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DEPT. OF MINES
REF. No. 10,819/85

FINAL REPORT

ON EXPLORATION LICENCE 9/74,

BIRCH INLET, TASMANIA

OPEN FILE

DATE: September, 1985

FOR: Geopeko, PO Box 217, Gordon, NSW, 2072

BY: W Herrmann, C/- PO, Forth, Tas., 7310

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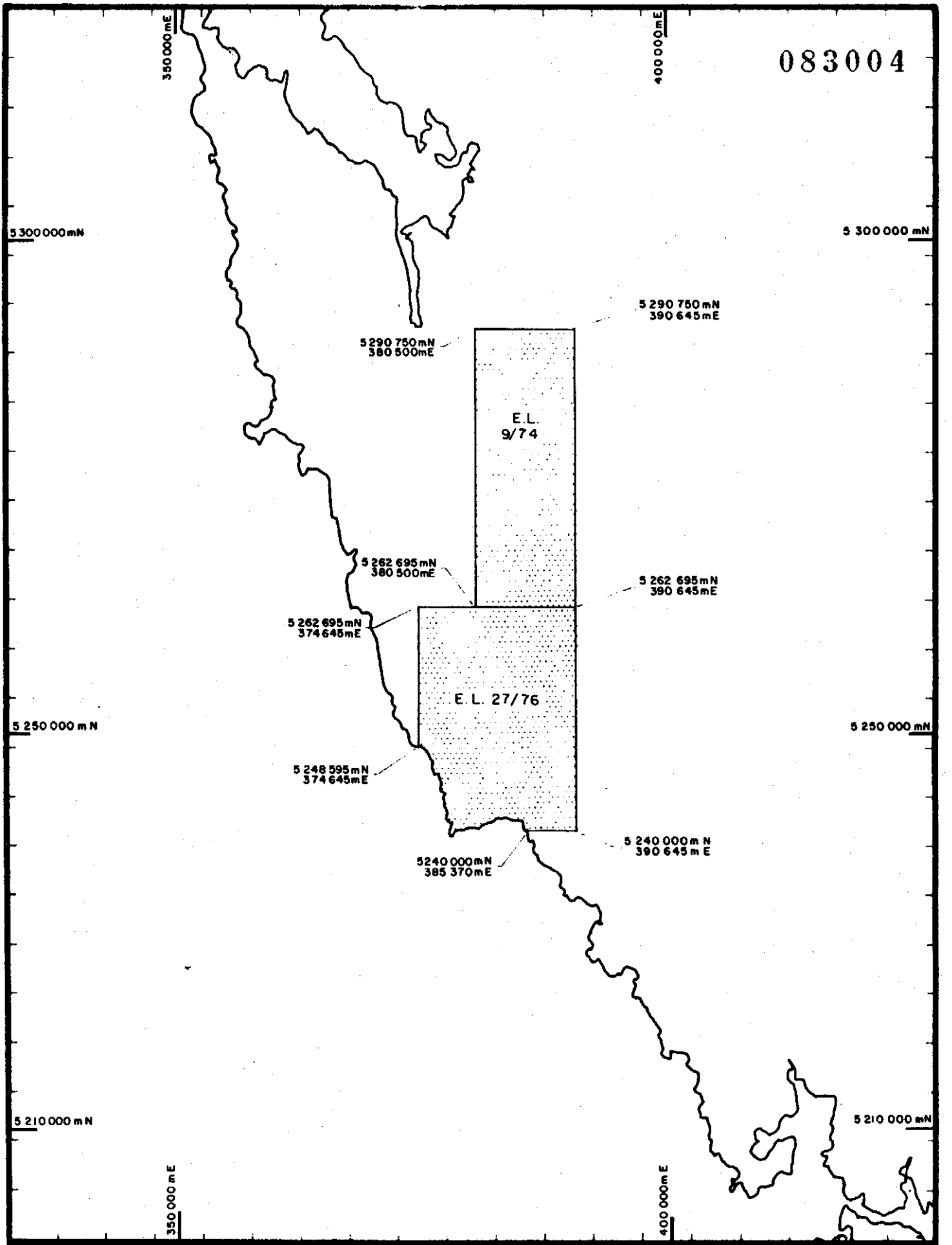

LEGEND

E.L. AREA

5 cm

GEOPEKO LIMITED

KING ISLAND

Scale 1: 500 000

Figure 1

E.L. 9/74 & E.L. 27/76

J.P.M.

1. INTRODUCTION

This final report on Exploration Licence 9/74 summarises the concepts, methods and conclusions of mineral exploration conducted by several companies during the licence's ten year history.

Informally known as "Birch Inlet", EL 9/74 covered an original area of 285 sq km embracing an exposure of Cambrian acid volcanics in the D'Aguilar Range-Moore's Valley area south west of Tasmania.

This report is based upon and supplementary to the several previously submitted progress reports referred to in the text.

A previously submitted DIGHEM II Report (No 313) with accompanying plans, is reproduced in full as Appendix I.

2. SUMMARY

Exploration Licence 9/74 of 285 sq km was granted in July 1974, reduced to 125 sq km in July 1984 and relinquished in May 1985.

Mineral exploration was carried out initially by Union Oil Development Corporation (UODC), later by Geopeko in joint venture with UODC and finally by Geopeko and Aquitaine Australia Minerals in joint venture with UODC.

The mineral exploration objective was to search for volcanogenic massive base metal sulphide deposits within the Lucas Volcanics which occupy a narrow (3km x 16km) meridianal belt in the central part of the Licence area. The Lucas Volcanics are considered to be of Cambrian age, consist dominantly of rhyolitic volcanics with minor epiclastic sediments are are correlated with the highly mineralized Mt Read Volcanics to the north.

The exploration method involved use of airborne EM/magnetic surveys, reconnaissance geological mapping, drainage geochemical sampling and gradient array IP for initial target identification with VLF-EM, ground magnetics, IP, C-Horizon geochemistry and detailed geological mapping for follow-up and prospect evaluation.

Due to the remoteness and (local) ruggedness of the terrain, exploration field parties in early years logistically relied heavily upon the use of Bombardiers with some helicopter support.

Access in the later phases of exploration was accomplished entirely by helicopter.

In general, the results of exploration in EL 9/74 have been unspectacular.

3. TENURE HISTORY

Exploration Licence 9/74 of 285 sq km (368 sq km according to McGregor-Dawson, 1977) was granted to Union Oil Development Corporation (UODC) in July 1974.

Mineral exploration field work was conducted by UODC during the summer months of early 1975.

Subsequent to the establishment of a joint venture agreement between UODC and Geopeko in December 1976, the latter company assumed management and execution of the exploration project.

Following preliminary review and base map compilation Geopeko conducted field work in the area during the period January to March 1977.

Aquitaine Australia Minerals P/L joined the joint venture partnership in early 1980 and participated in a DIGHEM II airborne electromagnetic/magnetic survey and limited follow-up work during December 1980 and February 1981 respectively.

Aquitaine withdrew from the joint venture in 1983.

The licence area was reduced to 125 sq km in July 1984.

The UODC-Geopeko joint venture partnership relinquished the licence in May 1985.

4. DETAILS OF MINERAL EXPLORATION

4.1 Union Oil - 1975 (Ref: McGregor-Dawson 1975)

4.1.1 EXPLORATION SUMMARY

Union Oil carried out exploration during the period February-April 1975. The work was confined to the narrow belt (3km x 16km) of exposed Cambrian acid volcanics known as the Lucas Volcanics which are confidently correlated with the highly mineralized Mt Read volcanics to the north.

The work comprised:

* geological mapping on several traverses.

* stream sediment samplinng, total 129 samples, giving only partial coverage of volcanic exposure.

* Gridding: Approximately 30 line km of gridding on east-west lines spaced 800m apart over the southern half of the volcanic belt.

  A short (500m) line was cut over a ridge containing anomalous rock chip samples in the northern part of the grid.

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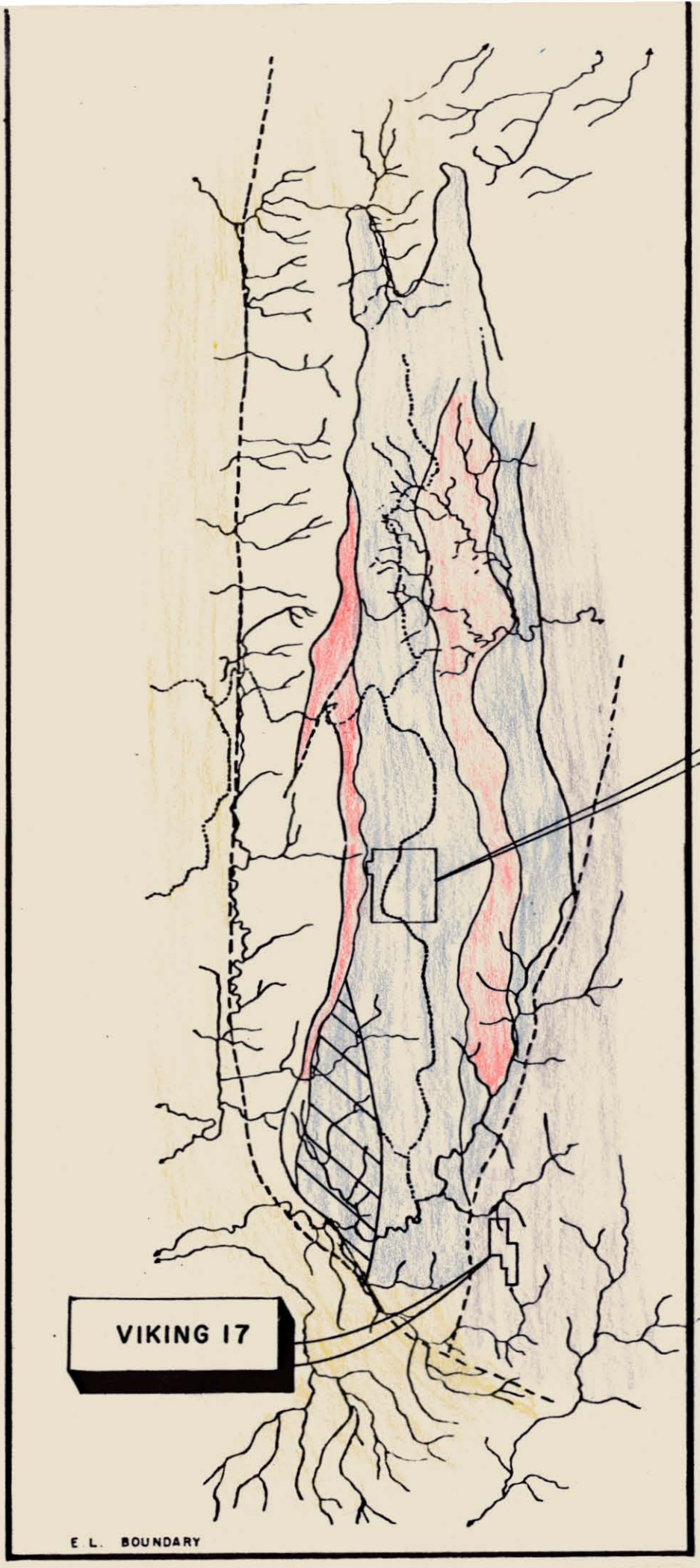

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- TERTIARY (MACQUARIE BEDS)
- ORDOVICIAN (CONGLOMERATE, SANDSTONE)
- € TYNDAL GROUP
- € ACID PYROCLASTICS AND LAVAS. UNIT OF INCREASED MAGNETIC CHARACTER
- € QUARTZ FELDSPAR BIOTITE PORPHYRY
- PRECAMBRIAN (QUARTZITE, q mica schist)
- ..... BOMBARDIER TRACKS
- — — FAULTS
- —— E.L. BOUNDARY

BIRCH INLET E.L.9/74

Prospect Location Diagram

SCALE: approx. 1:83000

0 1 2 3 KM

5 cm

* Soil sampling: A_1(?) horizon sampling (at 10cm depths) on 25m intervals on the main grid (total 1260 samples) and 15m intervals on the short northern grid line (total 34 samples).

* Rock Chip Sampling (total 42 samples).

* Gradient Array Induced Polarization: total of 21 line km on grid lines between 12800N and 19200N on the main southern grid.

* McPhar H-400 Airborne Electromagnetic/Magnetic survey over the southern third of exposed Lucas Volcanics.

4.1.2 CONCLUSIONS

The reconnaissance programme succeeded in defining seven anomalous areas considered worthy of further investigation. Anomalous areas comprised various combinations of airborne EM/Mag, soil-stream-rock geochemical and gradient IP anomalies.

Recommendations for further work included use of closer spaced soil/auger sampling, ground geophysics including pole-dipole and gradient array IP and more detailed geological mapping.

4.1.3 LOGISTIC METHODS

The Union Oil field party relied extensively on use of two Bombardier tracked vehicles (Muskeg and J5) for access over the undulating topography covering the southern two-thirds of the Lucas Volcanic belt.

Bombardiers were ferried by barge from Strahan across Macquarie Harbour, unloaded at a rough landing on the Sorell River 2km upstream from the head of Birch Inlet, and then driven southward along the pre-existing (graded) Bombardier track leading to Low Rocky Point.

Union Oil had constructed (by bulldozer) a five kilometre track branching eastward from the Low Rocky Point track to provide access to the Innes Peak area. This track remains un-rehabilitated.

Bombardiers were also extensively used in clearing grid lines on the large southern grid. It may be expected that these lines are by this date at least partially revegetated. Helicopter access was necessitated in the more rugged northern part of the Lucas Volcanics.

4.1.4 EXPLORATION PHILOSOPHY

Exploration philosophy is quite plainly stated by McGregor-Dawson (1975). The exploration work was directed to discovery of volcanogenic Cu-Pb-Zn deposits in the Cambrian (Lucas) volcanics "which are known to contain economic deposits at Queenstown and Rosebery".

4.2 Geopeko - 1977 (Ref: Strickland, 1978; Deakin, 1977)

A Geopeko field party carried out a detailed/reconnaissance exploration programme (termed Phase 1) over the exposed Lucas Volcanics during the period 15/1/77 to 19/3/77.

4.2.1 EXPLORATION SUMMARY

The Phase 1 programme comprised regional reconnaissance and preliminary prospect evaluation.

This included:

* Geological mapping at 1:10,000 scale.

* Collection of (736) rock specimens.

* Thin sectioning and petrographic description of (40) rock specimens.

* Analysis of (82) rock samples with significant chlorite/sericite alteration or sulphide mineralization for Cu, Pb, Zn, Ag, Mn, Cd, Fe, As and Sn.

* Collection of (959) stream sediment samples from the prospective volcanic area, giving an average sample density of 16 per square kilometre. The -80 mesh fractions were analysed for Cu, Pb, Zn, Ag, Mn, Fe, Ba and Sn. On the basis of weakly anomalous Pb or Zn results, thirty four (34) of drainage samples were re-analysed using semi-quantitative emission spectroscopy under analysis schemes ES 1-4 and ES 6 (which provide analysis for 42 elements including gold).

* Collection and analysis of (308) soil samples from (68) hand auger holes and (188) Jacro machine auger holes.

  Samples were collected from C-Horizon soils in:

  - Geochemical Orientation holes (2)

  - Auger holes at 50m centres on UODC grid lines 11200N, 14400N and 16000N for comparison with UODC A1 horizon sampling.

  - Auger holes at 25m centres on reconnaissance grids over selected prospect areas (Viking 1, 5, 10).

* 14,570 metres of grid line cutting over selected prospects and airborne EM anomalies.

* Geophysical ground follow-up of (12) electromagnetic anomalies defined by previous airborne surveys (SCINTREX, TURAIR, 1973 and GEOEX, McPar H-400, 1975) utilizing the VLF-EM technique with some additional magnetic traversing and minor (V1, V10) Gradient Array IP survey.

4.2.2 CONCLUSIONS

The conclusions of Strickland (1978), based upon the above programme, are manifold. The salient elements were:

* The Lucas Volcanics are equivalent to the Mt Read Volcanics and are prospective for massive Cu-Pb-Zn sulphide mineralization.

* Geochemical drainage sampling is an effective regional reconnaissance method in EL 9/74 though anomalous responses are expected to be subtle. (Anomaly thresholds determined at 10ppm Cu, 70ppm Pb, 160ppm Zn).

* C-Horizon soil auger sampling has proved to be more definitive than previous (UODC) shallow A1 horizon sampling.

* Existing aeromagnetic data (derived from Scintrex-Turair Survey of 1973) is considered inadequate and resurvey recommended.

* Recommendation for airborne EM survey over approximately 24 sq km of central EL 9/74 not previously covered.

* The conclusion that five prospect areas appear favourable for massive Cu-Pb-Zn sulphide mineralization on the basis of various combinations of geological, geochemical and geophysical characteristics.

  The areas are Viking 10, Viking 23-15 area, Viking 19-5 area, Viking 1-2 and Viking 3-4 area.

* Detailed recommendations for a Phase 2 appraisal of anomalous areas and extension of airborne geophysical coverage are given.

4.2.3 LOGISTIC METHODS

The modes of access and transport employed by the Geopeko field party were essentially similar to those of the previous UODC explorers. That is, it relied heavily upon the use of two Bombardiers (purchased from UODC) on the ground with periodic helicopter flights to resupply stores, equipment and personnel. Light fixed wing aircraft were probably also used to fly personnel and stores to and from the pre-existing Moore's Valley Airstrip.

No additional road or track construction was carried out by Geopeko although Bombardiers were probably extensively used to push through scrubby areas providing access tracks and traverse lines. It is assumed that no rehabilitation of such tracks was carried out.

A Bombardier mounted Jacro 200 auger drilling rig was used for C-Horizon geochemical sampling.

The field party occupied three (portable) camp sites (locations not known) during the Phase 1 exploration program in early 1977.

4.2.4 EXPLORATION PHILOSOPHY

The exploration objective of the Geopeko-UODC joint venture was to search for volcanogenic base metal sulphide deposits. Initial target selection was based on airborne electromagnetic/magnetic survey data with detailed appraisal by combined geological mapping, geochemical and geophysical techniques.

4.3 Geopeko-Aquitaine, 1980-81

(Ref: Pemberton, 1981 and Fraser & Dvorak, 1981)

Exploration of EL 9/74 was briefly revitalized following the addition of Aquitaine Australia Minerals to the joint venture partnership in 1980.

4.3.1 EXPLORATION SUMMARY

The 1980-81 exploration programme was managed and executed by Geopeko personnel with assistance from P Lewis and K Glasson from Aquitaine.

It comprised:

* A helicopter borne DIGHEM II electromagnetic/magnetic survey of the exposed Cambrian acid volcanic belt: the Lucas Volcanics.

  The DIGHEM II survey involved 585 line kilometres with average flight line spacing of 150m, EM bird height 41m and magnetometer bird height 56m.

* A six day Field Visit (Lewis and Glasson) which enabled brief ground inspection of some (eleven) weak DIGHEM II anomalies.

* Following a review of (generally disappointing) results two areas were selected for more detailed follow-up.

  These were:

  Viking 22 and 10 Area which was selected on account of anomalous stream and C-horizon geochemistry identified during the 1977 exploration programme.

  Detailed follow-up (1981) comprised:

  - Gridding

  - Hand auger "C-Horizon" sampling at 25m centres on lines 200m apart; analysis for Cu, Pb, Zn, Ag, Fe and Mn.

  - Ground magnetics

  - Geological mapping at 1:2500 scale.

  Viking 17 was selected for the occurrence of the two DIGHEM II anomalies with associated magnetic anomaly.

Detailed follow-up (1981) comprised:

- Gridding (4.125km)
- Hand auger "C-Horizon" geochemical sampling. (174 samples at 25m centres on lines 200m apart; analysed for Cu, Pb, Zn, Ag, Fe, Mn, W, Sn).
- Ground magnetics.
- 50m dipole-dipole IP on one line.
- Geological mapping at 1:2500 scale.
- Hand excavation of (2) small pits on magnetic peaks at 9605E and 9690E on line 9800N.
- * (Planned used of Moving Source Turam as electromagnetic follow-up was ruled out by equipment malfunction).

4.3.2 CONCLUSIONS

The results of the DIGHEM II Survey were disappointing and "no definite bedrock conductors of merit were selected from the data".

Field checking of weak DIGHEM II conductive responses did not identify any areas worthy of further investigation.

More detailed evaluation of the Viking 22-10 prospect identified three areas with moderately anomalous Pb-Zn soil geochemistry (max. 520ppm Pb and 800ppm Zn). Due to lack of outcrop it was intended to excavate "costeans" over the anomalies "during the next field season". Magnetics revealed broad responses of little interest.

It was concluded that the Viking 17 EM response was due to graphitic schists, the magnetic character was unexplained and the geochemical sampling did not indicate significant anomalies.

It was recommended that no further work be carried out.

4.3.3 LOGISTIC METHODS

Pemberton (1981) does not give details of his party's modus operandi.

However, it is known that the field crew was encamped (for approximately two weeks) at the pre-existing Moore's Valley Camp. Personnel, stores and equipment were flown to Moore's Valley Camp by chartered Squirrel helicopter which remained with the party for the duration of the programme, enabling daily helicopter access to the work areas. Environmental damage was thus kept to a desirable minimum.

Pemberton (1981) reports that two small pits were dug (undoubtedly by hand) at the Viking 17 prospect.

4.3.4 EXPLORATION PHILOSOPHY

The rationale of the 1980-81 phase of exploration of EL 9/74 was essentially an extension of that of previous UODC and Geopeko work. That is, to search for volcanogenic massive sulphide deposits in the Lucas Volcanics (equivalent to Mt Read Volcanics) usinng airborne EM/magnetic methods as the ititial target selection technique and combined geochemical, geophysical, geological mapping methods for prospect appraisal.

4.4 CSR - 1985

Exploration of EL 9/74 waned to a standstill subsequent to the disappointing results of the 1980-81 programme and Aquitaine's withdrawal from the joint venture partnership.

Whilst encouraging results were emerging from exploration of Geopeko's EL 27/76 (Elliott Bay) EL 9/74 was more or less shelved in anticipation that geological enlightenment and exploration clues would be derived from the work being undertaken in the analogous environment to the south.

Following Geopeko's 1984 exploration rationalization and withdrawal from active work in Tasmania, new joint venture partners were sought for EL 9/74 (and other tenure).

In early 1985, geologists of CSR (Minerals Division) examined the documented data and made a one day field visit to EL 9/74 during which some drainage sediment samples were collected.

Though not clearly stated it is implicit that CSR was perhaps primarily interested in the gold mineralization potential of the area. (Analysis for gold was not systematically undertaken by the previous (1977) drainage geochemical survey.

A letter, from CSR's R E Williams, outlining the field visit and analytical results, is reproduced in this report as Appendix II.

5. REFERENCES

Deakin, R 1977	Geophysical Progress Report on Birch Inlet EL 9/74 Tasmania (L A Richardson & Assoc. for Geopeko) 77-1205
Fraser, D C and Dvorak, Z Jan. 1981	Dighem II Survey of Birch Inlet Area, Tasmania (Dighem Ltd for Geopeko) (Reproduced as Appendix I) 85-2492
McGregor-Dawson, J L Aug. 1975	Birch Inlet EL 9/74, Annual Report, 1974-75 Season (Union Oil Development Corp) 75-1112
Pemberton, J June 1981	Progress Report on EL 9/74, Birch Inlet, Tasmania, 1980-81 (Geopeko) 81-1580
Pemberton, J May 1984	Relinquishment Report on Part of EL 9/74 Birch Inlet, Tasmania (Geopeko) 84-2124
Strickland, C D June, 1978	Progress Report, EL 9/74 Report No. KI/78/2 (in 2 parts) (Geopeko) 78-1275
Williams, R E 9 April 1985	Letter on Field Visit to Birch Inlet EL 9/74 (CSR) 85-2492

DIGHEM^{II} SURVEY

OF

BIRCH INLET AREA, TASMANIA

FOR

GEOPEKO LIMITED

BY

DIGHEM LIMITED

TORONTO, CANADA
JANUARY 7, 1981

D.C. FRASER
PRESIDENT

Z. DVORAK
GEOPHYSICIST

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SUMMARY

DIGHEM^{II} electromagnetic/resistivity/magnetic surveys were flown in November and December, 1980, for Geopeko Limited, in the Birch Inlet and Mt. Lyell Mine areas in Tasmania.

The geologic environment in both survey areas was mostly resistive. Several low resistivity lows were located in the Birch Inlet area which may reflect bedrock sources. In the Mt. Lyell Mine area the survey identified two moderately strong conductive zones which coincide with known ore bodies.

LOCATION MAP

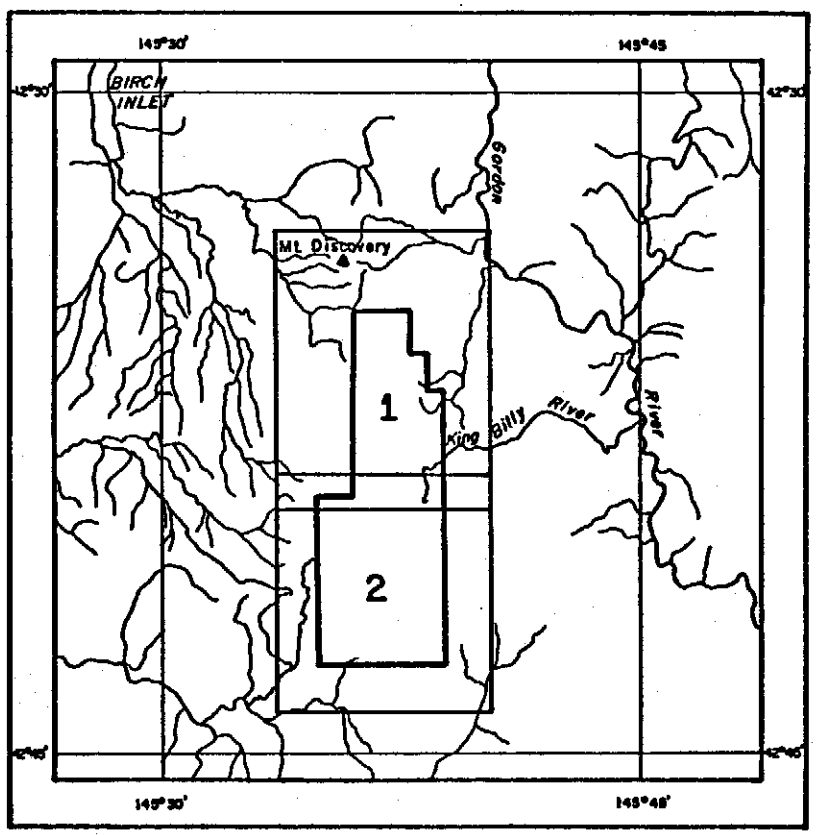

Figure 1a: Birch Inlet

LOCATION MAP

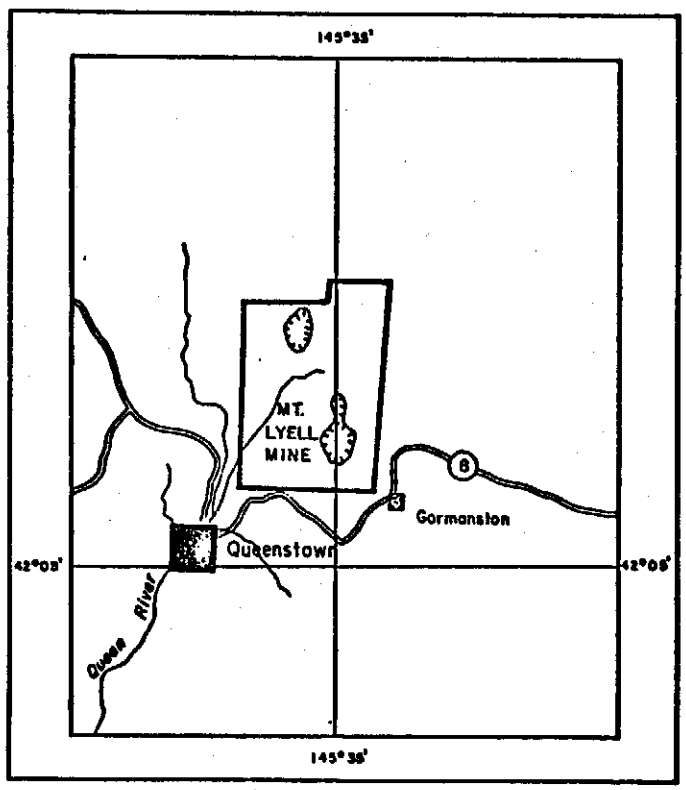

Figure 1b: Mt. Lyell

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APPENDIX A: The Flight Record and Path Recovery

APPENDIX B: EM Anomaly List

INTRODUCTION

DIGHEM^{II} surveys of 585 line-km were flown with a 150 m line-spacing for Geopeko Limited between November 30 and December 7, 1980, in the Birch Inlet and Mt. Lyell Mine areas of Tasmania (Figures 1a, 1b).

The Lama VH-PDU jet helicopter flew with an average airspeed of 119 km/h and EM bird height of 41 m. Ancillary equipment consisted of a Geometrics 803 magnetometer with its bird at an average height of 56 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 coaxial and coplanar 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

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procedure. The quoted noise levels are generally valid for wind speeds up to 35 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

[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.

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 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 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 local anomaly amplitudes. This contrasts with the use of true zero levels which are used to compute true EM amplitudes. Local anomaly amplitudes are shown in the EM anomaly list and these are used to compute the vertical sheet parameters of conductance and depth. Not shown in the EM anomaly list are the true amplitudes which are used to compute the horizontal sheet and conductive earth parameters.

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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, 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.

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

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 coplanar 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 channel rides above the zero level on the orange profile paper (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 then 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 more 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 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

[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.

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. 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.

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

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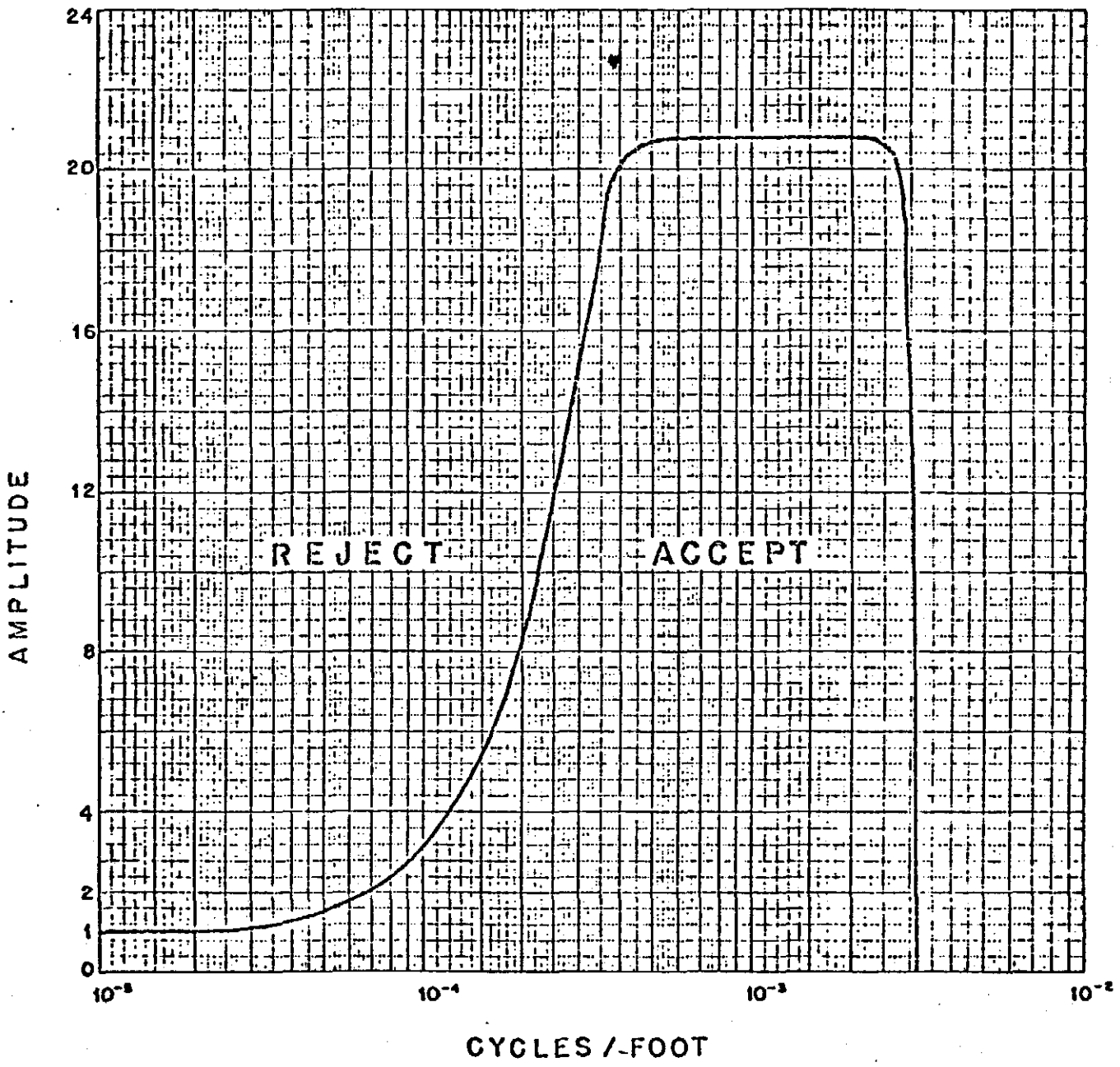

Figure 2 Frequency response of magnetic operator

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.

CONDUCTORS IN THE SURVEY AREA

The electromagnetic maps show 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 where 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 consisted of an east-west grid in the Birch Inlet area flown along lines spaced at 150 m, and an irregularly spaced grid in the Mt. Lyell Mine area flown in a northeasterly direction. The production statistics are as follows:

Area	Line-numbers	Line-km
Birch Inlet	1-112	568
Mt. Lyell Mine	201, 204-207, 301-303	17
		585

Birch Inlet Area

The survey area is characterized by background resistivities in excess of 1000 ohm-m. Several low resistivity zones of a limited areal extent, with values as low as 150 ohm-m, occurred due to locally conductive bedrock and overburden features. When evaluating the relative potential of these conductive zones, the apparent depth parameter (DP on the orange profiles) should be used as a guide. For example, the low resistivity zone centered at fiducial 279, line 44, appears to reflect a bedrock source because the depth parameter rides at or below the zero level.[4]

[4]For surface conductors, the DP channel rides above the zero level.

Similarly, the two low resistivity zones which occur along the southern boundary of the survey block reflect bedrock sources.

The survey area almost totally lacks well defined EM anomalies and responses which would be indicative of bedrock conductors. EM anomalies 93A and 95A, and x-type responses 86xA, 89xB, 91xD, 94xC, and 94xE possibly could reflect bedrock sources. Response 111xC definitely reflects a magnetic bedrock conductor which extends in a southerly direction beyond the survey boundary.

The total magnetic field map shows well defined north-northwesterly trends which are particularly well portrayed by the enhanced magnetics. Except for the bedrock conductor 111xC, no direct correlation exists between the magnetic and low resistivity anomalies.

Mt. Lyell Mine area

Eight irregularly spaced lines of variable flight direction were flown in the Mt. Lyell Mine area. Only computer generated profiles and an EM map were produced because of the difficulties which commonly are encountered in the machine contouring of narrow data sets.

The background resistivities in this survey block are high, mostly in excess of 1000 ohm-m. Local low resistivity zones, however, exist due to bedrock conductors which are also indicated by EM anomalies and responses, e.g., 206xA-301A, 201D-302F, 302G.

Numerous cultural sources, such as power lines, pipe lines, metal buildings and the like, exist in this survey area. Occasionally, these sources have produced spurious EM and resistivity anomalies which, in most instances, can be readily identified. The cultural activity, however, caused serious problems on line 303. The electronic equipment was overdriven by signals from the mining equipment and, consequently, the EM responses must be regarded with caution.

Respectfully submitted,
DIGHEM LIMITED,

D.C. Fraser,
President.

Z. Dvorak,
Geophysicist.

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Nine map sheets accompany this report.

Electromagnetics	3 map sheets
Resistivity	2 map sheets
Magnetics	2 map sheets
Enhanced magnetics	2 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 Label	Parameter	Scale units/mm	Noise
MAG	magnetometer	10 gamma	2 gamma
ALT	bird height	10 feet	5 feet
CXI	coaxial coil-pair inphase	1 ppm	1-2 ppm
CXQ	coaxial coil-pair quadrature	1 ppm	1-2 ppm
CPI	coplanar coil-pair inphase	1 ppm	1-2 ppm
CPQ	coplanar coil-pair quadrature	1 ppm	1-2 ppm
VLFT	VLF-EM total field	1 %	1-2 %
VLFQ	VLF-EM vertical quadrature	1 %	1-2 %
CXS	ambient noise monitor (coaxial coil)	1 ppm	1 ppm
CPS	ambient noise monitor (coplanar coil)	1 ppm	1 ppm
DIFI	difference function inphase	1 ppm	1-2 ppm
DIFQ	difference function quadrature	1 ppm	1-2 ppm
REC1	first anomaly recognition function	1 ppm	1-2 ppm
REC2	second anomaly recognition function	1 ppm	1-2 ppm
SIGT	conductance	1 mho	
RES	log resistivity at main frequency	.03 decade	
DP	apparent depth at main frequency	3 m	
RES2	log resistivity at secondary frequency	.03 decade	
DP2	apparent depth at secondary frequency	3 m	

Note: Channels CC and EXP2 are experimental.

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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.

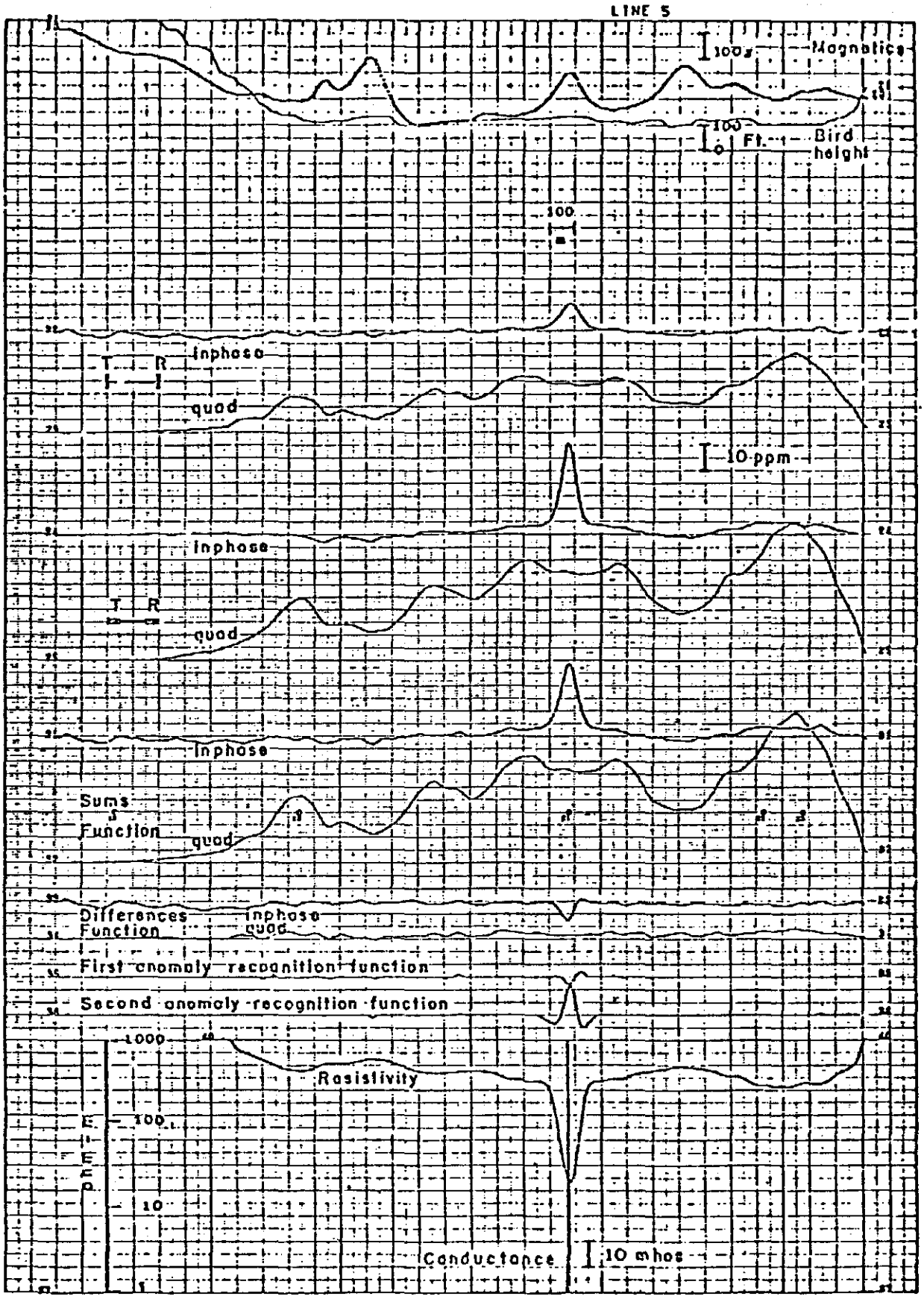

Fig. A1. Flight over Montcalm deposit, with line parallel to strike

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.

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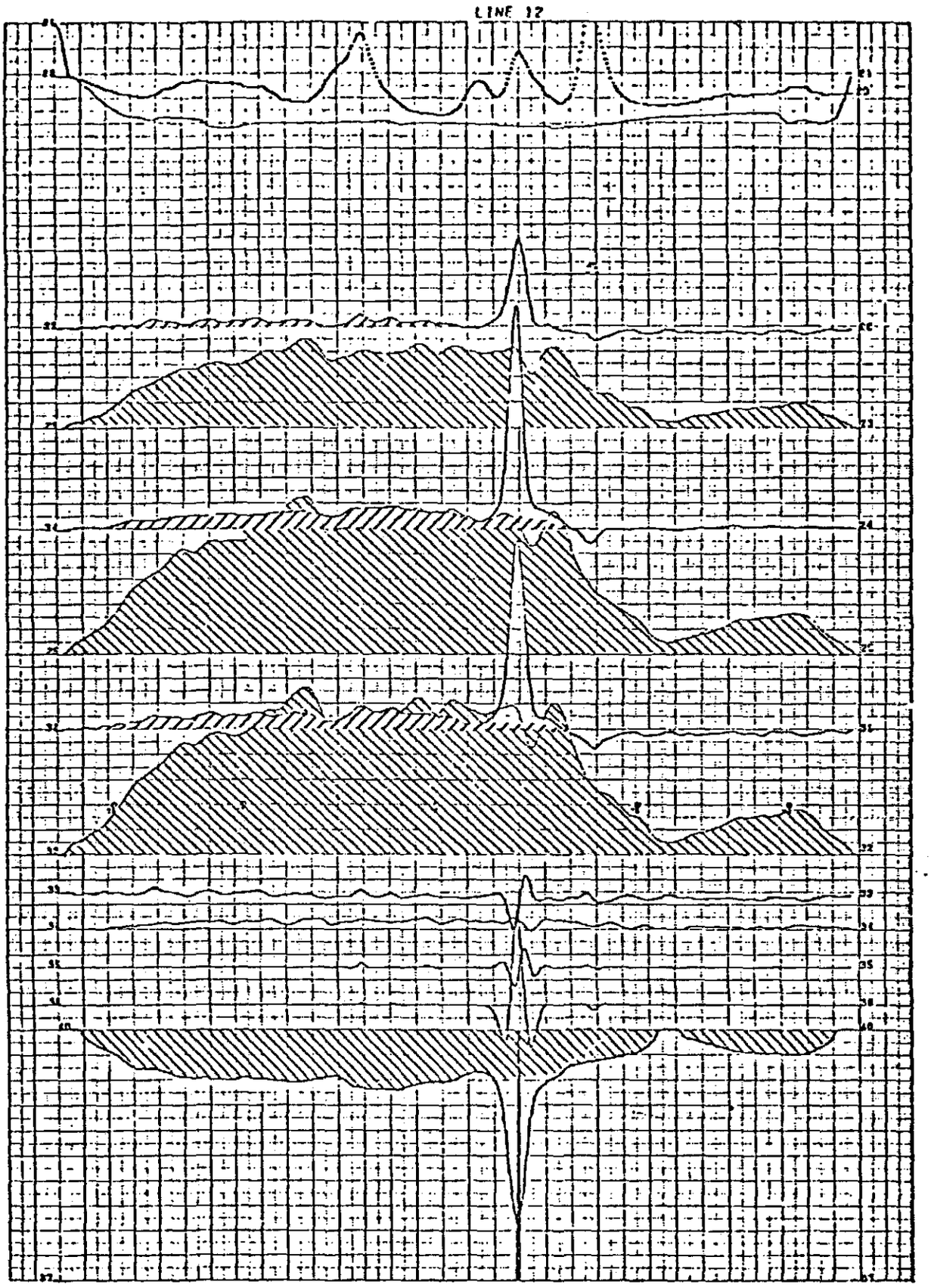

Fig. A2. Flight over Montcalm deposit, with line perpendicular to strike.

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.

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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.

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APPENDIX B

EM ANOMALY LIST

313-TEST AREA GEOPEKO,TASMANIA DEC/80

LINE & ANOMALY	COAXIAL COIL REAL PPM	COAXIAL COIL QUAD PPM	COPLANAR COIL REAL PPM	COPLANAR 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
201A	12	1	0	0	13	0	1	425	1035	0
201C	2	2	1	0	4	53	1	607	1035	0
201E	2	3	0	1	3	0	1	533	1035	0
201F	6	5	0	3	7	0	1	467	1035	0
201G	3	3	1	0	5	0	1	425	1035	0
201H	5	5	7	3	9	0	2	238	52	107
201I	5	1	1	0	15	0	1	374	645	0
204A	10	11	13	21	7	0	1	141	76	21
301A	23	36	51	67	10	0	2	125	27	44
301E	5	2	0	2	7	80	1	464	476	128
302C	0	0	0	3	9	21	1	676	1035	0
302F	16	25	26	28	8	4	2	176	28	85
302G	5	13	9	22	3	0	1	111	143	0
303A	0	0	6	4	8	188	5	576	10	476
303C	27	31	0	4	13	42	1	366	1035	0
303F	2	0	12	0	257	0	4	188	10	104
303H	2	6	3	6	2	0	1	242	148	71

.+ PROBABLE BEDROCK CONDUCTOR (SEE TITLE PAGE OF APPENDIX B)

.* 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.

313-SH 2 GEOPEKO TASMANIA DEC/80

LINE & ANOMALY	COAXIAL COIL REAL PPM	COAXIAL COIL QUAD PPM	COPLANAR COIL REAL PPM	COPLANAR 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
74B	6	2	0	2	19	200	1	536	1012	86
93A	3	2	0	1	5	211	1	440	1035	0
95A	4	2	0	0	12	230	1	625	1035	0

.+ PROBABLE BEDROCK CONDUCTOR (SEE TITLE PAGE OF APPENDIX B)

.* 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.

CSR

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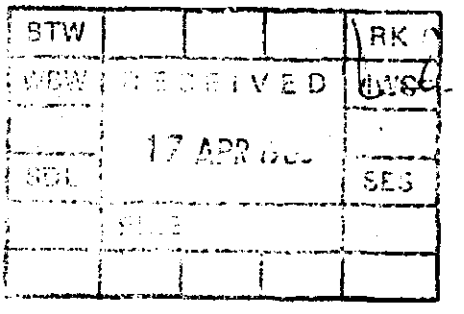
April 9, 1985



Mr. I.W. Calder
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Dear Ian,

TASMANIAN EXPLORATION
BIRCH INLET EL 9/74

CSR geologists visited the Birch Inlet EL on February 12, 1985 by helicopter chartered from Queenstown. The purpose of this visit was to inspect the geology and undertake limited stream sediment sampling in order to assess if CSR should farm into the area.

An initial aerial inspection of the area included:

(i) no anomalous geomorphological features, and

(ii) helicopter landing sites to be adequate except for the drainage of the Hales River.

The stream sediment sampling undertaken included 13 sample sites from 6 helicopter landings. The attached map at 1:100,000 scale shows these sample sites and the attached table shows the analytical results. This stream sediment sampling involved the collection of the following sample types:

(i) Bulk gold samples (BG) - 5 kg samples of active stream sediment which was subjected to cyanide leach and analysis of the gold thereby leached.

(ii) Panned concentrate samples (PC) - only 4 panned concentrate samples were collected due to problems with adequate sample sites, time and sample weight considerations. All panned concentrate samples were taken from heavy mineral trap sites and involved a volume of 2 medium panning dishes of -10 mesh material panned to the sample weight of ~50 g of concentrate. At the time of writing this letter the laboratory had been unable to provide the actual weight of concentrate received for analysis.

(iii) Standard stream sediment samples (SS) - of the active sediment seived to the following:

-20+80 mesh - Sn, W, As, Sb, Ba analysed by XRF
-80 mesh - Cu, Pb, Zn, Ni, Bi analysed by XRF
-20 mesh - Hg, Fe, Mn, Ag, analysed by AAS and Au by fire assay/AAS

Observations during this sampling were:

(i) most samples seemed to consist of fine quartz grains which probably are derived from the surrounding Ordovician sediments.

(ii) <0.5 mm flakes of gold were observed in the following samples:

A183852	- 8 grains
A183855	- 2 grains
A183862	- 2 grains

Analytical results for this sampling were disappointing with the only anomalous results being gold values in the panned concentrate samples viz.

A183852	- 10.5 g/t Au
A183855	- 0.55 g/t Au
A183862	- 0.74 g/t Au
A183874	- 0.90 g/t Au

The lack of any other anomalous values suggest that this gold is reworked from the Ordovician sandstones and conglomerates. As such this gold source is of no interest to CSR.

The single sample site on the Hales River can not be considered an adequate test of the Hales River drainage.

The lithologies of the Cambrian volcanics are interpreted to be similar to those of the Mt. Read Volcanics in the area between Mt. Romulus and Lake Lea to the NE of Tullah (Burnie 1:250,000 Sheet SK 55-3) which is not known to host significant mineralisation. This would suggest that the Birch Inlet Cambrian volcanics are probably on the eastern side of the Mt. Read Volcanics.

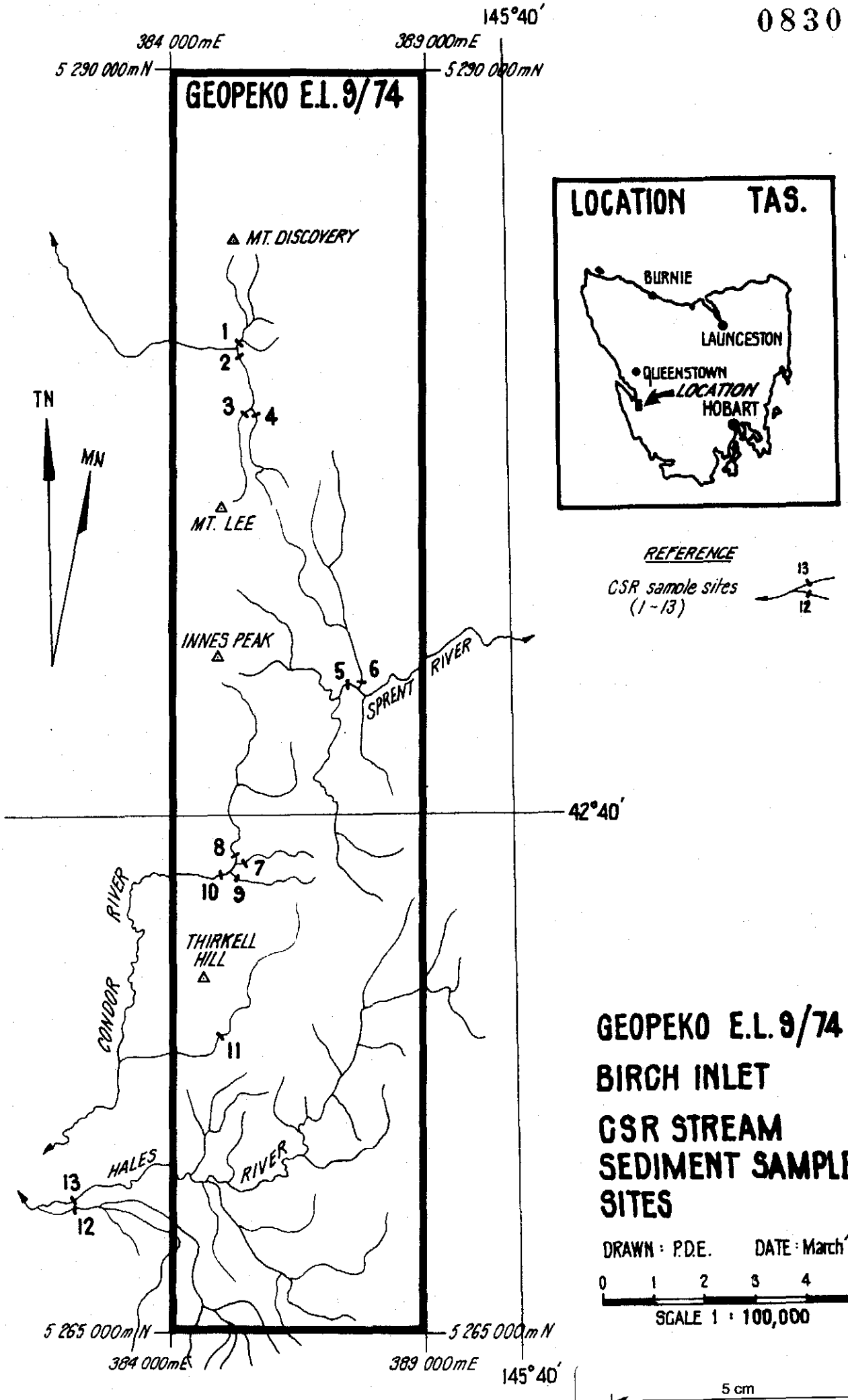
As a result of our investigation we advise you that we are not interested in further exploration of the Birch Inlet Exploration Licence. We thank you for the opportunity to consider this area and wish you success in further farm out negotiations and exploration.

Yours sincerely

R.E. Williams
Supervising Geologist
- S.E. Australia

060

083061



GEOPEKO E.L. 9/74

BIRCH INLET

CSR STREAM SEDIMENT SAMPLE SITES

DRAWN : P.D.E. DATE : March '85

0 1 2 3 4 5km

SCALE 1 : 100,000

5 cm

All analyses in ppm unless otherwise indicated

Sample Site No.	Sample No.	Sample Type	Sn	As	W	Sb	Ba	Cu	Pb	Zn	Ni	Bi	Au	Fe	Mn	Ag	Hg
1	A183851	BG*						32 ppb					0.073 ppb			0.7 ppb	
	A183852	PC*	6	4	x	4	30	9	4	30	32	x	10.5	4000	18	x	x
	A183853	SS*	4	5	x	8	20	x	4	8	6	6	x	1850	12	x	x
2	A183854	BG						48 ppb					0.176 ppb			0.8 ppb	
	A183855	PC	14	4	x	6	100	10	55	30	16	x	0.55	3800	36	x	x
	A183856	SS	8	6	x	6	135	10	6	6	6	4	x	2250	16	x	x
3	A183857	BG						27 ppb					0.167 ppb			1.2 ppb	
	A183858	SS	4	6	x	4	165	x	16	10	4	4	x	2800	32	x	x
4	A183859	BG						28 ppb					0.308 ppb			0.3 ppb	
	A183860	SS	6	6	x	6	45	14	6	10	14	4	x	3000	20	x	x
5	A183861	BG						55 ppb					x			1.5 ppb	
	A183862	PC	x	4	x	4	85	14	24	12	20	x	0.74	4650	75	x	x
	A183863	SS	10	4	x	4	120	x	8	7	14	4	x	2450	22	x	x
6	A183864	BG						34 ppb					x			1.9 ppb	
	A183865	SS	12	5	x	x	160	x	6	6	x	4	x	1750	24	x	x
7	A183866	BG						38 ppb					0.086 ppb			1.7 ppb	
	A183867	SS	8	4	x	x	100	x	8	14	6	x	x	2550	80	x	x
8	A183868	BG						42 ppb					0.143 ppb			1.6 ppb	
	A183869	SS	4	6	x	x	70	5	8	14	6	x	x	2350	24	x	x
9	A183870	BG						67 ppb					0.077 ppb			1.3 ppb	
	A183871	SS	10	4	x	x	65	9	10	14	10	x	x	2450	60	x	x
10	A183872	BG						59 ppb					x			1.5 ppb	
	A183873	SS	4	4	x	x	65	x	6	14	10	x	x	2450	44	x	x
	A183874	PC	8	6	x	x	50	42	24	80	34	x	0.90	4850	90	x	x
11	A183875	BG						50 ppb					0.078 ppb			1.1 ppb	
	A183876	SS	6	5	x	4	50	16	10	10	6	x	x	2400	55		
12	A183877	BG						71 ppb					x			2.5 ppb	
	A183878	SS	6	4	x	4	130	x	10	9	10	x	x	4500	36	x	x
13	A183879	BG						348 ppb					x			23.2 ppb	
	A183880	SS	4	5	x	x	85	20	8	5	6	8	x	2500	65	x	x
Detection limit (excluding bulk gold samples)			<4	<2	<10	<4	<10	<2	<4	<2	<4	<4	<0.1	<4	<4	<1.0	<0.05

* Sample Types : BG = Bulk Gold PC = Panned Concentrate SS = Active Stream Sediment

318

DIGHEM^{II} SURVEY

BIRCH INLET AREA, TASMANIA

MAGNETICS

FOR

GEOPEKO LIMITED

083063

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

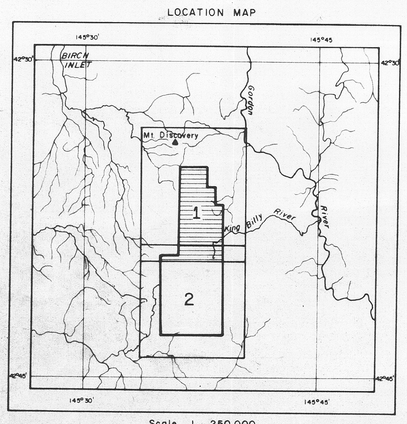
1/4 0 1/4 1/2 Miles

5 cm

Sheet 1

85-2497

LOCATION MAP



Scale 1 : 250,000

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°

NEW BOUNDARY E.L. 9/74

OLD BOUNDARY E.L. 9/74

318

DIGHEM^{II} SURVEY

BIRCH INLET AREA, TASMANIA

MAGNETICS

FOR

GEOPEKO LIMITED

083064

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

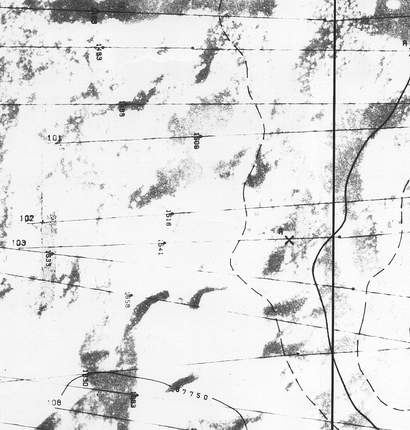
1/4 0 1/4 1/2 Miles

Sheet 2

5 cm

85-2492

LOCATION MAP



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°

NEW BOUNDARY E.L. 9/74

OLD BOUNDARY E.L. 9/74

5278000N

5267000N

385000E

390000E

5278000N

394000E

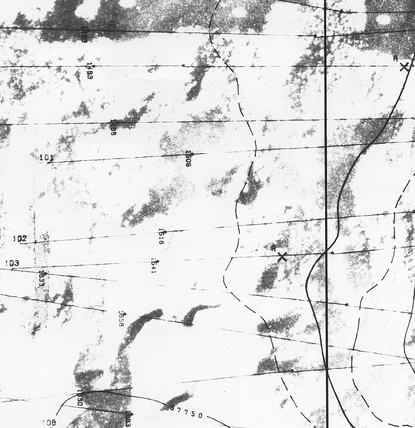
NEW BOUNDARY E.L. 9/74

5267000N

384000E

OLD BOUNDARY E.L. 9/74

LOCATION MAP



Scale 1 250,000

DIGHEM^{II} SURVEY

BIRCH INLET AREA, TASMANIA

MAGNETICS

FOR

GEOPEKO LIMITED

083064

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

Sheet 2

5 cm

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

85-2492

Flight line

1248

Fiducials and numbers

1236

ISOMAGNETIC LINES

(total field)

1000 ..... 1000 gammas

200 ..... 200 gammas

..... 50 gammas

..... 25 gammas

..... magnetic depression

Magnetic Inclination within the survey area: 72°

319

5286000N

384000E

390000E

5286000N

NEW BOUNDARY E.L. 9/74

OLD BOUNDARY E.L. 9/74

5275000N

DIGHEM^{II} SURVEY

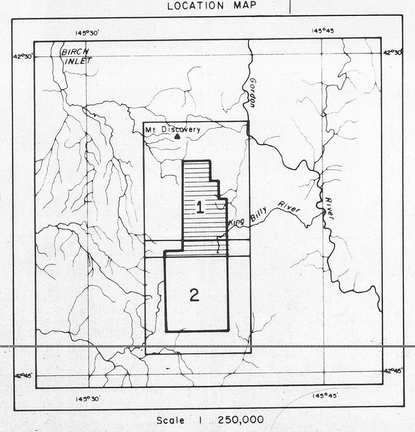
BIRCH INLET AREA, TASMANIA

RESISTIVITY

FOR

GEOPEKO LIMITED

LOCATION MAP



Scale 1 250,000



083065

SCALE 1 : 10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

Sheet 1

85-2492

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.

DIGHEM^{II} SURVEY

BIRCH INLET AREA, TASMANIA

RESISTIVITY

FOR

GEOPEKO LIMITED

083066

LOCATION MAP



Scale 1 : 250,000

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

Sheet 2

5 cm

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

Flight line

Fiducials and numbers

NEW BOUNDARY E.L. 9/74

OLD BOUNDARY E.L. 9/74

LEGEND

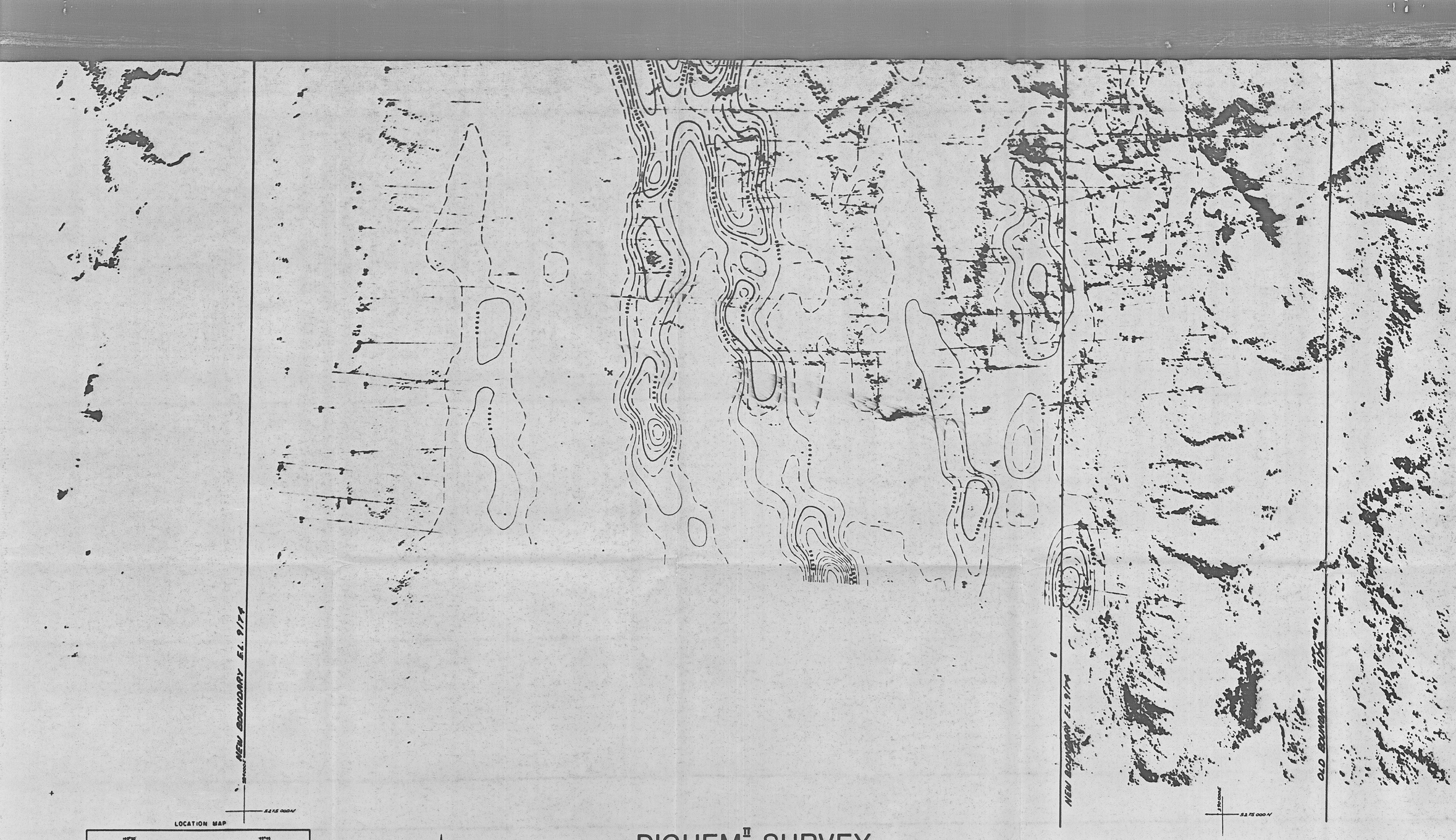
Contours in ohm-m
at eight intervals per decade

100
75
56
42
31
23
17
13
10

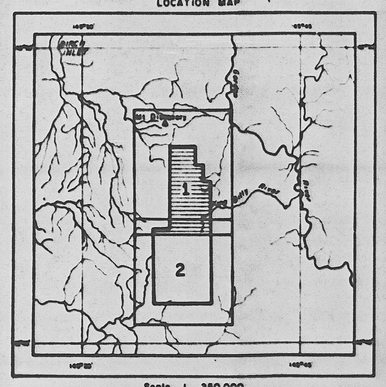
Note

The numbers face in the direction of increasing value.

85-2492



LOCATION MAP



Scale 1 250,000

DIGHEM^{II} SURVEY

BIRCH INLET AREA, TASMANIA

ENHANCED MAGNETICS

FOR

GEOPEKO LIMITED

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

083067

Flight line

Fiducials and numbers

ISOMAGNETIC LINES

(enhanced field)

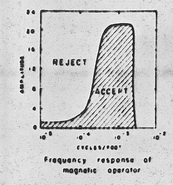
5000 gammas

1000 gammas

200 gammas

100 gammas

magnetic depression



Frequency response of magnetic operator

Sheet 1

(SOUTH)

85-2492

CENTRE BOTTOM

MICROFILMED FICHE No. 4 -

322

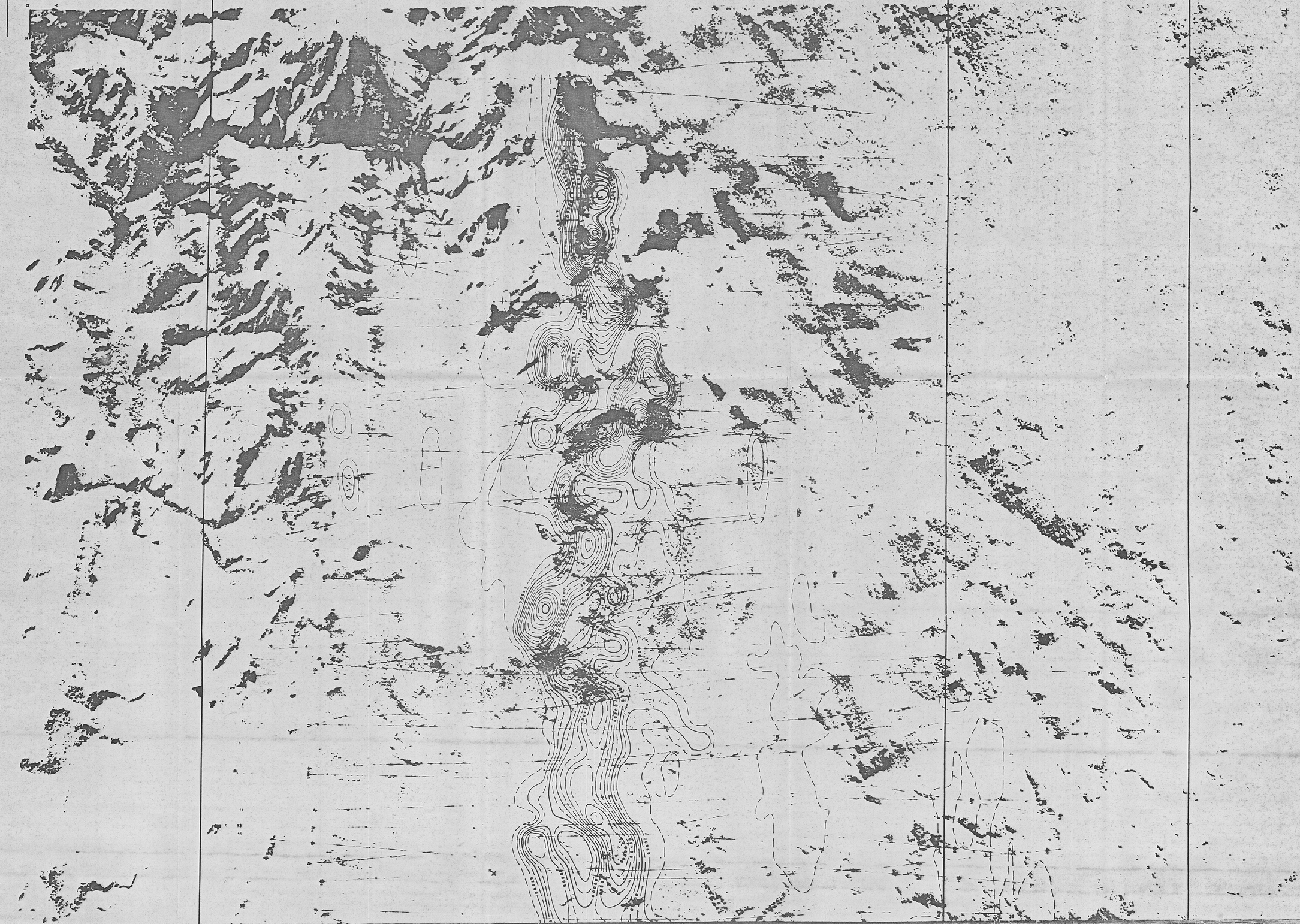
322

85-2492

SHEET 1
(NORTH)

CENTRE TOP
MICROFILMED
FICHE No. 4 -

083068



DIGHEM^{II} SURVEY

BIRCH INLET AREA, TASMANIA

ENHANCED MAGNETICS

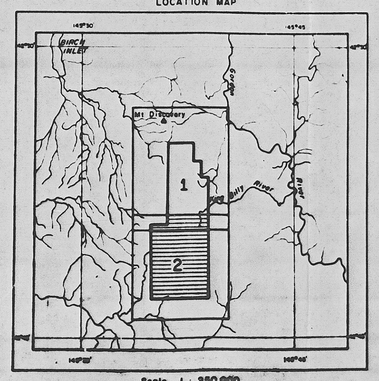
FOR

GEOPEKO LIMITED

NEW BOUNDARY E.L. 9/74

OLD BOUNDARY E.L. 8/74

LOCATION MAP



Flight line

Fiducials and numbers

ISOMAGNETIC LINES

(enhanced field)

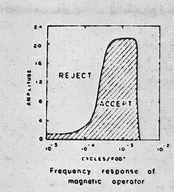
5000 gammas

1000 gammas

200 gammas

100 gammas

magnetic depression



Frequency response of magnetic operator

083069 SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

Sheet 2

(SOUTH).

85-2492

BOTTOM RIGHT

MICROFILMED
FICHE No. 4 -

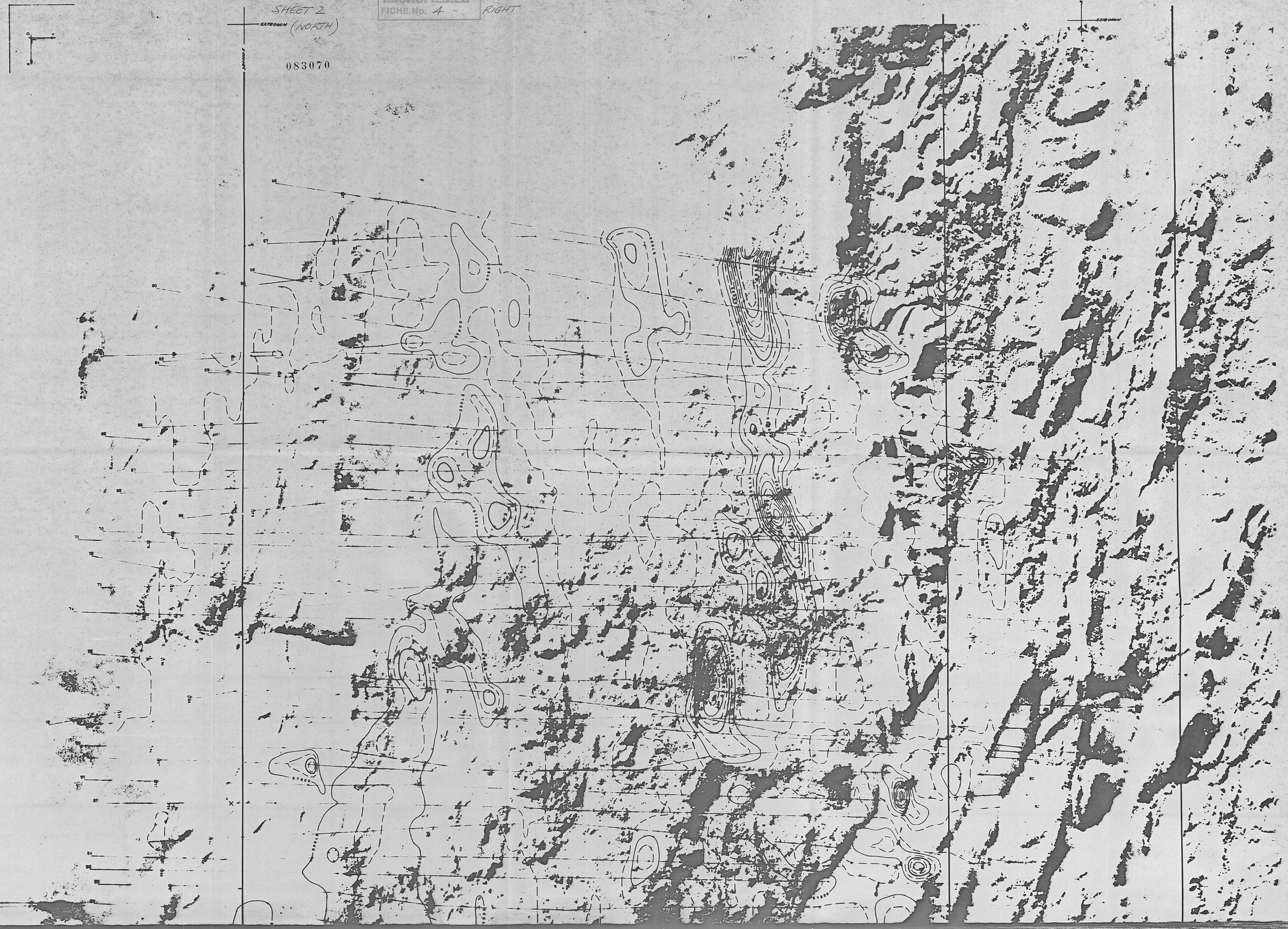
323

85-2492
SHEET 2
(NORTH)

MICROFILMED
FICHE No. 4 -

TOP
RIGHT

083070



323

DIGHEM[II] SURVEY

BIRCH INLET AREA, TASMANIA

ELECTROMAGNETICS

FOR

GEOPEKO LIMITED

083071

NEW BOUNDARY E.L. 9174

OLD BOUNDARY E.L. 9174

NEW BOUNDARY E.L. 9174

5275000 N

5275000 N

LOCATION MAP

Scale 1 250,000

Flight line

Fiducials and numbers

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

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

DIGHEM anomalies are divided into six grades on the basis of thickness product. This product is mainly the ratio of conductance and resistance in ohms. The mho value is a measure of conductance and is a geologic parameter. Most seepages are Grade 1 anomalies. The few highly conducting rock contact and shear zones are Grade 6 anomalies. The multi-line anomaly shapes often indicate multiple conductors to be recognized, and these are indicated by the letters S on this map. The remaining Grade 1 and 2 anomalies could be weak bedrock conductors. The higher grades indicate moderate to strong conductances. Examples: The ore bodies of the Mosquito River camp yield Grade 6 anomalies, while Mynah and Matchless give Grade 5. Graphite and sulphides can span all grades but ... Thus surveys area, field work may show that the different grades indicate different types of conductors.

The actual mho value is plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal bar is 50% indicate anomaly amplitude in the 1 ppm unit and the vertical column gives the estimated depth. This depth may be immediate because the strongest part of the conductor may be below ... Depth estimates of the flight line or because of thick ... overburden effects.

DIGHEM maps are designed to provide a correct impression of conductor quality by means of the conductive 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 sign 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.

Sheet 1 (SOUTH)

MICROFILMED FICHE No. 5 — LEFT BOTTOM

85-2492

324

083072

324

85-2492

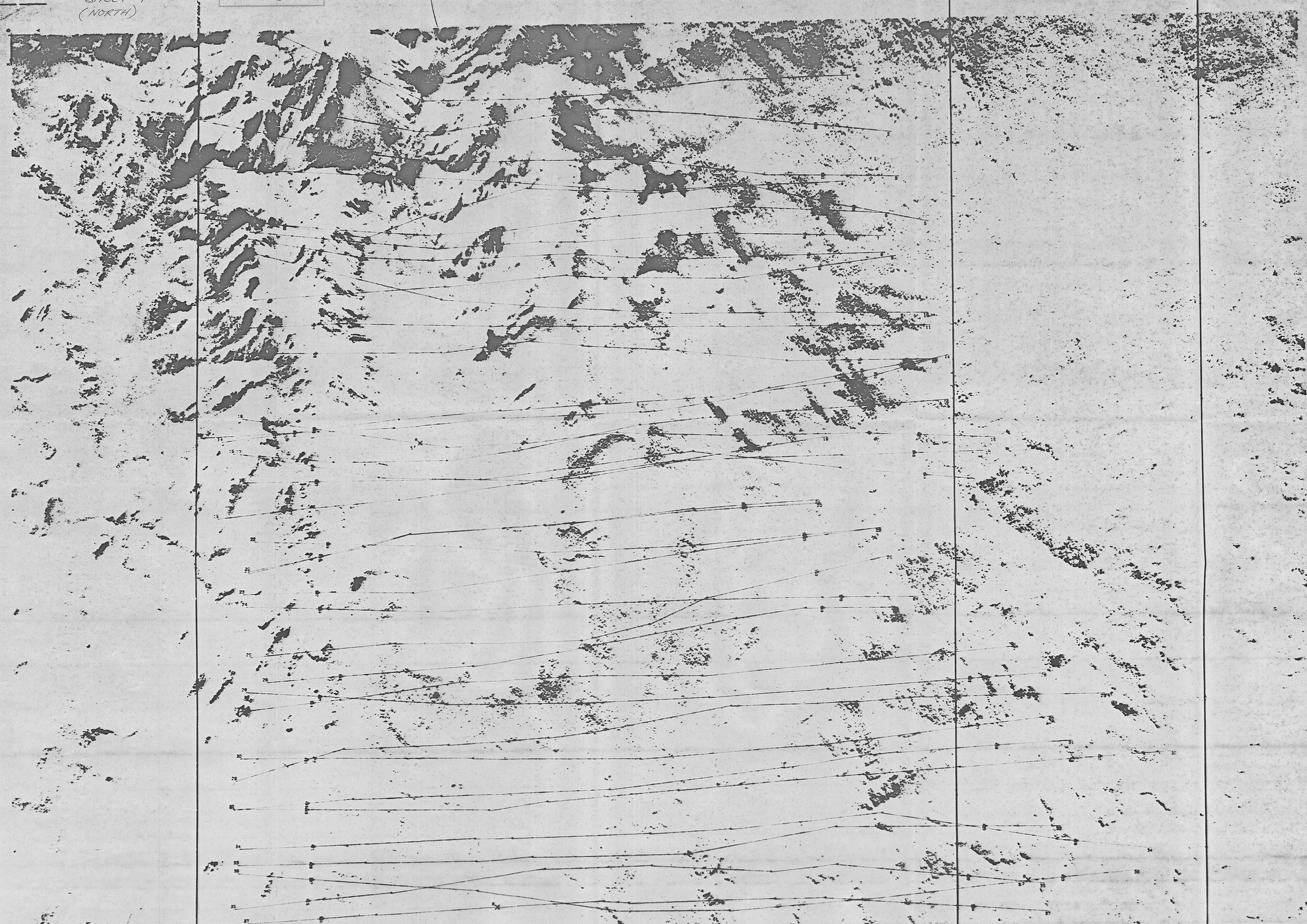
SHEET 1

(NORTH)

MICROFILMED
FICHE No. 5

TOP LEFT

324



NEW BOUNDARY E.L. 9/74

OLD BOUNDARY E.L. 9/74

DIGHEM^{II} SURVEY

BIRCH INLET AREA, TASMANIA

ELECTROMAGNETICS

FOR

GEOPEKO LIMITED

083073

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

Flight line

Fiducials and numbers

LOCATION MAP

Scale 1 250,000

Sheet 2
(SOUTH)

MICROFILMED
FICHE No. 5 -

RIGHT BOTTOM

85-2492

325

083074

85-2492
SHEET 2
(NORTH)

MICROFILMED
FICHE No. 5

TOP
RIGHT

