'	Main Open Cut	1,260,000	1.2	2.0:1
Hole Spacing 200' x 100'	Gunyot	80,000	0.95	1.2:1
Total Drill Measured		1,340,000	1.18	1.95:1
Drill Indicated Hole Spacing 400' x 100'	Lagoon	460,000	1.3	0.9:1
Total Drill Measured and Drill Indicated		1,800,000	1.2	1.7:1

B. Availability of Process Water

On the basis that process water requirement will be governed by the quantity required to move tailing at 50% solids and that 70% of the tailing water is not recoverable then the quantity of make up water required for the assumed smallest operation i.e 500 T.P.D mill thruput is approx. 50 I gpm.

Thus the assumed minimum process water requirement is taken as 50 I gpm.

There is no known source of surface water within 50 miles of the area and the possible sources of process water are assumed to be:-

1. Sub artesian.

2. The Woomera Rocket Range water supply line which runs within approx. 6 miles of the property.

Study of available hydrological data indicates that "fresh" water supplies in the general area are strictly limited and are completely utilized in pastoral pursuits, however there is virtually no recorded data concerning "salt" water occurrences. At first sight the relatively flat topography precludes the possibility of impounding sufficient surface run off water.

A requested field examination of the area was carried out by the Mines Dept. Hydrology section during the Stage 2 Exploration program but no pertinent additional hydrological data was gained.

Metallurgical test work carried out in 1937 by governmental agencies indicates that Pernatty Lagoon water, effectively a saturated brine solution, is entirely suitable as process water for acid digestion of the Gunson Cu mineralization.

The Stage 2 Exploration drilling of the Lagoon workings in the dry salt lake, Pernatty Lagoon, revealled that once the top few inches of crust is broken the "playa" deposit down to bed rock (bed rock is from 2 - 30 ft. below surface in the drilled area) was at least "sloppy". It was noted that ruts left after removal of bogged vehicles filled with water within 1 - 2 hours, also all Lagoon drill holes filled with water within a few hours of being drilled. The presence of this water severely hampered drilling operations, but does indicate that it may be possible to obtain process water from this source.

Technical data concerning the Woomera water supply line was obtained during Stage 2 Exploration and computations made indicate that the present flow through this line could be increased by 50 I gpm by the addition of pumps in two existing pumping installations at reasonable cost.

Since the Woomera water supply line is a Federal Govt. installation and is servicing a space research establishment it is believed that, although preliminary study indicates that it is feasible to tap this line from an engineering viewpoint, investigation to establish whether or not it is also "politically feasible" should be delayed until:-

1. The availablity and suitability of sub artesian "salt" water has been proved to be unfeasible.

2. The actual process water requirement has been established.

C. Metallurgical Research

The metallurgical investigations carried out to date by the Ore Dressing Division of C.S.I.R.O on samples submitted is reported in the attached C.S.I.R.O Ore Dressing Investigation Report No.663 "Acid Leaching of Oxidized Copper Ore From Mount Gunson, S.A." by J.T.Woodcock, dated July, 1966.

It is considered that this report fully justifies continuance of amenability tests of acid leaching of Mount Gunson mineralization.

The samples submitted to C.S.I.R.O to date have all been obtained from the Main Open Cut area. The Sample C referred to in the C.S.I.R.O report is considered to be the most representative sample of Main Open Cut mineralization obtainable at present.

No metallurgical testing has as yet been carried out on samples from the Lagoon workings where the principal Cu mineral present has been identified as chalcocite.

C.S.I.R.O metallurgical testing of Gunson mineralization is continuing.

It is noted that an acid consumption of 2.3 lbs/lb Cu is indicated by the present C.S.I.R.O testing, as against 3.6 lbs/lb Cu assumed in T.A.P.G Progress Report No.2, Appendix No.4. Such a reduction in acid consumption would reduce the Direct Operating Cost by some 45 ¢/ ton milled.

D. Marketing

Preliminary discussions concerning off shore marketing of cement copper and/or copper sulphide concentrates suggest that the ex mine site deductions estimated in T.A.P.G Progress Report No.2 Appendix No.4 to be 5.25 ¢ / lb Cu shipped, could well be at least 2 ¢ / lb Cu too high.

Follow up discussions to explore the marketing of at least 4 million lbs Cu/year are scheduled.

111. Total Expenditures to Date 30 June, 1966

T.A.P.G. Venture No.1
Conversion $Au = $US 1.12

	$Au.	$US
Salaries	23,751	26,601
Travel	3,307	3,704
Vehicles	2,098	2,350
Office & Communications	235	263
Direct Field Expense	2,201	2,465
Drilling	13,741	15,390
Assaying	1,223	1,370
Geo Chemistry	195	218
Field Equipment	395	442
Maps and Photos	52	58
Legal	166	186
Acquisition of SML 96	54	60
Total to 30 June, 1966	47,418	53,107

Proposed Stage 3 Exploration Program

A. Introduction

It is considered that the T.A.P.G. Venture No.1 has responded favourably to Stages 1 & 2 Exploration and so far is exceeding the minimum assumed requirements set out in T.A.P.G Progress Report No.2, Appendix No.4 namely:-

The establishment of 1 million tons of 1.5% Cu mineralization yielding 28 lbs Cu recoverable per ton as feed for a 500 TPD operation with a Direct Operating Cost of $4.60/ton milled and a Total Capital Outlay at $1,425,000.

Stages 1 & 2 Exploration have been directed at outcrops of siliceous rocks known to contain Cu mineralization. No exploration of outcrops of dolomitic rocks containing Cu mineralization has been undertaken to date as leaching acid consumption of such mineralized host rock is considered to be beyond economic consideration.

As yet geochemical sampling of residual soils and stream sediments has not demonstrated that this technique is applicable to the area. Geological reconnaissance and air photo interpretation have yielded no specific features to identify Cu mineralization with structural controls.

Geophysical methods have not been tried by C.W.G & E but other exploration groups have carried out such surveys in the past. C.W.G & E believes that the geophysics undertaken to date has been unsuccessful in determining Cu occurrences in the area.

The results obtained in Stage 2 Exploration drilling of the Lagoon workings, in Pernatty Lagoon, where significant intersections of copper sulphide mineralization (presumed secondary sulphides) are considered to be of importance e.g 30 ft. of 4.48% Cu (which includes 5 ft of + 12% Cu), 25 ft. of 3.12% Cu.

The goal, that has conditioned the T.A.P.G Venture No.1 to date, has been to find, delineate, and establish the amenability to treatment, a sufficient Cu reserve to justify a small (500 T.P.D) operation.

So far no attempt has been made to establish the genesis of the Cu mineralization nor study the area on a regional scale.

The 1:250,000 Geology Sheet "Torrens" H 53.16 shows sporadic Cu occurrences along the 20 mile western shore of Pernatty Lagoon in the Pernatty Grits close to, and in the Woocalla Dolomite, geologic members of the Upper Proterozoic Sturtian sediments.

To date T.A.P.G Venture No.1 has been restricted to approx. 5 sq.miles of a geologically favourable zone which is say 100 sq.miles in area.

The percussion drilling and on site assaying procedure used to date has yielded positive results at low cost to indicate three zones of significant Cu mineralization, the largest being some 2,000 ft. in length and up to 600 ft. in width. The overall cost to date including metallugical testing is less than 3 ¢ per ton of reserve. However without an appropriate prospecting technique such a drilling and assaying assessment could not be considered for the entire geologically favourable zone.

The only untried possibly applicable exploration technique known to C.W.G & E is bio geochemical prospecting ("twig burning") and it is proposed that this technique warrants trial.

Now that high grade Cu sulphide mineralization has been identified at the Lagoon workings in Pernatty Lagoon electrical geophysical techniques should be tried in this area, even though the highly saline water bearing overburden cover would most likely mask any electrical response, resulting from the presence of sulphides.

With the above considerations in mind it is recommended that Stage 3 Exploration be undertaken immediately with two objectives in mind:-

1. Establish that the mineralization delineated in Stages 1 & 2 Exploration is in fact "ore" and that the production goal is at least a 500 TPD operation commencing say in July, 1967.

2. Prospect the geologically favourable zone, the Pernatty Grit horizon westerly of and in Pernatty Lagoon - an area of some 150 - 200 sq.miles, by geological reconnaissance and bio geochemical methods; to be followed by percussion drilling with on site assaying where indicated.

Until 31 July, 1966 the greater portion of this area is held by others (Geo Science) under a Special Mining Lease.

On 31 July, 1966 the 2 year tenure of the Geo Science SML will expire and an application by Austminex for a SML is in order.

In respect to metallurgy, C.W.G & E is aware of two possible processes of concentrating "oxidized Cu" to a saleable product, neither of which require acid or iron and can operate in an alkaline environment.

These processes are ammonia leaching, and sulphidization, and both processes are being researched. The "segregation" process is considered unfeasible for Gunson due to its heat requirement.

In respect to the Lagoon area where two high grade near surface chalcocite drill intersections of + 3% Cu over 25 ft were obtained, it would be possible to immediately produce a saleable product at low installed cost, - say 4 men equipped with a jack hammer, a front end loader, a small crusher and a jig for a total outlay of less than $7,000 could yield a direct operating profit of $500 per day for 60-90 day period. However such an operation is not envisaged as being appropriate at this time.

B. Specific Objectives

It is considered that Stage 3 Exploration consisting of the following tasks should be completed by 30 November, 1966:-

1. Obtain a representative bulk sample of the Main Open Cut Drill Measured reserve.

2. Conduct a "draw down" test of Pernatty Lagoon water.

3. Conduct an electrical resistivity survey over the Lagoon workings.

4. Obtain exploration rights to the Pernatty Grit horizon, some 150 sq.miles and conduct a bio geochemical Cu survey of the area.

5. Continue the present metallurgical tests and conduct bulk metallurgical tests on the representative bulk sample obtained from 1 above.

It is appropriate that the Drill Measured reserve of the Main Open Cut area be compared with a representative bulk sample say 1 ton to 2,500 tons of reserve i.e require 500 Tons for 1.25 million tons.

It is proposed that this representative sample be taken from two locations, one from the North East section of the blocked out area, the other from the South West. Each opening being a side hill cut to yield nominally mineralization 5 ft. wide 30 ft long and 20 ft. deep. The entire 500 Ton sample to be crushed to - 2 inch size before splitting into four 10 ton representative samples.

For the "drawn down" test of Pernatty Lagoon water, it is proposed that two 1,000 ft.long trenches say 2 ft. wide, 3 ft deep be cut using a back hoe, and connected to a common sump. Then pump on a continuous basis for one week at a rate of at least 50 I gpm, discharging the water into sand dunes approx. 1 mile from the lagoon.

In respect to conducting an electrical resistivity survey over the Lagoon workings, the Mines Dept. Geophysical section has displayed a willingness to undertaken such a survey and it is proposed that a request be made to this section to carry out this work.

C.W.G & E is presently researching bio geochemical techniques and proposes that a field program by C.W.G & E staff will be undertaken commencing in August 1966 provided that a Special Mining Lease is obtained for the subject 150-200 sq.mile area.

In regard to metallurgical testing C.S.I.R.O is presently continuing its testing of drill cuttings samples submitted as reported in its attached report. The L.P.F (Leach Precipitate Float) test already reported is being re-run using various forms of granulated iron.

Sulphidizing tests using Na_2 S & Ca S are scheduled.

C.S.I.R.O has a sample of Pernatty Lagoon water and will synthesize its composition for further test work.

Investigation will be undertaken to determine the possibility of recovering Ag (and Au) suspected of being present in the Gunson deposit.

The 30,000 tons of mine run ore processed through the Port Pirie smelter in 1941-43 contained in excess of 0.4 oz Ag/ton.

The C.S.I.R.O Ore Dressing division is not equipped to run bulk metallurgical tests.

The Australian Mineral Development Laboratory (AMDEL) in Adelaide, South Australia sponsored jointly by governmental agencies and private enterprise, is equipped for bulk metallurgical tests and has had considerable experience in pilot plant leaching of uranium ores.

Preliminary discussions with AMDEL indicate that bulk testing of 5-10 Ton samples of Gunson mineralization could be scheduled to commence in October, 1966.

C.S.I.R.O and AMDEL have worked jointly on metallurgical projects in the past.

C. Cost Estimate and Timing of Proposed Stage 3 Exploration

Stage 1 Exploration was carried out under primitive camp conditions using the remains of the Jervois Sulphates camp. The Stage 2 Exploration camp consisted of the Mount Gunson Out Station buildings, kindly made available by the Pernatty Lagoon station owner, supplemented by two rented 2-berth trailers and was adequate for the 9 man crew for the 60 day field program. Normally the Mount Gunson Out Station is occupied and thus cannot be assumed to be available in the future.

In view of the longer time required to complete the proposed Stage 3 Exploration program and now having a significant drilled reserve it is considered that a permanent camp should be established.

This circumstance was discussed by telephone with Vancouver on 11 July and approval was received on 13 July to proceed with the purchase of the necessary camp units.

A base, established similar to the Craigmont pre production camp, has been ordered from the Australian subsidiary of Alberta Trailers (the supplies of the Craigmont camp) for delivery at Gunson on 15 August, 1966.

This camp will consist of the following units:-

2 x 8 man bunk houses, 2 men per 100 sq.ft.
1 x 20 man wash car
1 x 30 man kitchen diner
1 x Laboratory (20' x 10') later to be either a mobile geochem lab. or alternatively the permanent Gunson assay office.

All units to be equipped with evaporative cooling and to be transportable - one set of "running gear" included in the order. Quoted Purchase Price $Au. 23,540

A used 35 KVA motor-generator set powered by a 50 HP diesel engine has already been purchased for power generation of camp and plant electrical requirements.
It is considered that the above camp units are entirely suitable as the base units for single accommodation at the production stage of a Gunson operation.

At the conclusion of Stage 3 Exploration the camp would require at least a caretaker but at that time serious consideration should be given to immediately commence a small scale mining operation in the Lagoon workings as suggested on page V1-13 of this report.

It is proposed that the cost of this camp will be bank financed and repaid at approx. $2,000 per month over 12 months rather than an outright T.A.P.G expenditure or taking a rental-purchase agreement from the supplier at $3,000 per month over 12 months.

Cost Estimate:-

(a) Bulk Sample Mining Cost.

On the basis that two 250 Ton bulk samples will be taken with the following controls:-

1. Side hill slope is 3:1.
2. Overburden is rock 10 ft. in thickness.
3. Ore zone will be stripped at the top to 18 ft. width.
4. Side wall slope is 1 horizontal to 2 vertical.
5. The ore cut is 5 ft. wide, 30 ft.long, 20 ft deep taken in two lifts - the top lift widened to 10 ft. before removal of the lower lift.

Then the total rock quantity to be removed to yield 500 Ton sample is 12,000 tons.

Assuming jack hammer drilling of rock, waste removal by front end loader, ore removal by hand, with 1 ft. of drilling required per ton of rock removed and drilling and blasting of 200 ft of hole per day, then require 60 days to obtain 500 Ton representative bulk sample crushed and sorted.

	$Au.
Labour 3 men per day @ $20/man day for 60 days	3,600
1 front end loader & operator 60 days @ $70/day	4,200
Explosives at 0.25 lbs/ton at 30 ¢/lb = 3000 lbs @ 30 ¢	900
Caps - electric 2,000 @ 25 ¢	500
Compressor & 2 Jack hammers @ $25/day for 60 days	1,500
Drill steel @ 5 ¢/ft. for 12,000 ft.	600
Crusher say 10" x 14" second hand installed twice	500
Hand tools	100
Contingencies	1,100
	13,000

	$Au.
(b) "Draw down" test in Pernatty Lagoon	
300 ft. ditch/day, back hoe attachment to front end loader and carried out following bulk sample say require 3,000' = 10 days digging plus further 10 days on stand by.	
20 days @ $70/day	1,400
Pump 50 gpm pushing 100 ft.head (already purchased)	200
Piping 5,000 ft. PVC @ 50 ¢ / ft.laid	2,500
Labour 2 men 10 days @ $20/man day	400
Contingencies	500
Total Draw down cost	5,000
(c) On site supervision and data assessment	
3 x C.W.G & E staff for 4 months	9,000
(d) On site geology and bio geochemical assessment	
2 x C.W.G & E staff for 4 months	7,000
Geochem 120 days @ $20/day	2,500
Total geology	9 500
(e) Camp labour	
1 Cook @ $400/mo for 4 mo.	1,600
1 Helper @ $250/mo for 4 mo.	1 000
Total Camp labour	2,600
(f) Vehicles	
2 units @ $250/mo for 4 mo.	2 000
(g) Camp Supplies	
1300 man days @ $3 per man day	4,000
(h) Camp Charge	
$2,000 per mo for 4 mo.	8,000
(i) Camp Set Up	
Power & Water Supply, Septic Tank say	2,500

	$Au.
(j) Crew travel 11 men @ $60	700
(k) C.W.G & E Head Office direction, communications, field visits. 4 mo's @ $1,250 per mo.	5,000
(l) Metallurgical Testing Transportation of 100 T sample @ 5 ¢/ton mile for 280 miles	1,400
AMDEL Quote $10,000 say	15,000
C.S.I.R.O Donation say	1,000
Ammonia Leach Test say	600
Total Metallurgical Testing	18,000

Recapitulation of Estimated Stage 3 Exploration Cost

	$Au	$US
Bulk Sample Mining Cost	13,000	14,500
"Draw down" test in Pernatty Lagoon	5,000	5,600
On site supervision & data assessment	9,000	10,100
On site geology and bio geochemistry	9,500	10,700
Camp labour	2,600	2,900
Vehicles	2,000	2,200
Camp Supplies	4,000	4,500
Camp Charge	8,000	9,000
Camp Set up	2,500	2,800
Travel	700	800
C.W.G & E Head Office Direction	5,000	5,600
Metallurgical Testing	18,000	20,200
Total Estimated Stage 3 Exploration Cost	79,300	88,900

Anticipated Rate of Stage 3 Expenditure

	Unit $US Aug.	Sept.	Oct.	Nov.	Total
Bulk Sample	1 600	6,300	6,600	-	14,500
"Draw down" Test			2,800	2,800	5 600
On Site Supervision	2,500	2,500	2,500	2,600	10,100
On Site Geology	2,700	2.700	2,700	2,600	10,700
Camp labour	500	1,000	1,000	400	2,900
Vehicles	400	700	700	400	2,200
Camp Supplies	1 000	1,500	1,500	500	4,500
Camp Charge	2,200	2,300	2,300	2,200	9,000
Camp Set Up	1,000	1,800			2,800
Travel	400			400	800
C.W.G & E Direction	1,400	1,400	1,400	1,400	5,600
Met Testing	1,000	2 000	5,000	12,200	20 200
Totals	14,700	22,200	26,500	25,500	88,900

COMMONWEALTH OF AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

AND THE

MINING DEPARTMENT, UNIVERSITY OF MELBOURNE

ORE-DRESSING INVESTIGATIONS

REPORT No 663

ACID LEACHING OF OXIDIZED COPPER ORE FROM MOUNT GUNSON, S.A.

By

J.T. WOODCOCK

Melbourne
July, 1966

REPORT No 663

ACID LEACHING OF OXIDIZED COPPER ORE FROM MOUNT GUNSON, SOUTH AUSTRALIA

Abstract

Three samples of an oxidized copper ore were investigated. These contained malachite, chrysocolla, and atacamite in a siliceous gangue, with some calcite.

Sample A, which was an unrepresentative sample of high grade ore (8 per cent copper) was treated by percolation leaching of minus ½ in ore. About 96 per cent of the copper was extracted in 7 days treatment with a sulphuric acid consumption of 363 lb/ton (2.0 lb/lb Cu dissolved).

Sample B assayed 1.6 per cent copper and was derived from percussion drill cuttings. Only 80 per cent of the copper was dissolved in 1 hr leaching with sulphuric acid of minus 10 mesh material, and longer leach times or finer grinding did not improve this.

Sample C assayed 1.3 per cent copper, and was a representative sample of percussion drill cuttings from a number of drill holes. Acid leaching of minus 14 mesh ore extracted 90 per cent of the copper in 2 hr, and longer leaching times or finer grinding gave no significant benefit. Acid consumption was about 60 lb/ton (2.3 lb/lb Cu dissolved).

A leach-precipitation-flotation test on Sample C recovered 70 per cent of the copper in a concentrate assaying 21 per cent copper, and this result could probably be improved.

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CONTENTS

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INTRODUCTION

Three samples of an oxidized copper ore from Mount Gunson, South Australia, were submitted by Chapman, Wood, Griswold & Evans Pty. Ltd. with the request that we conduct a preliminary examination of the samples to determine the copper extraction and acid consumption during sulphuric acid leaching. One leach-precipitation-flotation test was also conducted.

Sample A, the first sample submitted, was known to be high grade, but was not representative of the orebody. The main purpose of working on this sample was to check the results of work conducted in 1937 by the Bonython laboratory, Adelaide (New Series Reports No 40 and 47).

Sample B had been prepared from percussion drill cuttings taken from the first few holes drilled.

Sample C was also composed of percussion drill cuttings, but had been prepared from drill holes throughout the volume of mineralization and was the most representative sample available in regard to grade and location of drill holes.

Note: No responsibility is taken for the results in this report except insofar as they apply to the samples investigated. Reagent consumptions are based on long tons (2240 lb). The screens mentioned are from the British Standard sieve series.

HEAD SAMPLES

HEAD ASSAYS

Analyses conducted on the samples submitted are set out below.

	Sample A	Sample B	Sample C
Cu (total), %	8.4	1.6*	1.31
Cu (oxide), %	n.d.	n.d.	1.23
S (total), %	n.d.	n.d.	0.10
S (sulphate), %	n.d.	n.d.	0.08

n.d. Not determined
* Calculated from test products.

NATURE OF SAMPLES

Generally speaking the samples consisted of green oxidized copper minerals disseminated in sandstones and quartzite. In Sample A the main copper mineral appeared to be malachite, but some atacamite and chrysocolla may have been present. The nature of the copper minerals in the other samples was not determined, but green particles picked out of the ore dissolved in dilute sulphuric acid and most of them effervesced while dissolving, so that they were probably carbonates.

Sample A contained numerous gypsum crystals but little calcite was observed.

SAMPLE PREPARATION

Sample A was received in the form of lump ore (3700 g).

The whole of the sample was crushed minus ½ in., and about one-eighth riffled out and pulverized to provide a sample for head assay. The remainder of the minus ½ in. ore was used in a percolation test.

Sample B was received as 887 g of percussion drill cuttings. The sample was minus 10 mesh and was riffled into 250g and 100g lots for investigation. No direct head assay was conducted on this sample.

Sample C was received as 49 lb of percussion drill cuttings. The maximum particle size present was about ⅜ in., and about two-thirds of the sample was plus 14 mesh. The sample was crushed minus 14 mesh and then riffled into 250g lots for investigation. One 250g portion was pulverized to provide a sample for head assay.

PERCOLATION LEACHING

OF SAMPLE A

As noted previously a percolation test only was conducted on Sample A. The whole of the crushed ore remaining after removing the assay sample (3069g of minus ½ in. ore) was carefully placed in a 4 in. diameter tube, so as to minimize size segregation, giving a bed depth of 8½ in.

Details of percolation are shown in Table 1. The first step was to run 2000 ml. of 5 per cent sulphuric acid onto the charge by upward percolation, and to allow it to stand for 1 hour. Thereafter the standard procedure was to displace the solution in the bed by a fresh batch of 5 per cent acid, using downward percolation, and to then allow the acid to remain in contact with the bed for a convenient time that resulted in a relatively blue solution. In the early stages of the run the contact time varied from 1 to 2 hours, but in the later stages it was 24-64 hours.

Copper and free acid determinations were made on effluent solutions as shown in Table 1. Copper determinations were made by a variation of the iodide-thiosulphate method. Free acid determinations were made by titrating an aliquot of the solution with N/1 caustic soda to the first permanent precipitate. When the solution was low in copper, pH paper which changed colour at pH 4-4.5 was used as an indicator.

When the amount of copper dissolved per cycle had fallen to a relatively low proportion of the total, the bed was given four 2000 ml. water washes. The residue was then dried, weighed, sampled, and assayed. Some undissolved particles of green copper mineral were observed in the bed, and these probably occurred in parts where there had been some segregation of slimes which were not penetrated properly by the leach solution.

The total time involved in the test was about 7 days. Details of copper extraction and acid consumption are shown in Table 2.

DISCUSSION

These results show that after 173 hours treatment (7 days) nearly 96 per cent of the copper was extracted. Most of the copper (i.e. about 90 per cent) was extracted in the first 3 days of treatment. On the remaining 4 days the copper extraction was equivalent to a little over 1 per cent per day. A higher extraction could have been obtained with longer treatment since there were some undissolved, but soluble copper minerals in the residue.

Table 1. Details of percolation leach on Sample A

Solution added		Effluent solution				Contact time
Vol. ml.	H_2SO_4 g/l.	Prod. No.	Vol. ml.	H_2SO_4 g/l.	Cu g/l.	hr
2000	50.0	1	1910	18.7	19.4	1
2000	50.0	2	1980	20.4	19.4	2
2000	50.0	3	1960	24.8	16.1	2
1970	50.0	4	2000	14.2	24.7	16
2000	50.0	5	1980	29.3	13.9	8
2000	50.0	6	1980	30.4	12.9	16
2000	50.0	7	1940	41.0	5.8	8
1960	50.0	8	1990	41.0	6.3	24
2000	50.0	9	1950	41.9	4.9	64
2000	50.0	10	1980	43.0	1.6	24
2000	Nil	11	2000	)	)	2
2000	Nil	12	2000	) 2.9	) 0.1	2
2000	Nil	13	2020	)	)	2
2000	Nil	14	1620	)	)	2
-						

Feed weight 3069 g — Bed diameter 4 in.

Residue weight 2535 g — Bed depth $8\frac{1}{2}$ in.

Table 2. Metallurgical results of percolation on Sample A

Product No.	Contact time hr		H_2SO_4 consumption				Cu extraction %	
			lb/ton		lb/lb Cu*			
	Stage	Prog.	Stage	Prog.	Stage	Prog.	Stage	Prog.
1	1	1	120	120	4.4	4.4	14.4	14.4
2	2	3	44	164	1.6	3.0	14.9	29.3
3	2	5	36	200	1.6	2.6	12.2	41.5
4	16	21	52	252	1.4	2.2	19.1	60.6
5	8	29	31	283	1.5	2.1	10.7	71.3
6	16	45	29	312	1.6	2.0	9.9	81.2
7	8	53	13	325	1.6	2.0	4.4	85.6
8	24	77	13	339	1.5	2.0	4.9	90.5
9	64	141	13	352	1.9	2.0	3.7	94.2
10	24	165	11	363	4.8	2.0	1.2	95.4
11-14	8	173	-	363	-	2.0	0.3	95.7

* lb H_2SO_4 per lb copper dissolved

Residue assay 0.44% Cu

Residue weight 82.6% of original feed

Calculated feed assay 8.4% Cu

The sulphuric acid consumption was 363 lb/ton for the duration of the test and this was equivalent to 2.0 lb/lb Cu dissolved. The theoretical acid consumption for dissolving $CuCO_3$ is about 1.5 lb/lb Cu dissolved. In the first hour of treatment the acid consumption was much higher than the theoretical figure, indicating acid attack on gangue minerals (probably other carbonates). Thereafter the acid consumed was only a little over the theoretical figure.

For dissolution of 95.7 per cent of the copper present (assuming it present as $CuCO_3$) the theoretical consumption is 276 lb/ton, indicating that about 87 lb/ton was consumed in dissolving gangue minerals. This was a little higher than the consumption obtained by the Bonython laboratory, but generally speaking the results are similar.

The percolation rate was relatively high during both upward and downward percolation, but could be slower in a deeper bed. Nevertheless the results as a whole indicate that ore of this nature can be satisfactorily treated by percolation leaching with sulphuric acid.

AGITATION LEACHING

TESTS ON SAMPLE B

Three agitation leaching tests were conducted on Sample B. Each test was conducted at a liquid/solid ratio of 3/1 by agitation with a variable speed stirrer in a glass beaker. Test 352 was conducted by agitation of 250 g of minus 10 mesh material, Test 353 with 100 g of minus 10 mesh material, and Test 354 with 100 g of material that had been dry ground minus 100 mesh with a mortar and pestle. Because of differences in sizing and total volume, stirring conditions were not identical in each test.

Table 3. Agitation leach details for Sample B

Liquid/solid ratio 3/1
Theoretical H_2SO_4 for dissolution of 1.5% Cu as $CuCO_3$ = 50 lb/ton

Time min	Test 352 -10 mesh ore 1 hr leach			Test 353 -10 mesh ore 3 hr leach			Test 354 -100 mesh ore 3 hr leach		
	Cu g/l.	pH*	Acid addn. lb/ton	Cu g/l.	pH*	Acid addn. lb/ton	Cu g/l	pH*	Acid addn. lb/ton
0	0	7.6	50	0	7.8	55	0	8.0	55
5		1.75	16		1.8	7		2.1	
10		1.65			1.95	7		2.5	14
15		1.7							
20	3.3	1.8	8		1.8	14		2.0	7
30		1.6		3.7	1.7		3.9	1.85	7
40	3.95	1.75	16		1.7				
50		1.55			1.7			1.8	7
60	4.05	1.6		4.1	1.7	7	4.1		7
90				4.2	1.7	7	4.2	1.5	14
110					1.6			1.5	
120				4.2	1.5	28	4.2	1.4	14
180				4.2	1.45		4.3	1.5	
Total acid			90	Total acid		125	Total acid		125

* pH measured before addition of acid.

Table 4. Metallurgical results for Sample B

	Test 352	Test 353	Test 354
Time (min)	% Cu extr.	% Cu extr.	% Cu extr.
0	0	0	0
20	62.7	70.7	73.6
30			
40	75.3	78.3	77.4
60	77.3	80.3	79.2
90		80.3	79.2
120		80.3	81.1
180			
Total acid addition, lb/ton	90	125	125
Final acid conc. g/l.	5.1	9.4	10.0
Actual acid consumpt. lb/ton	65	62	58
lb H_2SO_4/lb Cu dissolved	2.37	2.18	2.02
Final residue wt., %	96.0	95.5	95.5
Cu assay of residue, %	0.38	0.32	0.31
% loss of Cu in residue	22.8	19.7	18.9
Calc. Cu assay of feed, %	1.58	1.57	1.59
Sizing (% - 200 mesh)	22	22	53

At the start of Test 352, sulphuric acid equivalent to the theoretical amount required to dissolve the copper was added, whereas in Test 353 and 354 the theoretical acid plus an excess of 10 per cent was added. During the test further acid was added as required to keep the pH below 1.8 as shown in Table 3.

The copper concentration was measured at appropriate intervals and the free acid concentration was determined at the end of the run (Tables 3 and 4).

RESULTS AND DISCUSSION

A summary of the metallurgical results is given in Table 4. In Test 352, which was a 1 hour leach of minus 10 mesh material about 63 per cent of the copper had been dissolved after 20 min leaching but this had risen to only 77 per cent after 60 min agitation, for an acid consumption of 65 lb/ton or 2.37 lb/lb Cu dissolved. This was a relatively low extraction (leaving a residue assaying 0.38 per cent copper) and two possible reasons for this were insufficient agitation time, or too coarse a feed, with the possibility of there being too low an acid addition.

In Test 353 a 3 hour leach period was used on minus 10 mesh material and a greater amount of acid was added in the early stages of the run. This longer leaching time and higher acid strength gave only a small increase in copper extraction (to 80 per cent), and the acid consumption was about the same.

In Test 354 the ore was ground minus 100 mesh before leaching

and was then leached for 3 hours with a relatively high sulphuric acid addition. This resulted in a small increase in extraction (to 81 per cent), but left a residue assaying 0.31 per cent copper.

It seems likely that the copper in the residue is present as either metallic copper, which would dissolve relatively slowly under the conditions used, or as a sulphide, which would dissolve very slowly. This point was not investigated further in view of the work to be done on the more representative sample (Sample C) and because very little sample was available, but it does warrant additional study. Possibly an addition of ferric ion would aid dissolution.

AGITATION LEACHING

TESTS ON SAMPLE C

Four agitation leaching tests were conducted on Sample C - two with a 'low' acid addition (one on minus 14 mesh ore and one on minus 48 mesh ore) and two with a 'high' acid addition (one on minus 14 mesh ore and one on minus 48 mesh ore). The 'low' acid addition was 46 lb/ton and was the theoretical acid required to dissolve 1.22 per cent copper as $CuCO_3$ plus an excess of 10 per cent. The 'high' acid addition was 79 lb/ton and was sufficient to maintain a pH of about 1.6 at the end of the run. In each test 46 lb/ton sulphuric acid was added at the start and then the additional acid added as shown in Table 5.

All tests were conducted with 250 g ore at a liquid/solid ratio of 3/1, and were stirred as noted for Sample B. The minus 48 mesh ore was prepared by dry grinding in a mortar and pestle. Copper determinations were made at appropriate intervals and the free acid concentration was determined at the end of the run. The final residue was filtered, washed, and assayed after each test.

RESULTS AND DISCUSSION

Metallurgical results are shown in Table 6. In Tests 355 and 358, which were conducted with a 'low' acid addition (theoretical plus 10 per cent) about 66 per cent of the copper was extracted after 1 hour of leaching and this increased to only 68 per cent after 3 hours leaching. The pH rose to over 3 after 1 hour, and it was clear that reaction with gangue had consumed more than the 10 per cent excess acid added and reaction with copper minerals ceased. It is worth noting that the results for minus 14 and minus 48 mesh ore were very similar.

In Tests 356 and 357, in which a greater acid addition was made, the pH at the end of the tests was about 1.6. Under these conditions 91 per cent of the copper was dissolved leaving a residue assaying about 0.1 per cent copper. There was very little difference between the extraction after 2 hours and after 3 hours. The extraction was not significantly different for minus 14 mesh ore or for minus 48 mesh ore.

The acid consumption under these conditions for minus 14 mesh ore and for minus 48 mesh ore was about 60 lb/ton (or 2.4 lb/lb Cu dissolved) and was about 18 lb/ton higher than the theoretical figure of 42 lb/ton.

To sum up then, these preliminary tests show that the ore can be readily treated by crushing minus 14 mesh and then acid leaching. It might be necessary to grind finer than 14 mesh for satisfactory agitation, and this would introduce additional iron into the pulp which would consume additional acid. This should be investigated.

Table 5. Agitation leach details for Sample C

Liquid/solid ratio 3/1

Theoretical H_2SO_4 for dissolution of 1.22% Cu as $CuCO_3$ = 42 lb/ton

Test 355 minus 14 mesh ore				Test 358 minus 48 mesh ore			
Time min	Cu g/l.	pH*	H_2SO_4 lb/ton	Time min	Cu g/l.	pH*	H_2SO_4 lb/ton
0	0	7.0	46	0	0	7.2	46
15		2.65		15		2.0	
45		3.0		45		3.3	
60	2.78	3.2		60	2.73		
90		3.4		120	2.78	3.6	
105	2.83						
165		3.65		180	2.86	3.5	
180	2.86	3.6					

Test 356 minus 14 mesh ore				Test 357 minus 48 mesh ore			
Time min	Cu g/l.	pH*	H_2SO_4 lb/ton	Time min	Cu g/l.	pH*	H_2SO_4 lb/ton
0	0	8.0	46	0	0	7.3	46
5		2.2		5		1.9	
30		2.4		30		3.1	
60	2.75	3.0	$16\frac{1}{2}$	60	2.74	3.3	33
90	3.22	2.0	$16\frac{1}{2}$	75		1.4	
150	3.72	1.6		120	3.58	1.5	
180	3.68	1.6		180	3.79	1.6	

pH measured before addition of acid.

LEACH-PRECIPITATION-FLOTATION TEST ON SAMPLE C

One preliminary leach-precipitation-flotation test was conducted on Sample C to obtain some data on this method of treatment.

A 250 g portion of minus 14 mesh ore was wet ground in a rubber lined mill, using steel balls, for 20 min; 165 lb/ton sulphuric acid was then added and grinding continued for a further 20 min. The pH was then 0.8 and the balls were covered with metallic copper. About 30 lb/ton of iron filings (prepared by filing mild steel) were then added (this was about 20 per cent more than the theoretical amount required to precipitate all the copper dissolved) and grinding continued for a further 10 min. The resultant sizing was 98 per cent minus 48 mesh and 58 per cent minus 200 mesh. The pulp was transferred to a flotation cell, and the mill and balls were cleaned by grinding with sand and ammonia solution (these products were

assayed as noted later).

Table 6. Metallurgical results for Sample C

	Test 355	Test 358	Test 356	Test 357
Time min	% Cu extr.	% Cu extr.	% Cu extr.	% Cu extr.
0	0	0	0	0
60	66.0	65.2	68.2	66.7
90			79.8	
105	67.5			
120		66.3	92.2	87.1
160	67.9	68.3	91.2	92.2
Total acid addition, lb/ton	46	46	79	79
Final acid conc., g/l.	Nil	0.2	2.94	3.0
Actual acid consumpt., lb/ton	46	45	60	59
lb H_2SO_4/lb Cu dissolved	2.40	2.33	2.43	2.32
Final residue wt., %	94.4	96.2	96.0	96.0
Cu assay of residue, %	0.42	0.415	0.12	0.10
% loss of Cu in residue	32.1	31.7	9.5	7.8
Calc. Cu assay of feed	1.26	1.26	1.21	1.23
Sizing (%-200 mesh)	23	30	23	30

The pulp was treated in a modified Ruth laboratory flotation cell under the following conditions.

Flotation time	20 min
pH	1.8
Secondary butyl xanthate	0.3 lb/ton) Added in
Minerec B	0.6 lb/ton) three stages

No frother was added as the froth was quite satisfactory. Metallic copper (or copper-coated iron) floated readily, as well as some gangue minerals. Results are shown in Table 7.

These results show that 70 per cent of the copper was recovered in a flotation concentrate assaying about 21 per cent copper. About 14 per cent of the copper was left on the grinding balls, and it is likely that by a change of technique (i.e. by grinding in neutral solution and then leaching and precipitating in an external vessel) that most of this copper could be recovered in the concentrate.

The total loss of copper in the flotation tailing was about 16 per cent which was made up of 9 per cent in solid tailing assaying 0.13 per cent copper, and 7 per cent in solution. It may be possible to reduce the loss in solution, but probably not that in solid tailing because the assay is similar to that in direct leach residue (Test 356 and 357 in Table 6).

These results are encouraging and further investigation is probably worth while.

Table 7. Results of leach-precipitation-flotation

Product	% wt.*	Assay			% Cu distrib.
		Cu %	Fe %	Insol %	
Flot. conc.	4.4	21.2	23.5	22.3	70.3
Flot. tail Cell soln.	92.4 1340	0.13 0.007			9.0) 16.1 7.1)
NH_3 soln. Cleaning sand	100 100	0.095 0.085			7.2) 13.6 6.4)
Calc. feed	100	1.33			100.0

* Based on original ore.

CONCLUSION

Results presented in this report show that ore from Mount Gunson is amenable to sulphuric acid leaching to dissolve copper. Referring particularly to Sample C (the most representative sample submitted) about 90 per cent of the copper was extracted from minus 14 mesh ore with an acid consumption of 60 lb/ton (about 18 lb/ton more than theoretical). Commercial grinding may introduce more iron into the system than laboratory work and so the acid consumption would be higher. In addition, some discard of solution containing unused acid is probably inevitable and this would also result in a higher acid consumption.

A good copper extraction was obtained on the high grade sample (Sample A) by percolation leaching. On Sample B a poor extraction was obtained during agitation leaching for reasons not evaluated.

As the results reported on Samples B and C were obtained on percussion drill cuttings, it is desirable that the results be checked on a sample of bulk ore. This work should include

1. percolation leaching of average grade material,
2. agitation leaching of ground ore as a function of grinding in an iron mill, acid addition, and leach time, and
3. leach-precipitation-flotation tests.

In addition consideration needs to be given to a source of iron for precipitation.

J. Woodcock.

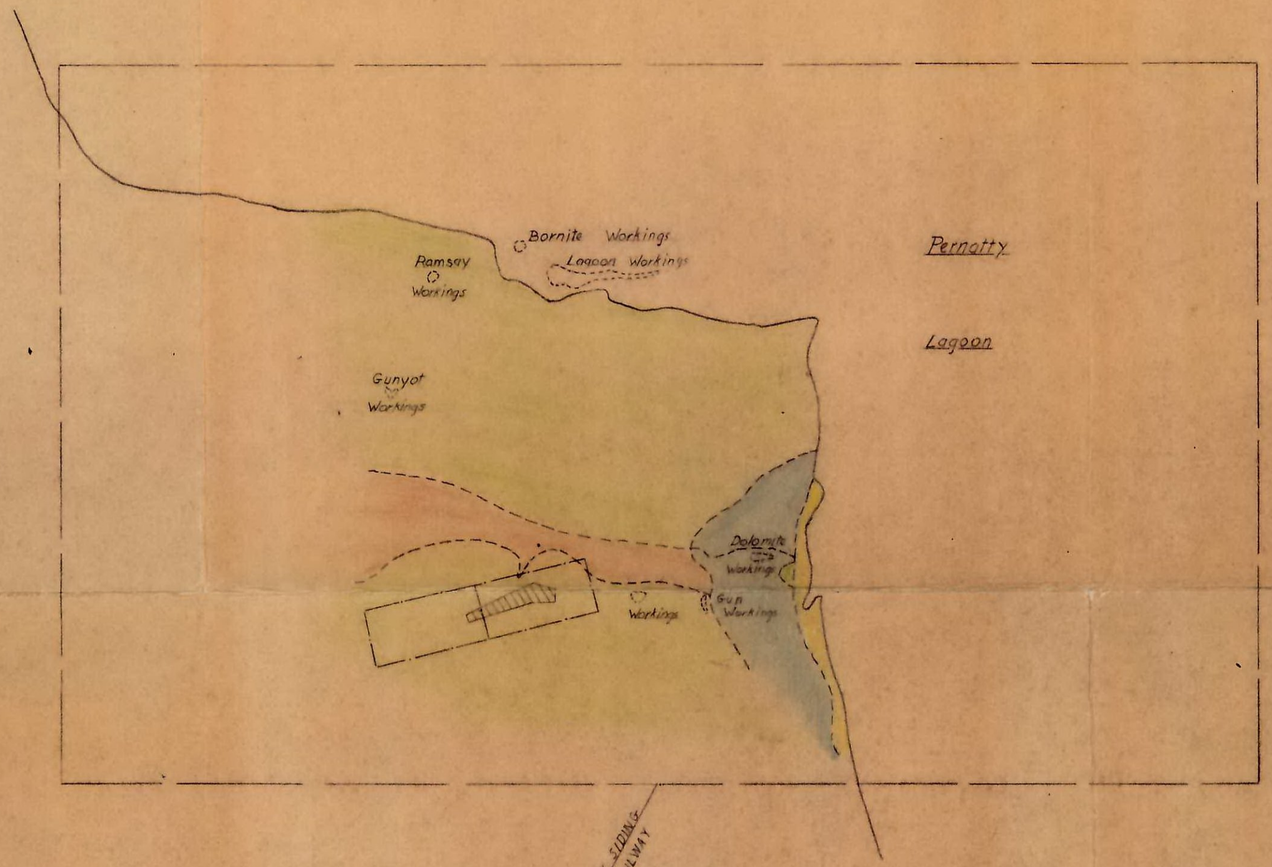
(J.T.Woodcock)
SENIOR RESEARCH SCIENTIST

H. H. Dunkin

(H.H.Dunkin)
OFFICER-IN-CHARGE

19th July, 1966
6502
M.C.

T N



LEGEND

- AUSTMINEX SPECIAL MINING LEASE NO. 96
- AUSTMINEX-JERVOIS OPTION AREA
- GEOLOGICAL BOUNDARY
- OLD WORKINGS
- AREA COVERED BY AUSTMINEX DRILLING
- QUARTZITE
- DOLOMITE
- SAND & ALLUVIUM
- SAND

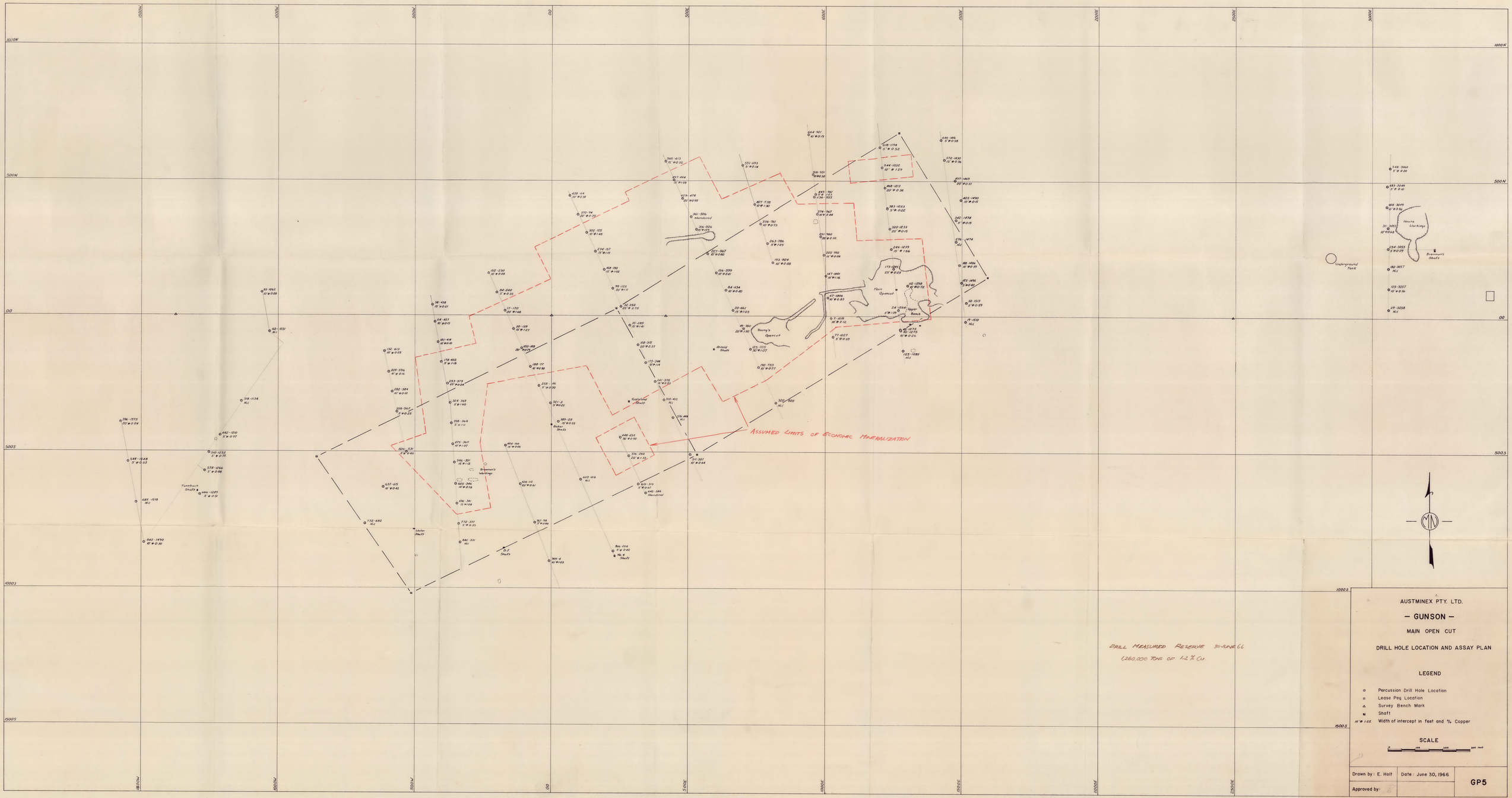
CHAPMAN, WOOD, GRISWOLD & EVANS PTY. LTD.

GUNSON

LEASE LOCALITY PLAN

Scale :- ½ mile = 1 inch	Date :- 2nd. Feb. 1966	GP 1
	Checked :-	
Drawn :-	Approved :-	

625-1



DRILL MEASURED RESERVE 30-JUNE 66
1,260,200 TONS OF 1.2% Cu

AUSTMINEX PTY. LTD.

— GUNSON —

MAIN OPEN CUT

DRILL HOLE LOCATION AND ASSAY PLAN

LEGEND

- Percussion Drill Hole Location
- Lease Peg Location
- Survey Bench Mark
- Shaft
- 15'@1.22 Width of intercept in feet and % Copper

SCALE

0 100 200 400 Feet

Drawn by: E. Holt	Date: June 30, 1966	GP5
Approved by:		

625-2


NORTH
NIL
NIL
NIL
267°
NIL
NIL
I
344°
H
G
NIL
NIL
050°
NIL
300°
15'-0·63%
5'-0·65%
F
NIL
15'-1·01%
15'-0·96%
15'-2·70%
21'-1·22%
5'-0·53%
5'-0·52%
E
D
C
B
A
NIL
25'-3·12%
15'-1·18%
15'-1·04%
NIL
NIL
264°
NIL
NIL
NIL
NIL
ASSUMED LIMITS OF ECONOMIC MINERALIZATION
NIL
NIL
NIL
30'-4·48%
4'-0·61%
10'-0·61%
NIL
NIL
NIL
NIL
NIL
NIL
NIL
NIL
NIL
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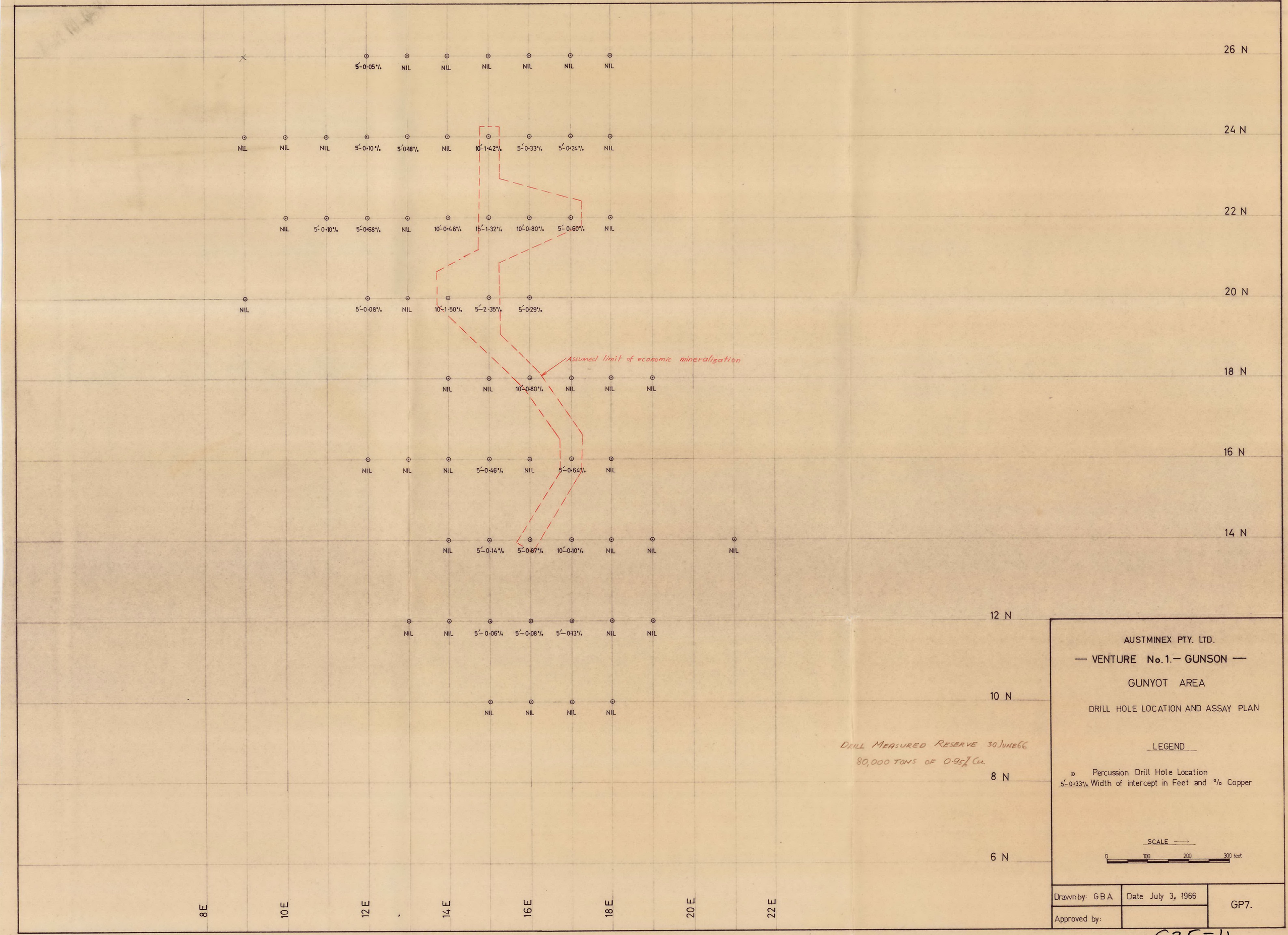
NIL
NIL
EDGE OF LAGOON
EDGE OF LAGOON
OFFICE
EDGE OF LAGOON
DRILL INDICATED RESERVE 30 JUNE 66
460,000 TONS OF 1.3% CU
AUSTMINEX PTY. LTD.
— VENTURE No.1 — GUNSON —
PERNATTY LAGOON AREA
DRILL HOLE LOCATION AND ASSAY PLAN
LEGEND
⊙ — Percussion Drill Hole Location
5'-0·52% — Width of Intercept in feet & % Copper
SCALE
0 100 200 300 Feet
Drawn by : G.B.&A
Date : July 4 — 1966
Approved by:
GP6
625-3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NIL
5'-0·10%
5'-0·18%
NIL
10'-1·42%
5'-0·33%
5'-0·24%
NIL
NIL
5'-0·10%
5'-0·68%
NIL
10'-0·48%
15'-1·32%
10'-0·80%
5'-0·60%
NIL
NIL
5'-0·08%
NIL
10'-1·50%
5'-2·35%
5'-0·29%
Assumed limit of economic mineralization
NIL
NIL
10'-0·80%
NIL
NIL
NIL
NIL
NIL
5'-0·46%
NIL
5'-0·64%
NIL
NIL
5'-0·14%
5'-0·87%
10'-0·10%
NIL
NIL
NIL
NIL
NIL
5'-0·06%
5'-0·08%
5'-0·13%
NIL
NIL
NIL
NIL
NIL
NIL
NIL
NIL
DRILL MEASURED RESERVE 30 JUNE 66
80,000 TONS OF 0·95% Cu.
AUSTMINEX PTY. LTD.
— VENTURE No. 1. — GUNSON —
GUNYOT AREA
DRILL HOLE LOCATION AND ASSAY PLAN
LEGEND
Percussion Drill Hole Location
5'-0·33% Width of intercept in Feet and % Copper
SCALE
0 100 200 300 feet
Drawn by: G B A
Date July 3, 1966
GP7.
Approved by:

625-4