EXPLORATION LICENCE 2/70, TASMANIA

FINAL REPORT ON EXPLORATION IN AREAS TO BE RELINQUISHED FROM THE EASTERN PART OF EL 2/70: MACKINTOSH EAST

NOVEMBER 1984
W. HERRMANN

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TS 2/70 B5	" " "	" " "	"
5577 S/B	Dighem II, Magnetics	Sheet 1	1:10,000
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5576 S/B	Dighem II, Electromagnetics	" "	"
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1. INTRODUCTION

This report presents details and results of all mineral exploration carried out, during the previous five years, in those parts which are to be relinquished from the eastern portion of Exploration Licence 2/70 designated "Mackintosh East".

Figure 1 illustrates the location of the Mackintosh East portion of EL 2/70 and indicates the areas to be relinquished on 30/12/84.

This report also includes a brief summary of mineral exploration in Mackintosh East carried out prior to September 1979. This previous work is reported in full detail in various progress reports (by Paringa and the Aberfoyle Group) which should now be on "Open File" at the Tasmanian Department of Mines.

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REFER TO THIS MAP AS: SHEET 8014 EDITION 3 1977

SCALE: 1:100,000

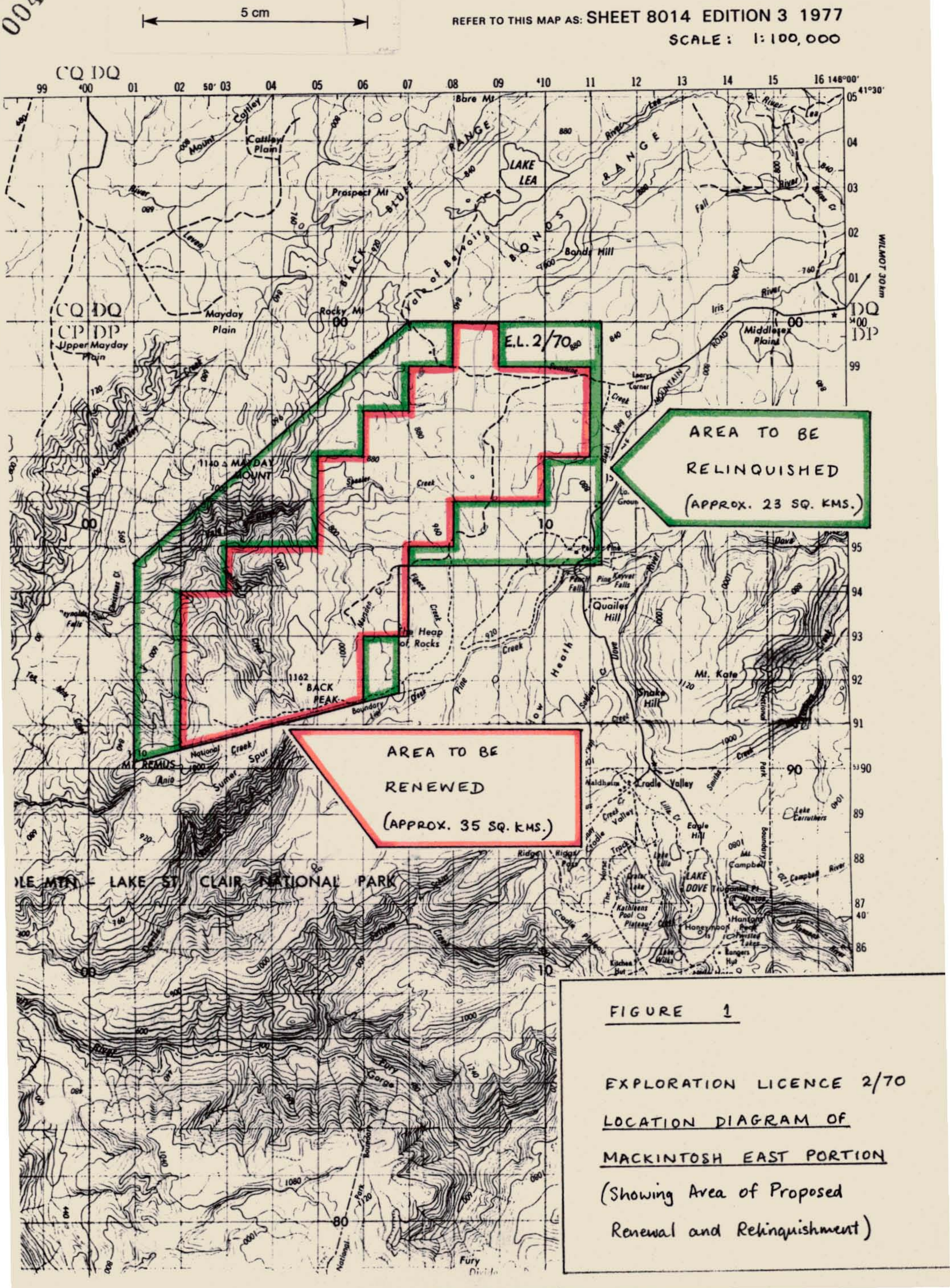


FIGURE 1

EXPLORATION LICENCE 2/70

LOCATION DIAGRAM OF

MACKINTOSH EAST PORTION

(Showing Area of Proposed Renewal and Relinquishment)

2. SUMMARY

Mineral exploration in the Mackintosh East part of EL 2/70 over the past five years has been directed towards the discovery of:

(a) Gold-bearing base metal massive sulphide deposits of the Rosebery, Que River type;

(b) Tin-tungsten bearing skarn or vein stockwork deposits related to Devonian granitic intrusions as at Moina.

Exploration methods used in that part of Mackintosh East which is to be relinquished have included:

- partial reconnaissance geological mapping
- partial coverage by stream sediment geochemical survey
- partial coverage by airborne Dighem II EM-MAG survey
- ground investigation of two Dighem II anomalies.

Most of the area to be relinquished is underlain by Pre-Cambrian deformed meta-sediments, Ordovician siliceous clastics and limestone and superficial Tertiary basalt. A small portion of the area to be relinquished is underlain by Cambrian massive quartz-feldspar-biotite porphyry (rhyodacitic) and minor acid pyroblastics of the "Mt Read Volcanics".

The stream sediment survey has indicated anomalous tin and minor gold in sediments from Fleece Creek and tributaries near the Heap of Rocks. These anomalies have been investigated by work on EL 46/80 which lies (upstream) immediately to the south east. The Dighem II airborne survey succeeded in defining two anomalies considered worthy of ground investigation.

Prover 7 is a cluster of large amplitude EM responses with associated magnetic character, found to be due to conductive weathered basalt (Tertiary).

Prover 8 is a weak magnetic feature lying at the contact between Cambrian porphyry and unconformably overlying conglomeratic sandstone on the southern edge of the Vale of Belvoir. Magnetic feature was found to be due to a small "window" of chloritically altered acid quartz crystal (lithic) pyroclastics with local magnetite-hematite veining and anomalous copper content (up to 1600 ppm). It has been concluded that the iron oxide veining and chloritization are products of alteration peripheral to the sill like (?) porphyry unit.

3. TENURE

Exploration Licence 2/70, currently of 232 sq.km, is held in two portions, designated Mackintosh West and Mackintosh East, by Cleveland Tin NL for Aberfoyle Limited.

The Mackintosh West portion includes the Que River and Hellyer base metal-gold deposits.

The Mackintosh East portion, currently of approximately 58 sq.km, covers part of the north eastern extremity of exposure of the Mount Read Volcanic Belt and lies adjacent to the north western boundary of the Cradle Mountain-Lake St Clair National Park.

Prior to September 1979, the area was explored by the Aberfoyle Group (90%), in joint venture with Paringa Mining and Exploration Co. Ltd (10%).

Under a joint venture agreement of 1st October 1979, Geopeko assumed management of exploration in the Mackintosh East portion and to this date has earned an equity of 40% in that part of the project.

As a consequence of Geopeko's decision to withdraw from active exploration in Tasmania, the company has concluded an arrangement with Amoco Minerals Aust. Company whereby the latter will take over management of exploration on Mackintosh East and acquire a part of Geopeko's interest in the Joint Venture.

Under new guidelines covering the term of Tasmanian exploration licences (effective from 1/7/82) EL 2/70 (entire) is to be reduced to no greater than 125 sq.km in area by 30/12/84.

The Joint Venture partners have agreed to reduce the eastern portion (Mackintosh East) to approximately 35 sq.km.

4. **PREVIOUS WORK** (Summary of Exploration Prior to September 1979).

In November 1969, Paringa Mining and Exploration Co Ltd, on behalf of the Aberfoyle Group, commenced exploration in the environs of a small occurrence of galena-sphalerite mineralization variously referred to as Carter's Prospect, Back Peak Prospect or Fury Plains Prospect.

B-Horizon soil geochemical survey established the existence of several lead anomalies, over some 600m of strike length, in soils overlying the narrow belt of "greenish volcanic rocks, cherts and slates of Cambrian age adjacent to the north western margin of the Pre-Cambrian Tyennan massif". There appeared to be a particular association between high lead values and soils overlying black slates and suggested an overall stratigraphic influence on the source of the lead anomalies. Minor galena-sphalerite mineralization was observed in NW trending fault fissures and also localized within breccia zones at the intersection of the latter faults and NE trending shears. It was considered that this mineralization represented re-mobilization of Pb-Zn from the anomalous slates and volcanics (G Krummei, 1970).

During the following summer season, November 1970 to March 1971, Paringa extended the soil geochemical survey grid to the north-east and south-west of Carter's Prospect and found that Pb-Zn anomalies extended for a combined strike length of about 5.5km in soils overlying the narrow Cambrian volcanic belt.

It was found that the Pre-Cambrian metasediments to the south-east and the Cambrian porphyries to the north-west were not anomalous.

During this season, a wide spaced stream sediment geochemical sampling survey was carried out over most of the northern part of EL 2/70 which at that time extended from Tullah and Que River in the west to the Forth River in the east, embracing the northern boundary of the Cradle Mountain-Lake St Clair National Park.

The stream sediments were analysed for Cu, Pb, Zn and supported the evidence derived from the soil survey, that the Cambrian volcanic suite was the most geochemically favourable rock group and was worthy of further investigation (Varley, 1971).

In February 1972, a helicopter borne electromagnetic and magnetometer survey (H400) was carried out over the northern parts of EL 2/70 by McPhar Geophysics P/L.

EL 2/70 was subsequently renewed in December 1972, in two parts designated Mackintosh West and Mackintosh East.

At Mackintosh East, exploration over the next two seasons (January - February, 1973 and the summer of 1973-1974) included ground follow-up of four "airborne" EM anomalies.

AEM anomalies Nos 9, 10 and 12 in the Northern part of Mackintosh East were found to be due to flat lying conductors related to Tertiary basalt or ground water accumulations and were subsequently dismissed.

AEM anomaly No. 11 was found to be a strong continuous conductor within the Pre-Cambrian meta-sediments and was attributed to a stratigraphic unit, probably a pyritic, graphitic slate horizon. Soil geochemical sampling failed to give any encouragement and no further work was recommended.

Ground EM reconnaissance was also carried out on part of the extensive Paringa (soil geochemical) grid. The EM survey on all lines (except 2100N) showed horizontal effects only; no massive conductors were indicated and there were no features related to interesting geology or geochemistry. However, the progress report of June 1974, recommended an Induced Polarization survey and testing of the soil geochemical anomalies by drilling (Skey, 1973 & 1974).

During February 1975, Geoquest P/L, on behalf of Cominco Exploration P/L, carried out Induced Polarization surveys on lines 8100N, 7300N, 2900N and 2100N over the Pb soil geochemical anomalies defined by Paringa in 1970/71. Weak frequency effect IP anomalies were found to occur, coincident with soil geochemical anomalies, on lines 7300N and 2100N within the Cambrian volcanic suite marginal to the Pre-Cambrian meta-sedimentary basement (Skey, 1975).

Testing of the anomalies by drilling was recommended.

Further investigation of the coincident IP-geochemical anomalies was delayed until 1978 when four trenches were excavated (by bulldozer) on the grid lines which had been covered by the IP survey. Mapping of the trenches revealed that the underlying rocks are weakly sheared barren rhyolites with minor late stage intersecting quartz-chlorite "veinlets with disseminated sulphides". It was concluded that the soil anomalies were derived from the latter veinlet mineralization but were not due to stratiform sulphide mineralization (Young, 1978).

5. **EXPLORATION BY GEOPEKO: 1/10/79 TO PRESENT**

Since 1st October 1979, mineral exploration within the Mackintosh East portion of EL 2/70 has been conducted by Geopeko as "operator" for the joint venture.

The exploration target has been twofold:

1. The principal objective has been to discover gold bearing massive base metal sulphide deposits of the type exemplified by Que River and Rosebery.

2. A secondary objective has been to discover tin-tunsgten bearing skarn (Gordon Limestone) or vein stockwork mineralization related to Devonian granitic intrusive activity as occurring (for example) at Moina.

The greater part of Geopeko's exploration work has been within the area of Mackintosh East to be retained after the forthcoming reduction, and will not be detailed herein.

Exploration work in the area to be relinquished has comprised:

- Geological reconnaissance mapping at 1:10,000 scale
- Partial coverage by stream sediment geochemical sampling survey
- Partial coverage by Dighem II airborne electromagnetic - magnetic survey
- Ground follow-up of the Prover 7 (Dighem II) EM-Magnetic anomaly.
- Ground follow-up of the Prover 8 (Dighem II) Magnetic anomaly.

This work was carried out during the period October 1979 to April 1982. Essentially no work has been conducted since the latter date.

5.1 Geological Mapping

(Refer to Plans TS 2/70 A2, TS 2/70 B2)

- South Eastern Part of Mackintosh East:
  (Heap of Rocks - Fury Plain - Pencil Pine Areas)

  This area, dominated by alpine grassland and heath, is underlain by metasediments forming the north-western margin of the Pre-Cambrian "Tyennan" cratonic nucleus. These rocks have not been mapped in detail. They consist principally of laminated and massive quartzites and psammo-pelitic schists with minor carbonaceous-pelitic schists. They show evidence of multiple deformation and regional metamorphism of the "greenschist" facies.

- North Eastern Part of Mackintosh East:
  (Charleston's Hut to Sunshine Creek Area)

  This area has not been mapped in detail but is presumed to be largely covered by Tertiary Basalt. Though not observed, the southern part of the Fall Plain is likely to be underlain by Cambrian massive quartz-feldspar biotite porphyry of more or less rhyodacitic composition which outcrops extensively in the central part of Mackintosh East and north-eastwards, north of the Iris River.

  In the vicinity of Charleston's Hut, the Cambrian porphyry is unconformably overlain by westward dipping siliceous conglomerates and conglomeratic sandstone which are succeeded westward by massive, grey, impure limestone. These units are correlates of the Ordovician Owen Conglomerate and Gordon limestone respectively.

- North Western Part of Mackintosh East:
  (Fourways - Vale of Belvoir Area)

  Ordovician limestone and underlying siliceous (locally hematitic) conglomerate/conglomeratic sandstone are tightly folded about a shallow north easterly plunging synclinal axis. They unconformably overly massive Cambrian quartz-feldspar-biotite porphyry. A narrow "window" of acid quartz crystal and crystal-lithic tuffs is exposed just under the Ordovician unconformity at Prover 8 (see section 5.5).

- Western Part of Mackintosh East

  No mapping has been carried out west of Fourways and Tumbling Creek. The country is rugged and densely forested and presumed to comprise massive quartz-feldspar-biotite porphyry unconformably overlain by the correlates of the Owen Group.

5.2 <u>Stream Sediment Geochemistry</u>

Stream sediment samples were collected at approximately 200-300m intervals along major streams and above confluences of tributary streams draining the accessible areas of the favourable (volcanic) rocks.

Plans No. TS 2/70 A4 and B4 show the sample locations and Cu, Pb, Zn and Au results for the area to be relinquished. Plans No. TS 2/70 A5 and B5 give Fe, Sn and W results.

The -80 mesh fractions of all samples were analysed by Australian Laboratory Services (of 44 Balaclava Street, Woolloongabba, Qld, 4102) in October-November 1979, by the following methods:

Cu, Pb, Zn, Fe, Bi, Ag (Au?)	:	AAS (Method 1)
Sn, W	:	XRF (Method 9A)

Every fourth sample only of sediments (-80 fraction) from the Fleece, Tumbling and Marsden Creek systems was analysed for gold using ALS's Carbon Rod - AAS Method No. 120A.

Anomaly thresholds (based on consideration of the entire population of 208 samples from the Mackintosh East area) were somewhat arbitrarily set at the following levels:

Cu	25ppm
Pb	110ppm
Zn	250ppm
Au	25ppb
Fe	5%
Sn	30ppm
W	30ppm

Silver values were in the range < 1 to 2ppm, considered of no significance and were not graphically plotted.

Bismuth values ranged from < 5 to 40ppm and likewise were not considered of significance to warrant plotting.

The only stream sediment anomalies considered to be of possible significance in the areas to be relinquished are a single gold value of 40ppb and several tin values ranging from 165 to 415ppm, from the Fleece Creek and tributaries threreof, just north of the Heap of Rocks. Rugless (1976) reported the occurrence of a banded quartz-tourmaline rock containing arsenopyrite from the Fleece Creek about 200m upstream from Carters Prospect. These drainage anomalies have been investigated by Geopeko under EL 46/80. (Refer to: Heithersay, 1982 and Pemberton & Sumpton, 1983).

5.3 Dighem II Airborne Electromagnetic/Magnetic Survey

A helicopter-borne Dighem II electromagnetic/magnetic survey was conducted over most of the Mackintosh East area in February-March 1980.

The geophysical report (Fraser & Dvorak, 1980) for the survey has been included in this report as Appendix 2. Plans to accompany the report are also included as:

Plan Nos: TS 2/70 D1-6, D1-7, D1-8, D1-9
and TS 2/7 D3-10, D3-11, D3-12, D3-13.

Within the area to be relinquished, only two anomalies considered worthy of ground investigation were defined. These are Provers 7 and 8 and the results of ground follow-up are detailed in the immediately succeeding sections of this report.

5.4 Ground Follow-Up: Prover 7 (Dighem II EM/Mag Anomaly)

A collection of large amplitude EM responses showing on all channels and with closely related magnetic anomalies. Thought to be basalt but we had to be certain. The MST profiles show considerable and constant variation consistent with traversing across weathered basalt with moderate and variable conductivity. This explains also the airborne response. The total magnetic intensity profiles also show typical response over magnetic basalt.

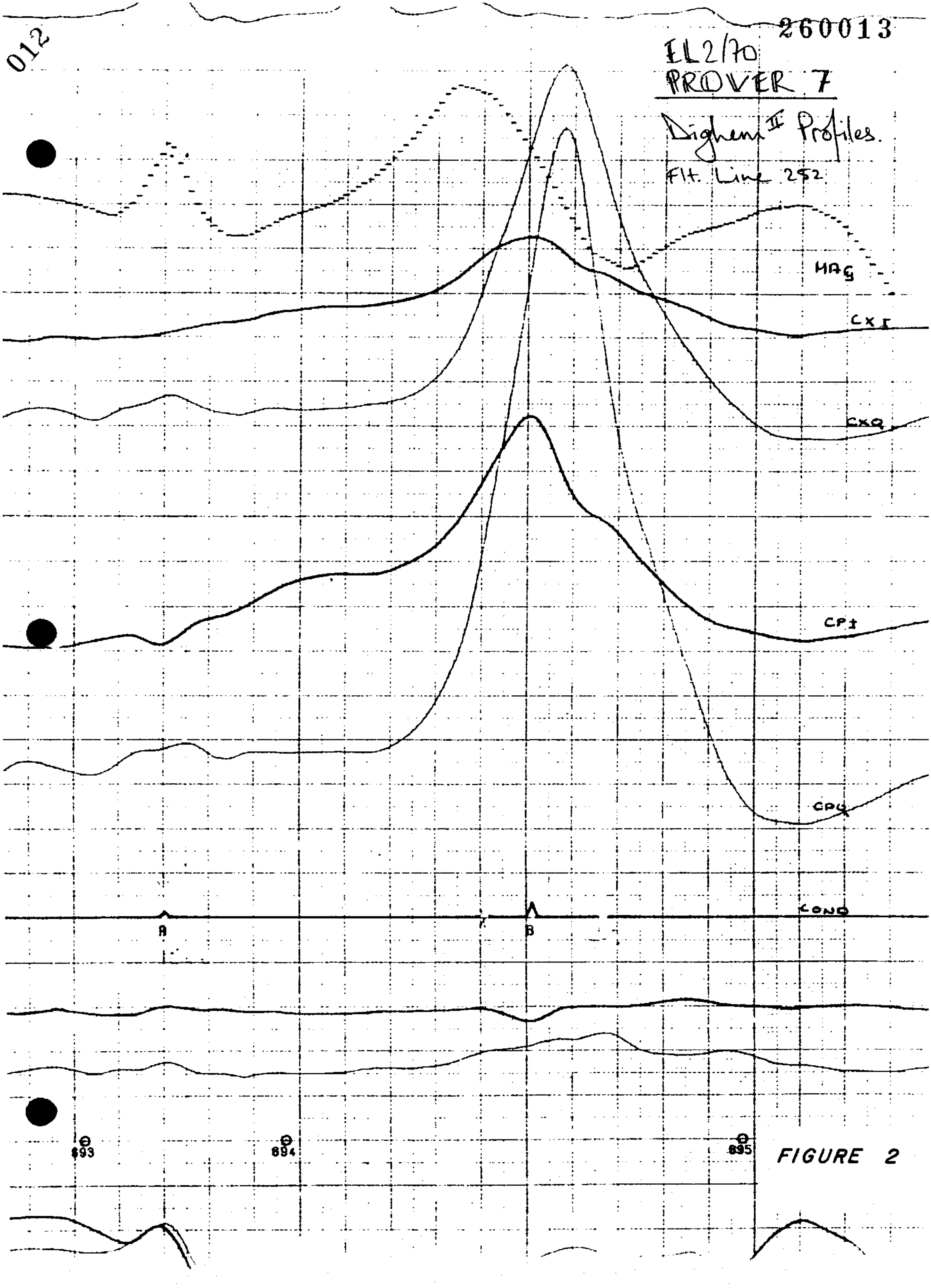
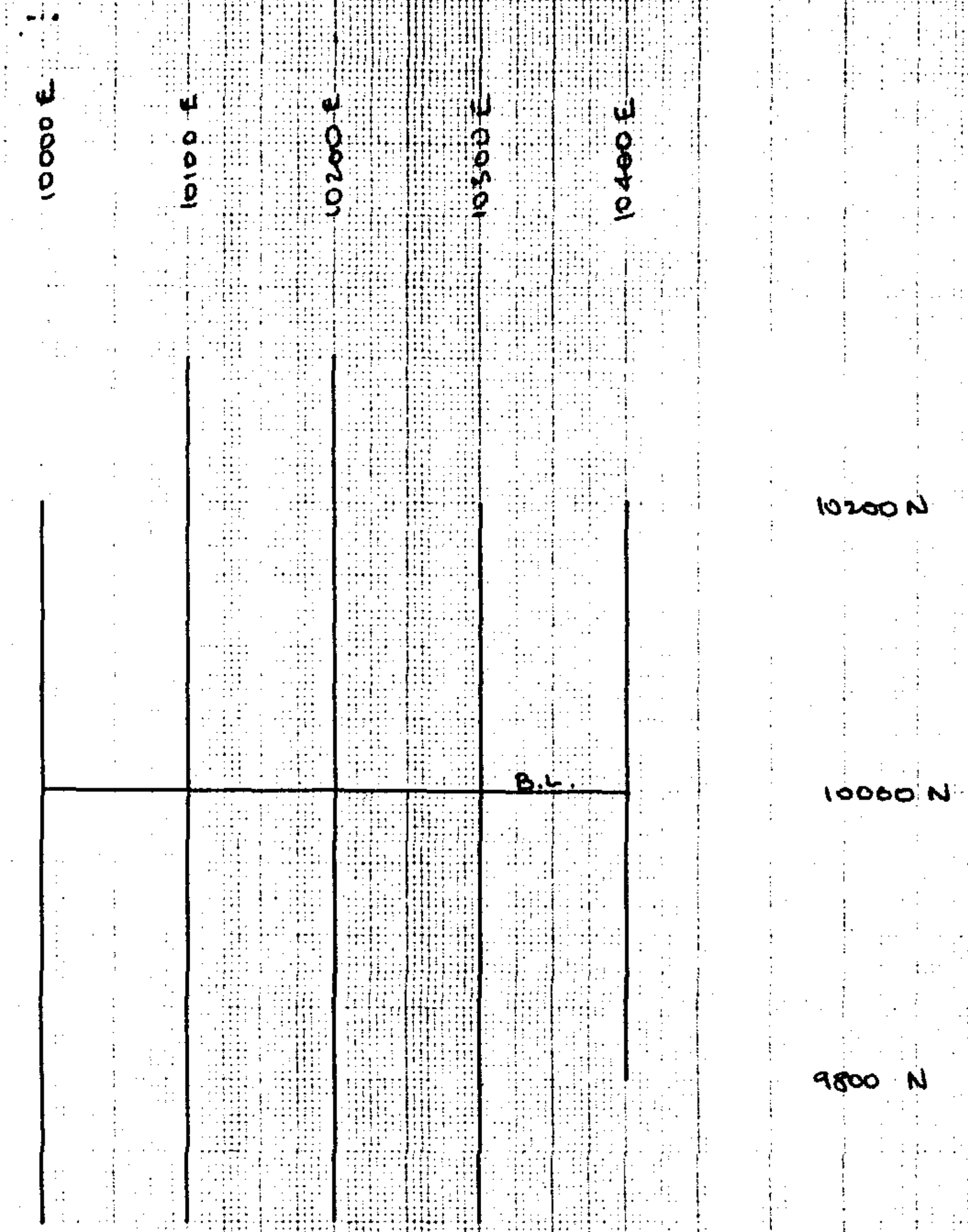

012
EL 2/70
PROVER 7
Dighem II Profiles.
Flt. Line 252
MAG
CXI
CXQ
CPI
CPQ
COND
A
B
893
894
895

FIGURE 2

013

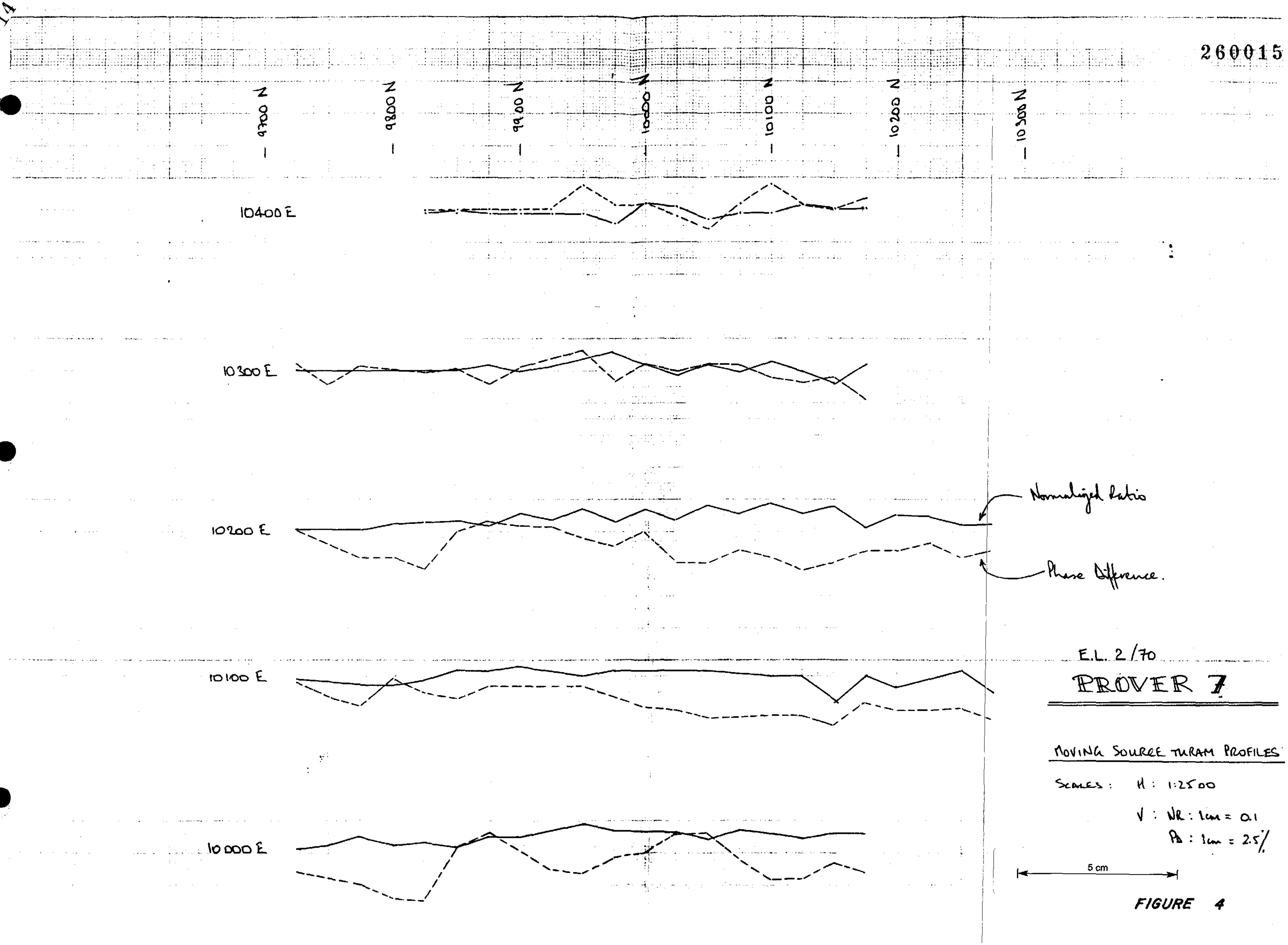
260014



E.L. 2/70 PROVER 7
GRID LAYOUT.
Scale : 1:5000.

5 cm

FIGURE 3



E.L. 2/70

PROVER 7

MOVING SOURCE TURAM PROFILES

SCALES: H: 1:2500

V: NR: 1cm = 0.1

PD: 1cm = 2.5%

FIGURE 4

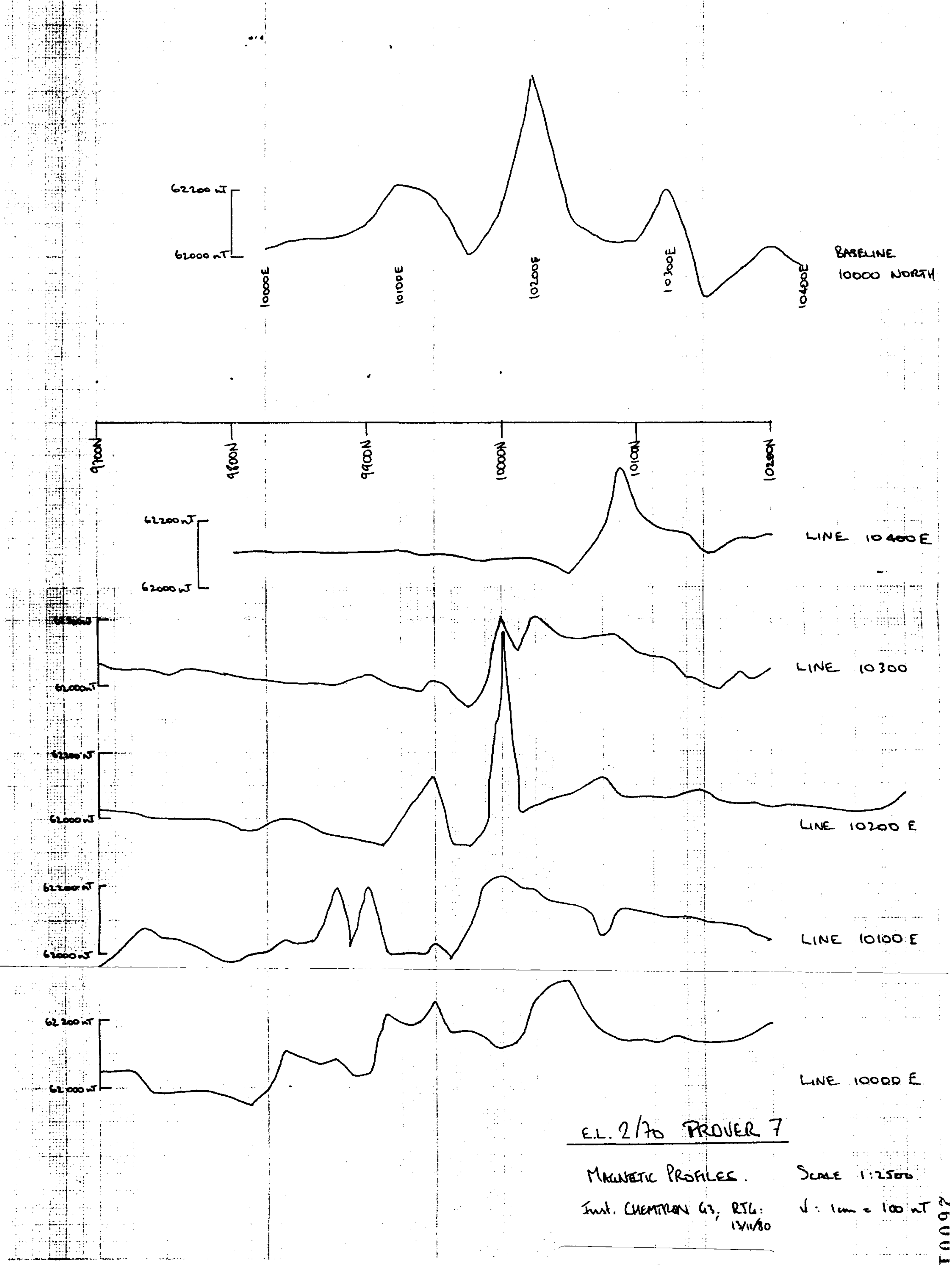

62200 nT
62000 nT
10000E
10100E
10200E
10300E
10400E
BASELINE
10000 NORTH
9700N
9800N
9900N
10000N
10100N
10200N
LINE 10400E
LINE 10300
LINE 10200 E
LINE 10100 E
LINE 10000 E
E.L. 2/70 PROVER 7
MAGNETIC PROFILES.
Inst. CHEMTRON G3, RJG: 13/11/80
SCALE 1:2500
V: 1cm = 100 nT
5 cm

FIGURE 5

5.5 Ground Follow-Up: Prover 8 (Dighem II Magnetic Anomaly)

(Notes on Reconnaissance Work) (November 1981, W Herrmann)

Prover 8 is a Dighem II detected aeromagnetic anomaly located at the southern end of the Vale of Belvoir near the north western boundary of EL 2/70.

A skeletal grid of 1100m x 500m was laid out and magnetically surveyed during November 1980. (P8 Figure 6). The magnetic profiles indicated a broad (200m) anomaly of about 200nT above a relatively "quiet" background. The anomaly was best developed on traverses 10100E and 10400E, suggesting a similar but deeper buried source at the eastern end.

Limited geological reconnaissance had not indicated the source of the anomaly.

Further geological reconnaissance mapping over the anomaly was carried out during late November 1981. (Magnetometer malfunction prevented more detailed magnetic traversing).

It was found that the peaks of the anomaly on 10100E, 10400E corresponded to a "window" of (previously unreported) pyroclastic rocks overlying the massive quartz-feldspar-biotite porphyry unit (6) and in turn unconformably overlain by conglomeratic sandstone and sandstone forming the base of the Ordovician Owen Group.

The Ordovician clastics (and the unconformity surface) dip steeply (35-50^{o}) to the north west and (since the southern slope of the Vale at this end is a steep dip of at least 30^{o}) form a thin cover over the underlying Cambrian rocks.

North-east of 10700E the Ordovician conglomerate/sandstones rest directly on Q-F-Bi porphyry. Mapping of porphyry/pyroclastic contact and lithological boundaries within the window suggest that the pyroclastic sequence extends to the north east under the Ordovician rocks - accounting for the broad magnetic anomaly in this area.

The lithologies within the "window" are typical acid quartz crystal tuffs and lesser lithic crytal tuffs generally with a strong purplish hematitic or brownish limonitic staining. One unit in particular is strongly chloritic and is transected by numerous limonitic veinlets and contains local patches of blebby or disseminated magnetite. This corresponds with the "noisy" segment of the magnetic profile on 10100E.

These iron rich and chloritic tuffs are not similar to the volcanics overlying the Pre-Cambrian gneisses to the south-east (Back Peak - Prover 3 areas). Rock chip samples indicate iron in the range 2.7 - 26% Fe and two samples containing magnetite/hematite veining contain 1600 and 720ppm copper. Lead and zinc (peaking at 110ppm, 305ppm respectively) do not seem to be exceptional.

Two lines of close spaced C-Horizon geochem sampling (Mate Auger) (on 10100m 10400E) showed subtle but spiky copper anomalies to 80ppm. Iron peaks at 5% Fe but is similarly rather spiky. Lead, zinc and silver do not seem to have anomalous character.

The copper "anomaly" on 10100E is "open" to the south and it is suggested that this relates to the Q-F-Bi porphyry contact (at about 9600N) - the porphyry may have slightly higher than usual copper background.

The magnetic anomaly can be attributed to weakly magnetic pyroclastics, abnormally high in iron, which occupy the window occurring stratigraphically above the Q-F-Bi porphyry and unconformably below the Ordovician sediments.

The chloritic composition of some of the pyroclastics and the magnetite-hematite veining/staining may be regarded as a form of alteration.

The conglomerate sandstones at the base of the Ordovician are commonly quite hematitic (especially at the north eastern end of P8 grid) but these have never been observed to be magnetic. It is unlikely that the iron rich alteration of the underlying pyroclastics relates to the Ordovician unconformity.

This writer favours the possibility that the iron rich alteration/veining is due to hydrothermal activity derived from crystallization of the massive Q-F-Bi porphyry. This porphyry "unit" is regarded as synvolcanic intrusive probably of sill-like form. The altered rocks exposed in the "window" at Prover 8 would have constituted the "hanging wall" to the intrusive porphyry. It is difficult to say at this stage, without detailed petrological studies, if there is any <u>fundamental</u> difference in composition of volcanic tuffs below and above (the porphyry) due to some change in the style of vulcanism. My feeling is that there is probably not much fundamental difference and that the iron rich rocks observed in the window were formed by local alteration at the hanging wall of a large sill like porphyry body intruded into an otherwise homogenous volcanic pile.

The high copper values in outcrop samples are interesting but the situation does not readily fit into the massive sulphide-acid volcanogenic models and the prospect does not appear to have much potential. The limited exposure in the window, extensive Ordovician cover, and absence of conductive features in Dighem II data are strong negative factors.

<u>Recommendation</u>

No further work.

<u>Postscript</u>: Note isolated W values (to 35ppm) in C-Horizon soils, appear to correlate with copper > 50ppm, but no correlation to Fe.

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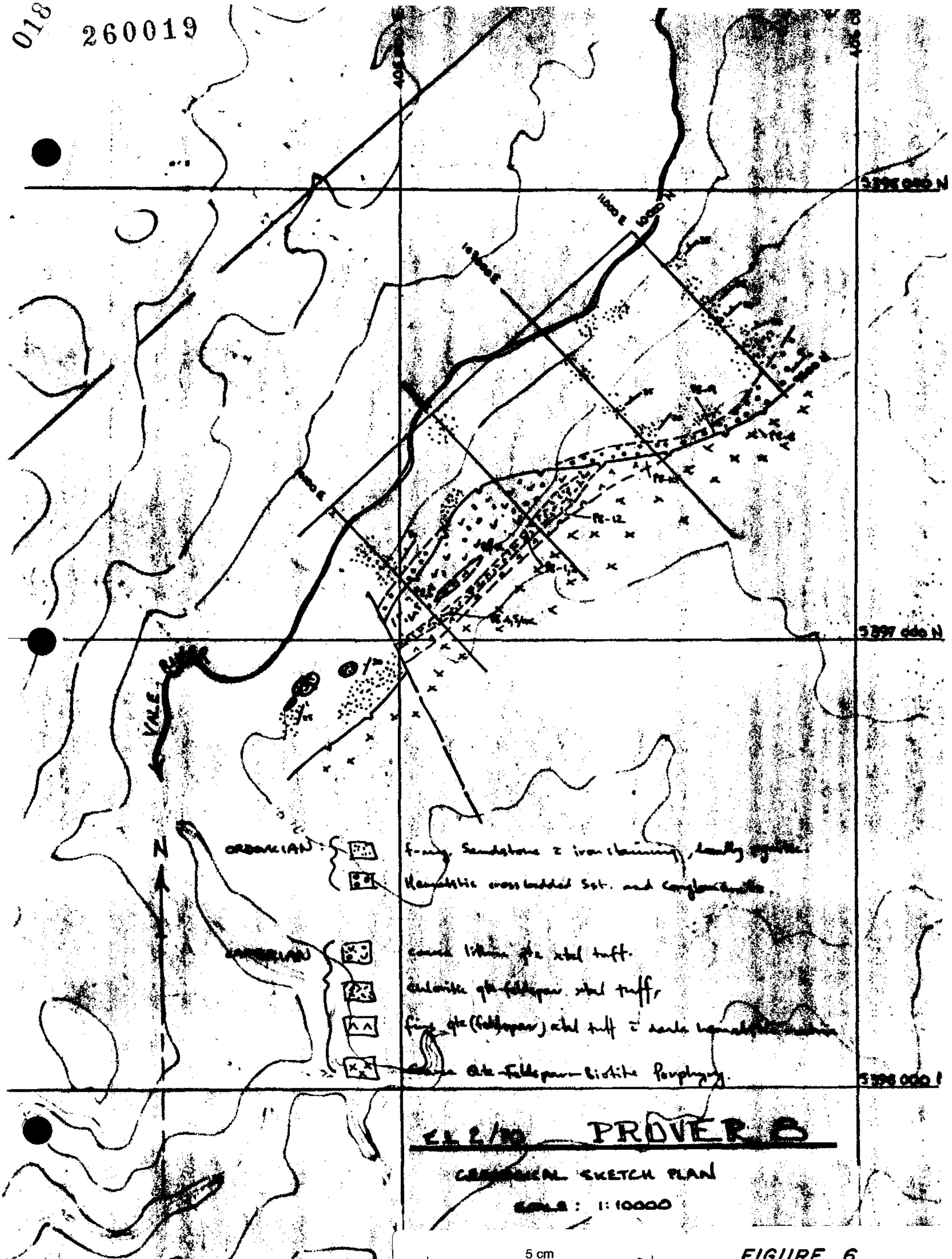

FIGURE 6

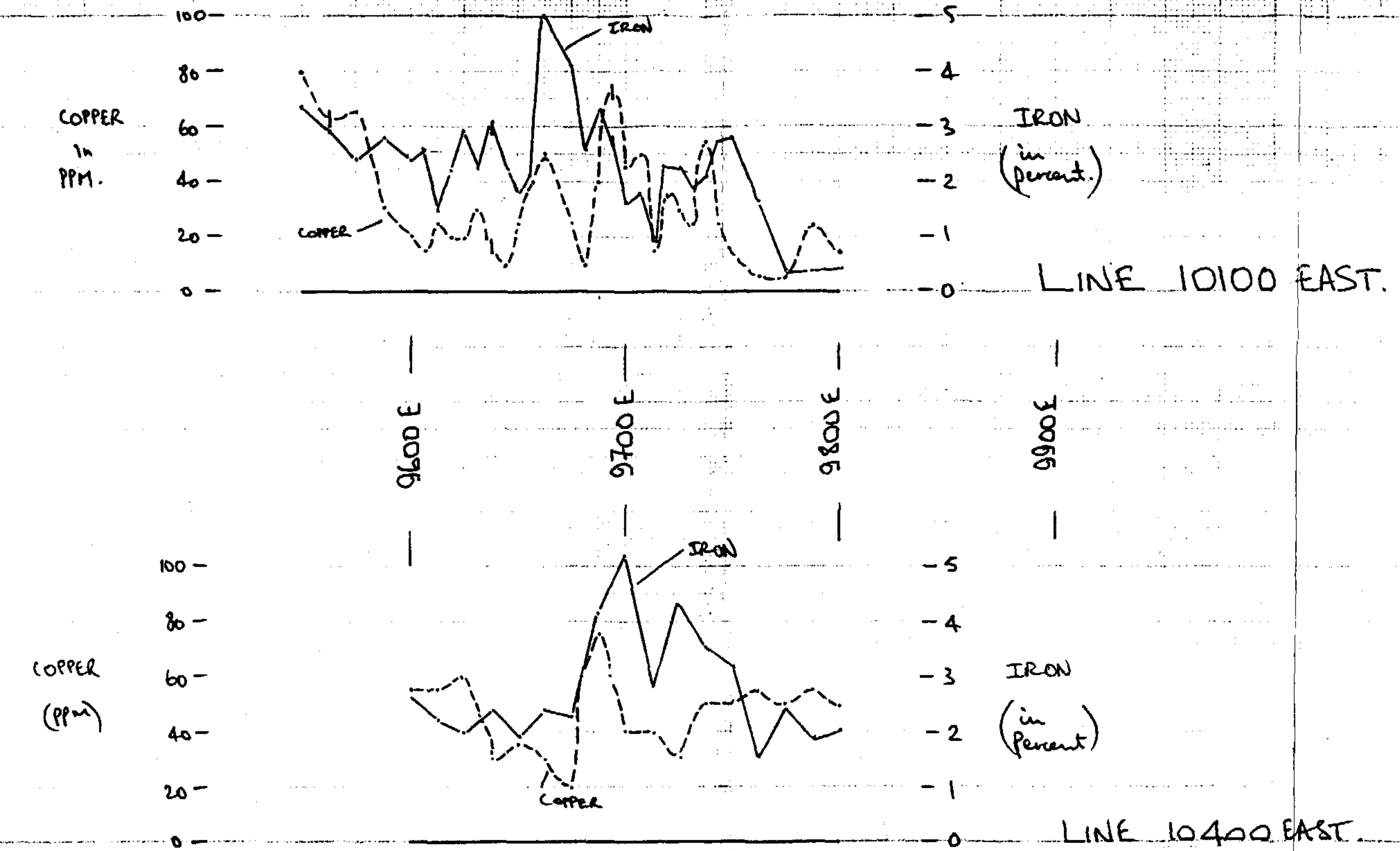

FIGURE 7

5 cm

E.L. 2/70 PROVER 8

C-HORIZON SOIL GEOCHEM.

COPPER, IRON PROFILES.

SCALE = 1:2500 November 1981

Sampling by 'MATE' Auger

260021

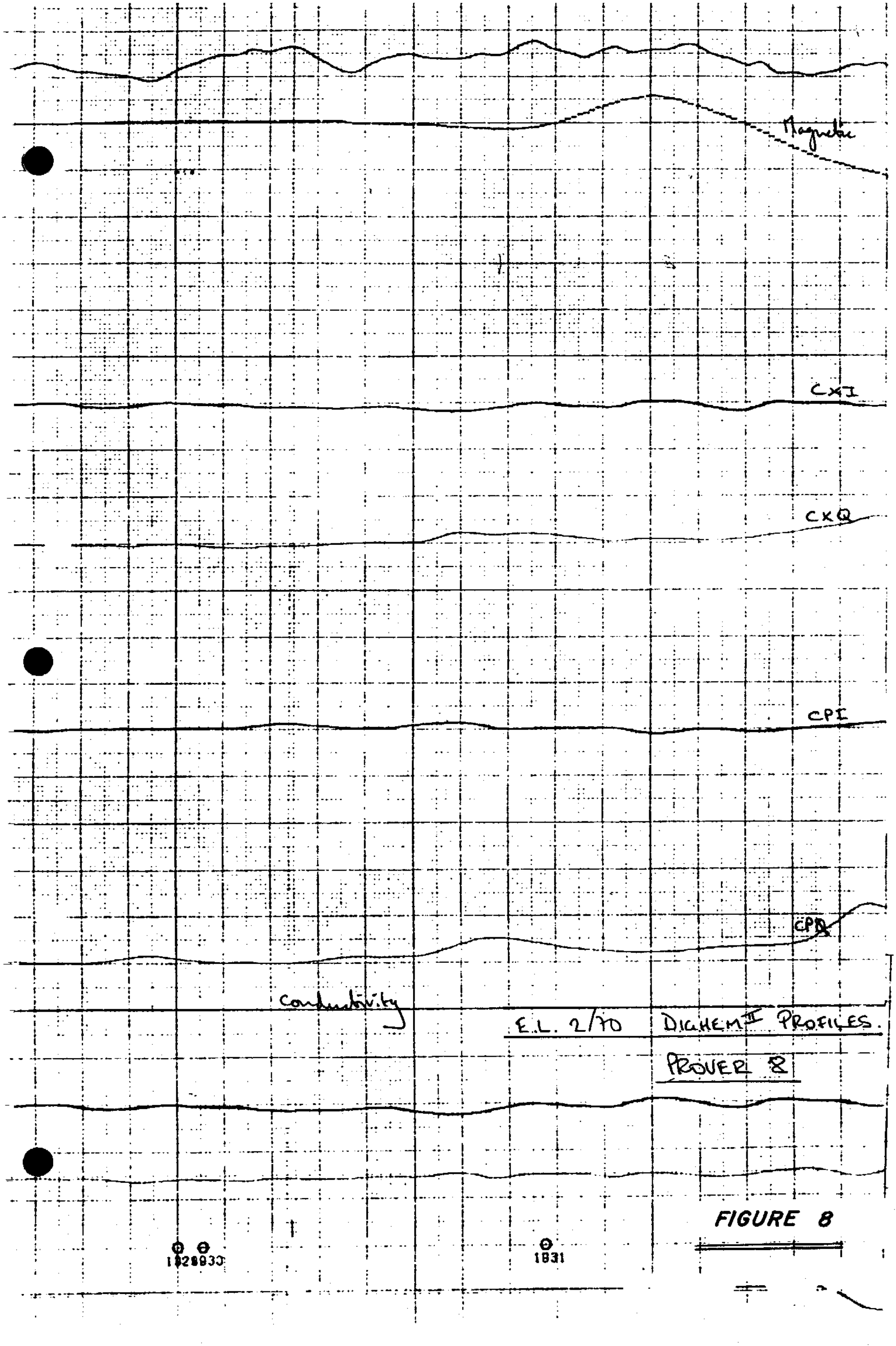

FIGURE 8

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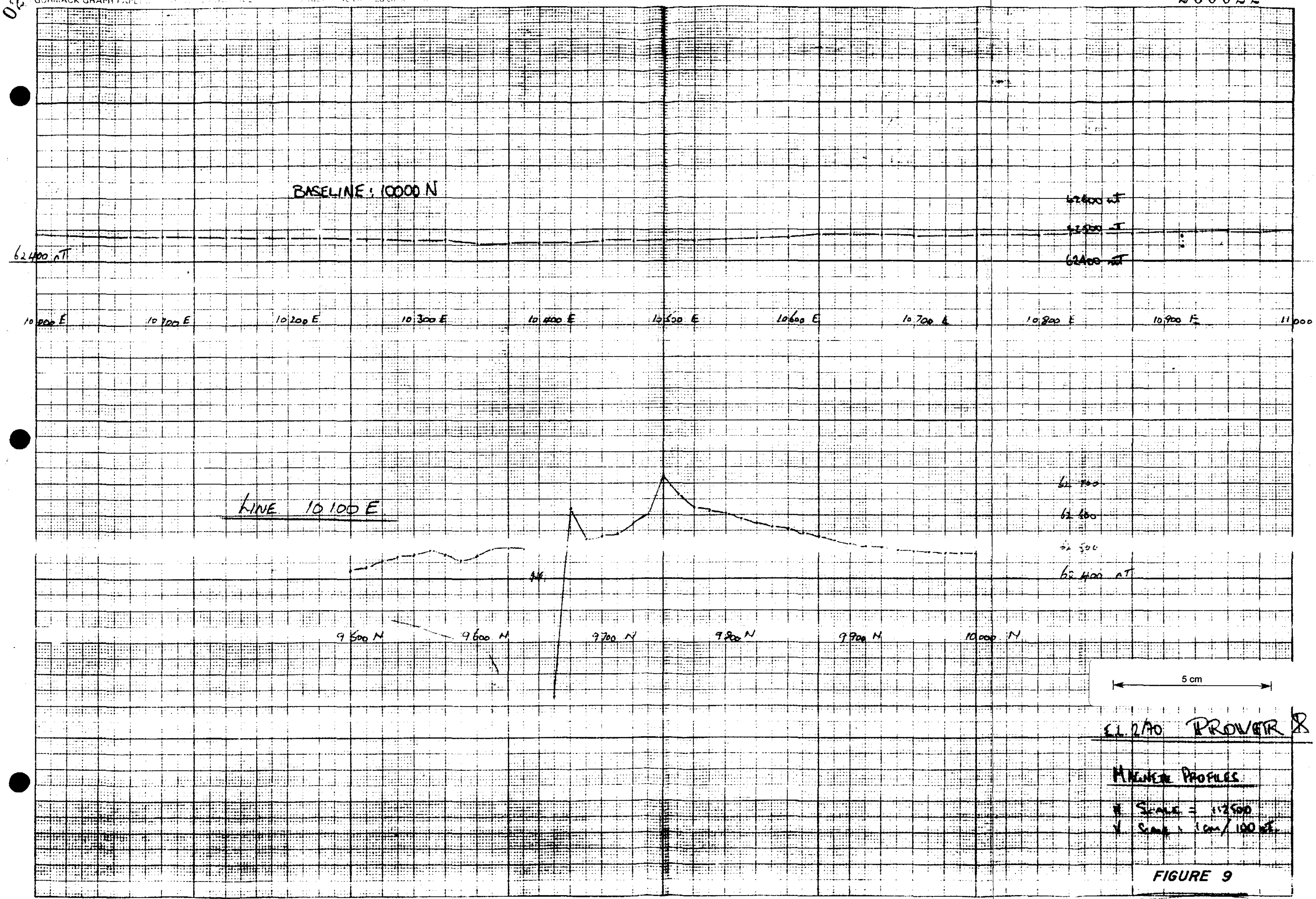
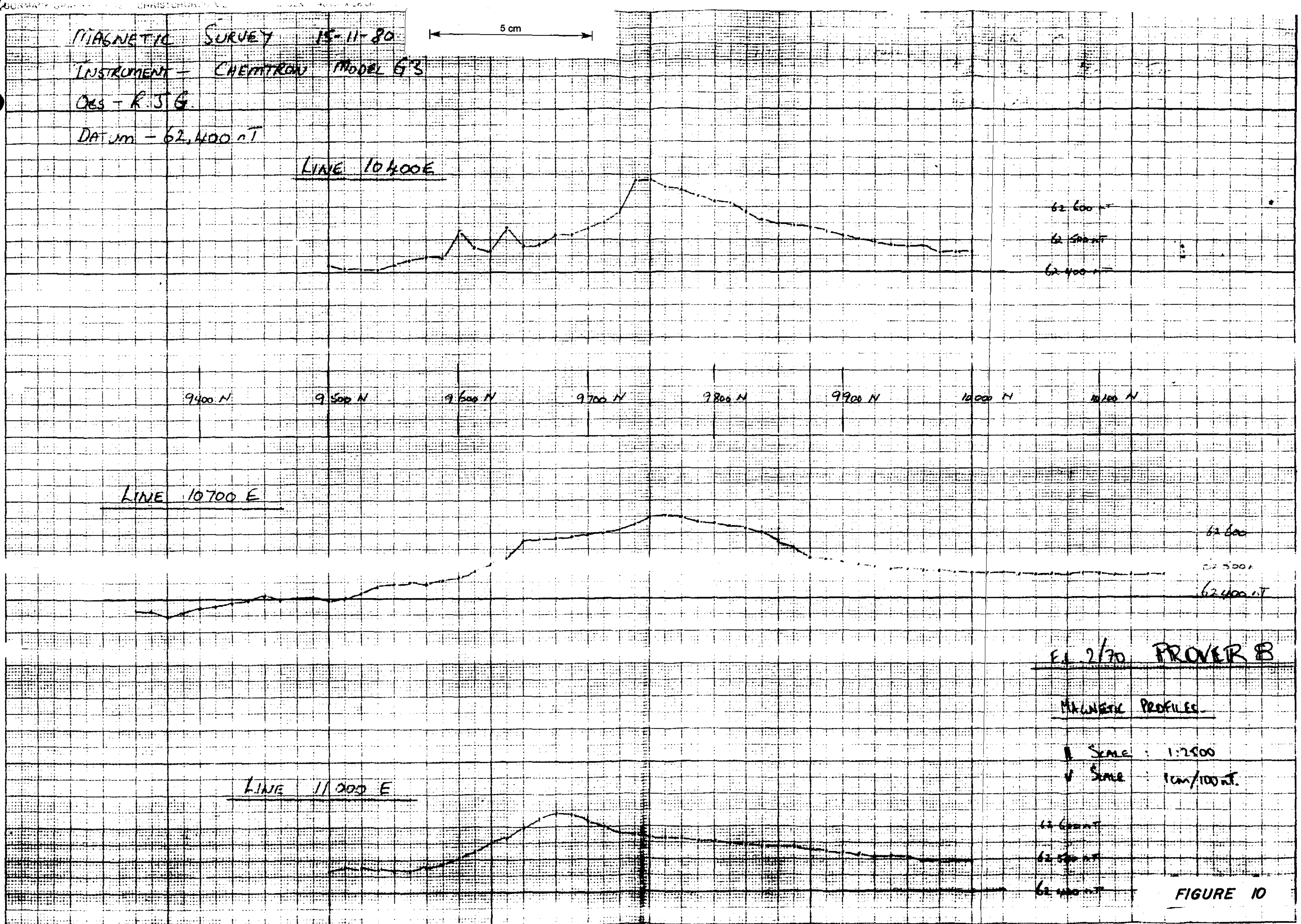


FIGURE 9


MAGNETIC SURVEY 15-11-80
5 cm
INSTRUMENT - CHEMTRON MODEL G3
OBS - R.J.G.
DATUM - 62,400 nT
LINE 10400E
62 600 nT
62 500 nT
62 400 nT
9400 N
9500 N
9600 N
9700 N
9800 N
9900 N
10000 N
10100 N
LINE 10700 E
62 600
62 500 nT
62 400 nT
EL 2/70 PROVER B
MAGNETIC PROFILES
H SCALE : 1:2500
V SCALE : 1cm/100 nT.
LINE 11000 E
62 600 nT
62 500 nT
62 400 nT
FIGURE 10

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WEBSTER, S.S. and SKEY, E.H. 1979	Geophysical and Geochemical Case Study of the Que River Deposit, Tasmania, Australia (Geol. Survey Canada, Report 81 p. 697-720)
YOUNG, C.H. 1978	Mackintosh East, Part of EL 2/70 Summary of Report of Exploration Conducted in 1978 Abminco Exploration NL)

APPENDIX I

ANALYTICAL RESULTS: STREAM SEDIMENT GEOCHEMISTRY
(-80 MESH FRACTION)

325 U

260026

MACKINTOSH EAST.
STREAM SEDS.

Australian Laboratory Services PTY. LTD.

CONSULTING CHEMISTS & ANALYSTS

ALS

LABORATORY REPORT

OFFICE & LABORATORY
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TELEX ALSEV 42344

R. W. YERBURY
DIRECTOR

BATCH No.: 169K CLIENT GEOPEKO LTD
ORDER No.: KP2288 AREA: TASMANIA DATE RECEIVED: 22.10.
SAMPLE TYPE: STM SED No.: 113 DATE COMPLETED: 30.10.7
ATTENTION: C D STRICKLAND

SAMPLE No.	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Bi ppm	Fe %	Au ppb	Sn ppm	W ppm	
KD1702	15	15	35	<1	20	2.88		190	20	
KD1706	5	10	10	< 1	20	1.04		415	10	
KD1708	5	<5	15	< 1	30	0.64	40	165	10	

NATA

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METHODS: Cu Pb Zn Bi Fe Ag Method 1 Sn W Method 9A (XRF)
Au Method 120 A

Signatory G. Dunn

326

Mackintosh East

Australian Laboratory Services PTY. LTD.

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LABORATORY REPORT

RESULTS TELEXED 19.12.79

R. W. YERBURY
DIRECTOR

BATCH No.: L 135 CLIENT GEOPEKO LTD.

ORDER No.: KP 2294 AREA: TASMANIA DATE RECEIVED: 15.11.79

SAMPLE TYPE: SEDIMENTS, [redacted] No.: 62 DATE COMPLETED: 18.12.79

ATTENTION:

SAMPLE No.	Sn ppm	W ppm	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Fe %			
KD 1821	-5	-10	10	105	40	1	10.2			
" 1822	-5	-10	10	100	40	-1	12.4			
" 1823	-5	-10	5	45	30	1	8.20			

NATA

METHODS: Cu, Pb, Zn, Ag BY METHOD 1
Fe
Sn, W BY METHOD 9-A (X.R.F.)

Signatory G. Dunn

0271

260028 Mackintosh C

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LABORATORY REPORT

RESULTS TELEXED 30.11.79

R. W. YERBURY
DIRECTOR

BATCH No.: L088 CLIENT GEOPEKO LIMITED

ORDER No.: K 304 AREA: DEVONPORT DATE RECEIVED: 12.11.7

SAMPLE TYPE: ~~SOIL~~ STM. SED. No.: 45 DATE COMPLETED: 30.11.7

ATTENTION: DR. R. LARGE

SAMPLE No.	Cu ppm	Pb ppm	Zn ppm	Ag ppm	Fe %	Sn ppm	W ppm			
KD 1878	10	370	260	2	6.80	-5	-10			
" 1879	10	180	110	1	5.60	10	-10			
" 1880	10	220	130	1	5.60	-5	-10			
" 1881	10	240	150	2	6.40	-5	-10			
" 1882	10	180	110	1	4.80	-5	-10			
" 1883	10	175	100	1	5.20	-5	-10			
" 1884	45	130	120	2	4.56	-5	-10			
" 1885	40	140	110	2	5.60	-5	-10			
" 1886	10	50	20	1	1.20	-5	-10			

NATA

METHODS:

Cu, Pb, Zn, Ag, Fe BY METHOD 1
Sn, W BY METHOD 9-A (X.R.F.)

Signatory G. Dunn

APPENDIX II

DIGHEM II SURVEY OF MACKINTOSH EAST AREA, TASMANIA

REPORT NO. 312
D.C. FRASER
Z. DVORAK
August, 1980

029

260030

REPORT NO. 312

DIGHEM^{II} SURVEY

OF

MACKINTOSH EAST AREA, TASMANIA

FOR

GEOPEKO LIMITED

BY

DIGHEM LIMITED

TORONTO, ONTARIO
AUGUST 15, 1980

D.C. FRASER
PRESIDENT

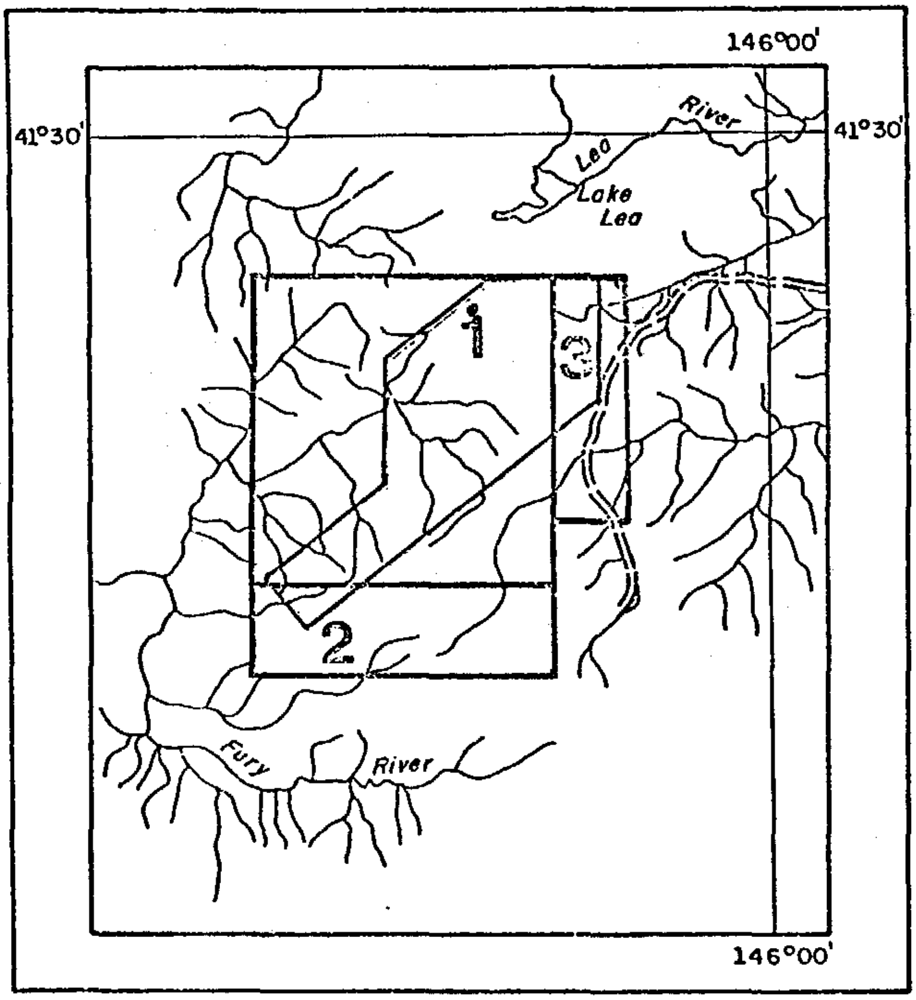
Z. DVORAK
GEOPHYSICIST

SUMMARY

A DIGHEM^{II} electromagnetic/resistivity/magnetic survey of 385 line-km was flown in the Mackintosh area of Tasmania in February and March 1980, for Geopeko Limited.

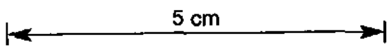
The survey identified a strong conductive zone as well as a few scattered weak and moderate conductors. The conductive zone is non-magnetic and consists of a number of parallel conductors.

LOCATION MAP



Scale 1: 250,000

Figure 1. The Survey Area



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APPENDIX B: EM Anomaly List

INTRODUCTION

A DIGHEM^{II} survey of 385 line-km was flown with a 150 m line-spacing for Geopeko Limited from February 27 to March 10, 1980, in the Mackintosh East area of Tasmania (Figure 1). The Lama VH-PDU jet helicopter flew with an average airspeed of 100 km/h and EM bird height of 35 m. Ancillary equipment consisted of a Geometrics 803 magnetometer with its bird at an average height of 55 m, a Sperry radio altimeter, Geocam sequence camera, Barringer 8-channel hot pen analog recorder, and a Geometrics G-714 digital data acquisition system with a Kennedy 9700 9-track 800-bpi magnetic tape recorder. The analog equipment recorded four channels of EM data at approximately 900 Hz, two ambient EM noise channels (for the standard and whaletail receivers), and one channel each of magnetics and radio altitude. The digital equipment recorded the EM data with a sensitivity of 0.25 ppm/bit, and the magnetic field to one gamma/bit.

The Appendix provides details on the data channels, their respective noise levels, and the data reduction procedure. The quoted noise levels are generally valid for wind speeds up to 30 km/h. Higher winds may cause the system to be grounded because excessive bird swinging produces difficulties in flying the helicopter. The swinging results from the 5 m^2 of area which is presented by the bird to broadside gusts. The DIGHEM system nevertheless can be flown under wind conditions that seriously degrade other AEM systems.

ELECTROMAGNETICS

DIGHEM electromagnetic responses fall into two general classes, discrete and broad. The discrete class consists of sharp, well defined anomalies from discrete conductors such as sulfide lenses and steeply dipping sheets of graphite and sulfides. The broad class consists of wide anomalies from conductors having a large horizontal surface such as flatly dipping graphite or sulfide sheets, saline water-saturated sedimentary formations, conductive overburden and rock, and geothermal zones. A vertical conductive slab with a width of 100 m would straddle these two classes.

The vertical sheet (half plane) is the most common model used for the analysis of discrete conductors. All anomalies plotted on the electromagnetic map are interpreted according to this model. The following section entitled Discrete conductor analysis describes this model in detail, including the effect of using it on anomalies caused by broad conductors such as conductive overburden.

The conductive earth (half space) model is suitable for broad conductors. Resistivity contour maps result from the use of this model. A later section entitled Resistivity mapping describes the method further, including the effect of using it on anomalies caused by discrete conductors such as sulfide bodies.

Discrete conductor analysis

The EM anomalies appearing on the electromagnetic map are interpreted by computer to give the conductance (i.e., conductivity-thickness product) in mhos of a vertical sheet model. DIGHEM anomalies are divided into six grades of conductance, as shown in Table I. The conductance in mhos is the reciprocal of resistance in ohms.

Table I. EM Anomaly Grades

Anomaly Grade	Mho Range
6	greater than 99
5	50 - 99
4	20 - 49
3	10 - 19
2	5 - 9
1	less than 5

The mho value is a geological parameter because it is a characteristic of the conductor alone; it generally is independent of frequency, and of flying height or depth of burial apart from the averaging over a greater portion of the conductor as height increases.[1] Small anomalies from deeply buried strong conductors are not confused with small anomalies from shallow weak conductors because the former will have larger mho values.

Conductive overburden generally produces broad EM responses which are not plotted on the EM maps. However, patchy conductive overburden in otherwise resistive areas can yield discrete-like anomalies with a conductance grade (cf. Table I) of 1, or even of 2 for conducting clays which have resistivities as low as 50 ohm-m. In areas where ground resistivities can be as low as 1 ohm-m, anomalies caused by weathering variations and similar causes can have conductance grades as high as 4. The anomaly shapes from the multiple coils often allow such surface conductors to be recognized, and these are indicated by the letter S on the map. The remaining anomalies in such areas could be bedrock conductors. The higher grades indicate increasingly higher conductances. Examples: DIGHEM's New Insco copper

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[1]This statement is an approximation. DIGHEM, with its short coil separation, tends to yield larger and more accurate mho values than airborne systems having a larger coil separation.

discovery (Noranda, Quebec, Canada) yielded a grade 4 anomaly, as did the neighbouring copper-zinc Magusi River ore body; Mattabi (copper-zinc, Sturgeon Lake, Ontario, Canada) and Whistle (nickel, Sudbury, Ontario, Canada) gave grade 5; and DIGHEM's Montcalm nickel-copper discovery (Timmins, Ontario, Canada) yielded a grade 6 anomaly. Graphite and sulfides can span all grades but, in any particular survey area, field work may show that the different grades indicate different types of conductors.

Strong conductors (i.e., grades 5 and 6) are characteristic of massive sulfides or graphite. Moderate conductors (grades 3 and 4) typically reflect sulfides of a less massive character or graphite, while weak bedrock conductors (grades 1 and 2) can signify poorly connected graphite or heavily disseminated sulfides. Grade 1 conductors may not respond to ground EM equipment using frequencies less than 2000 Hz.

The presence of sphalerite or gangue can result in ore deposits having weak to moderate conductances. As an example, the three million ton lead-zinc deposit of Restigouche Mining Corporation near Bathurst, New Brunswick, Canada, yielded a well defined grade 1 conductor. The 10 percent by volume of sphalerite occurs as a coating around the fine grained massive pyrite, thereby inhibiting electrical conduction.

Faults, fractures and shear zones may produce anomalies which typically have low conductances (e.g., grade 1 and 2). Conductive rock formations can yield anomalies of any conductance grade. The conductive materials in such rock formations can be salt water, weathered products such as clays, original depositional clays, and carbonaceous material.

On the electromagnetic map, the actual mho value and a letter are plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal rows of dots, beside each anomaly symbol, indicate the anomaly amplitude on the flight record. The vertical column of dots gives the estimated depth. In areas where anomalies are crowded, the identifiers, dots and mho values may be obliterated. The EM grade symbols, however, will always be discernible, and the obliterated information can be obtained from the anomaly listing appended to this report.

The purpose of indicating the anomaly amplitude by dots is to provide an estimate of the reliability of the conductance calculation. Thus, a conductance value obtained from a large ppm anomaly (3 or 4 dots) will be accurate whereas one obtained from a small ppm anomaly (no dots) could be inaccurate. The absence of amplitude dots indicates that the anomaly from the standard (maximum-coupled coaxial) coil-pair is 5 ppm or less on both the inphase and quadrature channels. Such small anomalies could reflect a weak conductor at the surface or a stronger conductor at depth. The mho value and depth estimate will illustrate which of these possibilities fits the recorded data best.

Flight line deviations occasionally yield cases where two anomalies, having similar mho values but dramatically different depth estimates, occur close together on the same conductor. Such examples illustrate the reliability of the conductance measurement while showing that the depth estimate can be unreliable. There are a number of factors which can produce an error in the depth estimate, including the averaging of topographic variations by the altimeter, overlying conductive overburden, and the location and attitude of the conductor relative to the flight line. Conductor location and attitude can provide an erroneous depth estimate because the stronger part of the conductor may be deeper or to one side of the flight line, or because it has a shallow dip. A heavy tree cover can also produce errors in depth estimates. This is because the depth estimate is computed as the distance of bird from conductor, minus the altimeter reading. The altimeter can lock on the top of a dense forest canopy. This situation yields an erroneously large depth estimate but does not affect the conductance estimate.

Dip symbols are used to indicate the direction of dip of conductors. These symbols are used only when the anomaly shapes are unambiguous, which usually requires a fairly resistive environment.

A further interpretation is presented on the EM map by means of the line-to-line correlation of anomalies, which is based on a comparison of anomaly shapes on adjacent lines. This provides conductor axes which may define the geological structure over portions of the survey area. The absence of conductor axes in an area implies that anomalies could not be correlated from line to line with reasonable confidence.

DIGHEM electromagnetic maps are designed to provide a correct impression of conductor quality by means of the conductance grade symbols. The symbols can stand alone with geology when planning a follow-up program. The actual mho values are plotted for those who wish quantitative data.

The anomaly ppm and depth are indicated by inconspicuous dots which should not distract from the conductor patterns, while being helpful to those who wish this information. The map provides an interpretation of conductors in terms of length, strike direction, conductance, depth, thickness (see below), and dip. The accuracy is comparable to an interpretation from a ground EM survey having the same line spacing.

An EM *anomaly* list attached to each survey report provides a tabulation of anomalies in ppm, and in mhos and estimated depth for the vertical sheet model. The EM anomaly list also shows the conductance in mhos and the depth for a thin horizontal sheet (whole plane) model, but only the vertical sheet parameters appear on the EM map. The horizontal sheet model is suitable for a flatly dipping thin bedrock conductor such as a sulfide sheet having a thickness less than 15 m. The list also shows the resistivity and depth for a conductive earth (half space) model, which is suitable for thicker slabs such as thick conductive overburden. In the EM anomaly list, a depth value of zero for the conductive earth model, in an area of thick cover, warns that the anomaly may be caused by conductive overburden. Since discrete bodies normally are the targets of EM surveys, local base (or zero) levels are used to compute anomaly amplitudes rather than true zero levels. The use of local base levels may distort the horizontal sheet and conductive earth parameters. True zero levels, however, are used for resistivity mapping, discussed below.

X-type electromagnetic responses

DIGHEM^{II} maps contain x-type EM responses in addition to EM anomalies. An x-type response is below the noise threshold of 2 ppm, and reflects one of the following: a weak conductor near the surface, a strong conductor at depth (e.g., 100 to 120 m below surface) or to one side of a flight line, or aerodynamic noise. Those responses that have the appearance of valid bedrock anomalies on the flight profiles are mentioned in the report. The others should not be followed up unless their locations are of considerable geological interest.

The thickness parameter

DIGHEM^{II} can provide an indication of the thickness of a steeply dipping conductor. The ratio of the anomaly amplitude of channel 24/channel 22 generally increases as the apparent thickness increases, i.e., the thickness in the horizontal plane. This thickness is equal to the conductor width if the conductor dips at 90 degrees and strikes at right angles to the flight line. This report refers to a conductor as thin when the thickness is likely to be less than 3m, and thick when in excess of 10 m. In base metal exploration applications, thick conductors can be high priority targets because most massive sulfide ore bodies are thick, whereas non-economic bedrock conductors are usually thin. An estimate of thickness cannot be obtained when the strike of the conductor is subparallel to the flight line, when the conductor has a shallow dip, when the anomaly amplitudes are small, or when the resistivity of the environment is below 100 ohm-m.

Resistivity mapping

Areas of widespread conductivity are commonly encountered during surveys. In such areas, anomalies can be generated by decreases of only 5 m in survey altitude as well as by increases in conductivity. The typical flight record in conductive areas is characterized by inphase and quadrature channels which are continuously active; local peaks reflect either increases in conductivity of the earth or decreases in survey altitude. For such conductive areas, apparent resistivity profiles and contour maps are necessary for the interpretation of the airborne data. The advantage of the resistivity parameter is that anomalies caused by altitude changes are virtually eliminated, so the resistivity data reflect only those anomalies caused by conductivity changes. This helps the interpreter to differentiate between conductive trends in the bedrock and those patterns typical of conductive overburden. Discrete conductors will generally appear as narrow lows on the contour map and broad conductors will appear as wide lows.

Channel 40 (see Appendix) and the resistivity contour map present the apparent resistivity using the so-called pseudo-layer (or buried) half space model defined in Fraser (1978)[2]. This model consists of a resistive layer overlying a conductive half space. Channel 41 gives the apparent depth below surface of the conductive material. The apparent depth therefore is simply the apparent thickness of the overlying resistive layer. The apparent depth (or thickness) parameter will be positive when the upper layer is more resistive than the underlying material,

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[2]Resistivity mapping with an airborne multicoil electromagnetic system: Geophysics, v 43, p. 144-172.

in which case the apparent depth may be quite close to the true depth.

The apparent depth will be negative when the upper layer is more conductive than the underlying material, and will be zero when a homogeneous half space exists. The apparent depth parameter must be interpreted cautiously because it will contain any errors which may exist in the measured altitude of the EM bird (e.g., as caused by a dense tree cover).

The inputs to the resistivity algorithm are the inphase and quadrature components of the whaletail coil-pair. The outputs are the apparent resistivity of the conductive half space (the source) and the sensor-source distance. The flying height is not an input variable, and the output resistivity and sensor-source distance are independent of the flying height. The apparent depth, discussed above, is simply the sensor-source distance minus the measured altitude or flying height. Consequently, errors in the measured altitude will affect the apparent depth parameter but not the apparent resistivity parameter.

The apparent depth parameter is a useful indicator of simple layering in areas lacking a heavy tree cover. The

DIGHEM^{II} system has been flown for the purpose of permafrost mapping, where positive apparent depths were used as a measure of permafrost thickness. However, little quantitative use has been made of negative apparent depths because the absolute value of the negative depth is not a measure of the thickness of the conductive upper layer and, therefore, is not meaningful physically. Qualitatively, a negative apparent depth estimate usually shows that the EM anomaly is caused by conductive overburden. Consequently, the apparent depth channel 41 can be of significant help in distinguishing between overburden and bedrock conductors.

Interpretation in conductive environments

Environments having background resistivities below 30 ohm-m cause all airborne EM systems to yield very large responses from the conductive ground. This usually prohibits the recognition of bedrock conductors. The processing of DIGHEM^{II} data, however, produces four channels which contribute significantly to the recognition of bedrock conductors. These are the inphase and quadrature difference channels (number 33 and 34), and the resistivity and depth channels (40 and 41). The EM difference channels eliminate up to 99% of the response of conductive ground, leaving responses from bedrock conductors, cultural features (e.g., telephone lines, fences, etc.) and edge effects. An edge effect arises when the conductivity of the ground suddenly changes, and this is a source of geologic noise. While edge effects yield anomalies on the EM difference channels, they do not produce resistivity anomalies. Consequently, the resistivity channel aids in eliminating anomalies due to edge effects. On the other hand, resistivity anomalies will coincide with the most highly conductive sections of conductive ground, and this is another source of geologic noise. The recognition of a bedrock conductor in a highly conductive environment therefore is based on the anomalous responses of the two difference channels (33 and 34) and the resistivity channel (40). The most favourable situation is where anomalies coincide on all 3 channels.

Channel 41, which is the apparent depth to the conductive material, also helps determine whether a conductive response arises from surficial material or from a conductive zone in the bedrock. When this profile rides above the zero level (i.e., it is negative), it implies that the EM and resistivity profiles are responding primarily to a conductive upper layer, i.e., conductive overburden. If channel 41 is below the zero level, it indicates that a resistive upper layer exists, and this usually implies the existence of a bedrock conductor.

Channels 35 and 36 are the anomaly recognition functions. They are used to trigger the conductance channel 37 which identifies discrete conductors. In highly conducting environments, channel 36 may not be generated because it is subject to some corruption by highly conductive earth signals. Some of the automatically selected anomalies (channel 37) are discarded by the human interpreter. The automatic selection algorithm is intentionally oversensitive to assure that no meaningful responses are missed. The interpreter than classifies the anomalies according to their source and eliminates those that are not substantiated by the data, such as those rising from geologic or aerodynamic noise.

The resistivity map often yields more useful information on conductivity distributions than the EM map. In comparing the EM and resistivity maps, keep in mind the following:

(a) The resistivity map portrays the absolute value of the earth's resistivity.

(b) The EM map portrays anomalies in the earth's resistivity. An anomaly by definition is a change from the norm and so the EM map displays anomalies, (i) over narrow, conductive bodies and (ii) over the boundary zone between two wide formations of differing conductivity.

The resistivity map might be likened to a total field map and the EM map to a horizontal gradient in the direction of flight[3]. Because gradient maps are usually more sensitive than total field maps, the EM map therefore is to be preferred in resistive areas. However, in conductive areas, the absolute character of the resistivity map usually causes it to be mre useful than the EM map.

Reduction of geologic noise

Geologic noise refers to unwanted geophysical responses. For purposes of airborne EM surveying, geologic noise refers to EM responses caused by conductive overburden and magnetic polarization. It was mentioned above that the

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[3]The gradient analogy is only valid with regard to the identification of anomalous locations. The calculation of conductance is based on EM amplitudes relative to a local base level, rather than to an absolute zero level as for the resistivity calculation.

EM difference channels (i.e., channel 33 for inphase and 34 for quadrature) tend to eliminate the response of conductive overburden. This marked a unique development in airborne EM technology, as DIGHEM^{II} is the only EM system which yields channels having an exceptionally high degree of immunity to conductive overburden.

Magnetite produces a form of geological noise on the inphase channels of all EM systems. Rocks containing less than 1% magnetite can yield negative inphase anomalies caused by magnetic polarization. This is described in more detail below. When magnetite is widely distributed throughout a survey area, the inphase EM channels may continuously rise and fall reflecting variations in the magnetite percentage, flying height, and overburden thickness. This can lead to difficulties in recognizing deeply buried bedrock conductors, particularly if conductive overburden also exists. However, the response of broadly distributed magnetite generally vanishes on the inphase difference channel 33. This feature can be a significant aid in the recognition of conductors which occur in rocks containing accessory magnetite.

<u>EM magnetite mapping</u>

The information content of DIGHEM^{II} data consists of a combination of conductive eddy current response and magnetic polarization response. The secondary field resulting from conductive eddy current flow is frequency-dependent and consists of both inphase and quadrature components, which are positive in sign. On the other hand, the secondary field resulting from magnetic polarization is independent of frequency and consists of only an inphase component, which is negative in sign. When magnetic polarization manifests itself by decreasing the measured amount of positive inphase, its presence may be difficult to recognize. However, when it manifests itself by yielding a negative inphase anomaly (e.g., in the absence of eddy current flow), its presence is assured. In this latter case, the negative component can be used to estimate the percent magnetite content.

A magnetite mapping technique was developed for the whaletail coil-pair of DIGHEM^{II}. The technique yields contours of apparent weight percent magnetite according to a homogeneous half space model. The method can be complementary to magnetometer mapping in certain cases. Compared to magnetometry, it is far less sensitive but is more able to resolve closely spaced magnetite zones, as well as providing an estimate of the amount of magnetite in the rock. The method is sensitive to 1/4% magnetite by weight when the EM sensor is at a height of 30 m above a magnetitic half space. It can individually resolve steeply dipping narrow magnetite-rich bands which are separated by 60 m.

The EM magnetite mapping technique provides estimates of magnetite content which are usually correct within a factor of 2 when the magnetite is fairly uniformly distributed. EM magnetite maps can be generated when magnetic polarization is evident as indicated by negative inphase responses.

The EM magnetite algorithm is basically quite simple because a linear relationship exists between volume percent magnetite and the negative inphase response in ppm. This linear relationship is true for a fixed survey altitude when demagnetization effects are disregarded and when a fixed susceptibility-volume percent relationship is assumed. The technique in practice involves, first, correcting the actual EM response for variations in flying altitude and, second, calibrating the negative inphase ppms in terms of volume percent magnetite.

EM magnetite mapping provides another method of airborne geologic mapping. It thus joins resistivity mapping, magnetometer mapping, spectrometry, photogeology, etc., as a possible means by which geologic information can be obtained from airborne techniques. It is not nearly as useful in the general sense as the other airborne mapping techniques, but can be of value in cases where the magnetite content gives an indication of lithology.

Like magnetometry, the EM magnetite method maps only bedrock features, provided that the overburden is characterized by a general lack of magnetite. This contrasts with resistivity mapping which portrays the combined effect of bedrock and overburden.

MAGNETICS

The existence of a magnetic correlation with an EM anomaly is indicated directly on the EM map. An EM anomaly with magnetic correlation has a greater likelihood of being produced by sulfides than one that is non-magnetic. However, sulfide ore bodies may be non-magnetic (e.g., the Kidd Creek deposit near Timmins, Ontario, Canada) as well as magnetic (e.g., the Mattabi deposit near Sturgeon Lake, Ontario).

The magnetometer data are digitally recorded in the aircraft to an accuracy of one gamma. The digital tape is processed by computer to yield a standard total field magnetic map which is usually contoured at 25 gamma intervals. The magnetic data also are treated mathematically to enhance the magnetic response of the near-surface geology, and an enhanced magnetic map is produced with a 100 gamma contour interval. The response of the enhancement operator in the frequency domain is shown in Figure 2. The 100 gamma contour interval is equivalent to a 5 gamma interval for the passband components of the airborne data. This is because these components are amplified 20 times by the operator of Figure 2.

The enhanced map, which bears a resemblance to a downward continuation map, is produced by digital bandpass filtering the total field data. The enhancement is equivalent to continuing the field downward to a level (above the source) which is 1/20th of the actual sensor-source distance.

Because the enhanced magnetic map bears a resemblance to a ground magnetic map, it simplifies the recognition of trends in the rock strata and the interpretation of geological structure. The contour interval of 100 gammas is suitable for defining the near-surface local geology while de-emphasizing deep-seated regional features.

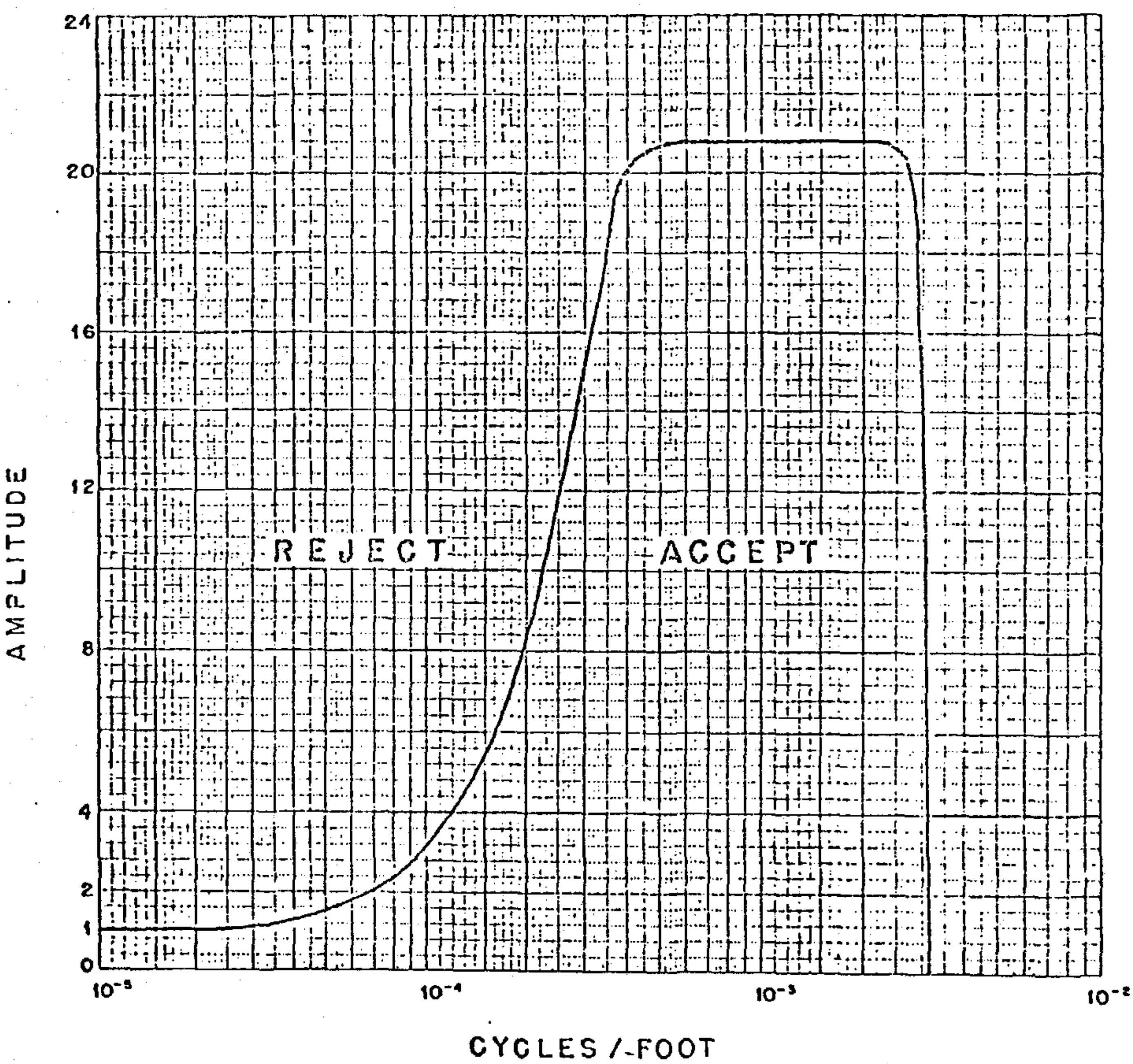

Figure 2 Frequency response of magnetic operator

CONDUCTORS IN THE SURVEY AREA

The electrogmanetic map shows the locations of conductors and their interpreted conductance (i.e., conductivity - thickness product), depth and, occasionally, dip. Their strike direction and length are also shown when anomalies can be correlated from line-to-line. When studying the maps for follow-up planning, consult the anomaly listings appended to this report to ensure that none of the conductors are overlooked.

The survey consists of a 94 line grid flown in a northwesterly direction. The data are presented on three map sheets. The EM maps indicate which anomalies are believed to be caused by cultural or surficial sources. Generally, such anomalies are not commented on below as the discussions are directed to identifying bedrock features.

Sheet 1

The resistivity in the area of sheet 1 is consistently in excess of 1000 ohm-m.

The magnetics appear to be quiet but the enhanced magnetic map indicates a change in the basement rock type across a boundary running northeasterly approximately along the 62,200 gamma contour interval in the southeast portion of the sheet. In addition, a dike-like features striking northeast at the north end of the sheet is evident.

The EM map consists of only two x-type responses, i.e., 294xA^4 and 310xA, which possibly could reflect bedrock conductors at depth. However, these responses are unlikely to be significant. Since the host rock is highly resistive and would provide a good contrast for conductors, it is clear that there are no conductors within in the upper 100 m this survey block.

Sheet 2

Sheet 3

The ground resistivity within the area of sheet 3 varies from 1 ohm-m to in excess of 1000 ohm-m. Three large conductive zones can be readily recognized. The most anomalous one occurs in the southwestern part of the sheet. The other two conductive zones, in the northern and northeastern parts of the sheet, are quite similar in character to each other and may be caused by similar material.

The magnetic map shows considerable activity correlating with the two moderately conductive zones in the north and northeast.

Anomaly 252A	This grade 1 conductor is directly associated with a 150 gamma magnetic anomaly. The whaletail inphase is negative which warns that the conductivity calculation for this anomaly may be underestimated.
Anomaly 262H-265xD	These grade 1 anomalies and associated x-type responses reflect a conductor which could have a bedrock source. The inphase responses are depressed due to the presence of magnetite, and so the conductances may be underestimated.
Anomaly 266C-267C, Response 268xF-269xC	A pair of weak bedrock conductors may be indicated by

these grade 1 anomalies and x-type responses. Conductor 266C-267C is magnetic.

Anomalies 278F-285A, 280E-284A

A pair of bedrock conductors is indicated by these grade 1 to 4 anomalies and associated x-type responses. Both conductors are non-magnetic and appear to have a west dip.

Anomalies 285F-290xA, 285D-291B, 286B-291A

These grade 2 to 4 anomalies reflect a series of parallel bedrock conductors. These conductors, and those listed immediately above, are part of the strong resistivity low discussed above. The magnetic correlation of 285D, 288A and

061

260062

289xA appears to be coincidental.

Respectfully submitted,

DIGHEM LIMITED

D. C. Fraser,
President

Z. Dvorak
Geophysicist

Twelve map sheets accompany this report.

Electromagnetic	3 map sheets
Resistivity	3 map sheets
Magnetics	3 map sheets
Enhanced magnetics	3 map sheets

APPENDIX A

THE FLIGHT RECORD AND PATH RECOVERY

Both analog and digital flight records are produced. The analog profiles are recorded on green chart paper in the aircraft during the survey. The digital profiles are generated later by computer and plotted on orange chart paper at a scale identical to the geophysical maps. The digital profiles, which may be displayed, are as follows:

Channel Number	Parameter	Scale units/mm	Noise
20	magnetometer	10 gamma	2 gamma
21	bird height	10 feet	5 feet
22	standard* coil-pair inphase	1 ppm	1-2 ppm
23	standard coil-pair quadrature	1 ppm	1-2 ppm
24	whaletail** coil-pair inphase	1 ppm	1-2 ppm
25	whaletail coil-pair quadrature	1 ppm	1-2 ppm
26	VLF-EM total field	1 %	1-2 %
27	VLF-EM vertical quadrature	1 %	1-2 %
28	ambient noise monitor (standard coil)	1 ppm	1 ppm
29	ambient noise monitor (whaletail coil)	1 ppm	1 ppm
33	difference function inphase	1 ppm	1-2 ppm
34	difference function quadrature	1 ppm	1-2 ppm
35	first anomaly recognition function	1 ppm	1-2 ppm
36	second anomaly recognition function	1 ppm	1-2 ppm
37	conductance	1 mho	
40	log resistivity at main frequency	.03 decade	
41	apparent depth at main frequency	3 m	
45	log resistivity at secondary frequency	.03 decade	
46	apparent depth at secondary frequency	3 m	
50	EM magnetite	0.5%	

* coaxial
** horizontal coplanar

The log resistivity scale of 0.03 decade/mm means that the resistivity changes by an order of magnitude in 33 mm. The resistivities at 0, 33, 67 and 100 mm up from the bottom of the chart are respectively 1, 10, 100 and 1000 ohm-m.

The fiducial marks on the flight records represent points on the ground which were recognized by the aircraft navigator. Continuous photographic coverage allowed accurate photo-path recovery locations for the fiducials, which were then plotted on the geophysical maps to provide the track of the aircraft.

The fiducial locations on both the flight records and flight path maps were examined by a computer for unusual helicopter speed changes. Such changes may denote an error in flight path recovery. The resulting flight path locations therefore reflect a more stringent checking than is provided by standard flight path recovery techniques.

The following brief description of DIGHEM^{II} illustrates the information content of the various profiles*.

*For a detailed description, see D.C. Fraser, Geophysics, v.44, p.1367-1394.

Single-frequency surveying

The DIGHEM^{II} system has two transmitter coils which are mounted at right angles to each other. Both coils transmit at approximately the same frequency. (This frequency is given in the Introduction.) Thus, the system provides two completely independent surveys at one pass. In addition, the digital flight chart profiles (generated by computer) include an inphase channel and a quadrature channel which essentially are free of the response of conductive overburden. Also, the EM channels may indicate whether the conductor is thin (e.g., less than 3 m), or has a substantial width (e.g., greater than 10 m). Further, the EM channels include channels of resistivity, apparent depth and conductance. A minimum of 11 EM channels are provided. The DIGHEM^{II} system therefore gives information in one pass which cannot be obtained by any other airborne or ground EM technique.

Figure A1 shows a DIGHEM^{II} flight profile over the massive pyrrhotite ore body in Montcalm Township, Ontario. It will serve to identify the majority of the available channels.

(iv)

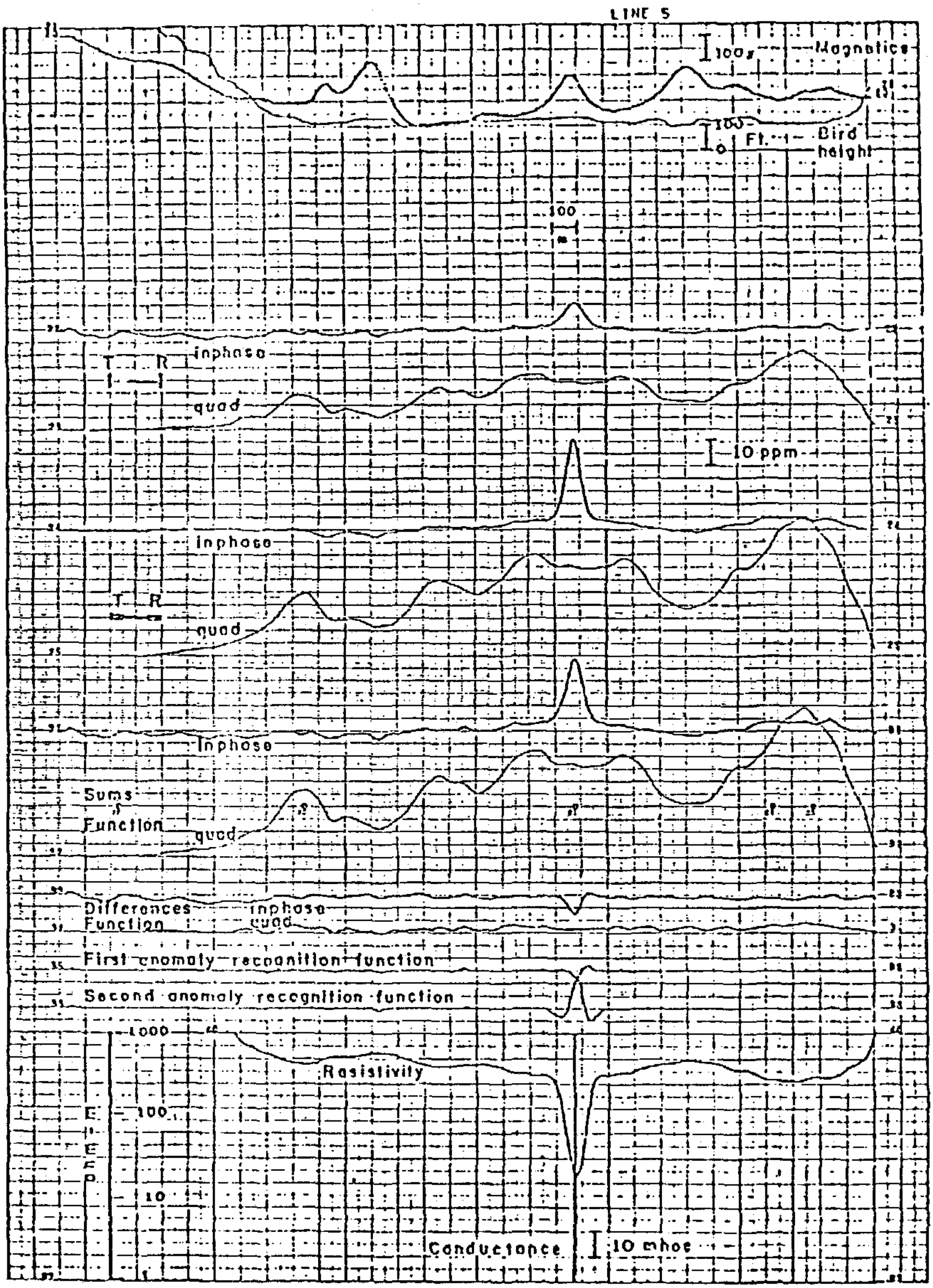

Fig. A1. Flight over Montcalm deposit, with line parallel to strike

The two upper channels (numbered 20 and 21) are respectively the magnetics and the radio altitude. Channels 22 and 23 are respectively the inphase and quadrature of the coaxial coil-pair, which is termed the standard coil-pair. This coil-pair is equivalent to the standard coil-pair of all inphase-quadrature airborne EM systems. Channels 24 and 25 are the inphase and quadrature of the additional coplanar coil-pair which is termed the whaletail coil-pair.

Channels 31 and 32 are inphase and quadrature sum functions of the standard and whaletail channels; they provide a condensed view of the four basic channels 22 to 25. The sum channels normally are not plotted.

Channels 33 and 34 are inphase and quadrature difference functions of the standard and whaletail channels. The difference channels are almost free from the response of conductive overburden. Channel 37 is the conductance. The conductance channel essentially is an automatic anomaly picker calibrated in conductance units of mhos; it is triggered by the anomaly recognition functions shown as channels 35 and 36.

Channel 40 is the resistivity, which is derived from the whaletail channels 24 and 25. The resistivity channel 40 yields data which can be contoured, and so the DIGHEM^{II} system yields a resistivity contour map in addition to an electromagnetic map, a magnetic contour map, and an enhanced magnetic contour map. The enhanced magnetic contour map is similar to the filtered magnetic map discussed by Fraser.*

Figure A2 presents the DIGHEM^{II} results for a line flown perpendicularly to the Montcalm ore body. Channel 20 shows the 175 gamma magnetic anomaly caused by the massive pyrrhotite deposit. For the EM channels, the following points are of interest:

1. On channels 22-25 and 31-34, the ore body essentially yields only an inphase response. The quadrature response is almost completely caused by conductive overburden (which also gives a small inphase response). The hachures show the EM response from the overburden. The overburden response vanishes on the

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*Cdn. Inst. Mng., Bull., April 1974.

(vii)

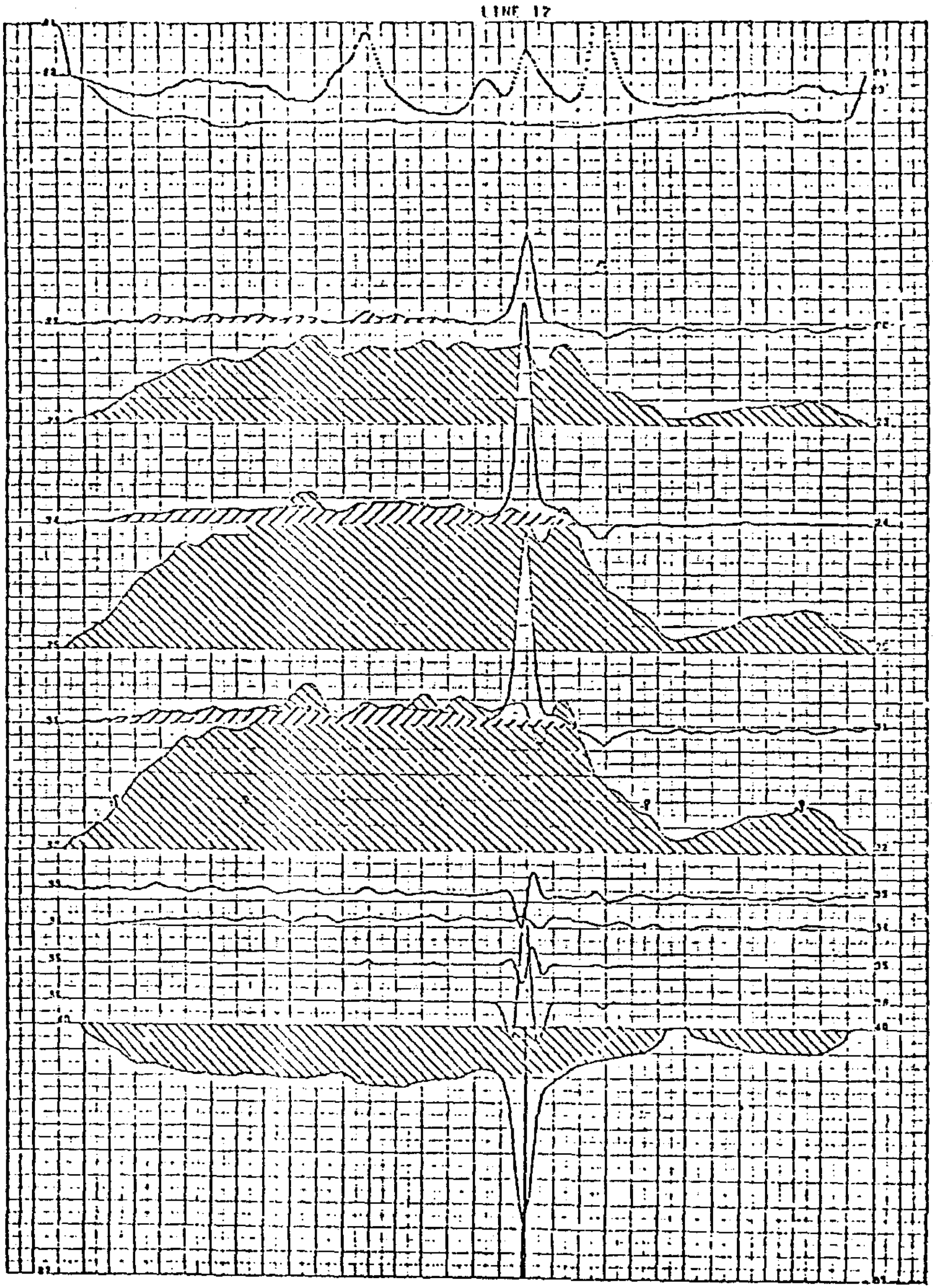

Fig. A2. Flight over Montcalm deposit, with line perpendicular to strike.

difference EM channels, as can be seen by comparing the quadrature channels 25 and 34. This is an important point to note because DIGHEM^{II} is the only EM system which provides an inphase channel and a quadrature channel which are essentially free of conductive overburden response.

2. The whaletail anomaly of channel 24 has a single peak. This shows that the conductor has a substantial width. If the width had been under 3 m, the conductor would have produced a weak m-shaped anomaly on channel 24.

3. The ore body yields a resistivity of 5 ohm-m in a background of about 200 ohm-m (cf. channel 40). A dipole-dipole ground resistivity survey with an a-spacing of 50 m showed a similar background, but the ore body gave a low of only 53 ohm-m because of the averaging effect inherent in the ground technique.

4. The ore body has a conductance of 330 mhos according to its EM response on this particular flight line. The conductance channel 37 saturates at 100 mhos, and so the deposit is indicated by a 100-mho spike.

Figure A1 illustrates the DIGHEM^{II} results for a line flown subparallel to the ore body. The ore body anomaly is small on the standard coil-pair (channel 22) but shows up strongly on the whaletail coil-pair (channel 24).

Dual-frequency surveying

For surveys flown primarily for resistivity mapping, as opposed to EM surveying, the two transmitter coils may be energized at two well-separated frequencies (e.g., 900 and 3600 Hz). Apparent resistivity and apparent depth maps can be made independently for each frequency. The interpretation procedure involves comparing the apparent resistivities and apparent depths at the two frequencies.

The use of two different coil-pair orientations (i.e., standard and whaletail) for dual-frequency resistivity mapping is an unorthodox procedure. However, as long as the current flow patterns are primarily horizontal, the different coil orientations do not influence the results, according to superposed dipole theory. Wire fences and other cultural features will produce local deviations, because they usually respond preferentially to one or the other of the coil-pairs.

The difference channels 33 and 34 are not produced because the divergent frequencies of the two coil-pairs renders them meaningless. In addition, channels 35 to 37 also are not produced.

APPENDIX B

EM ANOMALY LIST

312 GEOPEKO, TASMANIA MAY/80

LINE & ANOMALY	STANDARD COIL REAL PPM	STANDARD COIL QUAD PPM	WHALETAIL COIL REAL PPM	WHALETAIL COIL QUAD PPM	VERTICAL DIKE COND MHOS	VERTICAL DIKE DEPTH* FEET	HORIZONTAL SHEET COND MHOS	HORIZONTAL SHEET DEPTH FEET	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEP FE
251B	11	24	20	44	4	0	1	145	62	4
252A	1	5	1	5	1	0	1	214	730	
252B	11	52	27	98	3	0	1	31	85	
253E	8	22	12	39	3	0	1	129	103	2
254C	0	9	1	19	1	0	1	68	901	
256C	2	2	0	3	3	98	1	434	470	13
256D	3	6	5	13	3	0	1	218	137	6
258F	3	16	3	30	1	0	1	44	337	
259G	4	21	8	41	2	0	1	69	194	
259H	2	1	0	0	5	191	1	703	121	51
259I	2	5	13	13	5	42	1	294	75	15
260D	5	20	8	35	2	0	1	98	166	
261D	1	26	5	40	1	0	1	12	451	
261E	5	22	19	44	3	0	1	93	106	
261F	2	7	1	9	1	0	1	169	466	
262H	2	47	0	80	1	0	1	0	364	
262J	8	39	20	82	2	0	1	39	103	

* ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.

312 GEOPEKO, TASMANIA MAY/80

	STANDARD COIL		WHALETAIL COIL		VERTICAL DIKE		HORIZONTAL SHEET		CONDUCTIVE EARTH	
LINE & ANOMALY	REAL PPM	QUAD PPM	REAL PPM	QUAD PPM	COND MHOS	DEPTH* FEET	COND MHOS	DEPTH FEET	RESIS OHM-M	DEPT FEE
263H	0	64	0	125	1	0	1	0	282	0
263I	8	41	19	87	2	0	1	73	112	0
264E	3	12	9	29	2	0	1	125	167	0
265E	2	30	4	66	1	0	1	34	449	0
265F	0	34	2	84	1	0	1	0	398	0
265H	3	23	6	40	1	0	1	68	285	0
266A	4	26	9	46	2	0	1	65	192	0
266B	2	14	7	29	2	0	1	103	230	0
266C	4	8	3	12	3	25	1	245	153	92
267A	1	5	1	5	2	56	1	270	446	67
267B	3	15	2	27	1	0	1	63	359	0
267C	5	14	9	27	3	0	1	133	134	10
271C	1	24	5	48	1	0	1	8	431	0
276C	2	5	0	6	2	50	1	281	442	76
277D	7	32	13	60	2	0	1	76	127	0
278F	19	62	26	87	4	0	1	89	63	8
279C	88	69	194	136	29	0	7	93	3	51
280D	10	25	32	60	5	0	2	122	51	27
280E	24	36	20	49	6	16	2	157	37	68
281B	8	33	19	66	3	0	1	93	97	0
281C	1	4	1	6	1	42	1	298	580	43

* ESTIMATED DEPTH MAY BE UNRELIABLE BECAUSE THE STRONGER PART OF THE CONDUCTOR MAY BE DEEPER OR TO ONE SIDE OF THE FLIGHT LINE, OR BECAUSE OF A SHALLOW DIP OR OVERBURDEN EFFECTS.

312 GEOPEKO, TASMANIA MAY/80

LINE & ANOMALY	STANDARD COIL REAL PPM	STANDARD COIL QUAD PPM	WHALETAIL COIL REAL PPM	WHALETAIL COIL QUAD PPM	VERTICAL DIKE COND MHOS	VERTICAL DIKE DEPTH* FEET	HORIZONTAL SHEET COND MHOS	HORIZONTAL SHEET DEPTH FEET	CONDUCTIVE EARTH RESIS OHM-M	CONDUCTIVE EARTH DEPTH FEET
282C	21	60	66	114	6	0	2	88	32	14
282D	13	19	19	35	6	36	2	207	42	105
283A	95	66	194	124	33	0	7	77	3	38
284A	105	94	223	204	24	0	6	87	4	47
285A	6	11	9	17	4	31	1	234	85	102
285B	3	12	1	14	1	0	1	134	308	0
285D	23	25	46	26	16	0	4	178	11	112
285F	21	34	55	82	8	0	2	111	24	32
286A	8	49	25	98	2	0	1	70	98	0
286B	119	211	456	353	22	0	6	67	4	29
286C	84	225	261	382	11	0	3	50	11	2
286D	0	0	12	13	6	138	2	465	65	322
287A	32	36	65	70	13	0	3	140	14	74
288A	45	41	123	91	21	1	5	139	6	88
288B	72	99	164	213	14	0	4	91	9	38
289A	19	44	54	85	7	0	2	98	31	18
289B	40	74	118	163	10	0	3	65	15	2
290A	11	18	26	31	7	54	2	236	35	136
290B	62	104	150	203	12	0	3	74	12	18
291A	5	3	12	5	19	137	4	468	12	38
291B	15	14	54	39	16	0	4	175	12	109

APPENDIX III

ANALYTICAL RESULTS: PROVER 8
ROCK CHIP AND SOIL GEOCHEMISTRY

077

PROVER 8 260078
ROCK CHIPS.

ANALABS

A division of MacDonald Hamilton & Co. Pty. Ltd.

ANALYTICAL DATA

SAMPLE PREFIX	REPORT NUMBER	REPORT DATE	CLIENT ORDER No.	PAGE
KR	83.1 08 746	4.1.82	KP 2830	1 OF 4

TUBE No.	SAMPLE No.	Mn	Fe	Cu	Zn	Mo	Ag	Sn	W	Au
16	8566	175	4.35%	10	85	X	0.2	3	X	X
17	8567	155	5.45%	35	55	X	0.3	4	X	X
18	8568	50	2.75%	5	25	X	0.3	X	X	X
19	8569	1000	26.5%	1600	185	X	X	35	T	X
20	8570	720	16.5%	10	305	X	X	35	T	X
21	8571	790	14.5%	15	205	X	X	45	T	X
22	8572	385	9.5%	720	95	X	0.6	5	20	X
25										

Results in ppm unless otherwise specified
T = element present; but concentration too low to measure
X = element concentration is below detection limit
— = element not determined

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ANALYTICAL DATA

SAMPLE PREFIX	REPORT NUMBER	REPORT DATE	CLIENT ORDER No.	PAGE
KR	83.1 08 746	4.1.82	KP 2830	3 OF 4

TUBE No.	SAMPLE No.	Pb	Bi	Field No.					
16	8566	110	4	P8-1					
17	8567	85	X	P8-2					
18	8568	85	X	P8-3					
19	8569	70	X	P8-4					
20	8570	65	X	P8-5					
21	8571	55	X	P8-6					
22	8572	50	X	P8-7					
				Specimens in Crojales, Devonport. ROCK FILE					

Results in ppm unless otherwise specified
T = element present; but concentration too low to measure
X = element concentration is below detection limit
— = element not determined

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078

260079

ANALABS

PROVER 8
C-HORIZON SOILS.

A division of MacDonald Hamilton & Co. Pty. Ltd.
52 Murray Road, Welshpool, W.A. 6106

Phone (09) 458 2999 Telex AA92560

ANALYTICAL REPORT No. [illegible]

THIS REPORT MUST BE READ IN CONJUNCTION WITH THE ACCOMPANYING ANALYTICAL DATA

Geopeko Ltd
PO Box 598
Devonport
Tasmania 7310

ORDER No.	PROJECT
II 2819	MULEE

DATE RECEIVED	RESULTS REQUIRED
1.12.81	

No. OF PAGES OF RESULTS	DATE REPORTED	No. OF COPIES	TOTAL No. OF SAMPLES
	7.12.81	3	54

STATE OF SAMPLES (REFER BELOW)	SAMPLE NUMBERS	PRE-TREATMENT: DRY	CRUSH	SPLIT	PULVERISE	SIEVE	OTHER SEE REMARKS	NONE	ANALYSIS: REFER TO ANALYSIS SECTION	PREPARATION	METHOD
SO	TS 13051-85	1			3	2			Cu Pb Zn Fe Mn	A1	AAS
	TS 13087-105								As	A1	AAS
									Sn	A11	AAS
									W	A6	COL

RESULTS TO

As Above

RESULTS TO

REMARKS

STATE OF SAMPLES	
whole core	WC
split core	SC
cutting	CU
rock	Ro
soil	SO
pulp	PU
water	WA
tissue	TI
stream sediment	SS
heavy mineral	HM

ANALYSIS — PREPARATION			
perchloric acid	A1	cold acid	CA
hydrochloric acid	A2	specific sulphide	SS
nitric acid	A3	other mixed acids	Ma
aqua regia	A4	alkaline attack	AA
nitric-perchloric	A5	volatilization	VO
HF mixture	A6	ignition	IG
HF under pressure	A7	pressed powder (XRF)	PP
fusion	A8	glass fusion (XRF)	GF

ANALYSIS — METHOD	
atomic absorbtion	AAS
x-ray fluorescence	XRF
spectrophotometry	SPEC
colorimetry	COL
chromatography	CHR
titration	TTN
other chemicals means	CHEM
miscellaneous	MISC
fluorescence	FLUOR
inductively coupled plasma	ICP

10

07?

260080

PROVER 8
C-HORIZON SOILS.

ANALABS

A division of MacDonald Hamilton & Co. Pty. Ltd.

ANALYTICAL DATA

SAMPLE PREFIX	REPORT NUMBER	REPORT DATE	CLIENT ORDER No.	PAGE
15	8 1 08 722	10.12.81	KP 2819	1 OF 4

TUBE No.	SAMPLE No.	Mn	Fe	Cu	Zn	Ag	Sn	W	Pb	LINE : 10400 E
1	13051	65	2.00	50	50	X	X	2.5	5	9800 N
2	13052	60	1.90	55	60	X	X	2.5	10	9787.5 N
3	13053	60	2.40	50	40	X	X	5.5	10	9775 N
4	13054	105	1.55	55	55	X	X	2.0	15	9762.5 N
5	13055	125	3.20	50	60	X	X	3.5	10	9750 N
6	13056	100	3.55	50	60	X	X	2.5	X	9737.5 N
7	13057	120	4.30	30	75	X	X	3.5	X	9725 N
8	13058	85	2.80	40	45	X	X	5.0	X	9712.5 N
9	13059	155	5.25	40	115	X	X	3.0	15	9700 N
10	13060	230	4.15	75	55	X	X	20.0	X	9687.5 N
11	13061	215	4.20	75	50	X	X	25.0	5	9687.5 N
12	13062	85	2.30	20	30	X	X	5.5	5	9675 N
13	13063	60	2.35	30	30	X	X	4.0	X	9662.5 N
14	13064	70	1.90	35	25	X	4	2.5	5	9650 N
15	13065	50	2.40	30	20	0.1	1	4.5	5	9637.5 N
16	13066	410	2.00	60	25	X	X	1.5	X	9625 N
17	13067	370	2.20	55	50	0.1	10	2.5	10	9612.5 N
18	13068	415	2.60	55	125	X	X	2.5	5	9600 N
19	13069	1450	3.35	90	95	X	X	3.0	30	9550 N
20	13070	1400	2.95	60	135	0.1	X	8.5	5	9562.5 N
21	13071	1600	2.90	65	130	0.1	X	11.5	5	9562.5 N
22	13072	195	2.40	65	65	0.2	X	4.0	5	9575 N
23	13073	90	2.80	30	65	0.1	X	5.5	15	9587.5 N
24	13074	50	2.40	20	85	0.2	2	4.0	2	9600 N
25	13075	55	2.50	15	60	0.2	X	4.0	10	9606.25 N

Rows 1–18: LINE 10400 EAST
Rows 19–25: LINE 10100 EAST

Results in ppm unless otherwise specified
T: element present; but concentration too low to measure
X: element concentration is below detection limit
—: not determined

AUTHORISED OFFICER B. Dar

180

260081

PLOVER 8
C - HORIZON SOILS.

ANALABS

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ANALYTICAL DATA

SAMPLE PREFIX	REPORT NUMBER	REPORT DATE	CLIENT ORDER No.	PAGE
P	P .1 08 722	10.12.81	KP 2819	2 OF 4

TUBE No.	SAMPLE	Mn	Fe	Cu	Zn	Ag	Sn	W	Pb	LINE: NODE
1	13076	45	1.45%	25	40	X	X	4.0	5	9612.5 N
2	13077	50	2.20%	20	50	0.1	X	3.5	10	9618.75 N
3	13078	45	2.90%	20	55	0.1	X	4.0	5	9625 N
4	13079	45	2.25%	30	55	0.1	X	1.0	15	9631.25 N
5	13080	45	2.85%	15	40	0.1	X	5.5	X	9637.5 N
6	13081	45	3.10%	20	40	0.1	X	5.5	X	9637.5 N
7	13082	40	2.25%	10	50	X	X	4.0	5	9643.75 N
8	13083	55	1.80%	25	75	X	X	2.5	5	9650 N
9	13084	45	2.10%	40	60	X	X	2.5	X	9656.25 N
10	13085	85	5.00%	50	40	X	X	16.5	5	9662.5 N
11	13087	370	4.10%	25	30	0.1	X	9.5	5 *	9675 N
12	13088	110	2.55%	10	30	0.2	X	9.5	10	9681.25 N
13	13089	95	[illegible]	40	65	X	X	9.0	15	9687.5 N
14	13090	90	2.90%	25	70	X	X	2.5	15	9693.75 N
15	13091	90	2.70%	20	65	X	X	9.5	20	9693.75 N
16	13092	45	1.60%	45	40	X	X	7.0	15	9700 N
17	13093	40	1.90%	50	25	0.1	X	6.0	10	9706.25 N
18	13094	35	2450	15	15	0.1	X	9.0	X	9712.5 N
19	13095	35	2.30%	35	20	0.1	X	6.5	X	9718.75 N
20	13096	325	2.20%	30	25	0.2	X	6.0	15	9725 N
21	13097	85	1.90%	25	20	0.2	X	6.0	5	9731.25 N
22	13098	45	2.10%	55	30	X	X	11.0	X	9737.5 N
23	13099	240	2.25%	25	25	X	X	6.0	10	9743.75 N
24	13100	65	2.80%	15	20	0.2	6	3.5	X	9750 N
25	13101	70	2.20%	15	25	0.2	4	4.0	X	9750 N

Results in ppm unless otherwise specified
T = element present; but concentration too low to measure
X = element concentration is below detection limit
— = not determined

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[illegible] Soils.

ANALYTICAL DATA

SAMPLE PREFIX	REPORT NUMBER	REPORT DATE	CLIENT ORDER No.	PAGE
14	[illegible].1 08 722	10.12.81	KP 2819	3 OF 4

TUBE No.	SAMPLE No.	Mn	Fe	Cu	Zn	Ag	Sn	W	Pb	LINE RIDGE
1	13102	35	1.60%	5	15	0.1	6	3.0	X	97625 N
2	13103	25	3850	5	10	0.1	2	2.0	X	9775 N
3	13104	15	3800	25	85.	0.1	4	2.0	X	9787.5 N
4	13105	25	4650	15	10	0.1	X	1.5	5	9800 N
5										[illegible] N
6										[illegible] N
7										[illegible] N
8										[illegible] N
9										[illegible] N
10										[illegible] N
11										[illegible] N
12										[illegible] N
13										[illegible] N
14										
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

Results in ppm unless otherwise specified
T = element present; but concentration too low to measure
X = element concentration is below detection limit

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ANALYTICAL DATA

SAMPLE No.	REPORT NUMBER	REPORT DATE	CLIENT ORDER No.	PAGE
[illegible]	8 1 08 722	10.12.81	KP 2819	4 OF 4

TUBE No.	SAMPLE No.	Mn	Fe	Cu	Zn	Ag	Sn	W	Pb	
1	STD FS4	560	6.85%	295	705	0.9	-	-	95	
2	RPT 13051	60	1.95%	45	50	X	-	-	10	
3	RPT 13070	1650	3.00%	60	135	0.1	-	-	5	
4	STD FS4	555	7.50%	305	700	0.6	-	-	95	
5	RPT 13092	40	1.55%	40	35	X	-	-	20	
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
23	DETECTION	5	50	5	5	0.1	1	0.5	5	
24	DIGESTION	A1	A1	A1	A1	A1	A11	A6	A1	
25	METHOD	A1/1	A1/1	A1/1	A1/1	A1/2	A11/2	A6/4	A1/1	

Results in ppm unless otherwise specified
T = element present, but concentration too low to measure
X = element concentration is below detection limit

AUTHORISED OFFICER B. [illegible]

ANALABS

A division of MacDonald Hamilton & Co. Pty. Ltd.

ANALYTICAL DATA

SAMPLE PREFIX	REPORT NUMBER	REPORT DATE	CLIENT ORDER No.	PAGE
	8[illegible].1 0[illegible] 722	7.1.82	KP 2819	1 OF 1

TUBE No.	SAMPLE No.	W									
1	13060	35									
2	13061	35									
3	13071	10									
4	13085	30									
5	13098	20									
6											
7											
8											
[illegible]											
[illegible]											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23	DETECTION	10									
24	DIGESTION										
25	METHOD	XRF									

[illegible] in ppm unless otherwise specified
[illegible] but concentration too low to measure
[illegible] concentration is below detection limit

AUTHORISED OFFICER B. D[illegible]

LEGEND:

Geological Boundary

- mapped
- inferred
- unconformity
- unconformity inferred
- boundary tertiary basalt
- outcrop boundary
- float boundary

Faults

- mapped
- inferred
- fault breccia (bx)
- strike/dip of lithological layering/bedding
- strike/dip of flow layering in volcanic rocks
- strike/dip of schistosity (Metamorphic foliation)
- strike/dip of schistosity parallel to bedding / lithological layering
- strike/dip of cleavage
- cleavage vertical

- strike/dip of prominent joints
- strike/dip of vertical joints
- minor fold axis (in folded foliation) with plunge
- lineation (crenulation of metamorphic foliation)

Miscellaneous

KR 5600	Rock sample location and number for geochemical analysis
(M66)	Rock speciman location and number
	Foot track and bombardier track

GEOLOGICAL INTERPRETATION

Pencil No.	Age	Description
19-58	TERT.	Basalt
19-5	ORDO.	Limestone, impure limy siltstone
19-7	ORDO.	Sandstone, conglomeratic sandstone
19-21	Є	Quartz-feldspar-biotite porphyry-intrusive
19-19	Є	Rhyolitic quartz-feldspar-biotite porphyry-extrusives
19-28	Є	Rhyolitic quartz crystal tuff, minor crystal lithic tuff
19-24	Є	Rhyolitic fine grained massive or laminated vitric tuffs
19-17	Є	Fine grained volcaniclastic sediments
19-70	PRE Є	Psammo-pelitic schist and quartzite

5 cm

DATE JUNE '80
GEOLOGIST W.H.
DRAWN J.P.M.
CHECKED

GEOPEKO
DEVONPORT BASE, TASMANIA

260085

SCALE 1:10 000

No TS 2/70-A 2

MACKINTOSH EAST E.L. 2/70

GEOLOGICAL PLAN

001

A B

84-2304

[redacted]

LEGEND:

Geological Boundary
- mapped
- inferred
- unconformity
- unconformity inferred
- boundary tertiary basalt
- outcrop boundary
- float boundary

Faults
- mapped
- inferred
- fault breccia (bx)
- strike/dip of lithological layering/bedding
- strike/dip of flow layering in volcanic rocks
- strike/dip of schistosity (Metamorphic foliation)
- strike/dip of schistosity parallel to bedding / lithological layering
- strike/dip of cleavage
- cleavage vertical

- strike/dip of prominent joints
- strike/dip of vertical joints
- minor fold axis (in folded foliation) with plunge
- lineation (crenulation of metamorphic foliation)

Miscellaneous
- KR 5600 Rock sample location and number for geochemical analysis
- (M66) Rock speciman location and number
- Foot track and bombardier track

GEOLOGICAL INTERPRETATION

Pencil No.		
19-58	TERT.	Basalt
19- 5	ORDO.	Limestone, impure limy siltstone
19-7	ORDO.	Sandstone, conglomeratic sandstone
19-21	Є	Quartz - feldspar - biotite porphyry - intrusive
19-19	Є	Rhyolitic quartz - feldspar - biotite porphyry - extrusives
19-28	Є	Rhyolitic quartz crystal tuff, minor crystal lithic tuff
19-24	Є	Rhyolitic fine grained massive or laminated vitric tuffs
19-17	Є	Fine grained volcaniclastic sediments
19-70	PRE Є	Psammo - pelitic schist and quartzite

5 cm

DATE JUNE '80
GEOLOGIST W.H.
DRAWN J. P. M.
CHECKED W.H.

GEOPEKO
DEVONPORT BASE, TASMANIA
260086

SCALE 1:10 000

No. TS 2/70 - B2

MACKINTOSH EAST E.L. 2/70

GEOLOGICAL PLAN

002

A B

84-2304

[redacted]

GEOPEKO
DEVONPORT BASE, TASMANIA

260087

SCALE 1:10 000

No. TS 2/70-A3

DATE

GEOLOGIST

DRAWN J. P. M.

MACKINTOSH EAST E.L. 2/70

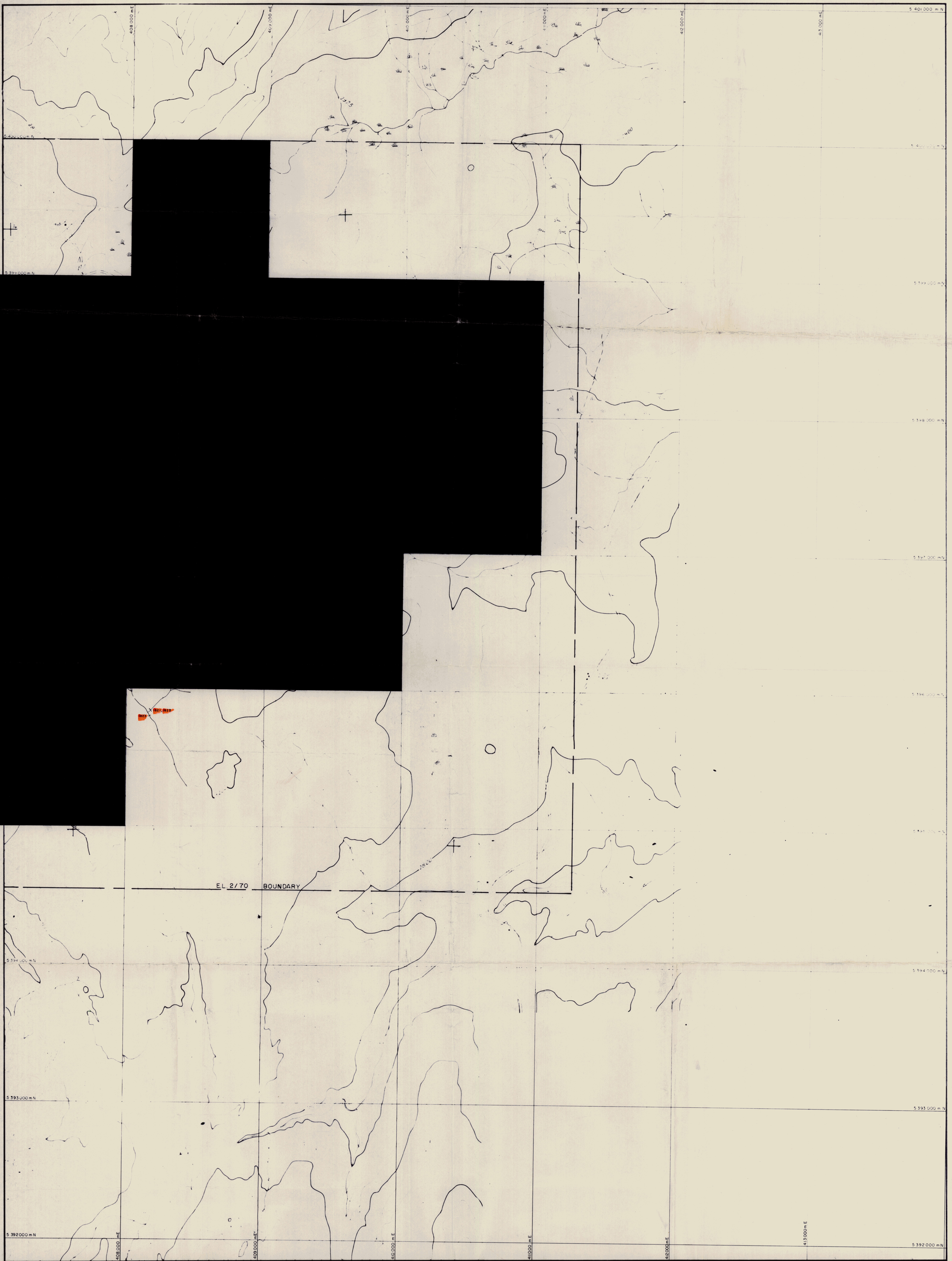
STREAM SEDIMENT SAMPLE LOCATIONS

A B

5 cm

003

84-2304



[redacted]

5 cm

* SAMPLE NUMBER PREFIX : KD

GEOPEKO
DEVONPORT BASE, TASMANIA

SCALE 1:10 000

No TS2/70-B3

DATE
GEOLOGIST
DRAWN J.P.M.
CHECKED

MACKINTOSH EAST E.L. 2/70

260088 004

STREAM SEDIMENT SAMPLE LOCATIONS

A B

84-2304.

[redacted]

LEGEND:

15 — Cu ppm
110 — Pb ppm
250 — Zn ppm
(15) — Au ppb

15 / 200 / 260 — Original sample assay
10* / 180 / 260 — Duplicate sample assay

ANALYTICAL METHODS

Cu, Pb, Zn, — AAS (method 1)
Au — AAS CARBON ROD (method 120a)

AUSTRALIAN LABORATORY SERVICES, Brisbane QLD.

ANOMALOUS VALUES - DRAINAGE SAMPLES:
(colour marked from sample location upstream to next location)

Copper	≥	25 ppm
Lead	≥	110 ppm
Zinc	≥	250 ppm
Gold	≥	25 ppb

B - HORIZON SOIL GEOCHEMISTRY
(Paringa 1970-71)

Pb > 300 ppm
Zn > 150 ppm

INDUCED POLARIZATION GEOPHYSICS
(Cominco 1975)

frequency effect anomaly

Paringa grid

5 cm

GEOPEKO
DEVONPORT BASE, TASMANIA

260089

SCALE 1:10 000

No TS 2/70 - A 4

DATE JUNE 1980
GEOLOGIST W. H.
DRAWN J. P. M.
CHECKED W.H.

MACKINTOSH EAST E.L. 2/70

DRAINAGE GEOCHEMICAL RESULTS
COPPER, LEAD, ZINC and GOLD

A B

005

84-2304

[redacted]

LEGEND

15 — Cu ppm
110 — Pb ppm
250 — Zn ppm
(15) — Au ppb

15, 200, 260 — Original sample assay
10*, 180, 260 — Duplicate sample assay

ANALYTICAL METHODS

Cu, Pb, Zn, — AAS (method 1)
Au — AAS CARBON ROD (method 120a)

AUSTRALIAN LABORATORY SERVICES, Brisbane QLD

ANOMALOUS VALUES - DRAINAGESAMPLES
(colour marked from sample location upstream to next location)

Copper ≥ 25 ppm
Lead ≥ 110 ppm
Zinc ≥ 250 ppm
Gold ≥ 25 ppb

B - HORIZON SOIL GEOCHEMISTRY
(Paringa 1970-71)

Pb > 300 ppm
Zn > 150 ppm

Paringa grid

5 cm

DATE JUNE 1980
GEOLOGIST W.H.
DRAWN J.P.M.
CHECKED W.H.

GEOPEKO
DEVONPORT BASE, TASMANIA

260090

SCALE 1:10000

No. TS 2/70-B4

MACKINTOSH EAST E.L. 2/70
DRAINAGE GEOCHEMICAL RESULTS
COPPER, LEAD, ZINC and GOLD

006

A B

84-2304.

LEGEND:

1·2 — Fe %
230 — Sn ppm
30 — W ppm

1·84 0·12 — Original sample assay
25 15 — Duplicate sample assay
<10 <10

ANALYTICAL METHODS:

Fe — AAS (method 1)
Sn, W — XRF (method 9A)

AUSTRALIAN LABORATORY SERVICES, Brisbane Qld.

ANOMALOUS VALUES — DRAINAGE SAMPLES:
(colour marked from sample location upstream to next location)

Iron ≥ 5%
Tin ≥ 30 ppm
Tungsten ≥ 30 ppm

5 cm

DATE: JUNE
GEOLOGIST W.H.
DRAWN J.P.M.
CHECKED [signature]

GEOPEKO
DEVONPORT BASE, TASMANIA

260091

SCALE 1:10 000

No TS 2/70-A5

MACKINTOSH EAST E.L. 2/70
DRAINAGE GEOCHEMICAL RESULTS
IRON, TIN and TUNGSTEN

A B

84-2304

007

[redacted]

LEGEND:

1·84 — Fe %
20 — Sn ppm
40 — W ppm

10·2 — Original sample assay
12·4* — Duplicate sample assay
<5 <5
<10 <10

ANALYTICAL METHODS:

Fe — AAS (method 1)
Sn,W — XRF (method 9A)

AUSTRALIAN LABORATORY SERVICES, Brisbane QLD.

ANOMALOUS VALUES - DRAINAGE SAMPLES:
(colour marked from sample location upstream to next location)

Iron	≥ 5 %
Tin	≥ 30 ppm
Tungsten	≥ 30 ppm

5 cm

GEOPEKO
DEVONPORT BASE, TASMANIA

260092

SCALE 1:10 000

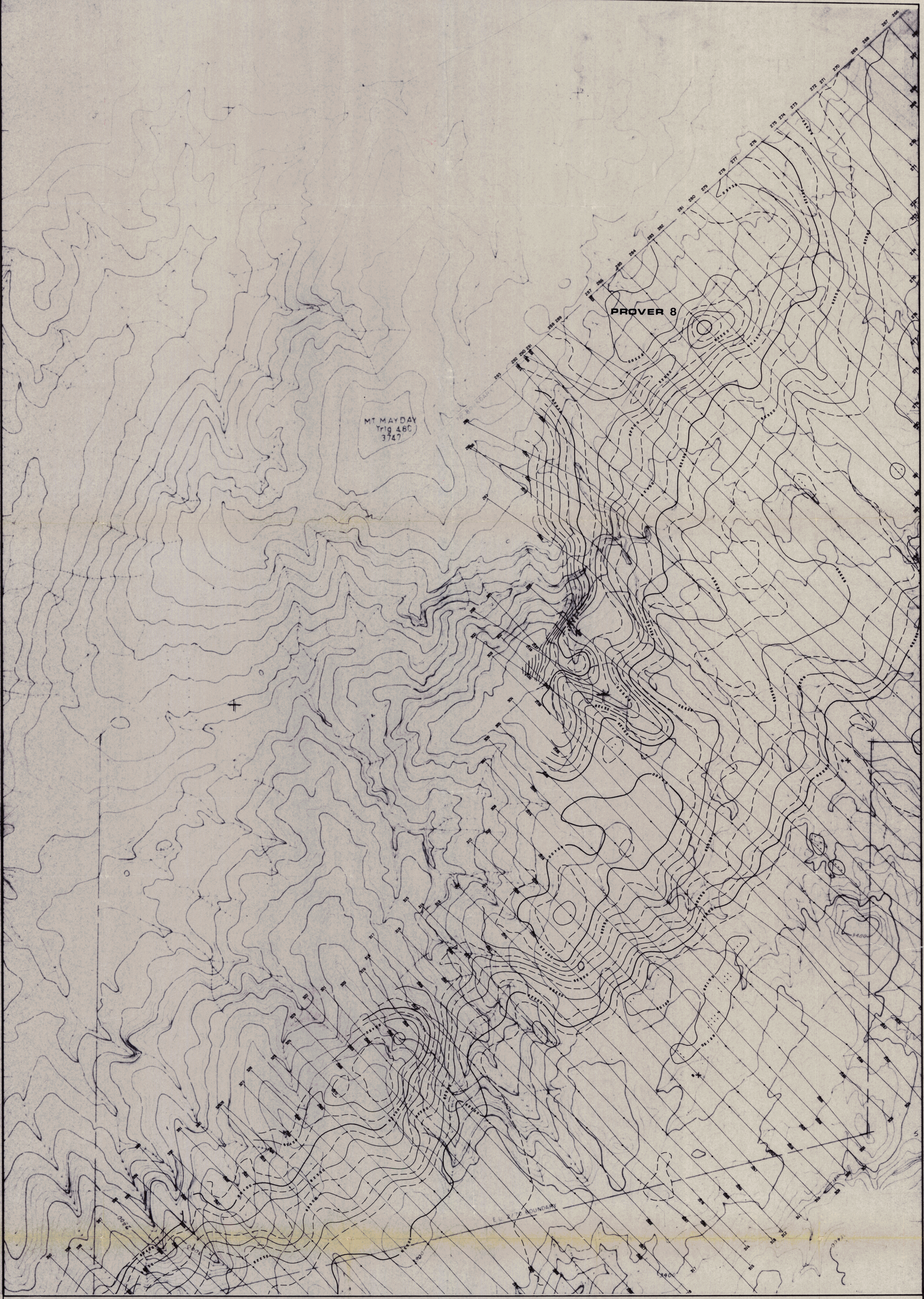
No. TS 2/70-B 5

DATE JUNE 1980
GEOLOGIST W.H.
DRAWN J.P.M.
CHECKED W.H.

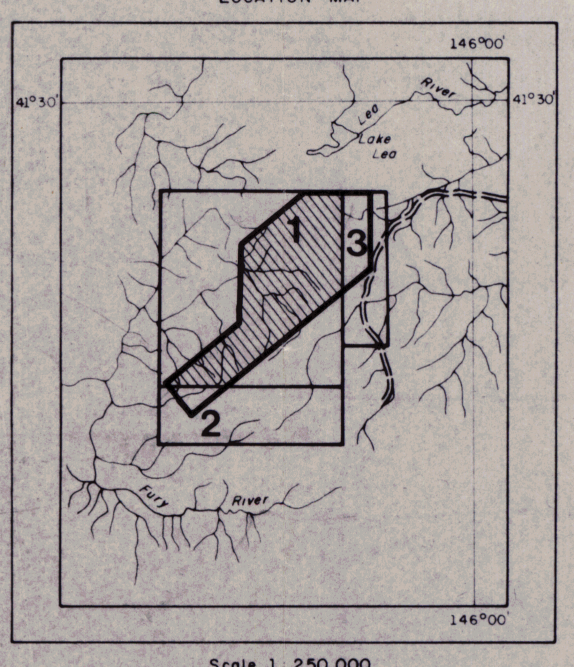
MACKINTOSH EAST E.L. 2/70
DRAINAGE GEOCHEMICAL RESULTS
IRON, TIN and TUNGSTEN 008

A B

84-2304.



LOCATION MAP



Scale 1 250,000

DIGHEM^II SURVEY

MAGNETICS

FOR

GEOPEKO LIMITED

260093

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

SHEET 1.

5 cm

010

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

Flight line

Fiducials and numbers

ISOMAGNETIC LINES

(total field)

1000 .... 1000 gammas

200 .... 200 gammas

.... 50 gammas

.... 25 gammas

.... magnetic depression

Magnetic Inclination within the survey area: 72°

GEOPEKO
DEVONPORT BASE, TASMANIA

N TS

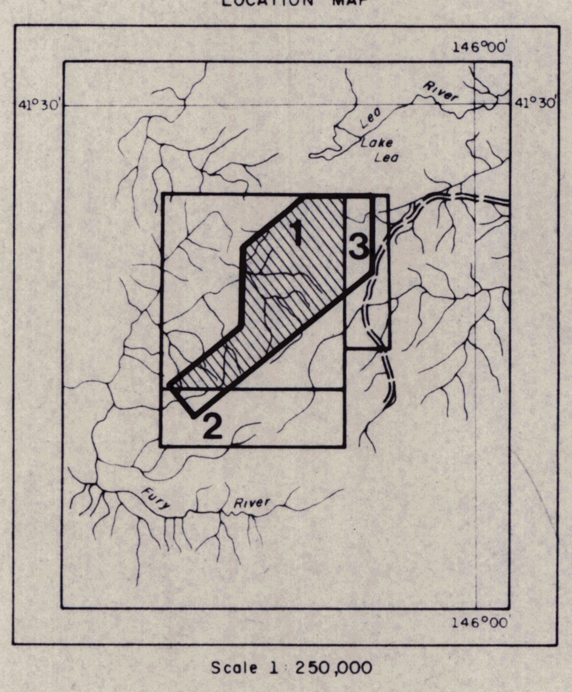
DATE
GEOLOGIST
DRAWN
CHECKED

MACKINTOSH EAST, SHEET 1

Plan No. 5577 S/B

84-2304

LOCATION MAP



Scale 1 : 250,000

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

DIGHEM[II] SURVEY

ENHANCED MAGNETICS

FOR

GEOPEKO LIMITED

260094

SCALE 1 : 10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

SHEET 1.

Flight line

Fiducials and numbers

ISOMAGNETIC LINES

(enhanced field)

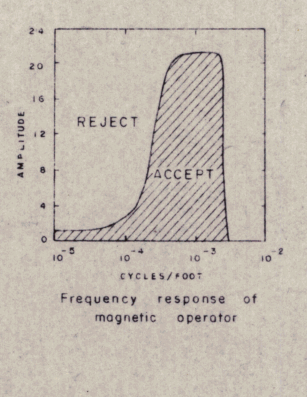
5000 .... 5000 gammas

1000 .... 1000 gammas

.... 200 gammas

.... 100 gammas

.... magnetic depression



Frequency response of magnetic operator

GEOPEKO
DEVONPORT BASE, TASMANIA

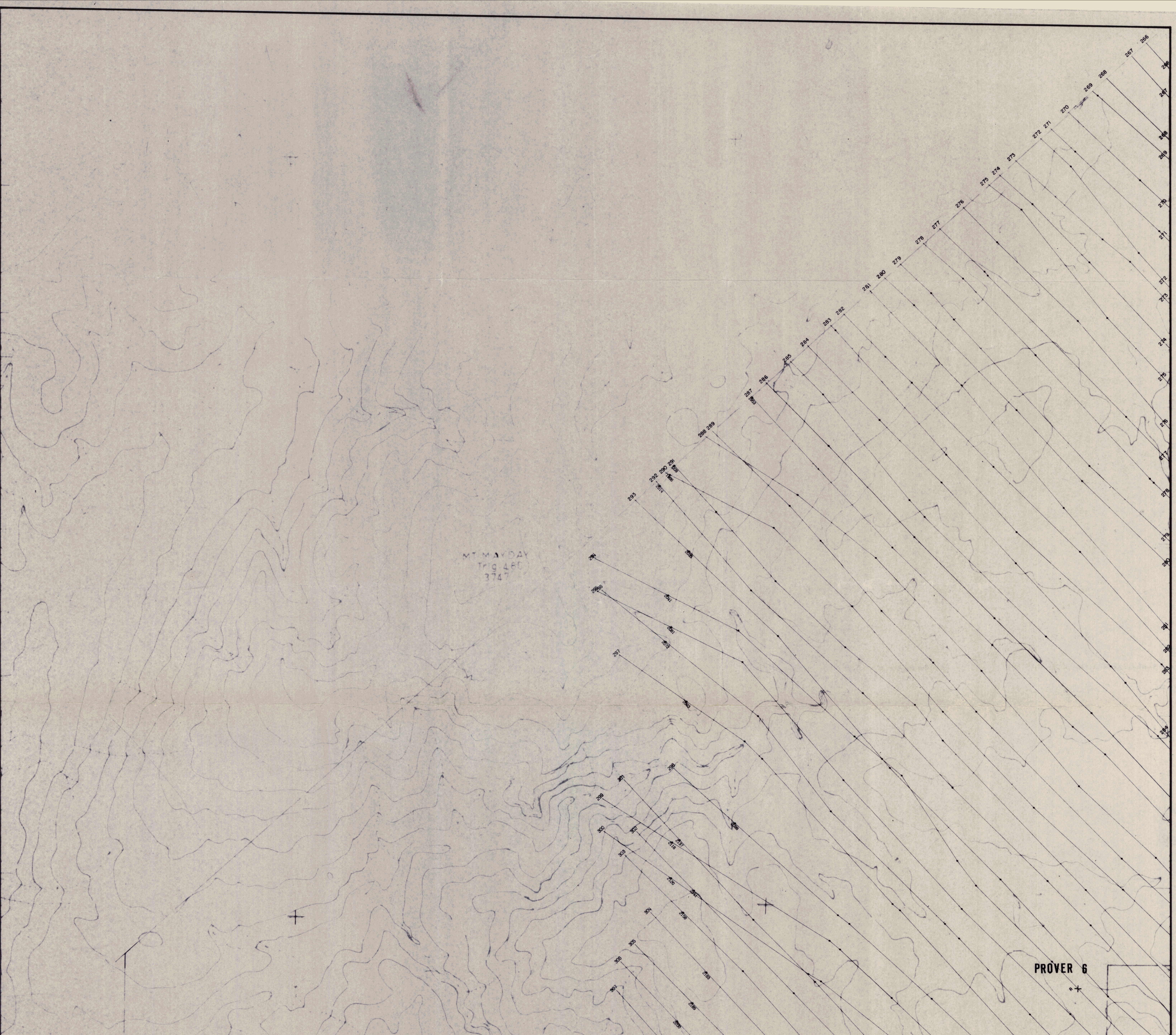
TS

MACKINTOSH EAST, SHEET 1

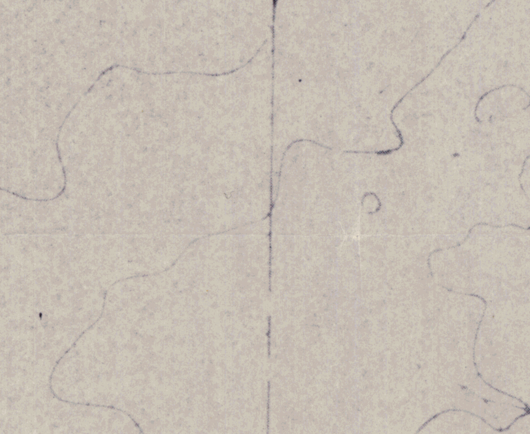
011

Plan No. 5578 S/B

84-2304



LOCATION MAP



Scale 1:250,000

DIGHEM II SURVEY

ELECTROMAGNETICS

FOR

GEOPEKO LIMITED

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

5 cm

26 0095

SCALE 1:10,000

1/2 — 0 — 1/2 — 1 Kilometres

1/4 — 0 — 1/4 — 1/2 Miles

SHEET 1.

009

84-2304

Flight line

Fiducials and numbers

1252

1266

ANOMALY GRADE	EM GRADE SYMBOL	MHO RANGE
6	●	⩾ 100
5	✹	50 — 99
4	●	20 — 49
3	◉	10 — 19
2	○	5 — 9
1	○	⩽ 4
	×	Possible conductor

DIGHEM anomalies are divided into six grades of conductivity – thickness product. This product in mhos is the reciprocal of resistance in ohms. The mho is a measure of conductance, and is a geologic parameter. Most swamps yield Grade 1 anomalies but highly conducting clays can give Grade 2 anomalies. The multi - coil anomaly shapes often allow surface conductors to be recognized, and these are indicated by the letter S on this map. The remaining Grade 1 and 2 anomalies could be weak bedrock conductors. The higher grades indicate increasingly higher conductances. Examples: The ore bodies of the Magusi River camp yield Grade 4 anomalies, while Mattabi and Whistle give Grade 5. Graphite and sulphides can span all grades but, in this survey area, field work may show that the different grades indicate different types of conductors.

identifier → c 38 ← mho value

Depth is greater than
. 50 feet
: 100 feet
⁝ 150 feet
⁞ 200 feet

Inphase and Quadrature of Standard coil is greater than
. 5 ppm
.. 10 ppm
... 15 ppm
.... 20 ppm

Refer to list of anomalies in survey report for the actual ppm values for all coils, and for conductor depths.

The actual mho value is plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal rows of dots indicate anomaly amplitude on the flight record, and the vertical column gives the estimated depth. This depth may be unreliable because the stronger part of the conductor may be deeper or to one side of the flight line, or because of a shallow dip or conductive overburden effects.

╱	Conductor axis
S	Probable surface response
S?	Possible surface response
L	Probable line (power, telephone, pipe, or fence)
L?	Possible line
?	Questionable anomaly
O	Apparent thickness > 10 m
>	Dip
100γ	Direct magnetic correlation of 100 gammas

DIGHEM maps are designed to provide a correct impression of conductor quality by means of the conductance grade symbols. The symbols can stand alone with geology when planning a followup program. The actual mho values are plotted for those who wish quantitative data. The anomaly ppm and depth are indicated by inconspicuous dots which should not distract from the conductor patterns, while being helpful to those who wish this information. The map provides an interpretation of all conductors in terms of length, strike direction, conductance and depth. The accuracy is comparable to an interpretation from a ground EM survey having the same line spacing.

GEOPEKO
DEVONPORT BASE, TASMANIA

SCALE 1:10 000

No. TS

DATE

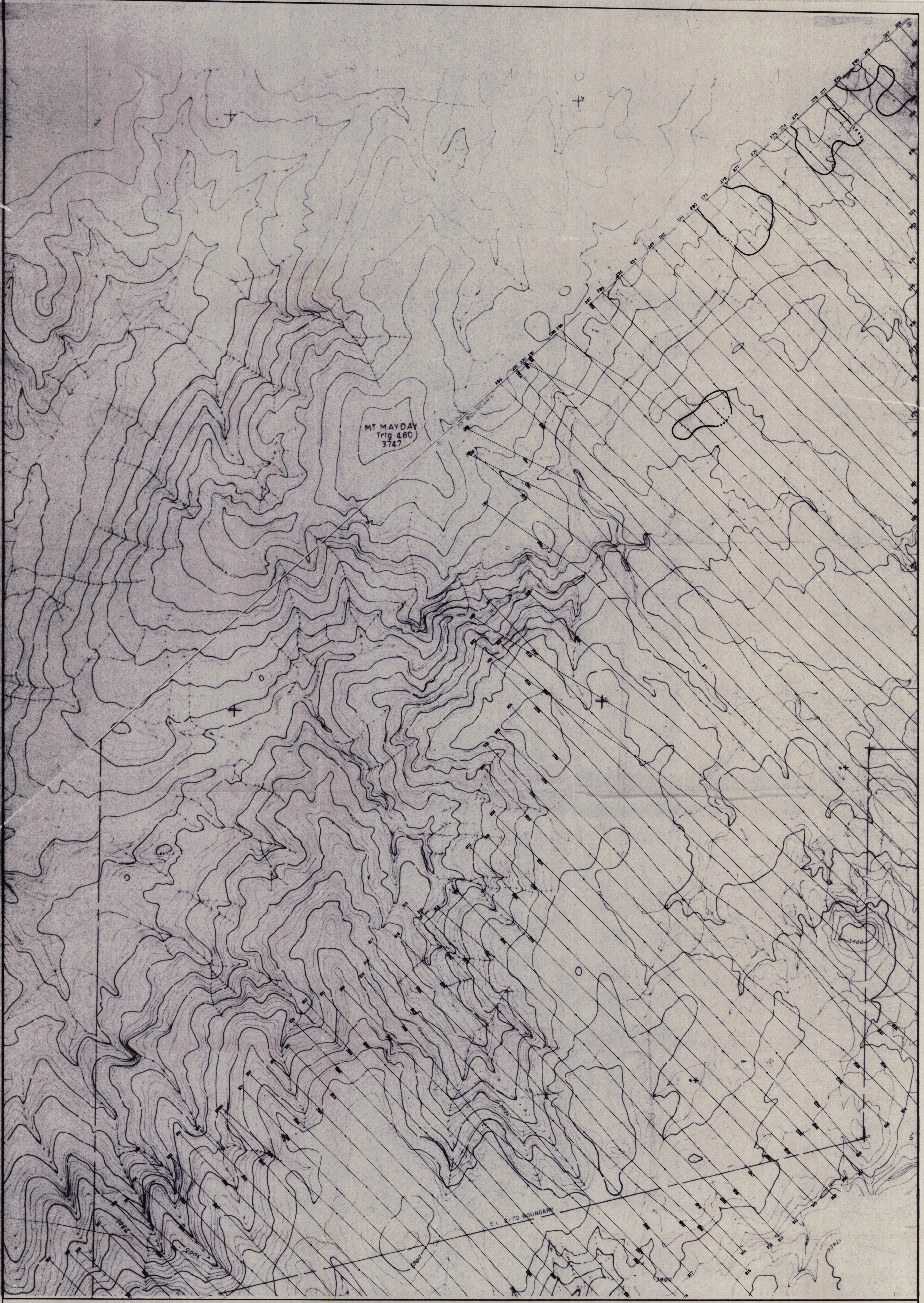
GEOLOGIST

DRAWN

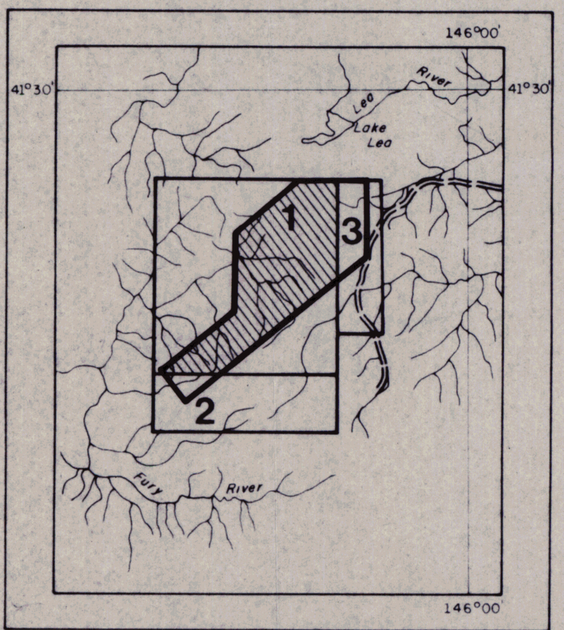
CHECKED

MACKINTOSH EAST, SHEET 1

Plan No. 5576 S/B



LOCATION MAP



Scale 1 250,000

DIGHEM^{II} SURVEY

RESISTIVITY

FOR

GEOPEKO LIMITED

260096

5 cm

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

SHEET 1.

012

Flight line

Fiducials and numbers

LEGEND

Contours in ohm - m at eight intervals per decade

100
75
56
42
31
23
17
13
10

Note

The numbers face in the direction of increasing value

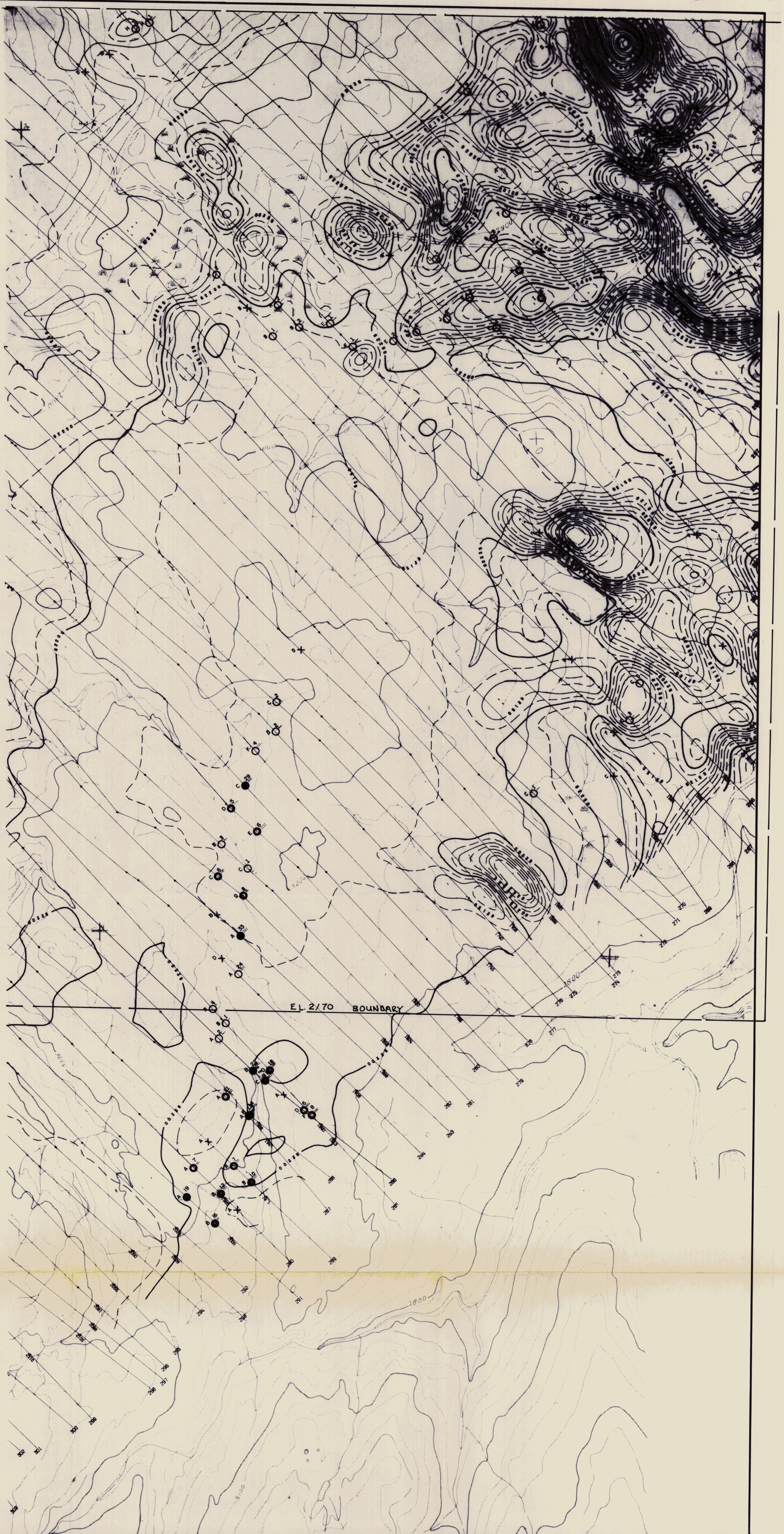
GEOPEKO
DEVONPORT BASE, TASMANIA

TS

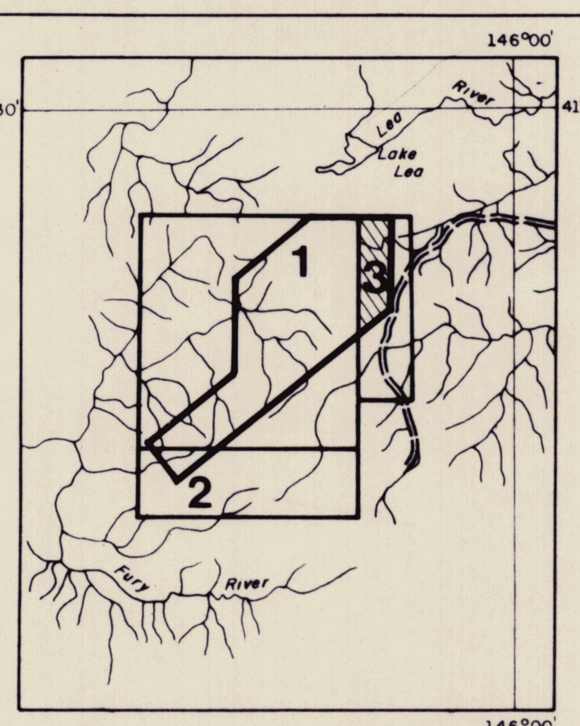
MACKINTOSH EAST, SHEET 1

Plan No. 5579 S/B

84-2304



LOCATION MAP



Scale 1:250,000

260097

5 cm

DIGHEM^{II} SURVEY

MACKINTOSH EAST, TASMANIA

MAGNETICS

FOR

GEOPEKO LIMITED

014

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

Flight line

Fiducials and numbers

ISOMAGNETIC LINES

(total field)

1000 gammas

200 gammas

50 gammas

25 gammas

magnetic depression

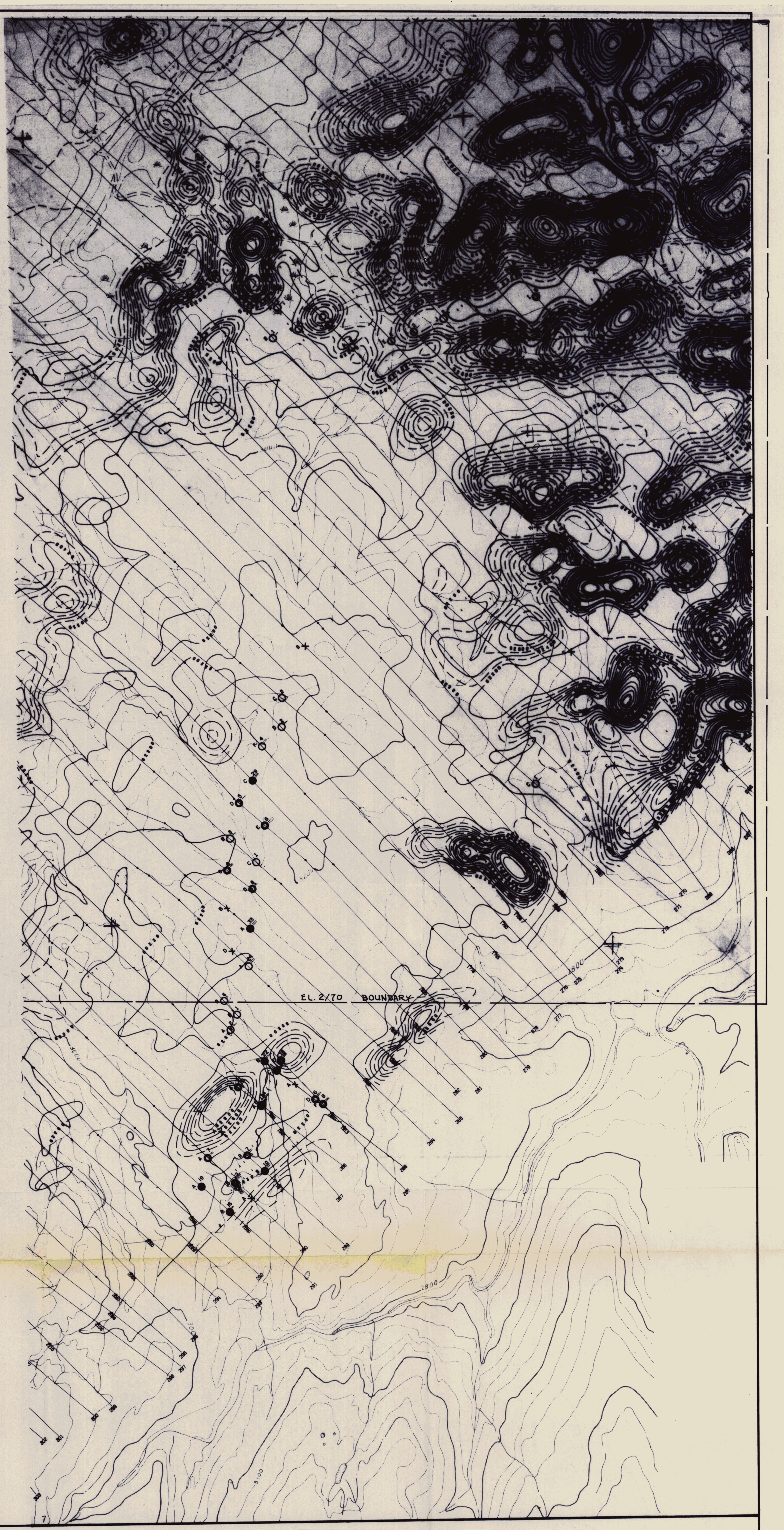
Magnetic Inclination within the survey area 72°

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

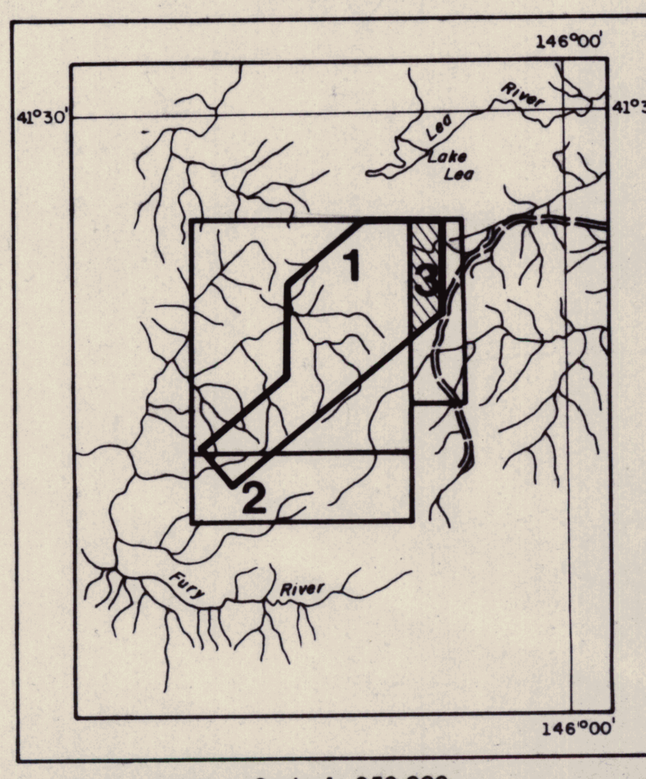
Plan No. 5585 S/B

SHEET 3

84-2304.



LOCATION MAP



Scale 1: 250,000

Plan No. 5586 S/B

260098

5 cm

DIGHEM^{II} SURVEY

MACKINTOSH EAST, TASMANIA

ENHANCED MAGNETICS

FOR

GEOPEKO LIMITED

SCALE 1:10,000

013

1/2 — 0 — 1/2 — 1 Kilometres

1/4 — 0 — 1/4 — 1/2 Miles

SHEET 3

84-2304

REGISTERED PROFESSIONAL ENGINEER — D. C. FRASER — PROVINCE OF ONTARIO

Flight line

Fiducials and numbers

ISOMAGNETIC LINES

(enhanced field)

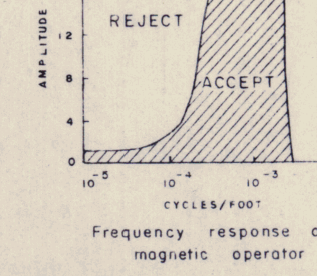
5000 .... 5000 gammas

1000 .... 1000 gammas

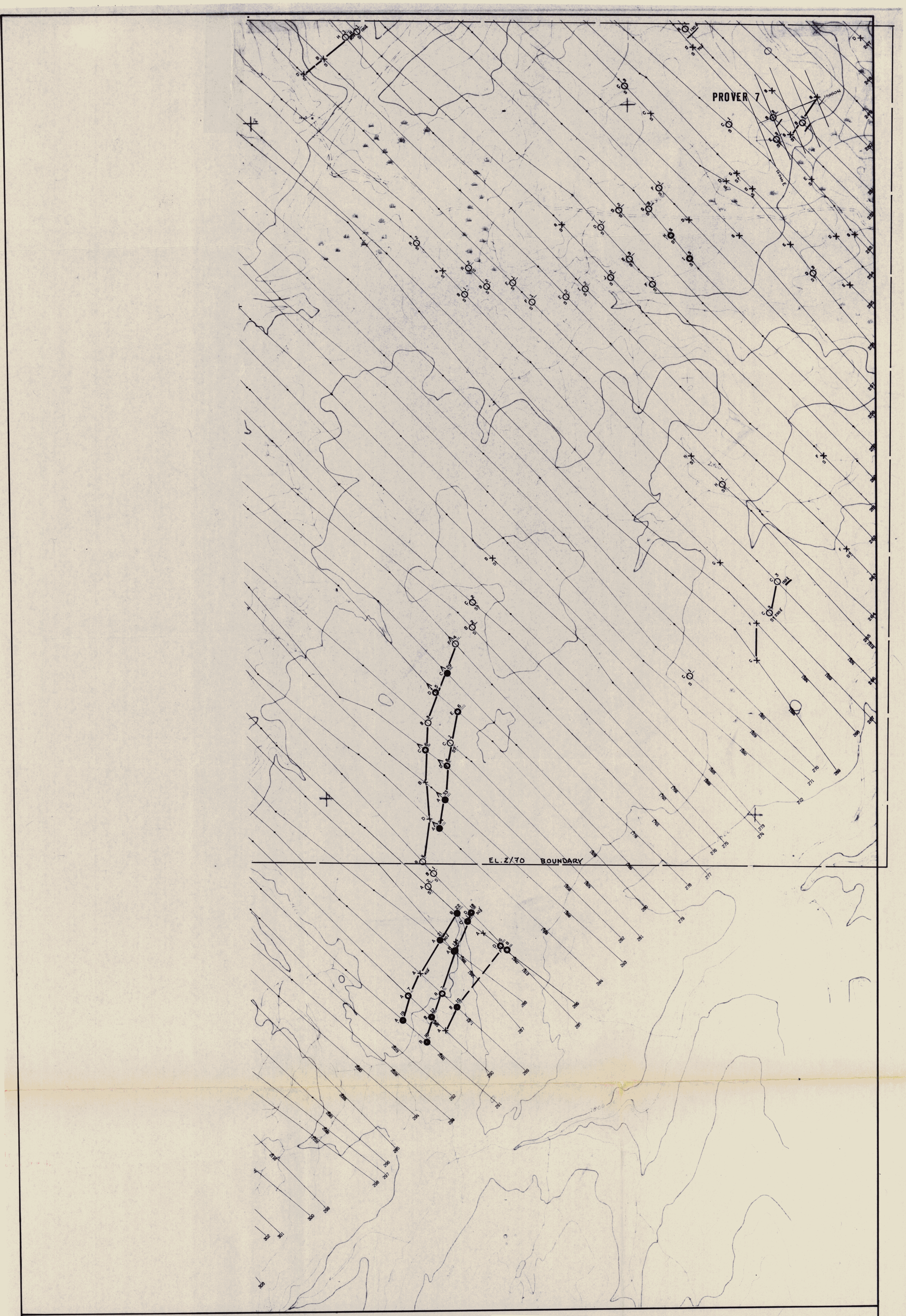
.... 200 gammas

.... 100 gammas

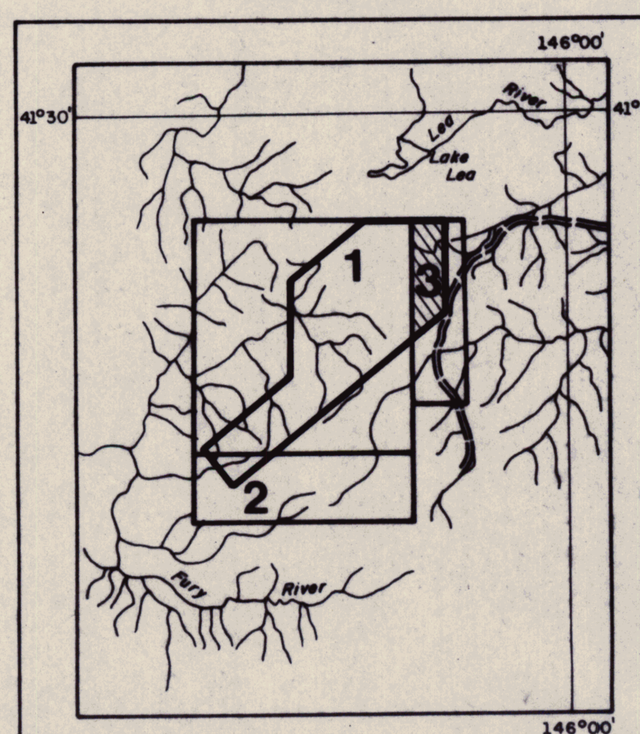
.... magnetic depression



Frequency response of magnetic operator



LOCATION MAP



Scale 1 : 250,000

260099

5 cm

DIGHEM II SURVEY

MACKINTOSH EAST, TASMANIA

ELECTROMAGNETICS

FOR

GEOPEKO LIMITED 015

SCALE 1 : 10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

SHEET 3

84-2304

REGISTERED PROFESSIONAL ENGINEER D.C. FRASER PROVINCE OF ONTARIO

Plan No. 5584 S/B

Flight line

1281

Fiducials and numbers

1286

ANOMALY GRADE	EM GRADE SYMBOL	MHO RANGE
6	●	≥ 100
5	✸	50 — 99
4	●	20 — 49
3	⊙	10 — 19
2	○	5 — 9
1	○	≤ 4
	×	Possible conductor

DIGHEM anomalies are divided into six grades of conductivity – thickness product. This product in mhos is the reciprocal of resistance in ohms. The mho is a measure of conductance, and is a geologic parameter. Most swamps yield Grade 1 anomalies but highly conducting clays can give Grade 2 anomalies. The multi - coil anomaly shapes often allow surface conductors to be recognized, and these are indicated by the letter S on this map. The remaining Grade 1 and 2 anomalies could be weak bedrock conductors. The higher grades indicate increasingly higher conductances. Examples: The ore bodies of the Magusi River camp yield Grade 4 anomalies, while Mattabi and Whistle give Grade 5. Graphite and sulphides can span all grades but, in this survey area, field work may show that the different grades indicate different types of conductors.

identifier → C 38 ← mho value

Depth is greater than
. 50 feet
: 100 feet
⋮ 150 feet
⁞ 200 feet

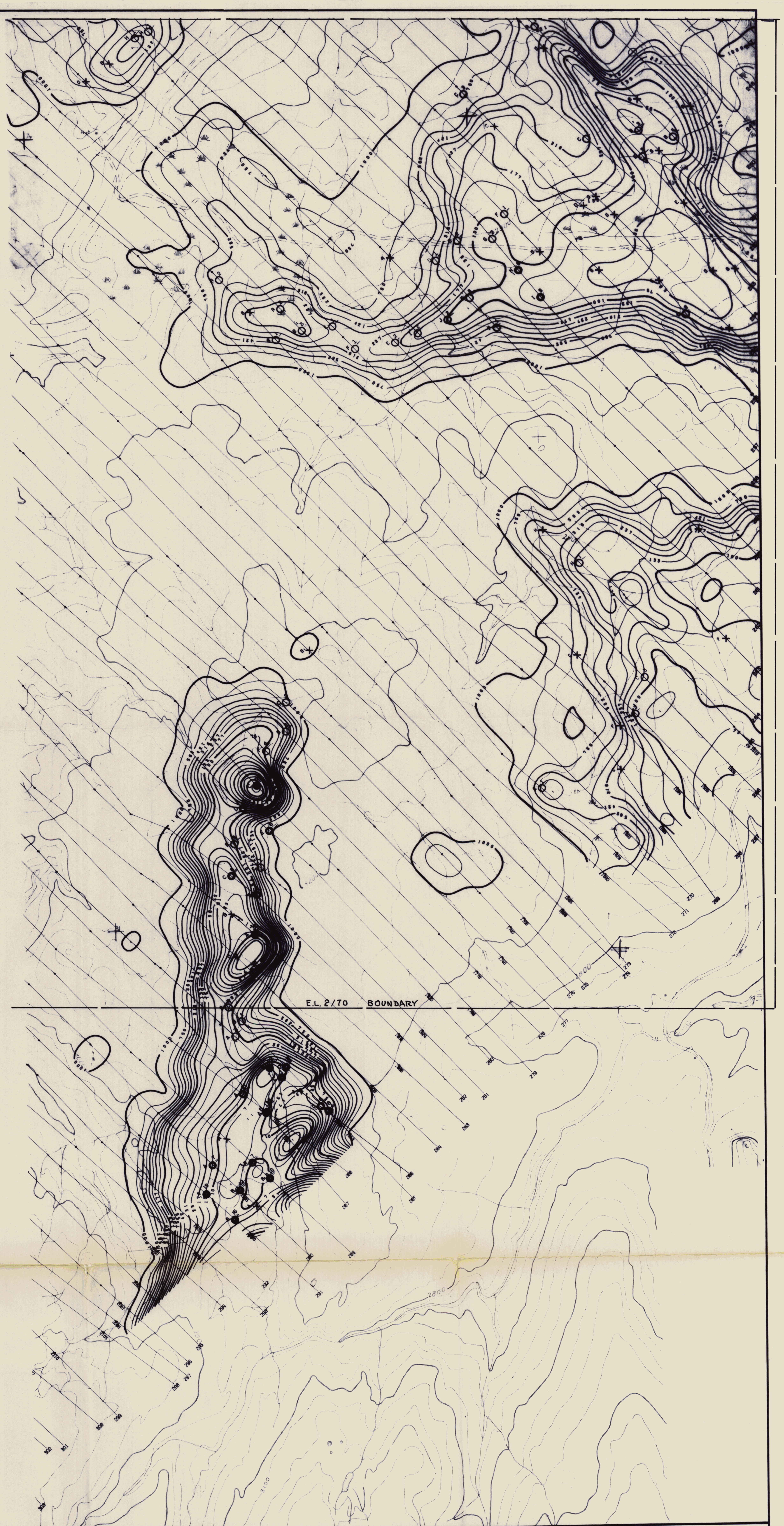
Inphase and Quadrature of Standard coil is greater than
. 5 ppm
.. 10 ppm
... 15 ppm
.... 20 ppm

Refer to list of anomalies in survey report for the actual ppm values for all coils, and for conductor depths.

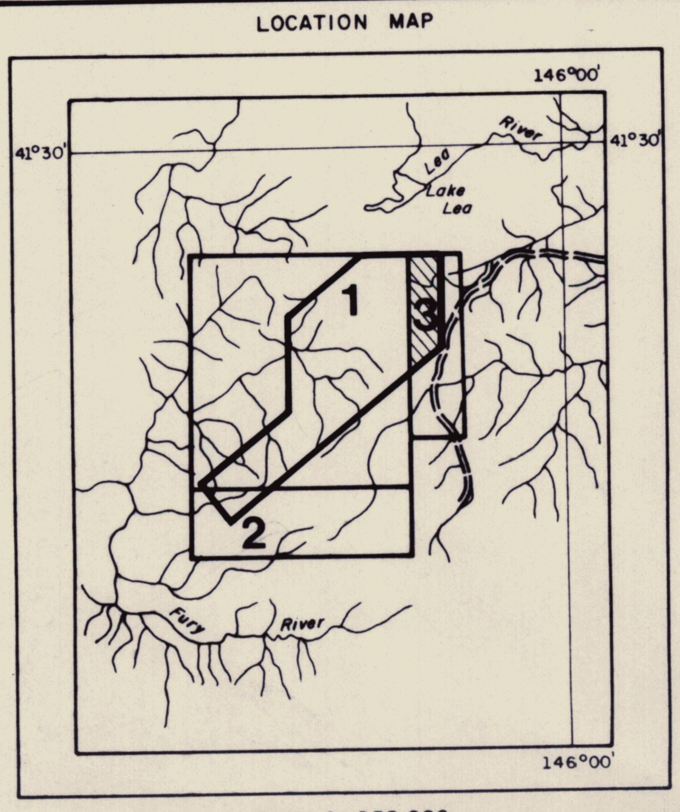
The actual mho value is plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal rows of dots indicate anomaly amplitude on the flight record, and the vertical column gives the estimated depth. This depth may be unreliable because the stronger part of the conductor may be deeper or to one side of the flight line, or because of a shallow dip or conductive overburden effects.

╱	Conductor axis
S	Probable surface response
S?	Possible surface response
L	Probable line (power, telephone, pipe, or fence)
L?	Possible line
?	Questionable anomaly
⊂⊃	Apparent thickness > 10 m
<	Dip
100γ	Direct magnetic correlation of 100 gammas

DIGHEM maps are designed to provide a correct impression of conductor quality by means of the conductance grade symbols. The symbols can stand alone with geology when planning a followup program. The actual mho values are plotted for those who wish quantitative data. The anomaly ppm and depth are indicated by inconspicuous dots which should not distract from the conductor patterns, while being helpful to those who wish this information. The map provides an interpretation of all conductors in terms of length, strike direction, conductance and depth. The accuracy is comparable to an interpretation from a ground EM survey having the same line spacing.



LOCATION MAP



Scale 1 : 250,000

260100

DIGHEM II SURVEY

MACKINTOSH EAST, TASMANIA

RESISTIVITY

FOR

GEOPEKO LIMITED

SCALE 1 : 10,000

016

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

Plan No. 5587 S/B

SHEET 3

84-2304.

Flight line

1252

1256

Fiducials and numbers

LEGEND

Contours in ohm - m at eight intervals per decade

100
75
56
42
31
23
17
13
10

Note

The numbers face in the direction of increasing value.