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Vol 1/2

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PROGRESS REPORT ON E.L. 10/74

BLACK BLUFF

TASMANIA

FEBRUARY 1980 TO JUNE 1981

OPEN FILE

MICROFILMED

J. PEMBERTON
DEVONPORT
JUNE, 1981

REFER TO : 81_1637
FOR DIGHEM
ALSO : 84_2147

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1. INTRODUCTION

Geopeko joined Union Oil Development Corporation in the Black Bluff Exploration Licence 10/74 in 1977. The area covered by this licence is 150 square kilometres. Prior holders of this ground were Pickhands Mather (1968), Tasminex (1973/74) and Union Oil (1974/75). Summaries of this work can be found in the progress report to the Mines Department by R. Van den Bogaart and G.L. Buckland, April 1978.

Portions of the licence cover the Cambrian aged Mt. Reid type volcanic suite which is prospective for Cu, Pb, Zn, Ag and Au mineralization. The Mt. Reid volcanics are unconformably overlain by the Ordovician Moina Sandstones and Gordon Limestone which has potential for Sn-W magnetite skarn mineralization related to late Devonian granites.

In early 1980 Aquitaine Australia Minerals Pty. Ltd. entered the Geopeko-Union Oil Joint Venture.

2. SUMMARY

A DIGHEM II survey was flown over the E.L. in early 1980. From the results of this survey seven prospects were chosen for further follow up work. This work entailed stream sediment sampling and reconnaissance geological mapping. Four of these prospects have been recommended for further work.

Geophysical work at Mariner 5 has used electrical methods and gravity in an attempt to identify a favourable drill target beneath the basalt. Interpretation of the data is in progress and a drill target should be available in the near future.

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RECOMMENDATIONS

Mariner 5: Site and drill hole.

Mariner 6: Ground magnetics and IP survey.
Panned concentrate sampling in Deep Creek.
Site and drill hole.

Mariner 7: Establish grid (800 metres by 600 metres).
C horizon auger sampling.
Ground EM survey

Mariner 8: Reconnaissance ground magnetics.
Stream sediment sampling.

Mariner 9: No further work.

Mariner 10: " " "

Mariner 11: Reconnaissance mapping and ground magnetics.
Stream sediment sampling.

Basalt Stream Project: No further work.

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4. BACKGROUND

The initial work by Geopeko entailed regional mapping and stream sediment sampling with detailed prospect work in the area between the Iris and Fall Rivers. These prospects were named Mariner 1 and 2 with Mariner 3 evolving out of the north eastern extension of Mariner 1.

In the Mariner 1-3 area a subvolcanic medium to coarse grained quartz-feldspar-biotite porphyry of Cambrian age gave Cu, Zn, Zn-Pb and Pb anomalies with a zonal distribution. This pattern was interpreted as a possible representation of epithermal vein type mineralization which could eminate from an Upper Devonian granite stock.

During the 1979 field season the Mariner 1-3 grid was extended further to the north east with additional stream sediment and panned concentrate sampling. The results of the panned concentrate samples peaked at 3.53%Sn, 430ppm W, 18.5ppm Au and the -80mesh stream sediment samples up to 235ppm Sn, 210ppm Cu, 900ppm Pb and 450ppm Zn. This extended grid (Mariner 5 - see fig 2) is covered by Tertiary Basalt. High Sn geochemistry supported the earlier postulation of epithermal mineralization which has led to the use of geophysical techniques in the Mariner 5 area in an attempt to "look through" the basalt cover. W. Herrmann reported on this work in July, 1980.

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5. DIGHEM SURVEY

5.1 INTRODUCTION DIGHEM II

The DIGHEM electromagnetic/resistivity/magnetic survey was flown over 675 line kilometres during February and March 1980. Results were presented to Geopeko in late August 1980. Follow up targets were chosen by Geopeko geophysicists and geologists taking into consideration the geology and local conditions.

The various anomalies were designated Mariner prospect numbers from 6 to 11 (see fig 2). Anomalies will be discussed with regard to geophysical character and the results of follow up work to date and recommendations.

5.2 GEOPHYSICS

The geophysical character of the DIGHEM anomalies is discussed by J. Sumpton in the appendix. The report by Dighem Ltd. will be forwarded to the Tasmania Mines Department with this report.

6. GEOLOGICAL FOLLOW UP OF DIGHEM SURVEY AND FUTURE WORK.

6.1 MARINER 6 (Prospective for Sn-W skarn + Au-pyrite veins)

The position of a magnetic anomaly adjacent to the Kauri Fault and coincident location of pre-World War 1 mining leases led to this prospect being investigated first.

Reconnaissance geology and stream sediment sampling was done in the vicinity of Mariner 6. Abundant evidence of old workings were discovered in a 500 metre by 500 metre area. Tertiary Basalt overlies one of the adits and is the most probable cause of the magnetic anomaly. The old workings are located in two separate geological environments:

1. In Ordovician Mt. Roland conglomerates and grits.

2. In pre-basalt Tertiary clays and limonitic grits and conglomerates.

The mineralization in the Ordovician sediments occurs in veins of quartz, pyrite and specular hematite with the country rock being silicified. This zone of mineralization is on the eastern side of the Kauri Fault. Grab samples from the dumps have assayed up to 68gm/tonnes Au, 570ppm Bi, 110ppm Sn, 480ppm W, 1050ppm Cu, 440ppm Zn and 675ppm Pb (see fig 4).

Assays of the Tertiary aged sediments have not had anomalous geochemistry. In an unpublished Mines Department report E. Broadhurst, 1934, notes that small amounts of fine gold have been recovered from the clays above the limonitic conglomerates.

A report by W.H. Twelvetrees, 1913, describes the layout of the old workings and quotes some assay values from a Mr. Hartwell Conder:-

120 tons - 3 dwt Au per ton

100 tons - 6 dwt Au per ton

15 stream sediment samples (TD7251-7265) were taken in the streams draining the Mariner 6 area. The samples were sieved to -20mesh in the field , with the -80mesh fraction being analysed. Four samples had anomalous Au (see fig 5).

Deep Creek to the east of Mariner 6 was sampled at a later date as the creek had a series of old leases on it. 17 samples were taken at 200 metre intervals (TD 3710-3726). Float of quartz-hematite and chlorite veining was present in the creek but no insitu outcrop of this material was located. Anomalous Au was present in TD7313 (144ppb) and TD 7314(304ppb). The creek cuts Ordovician sediments and appears to occupy a fault zone parallel to the Kauri Fault.

A grid is being cut at present over Mariner 6 with a north south baseline of 500 metres and grid lines of 350 metres every 50 metres. Auger samples of C horizon material are being taken every 12.5 metres where a soil profile has developed. Rock chip and peat samples will be taken in areas with no soil development. Geological mapping and sampling of the old workings will be undertaken on completion of the gridding and auger sampling.

A ground magnetic survey is planned for the Mariner 6 area to help delineate the extent of the Tertiary Basalt and possibly locate a non-basalt magnetic target. The pyrite veining is regarded as a chargeable source for the IP method and allowing for logistical problems this technique will be used.

If the gathered information is favourable a drill hole will be sited late in 1981.

Panned concentrate samples will be taken in Deep Creek and the Mariner 6 areas to more accurately locate the source of Au.

6.2 MARINER 7 AND 8 (Prospective for Cu, Pb, Zn, Ag + Au-volcanogenic model)

Mariner 7 is a DIGHEM anomaly in the Cambrian volcanics centred on 412420E 5 404 300N. A series of magnetic anomalies on the Ordovician-Cambrian contact to the north east of Mariner 7 has been designated Mariner 8.

In Union Oil's original stream sediment and rock chip sampling program anomalous Pb in the stream and Cu, Zn in a foliated quartz crystal tuff were discovered approximately 300 metres east of the Mariner 7 DIGHEM anomaly. Regional stream sediment sampling by Geopeko personnel in this area confirmed the Pb anomaly.

13 stream sediment samples were collected in the streams draining the Mariner 7 area (see fig 3). Two of these samples had anomalous Pb (TD7271 -180ppm and TD7272 -370ppm) and thus confirm the earlier results. A recent visit to this area revealed a zone of strongly altered pyritic acid tuffs with an associated horizon of grey tuffaceous siltstones within close proximity of the DIGHEM anomaly. Three rock samples were assayed from this area with KR 9815 having 3gm/tonne Ag and KR 9816 having 170ppm Pb.

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The volcanics in the Mariner 8 magnetic anomaly close to Mariner 7 are comprised of a dark green fine grained quartz crystal tuff with fine magnetite veining. At the north eastern end of Mariner 8 adjacent to the Kauri Fault the Ordovician Gordon Limestone outcrops with approximately 5% disseminated pyrrhotite. The combination of these two magnetic units could account for the Mariner 8 anomalies.

A grid will be established over Mariner 7 with a north-east baseline of 800 metres with grid lines of 600 metres every 100 metres. Geological mapping, C horizon auger sampling, ground magnetics and an EM survey will be completed on this grid.

The Mariner 7 grid will cover part of the Mariner 8 anomaly. A reconnaissance grid will be cut over the Gordon Limestone with ground magnetics being read. A major stream system adjacent to the Kauri Fault will be sampled as part of the Mariner 8 prospect work.

6.3 MARINER 9

A coincident DIGHEM and magnetic anomaly to the south west of the southern most arm of Lake Lea.

No outcrop was visible in this area but basalt float was present. Two stream sediment samples were taken and proved to have no anomalous geochemistry.

No futher work is planned on Mariner 9.

6.4 MARINER 10

A DIGHEM anomaly with a magnetic low to the north east. This anomaly is centred on 406 200E 5 403 400N.

The anomaly was in Ordovician Moina Sandstone and appears to originate as a result of a well developed bog.

No further work is recommended.

6.5 MARINER 11

A coincident DIGHEM and magnetic anomaly in the north west of the E.L. centred on 405 000E 5 410 200N.

According to previous mapping by the Mines Department this anomaly should be in Cambrian volcanics. A coarse lithic crystal tuff was seen to the west and south of the anomaly. In the vicinity of the anomaly a steeply dipping north east striking Ordovician conglomerate outcrops. Streams sediments taken by Geopeko personnel in the regional sampling program were not anomalous.

From the geology and stream sediment results available at present no explanation for the geophysical anomaly is available.

Detailed reconnaissance mapping and stream sediment sampling is planned in the area. Ground magnetics will be done to accurately locate the anomaly.

If this work proves favourable a grid will be established over the anomaly to allow more detailed prospect development.

6.6 BASALT STREAM PROJECT

Numerous DIGHEM anomalies were present in the area to the north east of Lake Lea covered by Tertiary Basalt. The streams were traversed and sampled to check for inliers of Ordovician Limestone and sandstone.

29 stream sediment samples were taken. The existence of Gordon Limestone on the northern side of Lake Lea is suggested by sinkholes. No other outcrop of Ordovician sediments was found.

Assay results from the stream sediment samples have no anomalous values (see fig 3). The results do show a dilution affect in Cu, Pb and Zn as the outcrops of Moina Sandstone in the Black Bluff Range is approached.

No further work is planned in these areas.

7. MARINER 5 (prospective Sn-W from Devonian granite.)

Both Electrical methods and gravity have been used at Mariner 5 in an attempt to locate favourable drill targets beneath the basalt cover.

An IP/Resistivity survey was conducted over a few lines of the grid, however no conclusive results were obtained.

An extensive gravity survey has been undertaken, the data from which is still being processed and interpreted. Approximately 220 stations were occupied, at 100m intervals on the grid, the remainder in the area surrounding the grid for regional control.

Preliminary examination of the data shows that it is most likely the grid covers the contact of a buried granite with denser rocks to the south-west. Interpretation, modelling and filtering of the data will proceed with the object of locating irregularities in this inferred contact.

8. REFERENCES

Broadhurst, E., 1934 — Extract from report on the Stormont and Black Bluff district. Unpublished Report of the Tasmanian Mines Department.

Herrmann, W., 1980 — Progress Report on E.L. 10/74 Black Bluff - Tasmania.

Twelvetrees, W.H., 1913 — The Middlesex and Mount Claude Mining Field. Geological Survey Bulletin 14. Department of Mines Tasmania.

Van den Bogaart, R. and Buckland, G.L., 1978 — Progress Report on E.L. 10/74. Black Bluff Area - Tasmania.

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APPENDIX 1

DISCUSSION OF DIGHEM II RESPONSES OVER MARINER PROSPECTS. JOHN SUMPTON JUNE 1981.

MARINER 6

The Mariner 6 aeromagnetic anomaly has an amplitude of about 450nT. It is a discrete response which is likely to have a source of fairly limited thickness. Although the basalt found in the area must be considered to be the most likely cause of the anomaly, the E-M channels do not show the activity we have come to expect from traversing across weathered basalt (e.g. the responses further to east of Mariner 6). Indeed the co-axial inphase channel shows a negative response reflecting the magnetite content of the source.

MARINER 7

This E-M anomaly is small (3ppm) and only exists on the co-axial inphase channel. This implies that the response could be system noise. However if the anomaly is real the lack of quadrature response suggests it could be a good conductor. Unfortunately the small amplitude will make ground E-M follow-up difficult.

MARINER 8

This is a magnetic "ridge" approximately 1.5km long, trending subparallel to the edge of the basalt but obviously of different character. The proposal to investigate this area towards the southern end near Mariner 7 and at its northern extremity is sound as the anomalies appear to change character

and orientation at least once along the length of the ridge. This could imply that the same style of source is not the cause of all the anomalies. The northermost feature, where the influence of the basalt does not disturb the shape, is about 250nT in amplitude.

MARINER 9

The Mariner 9 magnetic-EM anomaly appears to occur at the contact between two units varying in magnetite content and electrical properties. The E-M response shows a large quadrature component and is most evident on the coplaner coil channels, implying that this is a fairly poor surficial conductor. It is interesting to note that the resistivity algorithm shows this area to be no more conductive than other areas within the less resistive unit. The geological interpretation that these magnetic and EM anomalies have as their source an outlier of basalt adjacent to limestone on the west and Ordivician sandstones on the east is entirely consistent with the geophysical pattern.

MARINER 10

The almost complete lack of co-axial inphase response and the broad nature of the anomaly with larger amplitudes from the coplaner coil pair makes it most unlikely that this is a response from an ore body.

MARINER 11

The magnetic anomaly is discrete and symmetrical with an amplitude of about 200nT. The EM response is poor but this could be in part due to the effect of magnetite, the coplaner inphase channel acually goes negative. Nevertheless the coplaner/co-axial ratio and the width of the anomaly points to the possibility of this being a surficial conductor.

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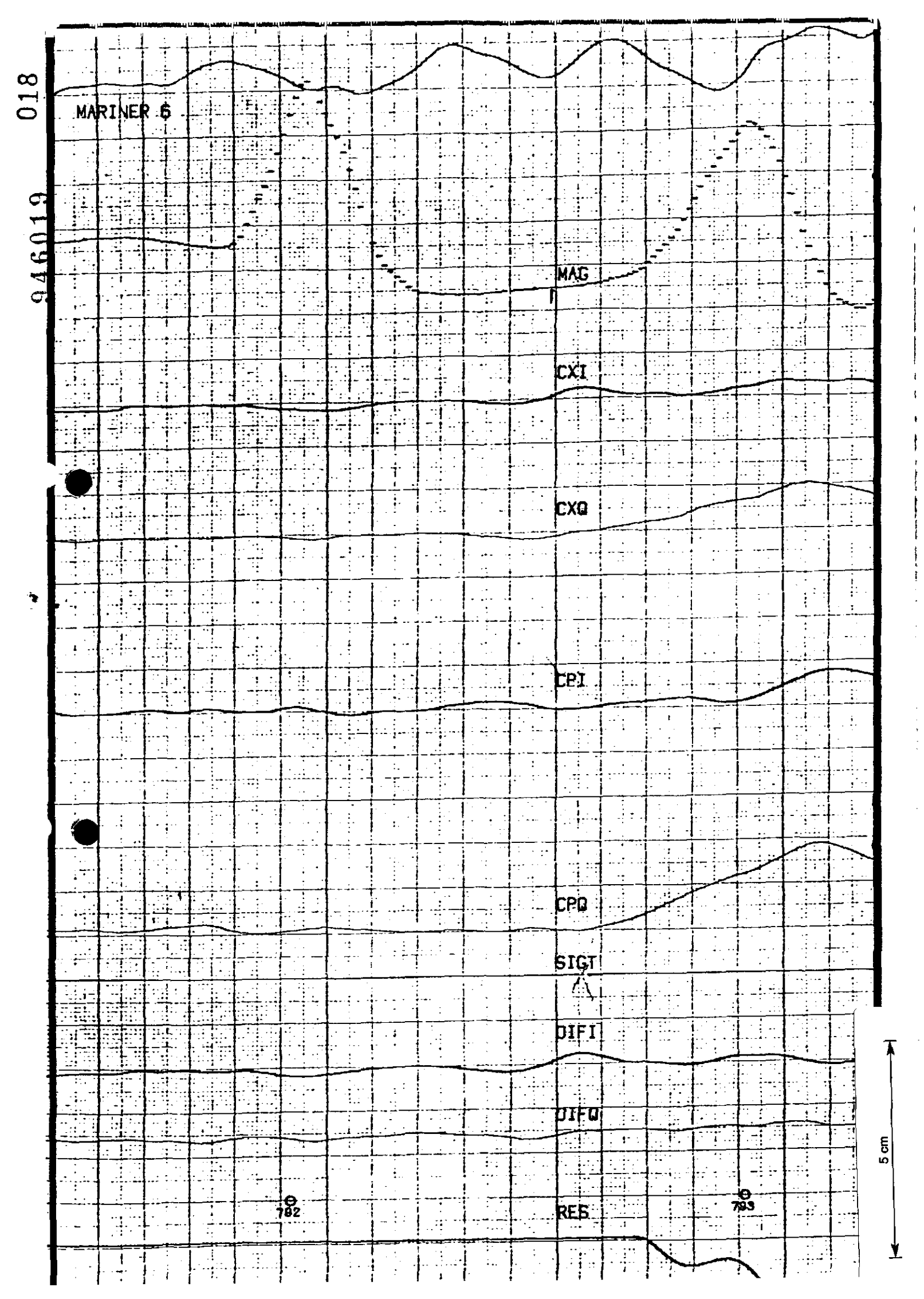
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DIGHEM II PROFILES FROM MARINER PROSPECTS

HORIZONTAL SCALE 1:10,000

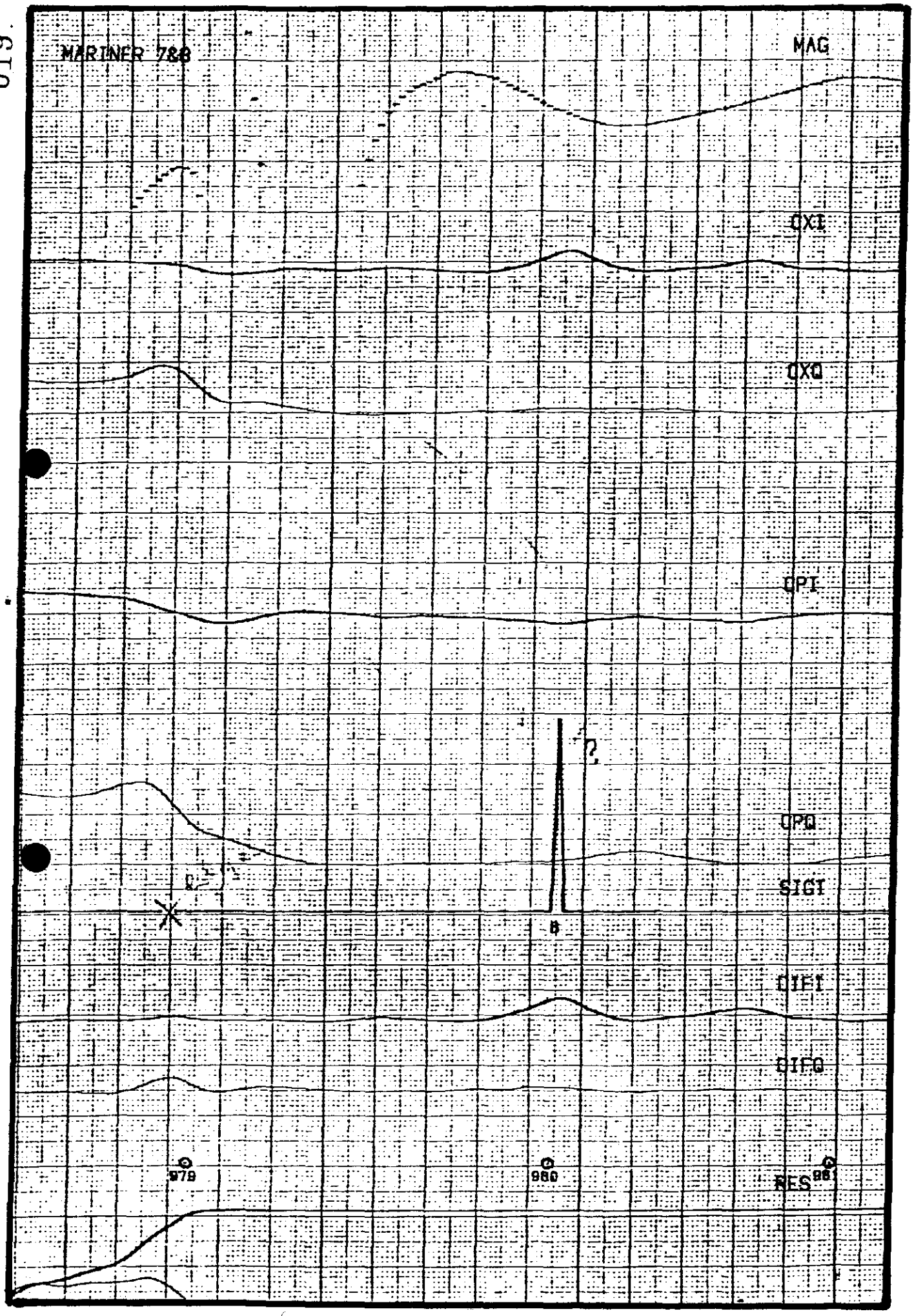
VERTICAL SCALES

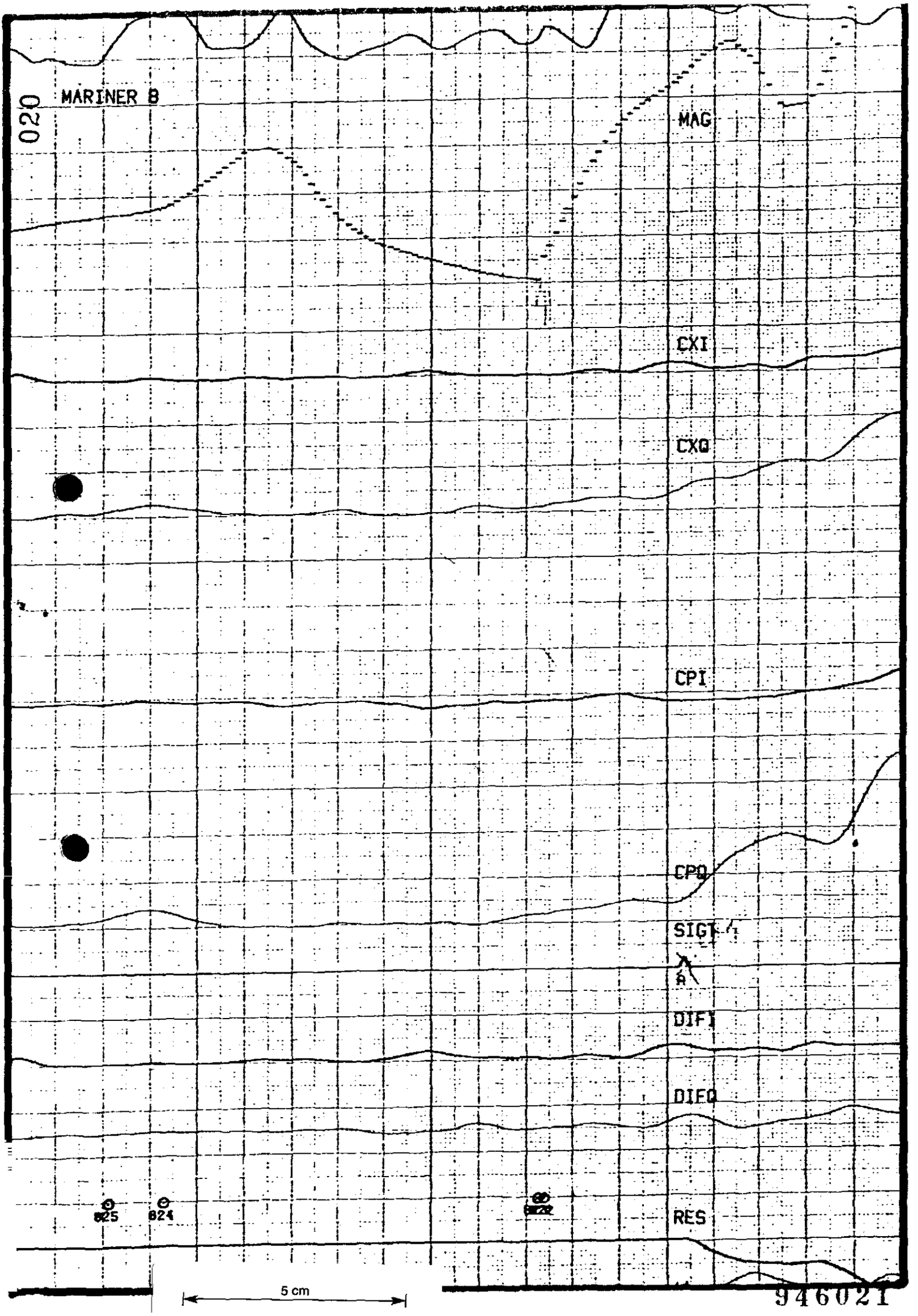
Magnetometer	1cm=100nT
EM Channels	1cm=10p.p.m.
Conductance	1cm=10mhos
Average bird height	55m


018
9460 19
MARINER 6
MAG
CXI
CXQ
CPI
CPQ
SIGT
DIFI
DIFQ
RES
782
793
5 cm

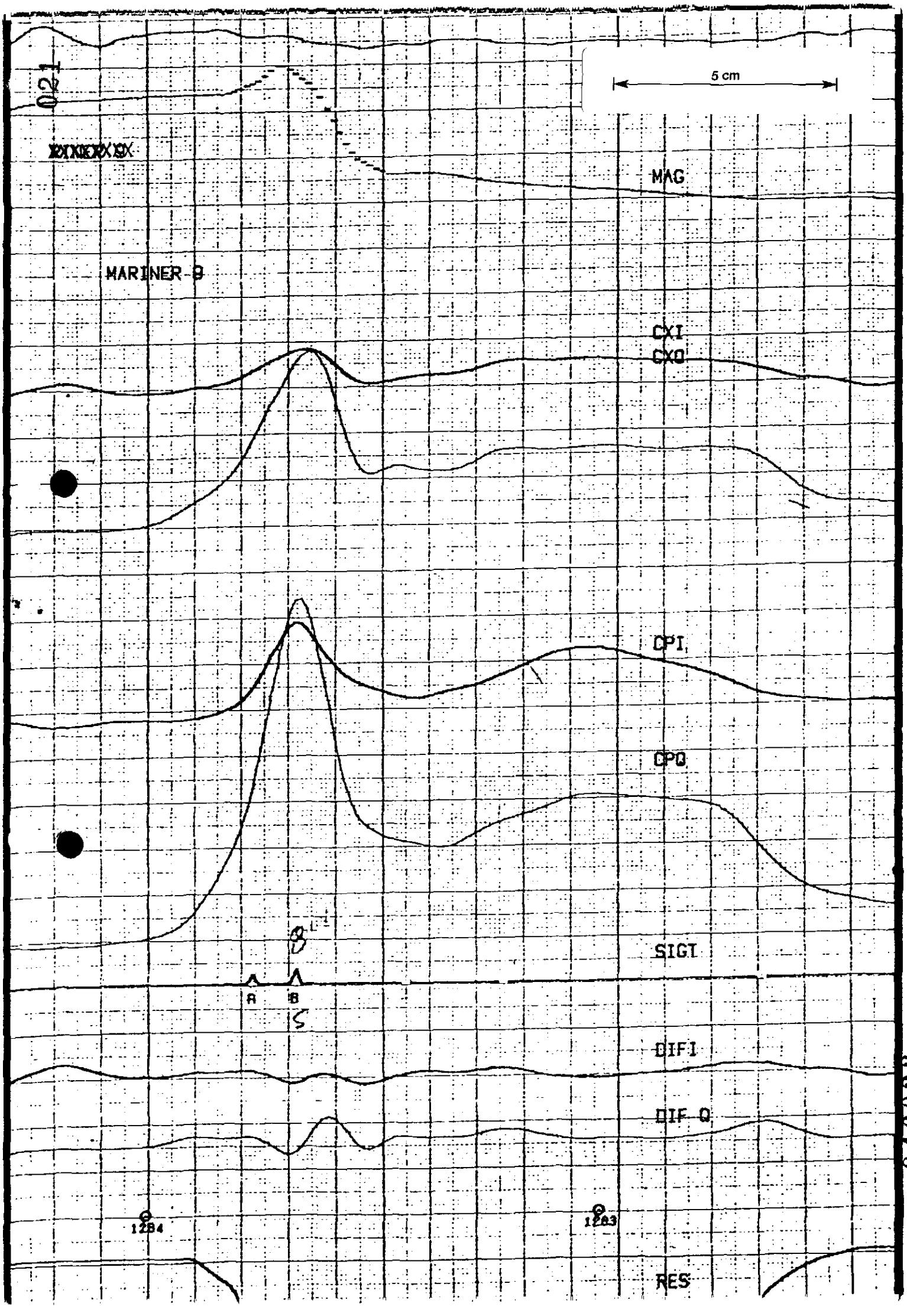
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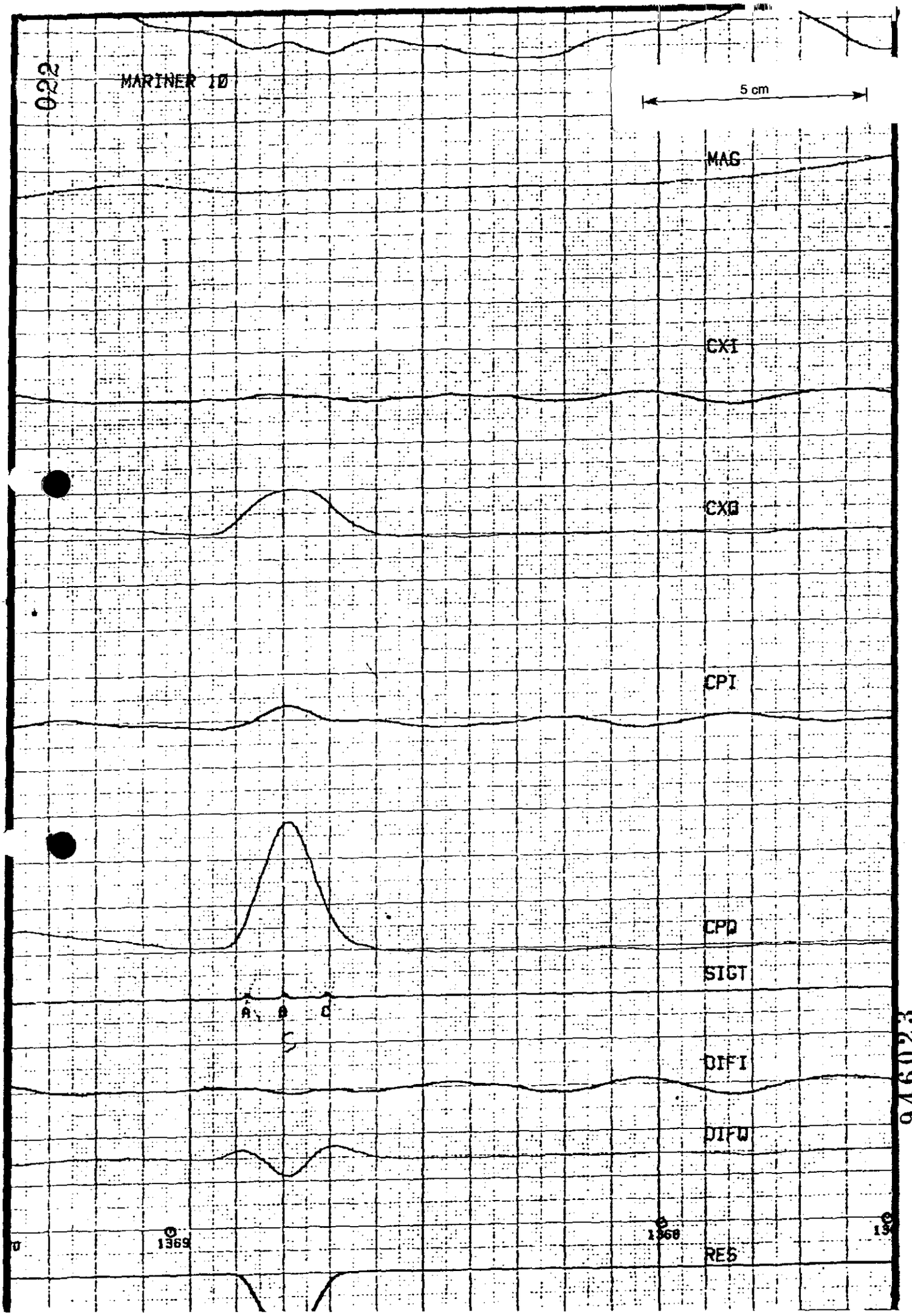
019.


MARINER 7&8
MAG
QXI
QXQ
QPI
QPQ
SIGI
QIFI
QIFQ
RES
979
980
981
5 cm


020
MARINER 8
MAG
CXI
CXQ
CPI
CPQ
SIGI
A
DIFI
DIFQ
RES
825
824
5 cm

946021


5 cm
MAG
MARINER-9
CXI
CXQ
CPI
CPQ
SIGI
A
B
DIFI
DIF Q
1284
1283
RES


MARINER 10
5 cm
MAG
CXI
CXD
CPI
CPD
SIGI
A
B
C
DIFI
DIFD
1369
1360
RES

023

MARINER II

MAG

CX1

CXQ

CP1

CPQ

SIGT

DIF1

DIFQ

RES

97

98

5 cm

946024

946025



LEGEND

- Significant Basemetal Mineralization
- Mt Read Acid Volcanics
- Mt Read Volcanics / Sediments

GEOPEKO
TASMANIA

Scale 1:500 000

Fig No 1

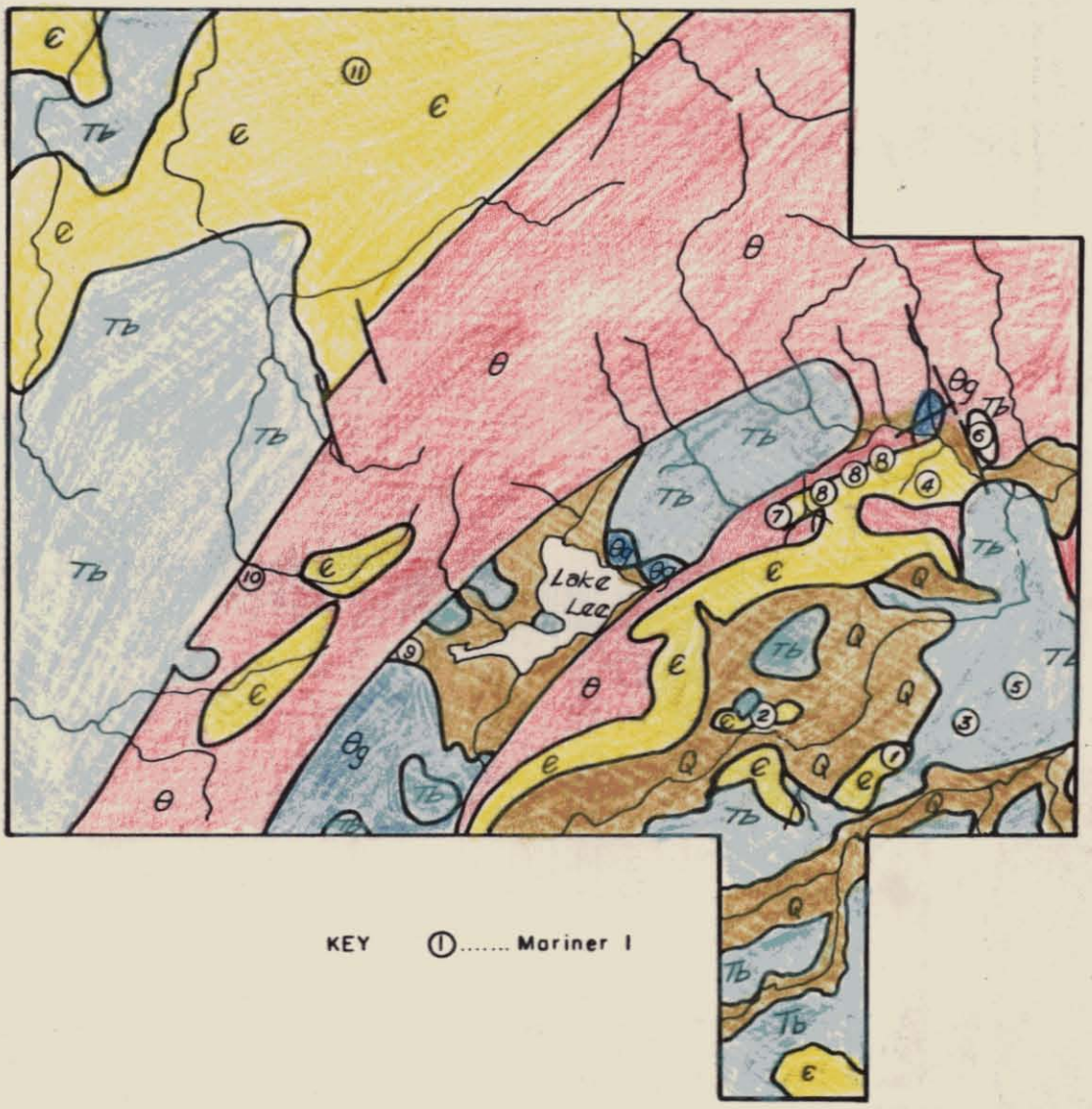
Location Map
E.L. 10/74

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5 cm

PROSPECT LOCATION MAP
E.L. 10/74 BLACK BLUFF



Q	19 – 57	Quaternary alluvium
Tb	19 – 40	Tertiary basalt
θg	19 – 38	Gordon ? limestone
O	19 – 19	Ordovician sandstone and conglomerate
Є	19 – 6	Cambrian volcanics

DATE
GEOL
DWN
CHKD

GEOPEKO
TASMANIA

Scale 1 : 100 000

FIGURE 2

5 406 000 N

408 000 E

410 000 E

412 000 E

414 000 E

416 000 E

5 404 000 N

5 402 000 N

5 400 000 N

Bare Mt.

Range

Bluff

Lake Lea

River

Lea

Black

Belvoir

Vale

of

Bond

Bond Peak

Range

Fall

River

Plain

Alluvial Gold Mine

Remnants of Water Race

U.D.H. Tasminex N.L.

MARINER 2

MARINER 1

Cu Adit

Iris

MOUNTAIN

CRADLE

ROAD

E.L. 10/74 BOUNDARY

5 cm

DATE MAY 81

GEOLOGIST J.P.

DRAWN J.P.M.

CHECKED

GEOPEKO

A DIVISION OF PEKO - WALLSEND OPERATIONS LTD

SCALE 1:10,000

No. KT10/74-3 F

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E.L. 10/74

BLACK BLUFF, TASMANIA

-80 mesh Stream Sediment Sample Locations

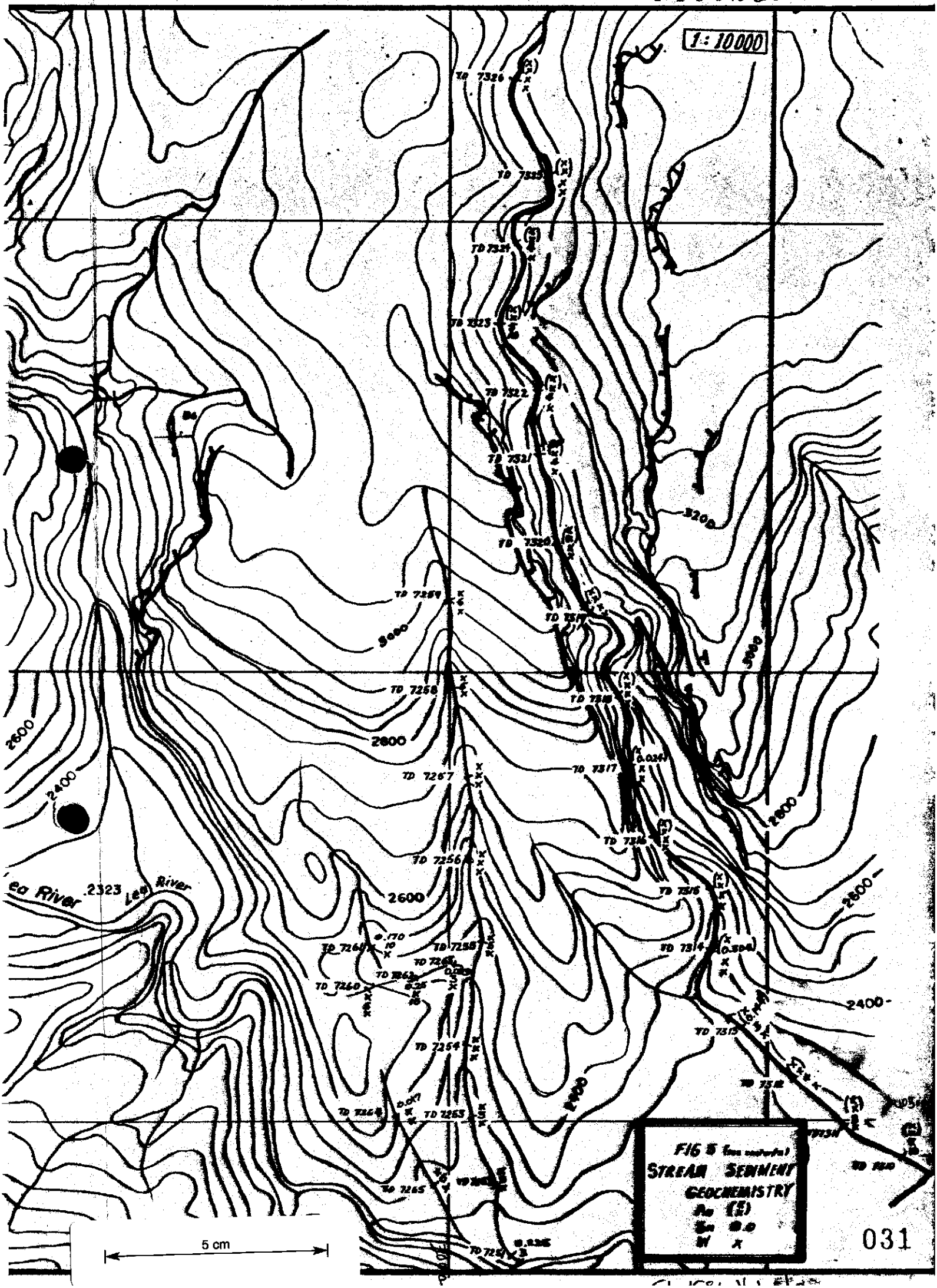
KT10/74-1

KT10/74-2 KT10/74-3

FIGURE 3

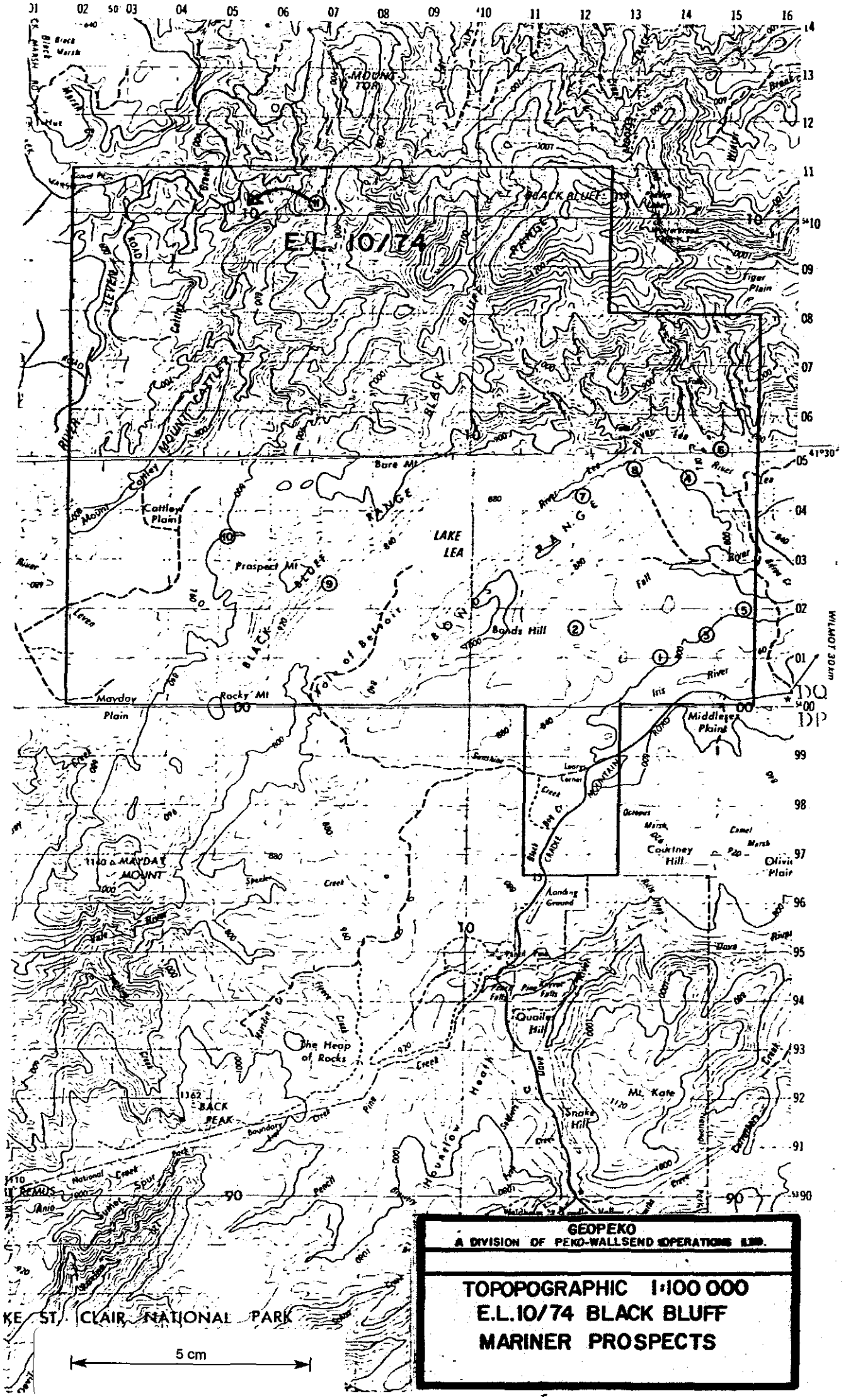
81-1591 Vol 1/2

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1:10000
Leo River
Leo River
2600
2400
2800
3000
3200
5 cm
FIG 5
STREAM SEDIMENT
GEOCHEMISTRY

026

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E.L. 10/74
BLACK BLUFF
MOUNT TOR
MOUNT CATTLEY
Cattley Plain
Bare Mt
Prospect Mt
LAKE LEA
Bonds Hill
Mayday Plain
Rocky Mt
Middlesex Plains
Courtney Hill
Olivin Plain
Quail Hill
The Heap of Rocks
Mt. Kate
Snake Hill
BACK PEAK
MAYDAY MOUNT
KE ST. CLAIR NATIONAL PARK
5 cm
GEOPEKO
A DIVISION OF PEKO-WALLSEND OPERATIONS LTD.
TOPOPOGRAPHIC 1:100 000
E.L.10/74 BLACK BLUFF
MARINER PROSPECTS

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946031 REPORT NO. 311

DIGHEM^{II} SURVEY

OF

BLACK BLUFF AREA, TASMANIA

FOR

GEOPEKO LIMITED

BY

DIGHEM LIMITED

TORONTO, ONTARIO

AUGUST 12, 1980

D.C. FRASER
PRESIDENT

Z. DVORAK
GEOPHYSICIST

946032

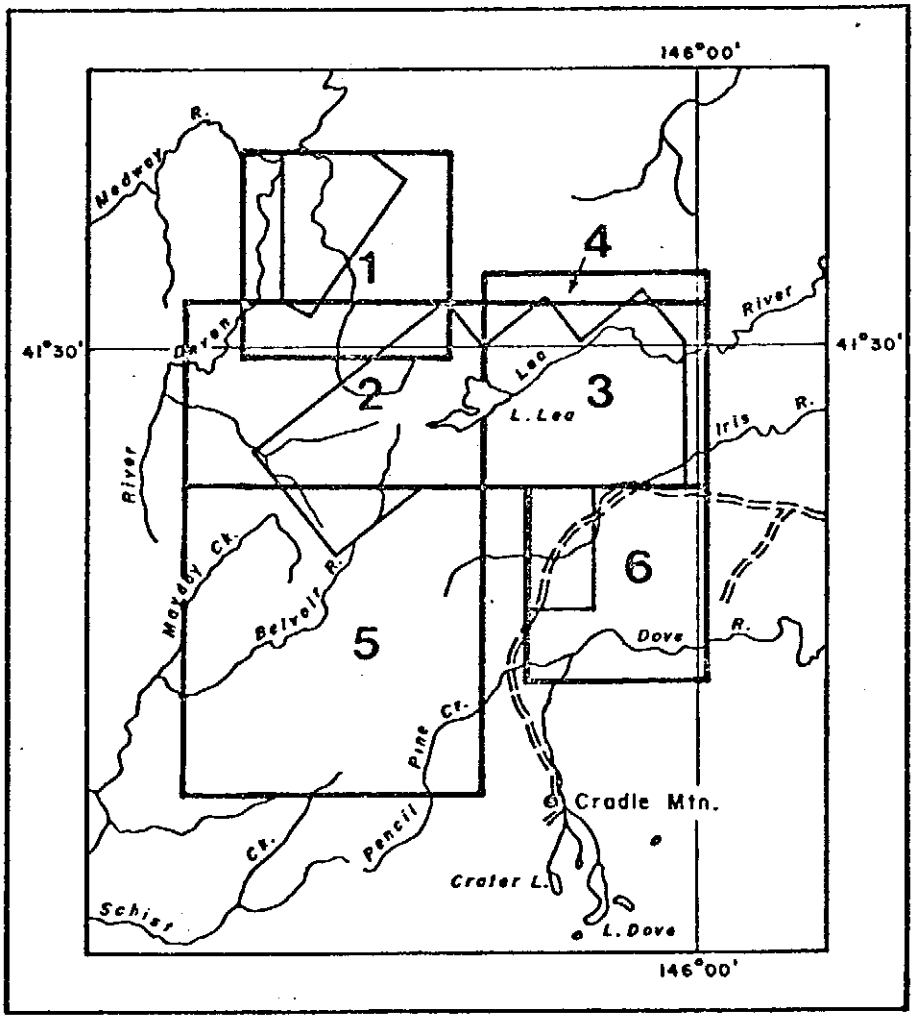
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SUMMARY

DIGHEM^{II} electromagnetic/resistivity/magnetic surveys were flown in February and March, 1980, for Geopeko Limited, over two survey blocks in the Black Bluff area in Tasmania.

The geologic environment within the survey areas varied from resistive to conductive. A few targets of low conductance were located which appear to warrant ground follow-up work.

LOCATION MAP



Scale: 1:250,000

Figure 1. The Survey Area

5 cm

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APPENDIX A: The Flight Record and Path Recovery

APPENDIX B: EM Anomaly List

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INTRODUCTION

A DIGHEM^{II} surveys of 675 line-km were flown with a 150 m line-spacing for Geopeko Limited from February 27 to March 11, 1980, in the Black Bluff 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, Barrringer 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 recievers), 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 inde-

pendent 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.

EM magnetite mapping

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.

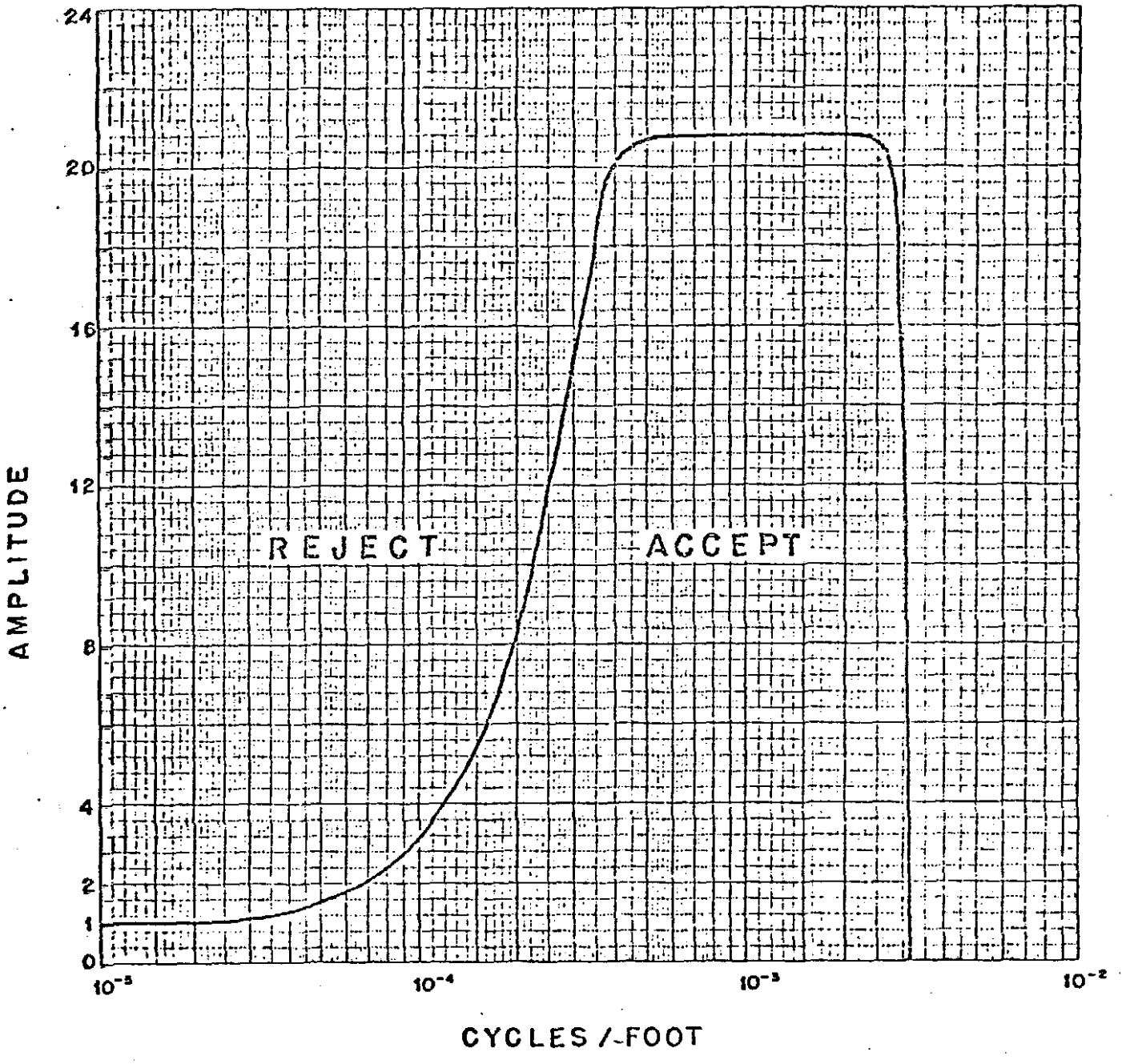


Figure 2 Frequency response of magnetic operator

5 cm

CONDUCTORS IN THE SURVEY AREA

The electromagnetic maps show the locations of conductors and their interpreted conductance (i.e., conductivity - thickness product) and depth. 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 consisted of two grids flown in a northwesterly direction along lines spaced at 150 m. The amounts flown are indicated below:

Sheet	Line-number	Line-km
1	1-37	87
2 to 6	201-293	588
		675 km

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

Group 1	The EM anomalies of group 1 have conductance grades of 1 and 2. They represent conductive variations associated with an ellipticaly shaped resistivity low of 50 ohm-m. The apparent depth channel 41 shows that the resistivity low is definitely a subsurface phenomenon, i.e., it is not due to surficial conductivity. The resistivity low is associated with magnetic activity but there is no direct correlation between magnetic and conductive anomalies.
Anomaly 11A	The grade 2 EM anomaly 11A[4] may represent a narrow weak conductor associated with a magnetic anomaly. There is no direct EM-magnetic correlation. The magnetic anomaly appears to represent the same geologic body which produced the magnetic activity described above for group 1.

[4]This designation refers to anomaly A on line 11.

Anomaly 5xA-6B	The weak grade 1 anomaly 6B, the response 5xA, and the associated resistivity low of 700 ohm-m correlate loosely with a magnetic anomaly. There is a possibility that much of the EM conductivity is caused by surface material.
Response 23xB-24xB	These x-type responses have the appearance, on the profile record, of surface responses. However, the associated resistivity low of 120 ohm-m to the east does not appear to be caused by surficial conductivity. This resistivity low did not generate any EM anomalies although it did result in a number of x-type responses (e.g., 29xA). Consequently, the low does not reflect discrete mineralized sources such as might be characteristic of ore deposits.

Sheet 2

The ground resistivity in the area of sheet 2 ranges from about 40 ohm-m to in excess of 1,000 ohm-m. The

highlands correspond to a high resistivity and the lowlands on either side of Black Buff are typically of high conductivity. The highest conductivities are recorded over a swampy area west of Black Bluff. The magnetic map shows a zone of high activity in the western half of the sheet.

Responses 259xA-260xA — These x-type responses might reflect a broad bedrock conductor which occurs on the flank of a major magnetic high.

Anomaly 265A — The conductor is evident primarily on the whaletail coil-pair, and produces a resistivity low of 50 ohm-m. The anomaly shapes and resistivity patterns warn that the conductor may simply reflect surface conductivity.

Anomaly 275C — This single-line anomaly may reflect a weak bedrock conductor which occurs within the high conductivity zone west of Black Bluff.

Response 281xA — This x-type response lies among other surficial conductors in the

high conductivity area west of Black Bluff. It might be a result of variations in surficial conductivity, but otherwise has the appearance of a bedrock conductor.

Sheets 3 and 4

The area of sheets 3 and 4 is characterized by ground resistivities ranging from 100 ohm-m to in excess of 1000 ohm-m. The lowlands have a much higher surficial conductivity than the highlands.

The magnetic maps show trends parallel to the Bond Range. A sill-like body may have caused the magnetic patterns in the Lea River lowlands, northeast of Lea Lake. A change in rock type, from the highlands and the area southwest of the Lea River valley to the area southeast of Bond Range, is indicated by the high magnetic activity of the latter area.

Anomaly 206xC-208xA — The conductive material, which caused the low on the resistivity map, has generated the grade 2 anomaly 207B and associated x-type responses. The

conductor does not have the appearance of a discrete body.

Anomaly 208A

This single-line grade 2 anomaly is located at the edge of a conductive area just to the west of a magnetic feature. It appears to reflect a weak bedrock conductor.

Anomaly 224A

This weak grade 1 bedrock conductor occurs in the conductive zone along the Iris River and, thus, could be surface related.

Group 2

These grade 1 and 2 anomalies and associated x-type responses occur southwest of Lea Lake. They appear to reflect conductors which occur within the bedrock as indicated by positive values of the apparent depth parameter (channel 41). The resistivity map provides a better picture of the conductivity variations within this group.

Anomaly 253B-255A — The EM anomaly shapes have the appearance of a bedrock conductor while the resistivity map displays well the conductivity distribution. The conductor has a strong magnetic correlation over its eastern half as can best be seen on the enhanced map.

Anomaly 261B-263G — These grade 1 anomalies reflect a weak conductor which may be of surficial origin. Negative inphase responses are caused by magnetite. Consequently, the conductance values may be underestimated. The conductor extends beyond the south boundary of the survey area.

Sheet 5

The resistivities within sheet 5 range from 750 to greater than 1000 ohm-m. Apart from regional trends, the total field magnetics are featureless.

Anomaly 281A-282xD — This short grade 1 bedrock conductor runs parallel to a weak magnetic

feature which is best portrayed by the enhanced magnetic map.

Sheet 6

The resistivities on sheet 6 range from about 50 ohm-m to more than 1000 ohm-m. The highlands are characterized by a high resistivity. The lowlands are typically of high conductivity. Thus, the resistivity contours closely follow the topography. The magnetics are quite active. Similar to the resistivity, the magnetic contours follow the topography. It is apparent that the lowlands are underlain by a rock type containing more magnetite than that under the highlands.

The EM map contains many surficial anomalies. There are no anomalies which have definite bedrock source.

Respectfully submitted,

DIGHEM LIMITED

D. C. Fraser
President

Z. Dvorak
Geophysicist

Twenty-four map sheets accompany this report.

Electromagnetics	Sheet 1	5552 S/B
	Sheet 2	5556 S/B
	Sheet 3	5560 S/B
	Sheet 4	5564 S/B
	Sheet 5	5568 S/B
	Sheet 6	5572 S/B
Resistivity	Sheet 1	5555 S/B
	Sheet 2	5559 S/B
	Sheet 3	5563 S/B
	Sheet 4	5567 S/B
	Sheet 5	5571 S/B
	Sheet 6	5575 S/B
Magnetics	Sheet 1	5553 S/B
	Sheet 2	5557 S/B
	Sheet 3	5561 S/B
	Sheet 4	5565 S/B
	Sheet 5	5569 S/B
	Sheet 6	5573 S/B
Enhanced Magnetics	Sheet 1	5554 S/B
	Sheet 2	5558 S/B
	Sheet 3	5562 S/B
	Sheet 4	5566 S/B
	Sheet 5	5570 S/B
	Sheet 6	5574 S/B

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A P P E N D I X 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

070

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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.

071

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.

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072

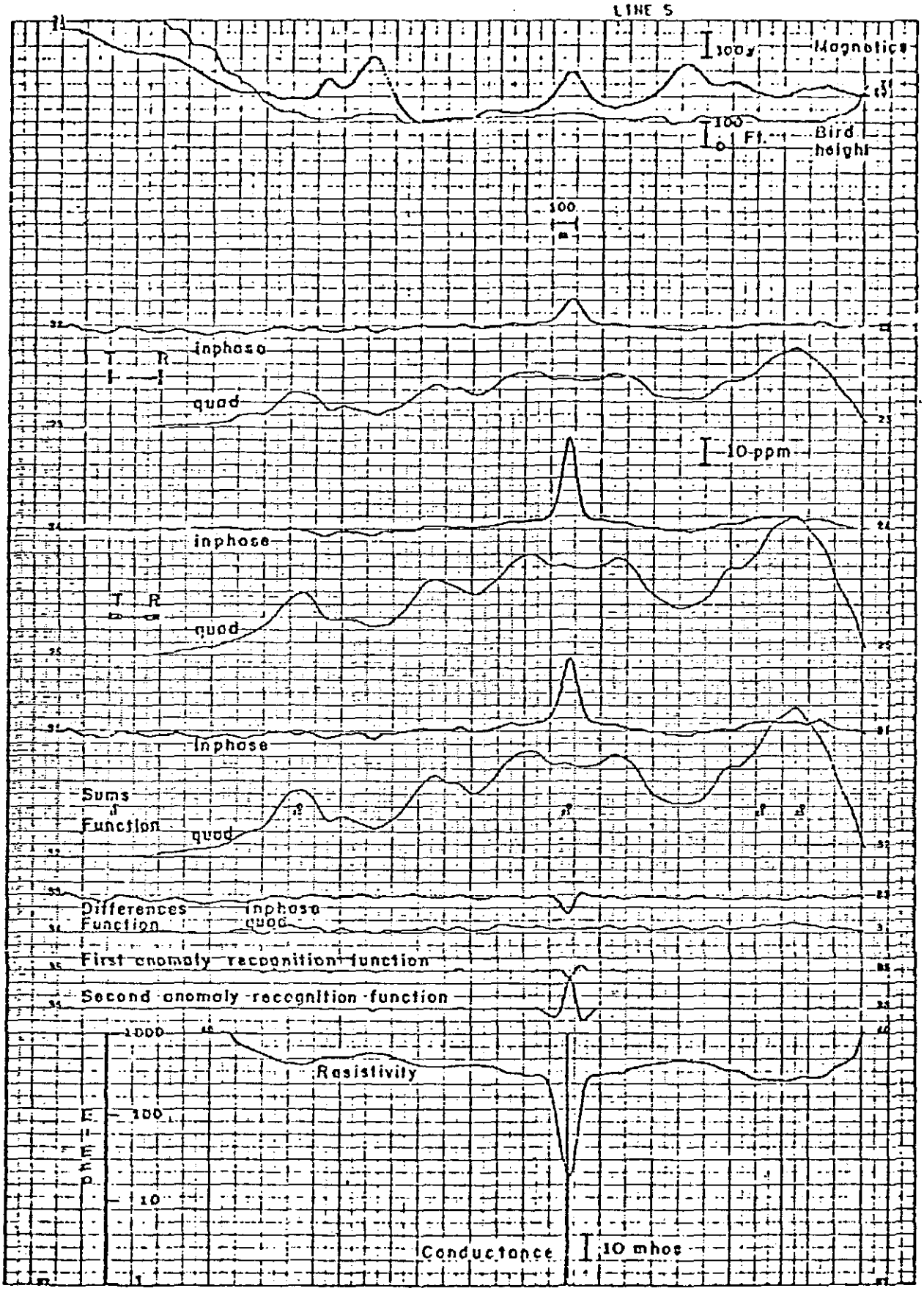


Fig. A1. Flight over Montcalm deposit, with line parallel to strike

5 cm

073

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.

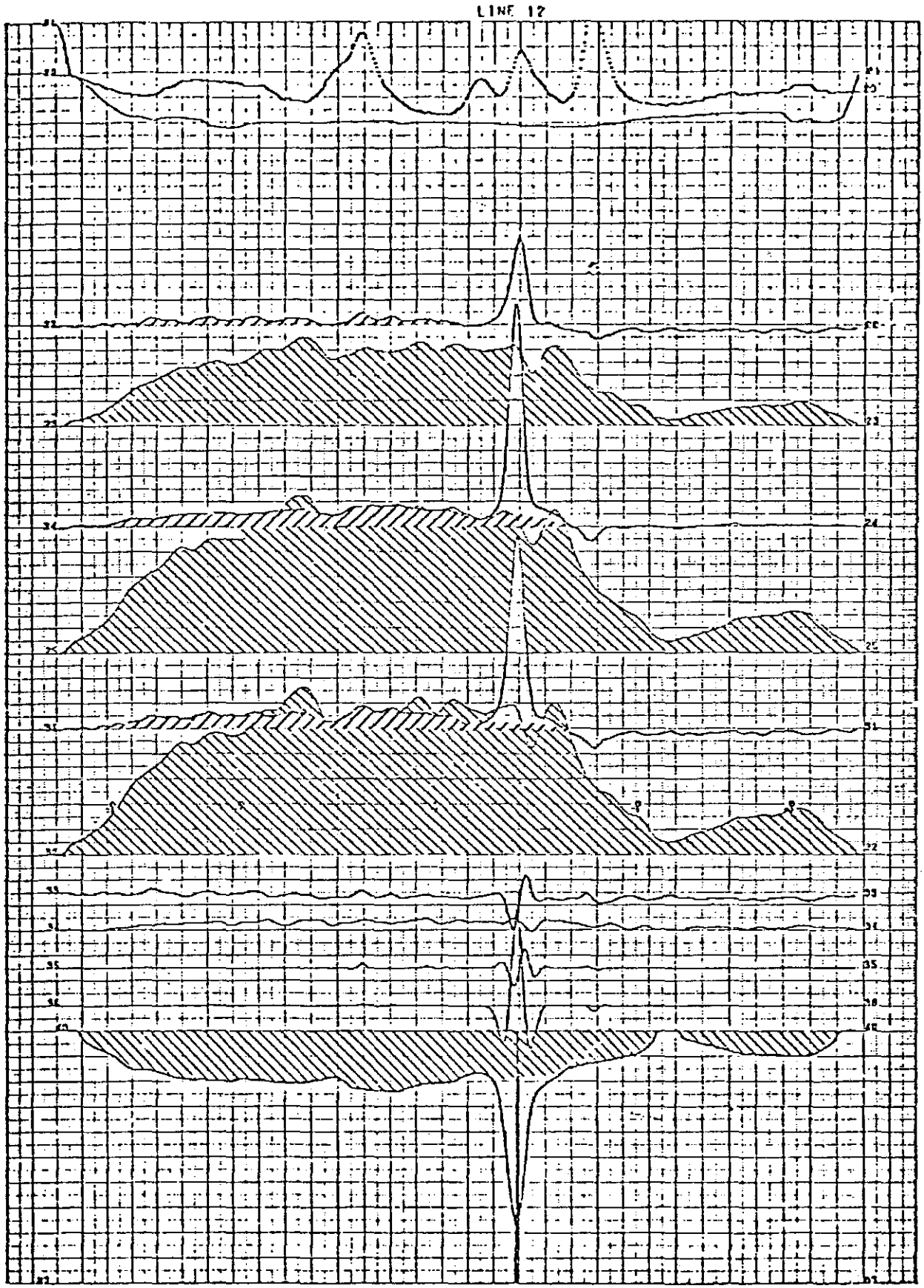


Fig. A2. Flight over Montcalm deposit, with line perpendicular to strike.

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.

270

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.

079

946077

APPENDIX B

EM ANOMALY LIST

3080

311 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
6A	2	5	5	7	3	93	1	361	168	183
6B	1	3	0	2	3	184	1	501	925	105
7A	3	4	6	7	5	178	1	487	75	336
7B	3	4	4	3	6	169	1	517	73	367
8B	3	6	7	18	3	79	1	295	141	146
8C	2	1	1	0	5	235	1	748	82	569
9A	3	2	3	4	8	227	2	623	52	479
10A	4	7	9	12	5	16	1	263	75	123
11A	3	2	0	1	5	222	1	659	103	481

* 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.

081

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 DEPT FEE
207B	4	5	7	8	5	30	1	308	71	16
208A	3	2	0	3	6	83	1	460	122	26
219B	2	1	0	0	10	252	1	690	91	50
220B	3	0	0	0	38	259	2	681	44	52
221B	3	4	2	5	3	74	1	373	151	18
221C	5	9	5	13	4	25	1	244	103	10
221D	2	9	7	19	2	0	1	163	202	2
222A	3	12	4	18	2	0	1	141	254	0
222B	11	42	21	80	3	0	1	69	89	0
223A	2	2	0	1	5	232	1	654	173	430
223B	3	1	0	0	16	223	2	670	45	516
223C	2	13	5	22	1	0	1	106	263	0
223D	4	10	4	17	2	16	1	200	202	56
224A	2	6	2	8	2	7	1	226	327	48
225B	2	6	4	10	2	38	1	275	205	107
225C	3	13	8	24	2	0	1	132	200	0
226C	2	17	10	32	2	0	1	95	199	0
227B	5	19	9	35	2	0	1	100	156	0

* 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.

082

946080

311 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
231A	2	8	4	14	2	0	1	181	275	2
236A	1	7	0	10	1	0	1	103	617	
238A	10	37	23	68	3	0	1	115	84	2
238B	2	12	4	21	1	0	1	121	319	
239A	3	9	4	13	2	26	1	221	221	6
239B	6	19	16	37	3	0	1	151	100	4
239C	5	19	7	30	2	1	1	141	175	2
239E	1	8	4	19	1	0	1	112	368	
241A	1	9	0	11	1	15	1	164	944	
241B	2	9	2	17	1	0	1	157	365	
243A	3	18	4	34	1	0	1	99	282	
244A	4	5	1	11	2	51	1	291	200	12
244C	5	12	7	28	2	0	1	137	153	
244D	1	7	5	14	2	0	1	162	289	
244E	5	5	6	13	4	12	1	262	87	11
245B	7	18	13	36	3	0	1	101	101	
246A	4	9	10	22	3	0	1	182	104	4
247B	4	11	12	22	3	0	1	175	111	4

* 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.

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
249A	5	14	9	25	3	20	1	191	128	
249B	6	18	8	26	3	23	1	182	135	
249C	4	16	8	27	2	0	1	119	176	
250A	7	12	11	21	4	53	1	248	74	1
250B	3	7	5	13	3	66	1	293	143	1
250F	4	6	6	10	5	43	1	306	79	1
251A	6	16	7	24	3	33	1	198	139	
253B	5	29	8	55	2	0	1	83	184	
253C	3	6	5	12	3	86	1	315	163	1
253D	5	7	8	12	5	92	1	338	65	2
253F	5	10	1	11	2	0	1	197	187	
253G	4	9	2	5	3	15	1	243	199	
253H	3	11	10	23	3	0	1	142	138	
254B	8	29	17	59	3	0	1	48	102	
254D	2	8	2	10	1	0	1	123	420	
255A	9	38	11	57	2	0	1	58	120	
255C	3	7	8	14	3	54	1	275	126	1
255D	3	8	7	12	3	67	1	290	132	1
255E	4	17	8	36	2	0	1	125	179	
256B	2	17	2	27	1	0	1	70	486	
257C	1	10	3	17	1	0	1	122	435	

* 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.

311 GEOPEKO, TASMANIA MAY/80 946082

084

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
258B	1	10	3	28	1	0	1	28	462	0
258D	4	14	5	29	2	0	1	63	220	0
258H	3	10	8	22	2	0	1	144	181	6
258I	5	9	10	19	4	0	1	196	87	62
259A	3	26	4	44	1	0	1	29	306	0
259D	2	43	8	81	1	0	1	14	330	0
259K	6	15	8	25	3	0	1	140	127	18
260A	2	13	2	15	1	0	1	124	388	0
260B	1	6	3	11	1	17	1	218	381	42
260C	2	12	3	22	1	0	1	85	340	0
260E	3	2	1	2	7	114	2	546	58	391
261B	0	48	0	103	1	0	1	0	331	0
262B	2	26	6	52	1	0	1	24	368	0
262D	2	5	4	0	4	121	1	496	87	332
262F	0	18	0	24	1	0	1	57	740	0
263B	0	14	0	24	1	0	1	77	803	0
263C	0	32	0	66	1	11	1	0	439	0
263E	0	19	0	29	1	0	1	27	681	0
263G	0	24	0	32	2	0	1	23	607	0
265A	2	2	5	6	4	30	1	360	109	184
265B	0	6	0	10	1	19	1	199	1034	0

* 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.

085

946083

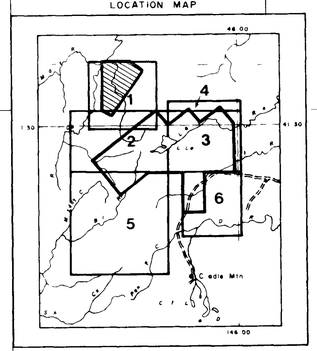
311 GEOPEKO TASMANIA MAY/80

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
269C	1	6	0	9	2	9	1	180	937	0
272B	5	26	12	46	2	0	1	58	146	0
272C	5	11	9	20	3	1	1	195	110	62
273A	4	13	12	25	3	0	1	173	116	47
273B	3	7	8	13	3	0	1	216	115	65
274A	3	4	1	5	3	67	1	353	174	166
274B	3	14	4	23	2	0	1	93	238	0
275A	4	11	11	24	3	0	1	147	107	19
275C	5	7	4	11	3	27	1	267	115	112
276A	7	24	15	46	3	0	1	88	103	0
277A	5	21	9	38	2	0	1	93	157	0
277B	3	22	9	42	2	0	1	82	192	0
277C	4	8	4	12	3	0	1	203	165	50
278B	5	20	12	36	3	0	1	101	130	0
278C	3	11	6	18	2	0	1	167	183	27
278D	6	29	13	50	2	0	1	71	132	0
279A	6	12	8	19	4	9	1	205	93	74
279B	5	18	10	35	2	0	1	94	140	0
280A	4	2	2	5	7	94	2	465	56	326
280B	5	16	8	28	2	0	1	103	153	0
281A	2	5	0	5	2	38	1	253	423	55
282B	3	3	0	4	3	94	1	430	143	236

* 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.

402 000 E
404 000 E
406 000 E
408 000 E
5 410 000 N
5 408 000 N
5 406 000 N
1
600
700
800
900
1000
400

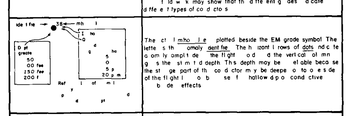
LOCATION MAP



Scale 1 250,000

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

DIGHEM anomalies are divided into six grades of conductivity, with the boundaries between the grades corresponding to the following approximate conductance values: Grade 6 ≥ 100 mhos, Grade 5 50—99 mhos, Grade 4 20—49 mhos, Grade 3 10—19 mhos, Grade 2 5—9 mhos, Grade 1 ≤4 mhos. The anomalies of Grade 2 and above are considered significant, while those of Grade 1 are usually caused by conductive overburden. The anomalies are plotted on the flight line maps using the EM grade symbols. The EM grade symbols are plotted beside the EM anomaly symbol. The letter symbols indicate the conductivity of the anomalous zone, while the number indicates the depth to the top of the conductive zone in feet. The depth values are based on the vertical coplanar coil system. The depths may be considered as reliable below the first 50 feet. The depth values above the first 50 feet may be deeper or shallower depending on the conductivity of the overburden. Flat lying conductive overburden usually causes the depth values to be deeper than the actual depth. Steeply dipping conductive bodies usually have depth values shallower than the actual depth. Flat lying conductive overburden usually causes broad, low amplitude anomalies with poorly defined boundaries. Steeply dipping conductive bodies usually produce sharp, high amplitude anomalies with well defined boundaries. Refer to the Interpretation Report for a more detailed discussion of the various types of conductive bodies.



The conductivity in mhos is plotted beside the EM grade symbol. The letter symbols indicate the conductivity of the anomalous zone, while the number indicates the depth to the top of the conductive zone in feet. The depth values are based on the vertical coplanar coil system. The depths may be considered as reliable below the first 50 feet. The depth values above the first 50 feet may be deeper or shallower depending on the conductivity of the overburden. Flat lying conductive overburden usually causes broad, low amplitude anomalies with poorly defined boundaries. Steeply dipping conductive bodies usually produce sharp, high amplitude anomalies with well defined boundaries.

Conductor axis
Probable conductor
Poor conductor
Flight path
Topographic contour
Base station
Approximate limit of EM coupling
Dip direction
Dip of magnetic contact
Dip of conductive zone
100Γ Direction and location of 100 gamma magnetic anomaly

DIGHEM maps are designed to provide accurate conductivity symbols. The symbols indicate the conductivity of the conductive zone or bedrock. The symbols are based on the EM response recorded by the receiver coil. Refer to the Interpretation Report for a more detailed discussion of the various types of conductive bodies.

5 cm

Flight line

Fiducials and numbers

946084

DIGHEM^{II} SURVEY

ELECTROMAGNETICS

REGISTERED PROFESSIONAL ENGINEER
D C FRASER
PROVINCE OF ONTARIO

GEOPEKO LIMITED
KING ISLAND GROUP

SCALE 1:10,000

No KT10/74-1

EL 10/74
BLACK BLUFF, TASMANIA

5 cm

KT10/74
KT 0/4 4

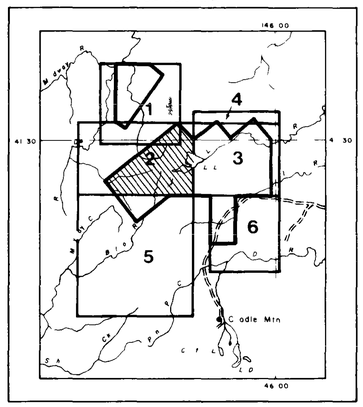
DATE
GEOLOGIST
DRAWN LG
CHECKED MCR

Plan No 5552 S/B

81-1581 Vol 2/2

4105

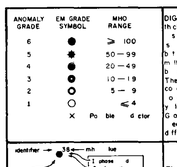
LOCATION MAP



Scale 1 250 000

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 measures induced electromagnetic fields in six frequencies of which five are used to derive conductivity-thickness products. These products are measured in siemens (mhos). The mho is a measure of conductance and is a function of conductivity and thickness. Most swamps yield Grade 1 anomalies but highly conductive graphitic zones yield Grade 2 anomalies. The amplitude of anomalies is also affected by the thickness of overburden. The anomalies are graded according to their amplitudes and are displayed on this map. The empirical Grade 1 and 2 anomalies should be viewed with caution as they may be caused by conductive overburden. The remaining grades are considered to be caused by graphitic bedrock conductors. The range of conductances encountered in the Mt Read Volcanics and Mt Black Sediments are tabulated below. Examples of the Mt Read Volcanics are found in the vicinity of Cattley Plain, Prospect Mt, Bluff, Belvoir and Vale. Examples of the Mt Black Sediments are found in the vicinity of Black Range. Grade 5 anomalies are usually caused by graphitic bedrock conductors. Grade 4 anomalies are usually caused by graphitic bedrock conductors but may also be caused by conductive overburden. Grade 3 anomalies are usually caused by conductive overburden but may also be caused by graphitic bedrock conductors. Grade 2 anomalies are usually caused by conductive overburden. Grade 1 anomalies are usually caused by swamps. Field work may show that the different grades do not necessarily indicate different types of conductors.



The conductivity mho value is plotted beside the EM grade symbol. The letter is the anomaly identifier. The horizontal bar of dots indicates anomaly width. The dot on the flight record indicates the vertical component gives the estimated depth. This depth may be estimated best on the strongest part of the conductor may be deeper or too deep if the flight is over the edge of shallow dipping conductive overburden effects.

	Contact
S	Probable weak conductor
S?	Possible weak conductor
L	Probable metal pipeline telephone cable
L?	Possible metal pipeline
?	Other probable anomaly
V	Approximate thickness >10m
>	Dip
100γ	Direction magnetometer counterclockwise reading of 100 gammas

DIGHEM maps are designed to provide accurate maps of conductivity by means of the conductance grade symbols. The symbols can stand alone with the topography when plotting a topographic map. The actual mho values are plotted for those who wish quantitative data. The anomaly peaks and depths are indicated by conductive dots which should be treated with caution as they may be caused by conductive overburden. The dots will be helpful to those who wish this information. The map provides the interpretation of the conductors in terms of length strike direction conductance and depth. The conductivity is comparable to one interpretation from a ground EM survey having the same line spacing.

Flight line

Fiducials and numbers

Plan No 5556 S/B

946085

DIGHEM^{II} SURVEY

ELECTROMAGNETICS

81-1581 Vol 2/2 2

REGISTERED PROFESSIONAL ENGINEER D C FRASER PROVINCE OF ONTARIO

5 cm

GEOPEKO LIMITED
KING ISLAND GROUP

SCALE

No KT10/74-2

DATE
GEOLOGIST
DRAWN G
CHECKED M R

E L 10/74
BLACK BLUFF, TASMANIA

SHEET 2

1:4166

DIGHEM^{II} SURVEY

ELECTROMAGNETICS

946086

GEOPEKO LIMITED
KING ISLAND GROUP

SCALE

No KTI0/74-3

E L 10/74
BLACK BLUFF, TASMANIA

SHEET 3

DATE
GEOLOGIST
DRAWN
CHECKED

Flight line

Fiducials and numbers

5 cm

REGISTERED PROFESSIONAL ENGINEER
D.C. FRASER
PROVINCE OF ONTARIO

Plan No 5560 S/B

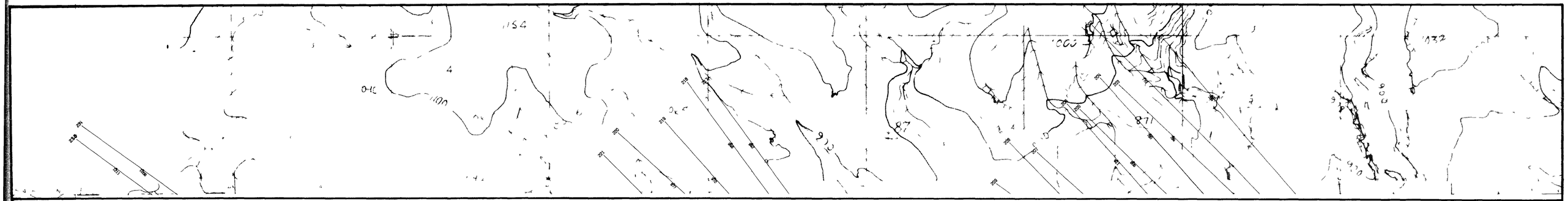
81-1581 Vol 2/2

3

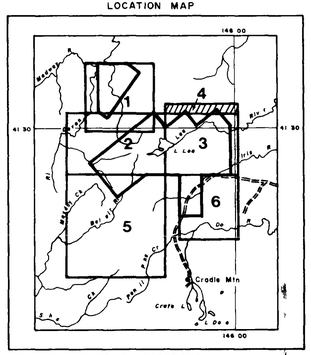
4167

LOCATION MAP

Scale 1:250 000



LOCATION MAP



Scale 1 250,000

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

DIGHEM^{II} SURVEY

BLACK BLUFF, TASMANIA

ELECTROMAGNETICS

FOR

GEOPEKO LIMITED

SCALE 1 10,000

1/2 0 1/2 Kilometres

1/4 0 1/4 1/2 Miles

946087

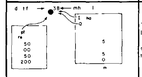
5 cm

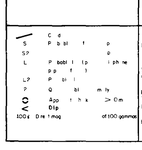
SHEET 4

Flight line

Fiducials and numbers

ANOMALY GRADE	EM GRADE SYMBOL	MAG RANGE
6	●	≥ 100
5	●	50 — 99
4	●	20 — 49
3	●	10 — 19
2	○	5 — 9
1	○	≤ 4
	× Pb d t	





Plan No 5564 S/B

81-1581 Vol 2/2

4

4168

DIGHEM II SURVEY

ELECTROMAGNETICS

FOR

GEOPEKO LIMITED

MT MARDAY
Trig 460
3747

Cradle Mtn

L. Dove

Crater L.

L. Lea

Dove R.

Pencil Pine Ck.

Scha...

Flight line

Fiducials and numbers

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

946088

5 cm

LOCATION MAP

146°00'

41°30'

Scale: 1:250,000

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

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 Sheeted 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
VO	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

BLACK BLUFF, SHEET 5

Plan No. 5568 S/B

Vol 2/2 81-1581

5

4169

DIGHEM[II] SURVEY

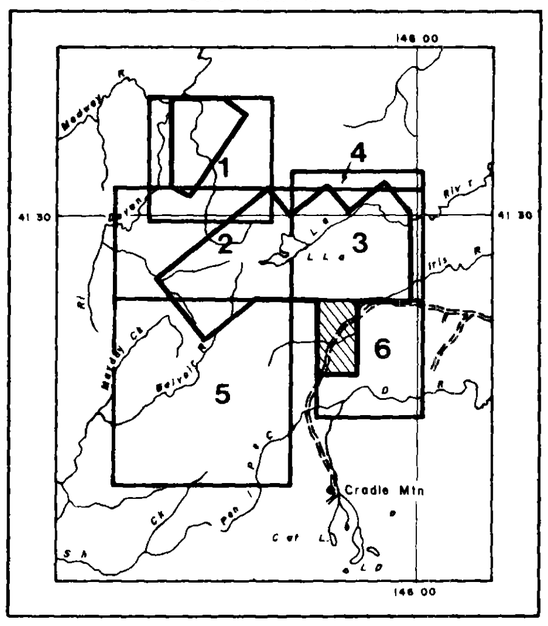
BLACK BLUFF, TASMANIA

ELECTROMAGNETICS

FOR

GEOPEKO LIMITED

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

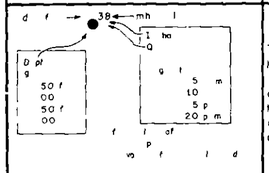
REGISTERED PROFESSIONAL ENGINEER
D C FRASER
PROVINCE OF ONTARIO

946089

SHEET 6

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

DIGHEM anomalies are divided to six grades of conductivity-thickness product. This product is mhos. This is the reciprocal of resistance in ohms. The mho is a measure of conductance and is equivalent to siemens. Most swamps yield Grade 1 anomalies but highly conducting clays can give Grade 2 anomalies. The multiple anomaly shapes often allow surface conductors to be recognized and these are indicated by the letter S on this map. The empirical Grade 1 and 2 anomalies could be weak bedrock conductors. The higher grades indicate massively higher conductances. Examples: The above bedrock mho Magus River camp yield Grade 4 anomalies while Mt Tabor and White Step Grade 5. Graphite and sphalerite can span all grades but this survey of the field work may show that the different types of conductors



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 of the flight record and the vertical column gives the estimated depth. This depth may be reliable because the strength of the conductivity may be dependent to some degree of the flight line location because of shallow dipping conductive overburden effects.

DIGHEM maps are designed to provide a correct impression of conductivity by means of the conductance grade symbols. The symbol can be tabulated with geology where plotting follows program. The actual mho values are plotted to those which satisfy the anomaly opinion and identified by conductance dots which should test if mho conductance letters while being helpful to those who wish this format. The map portrays interpretation of conductors terms of length strike direction conductance and depth. The accuracy is comparable to a detailed ground EM survey having the same line spacing.

Plan No 5572 S/B

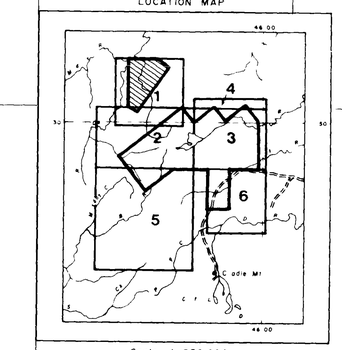
81-1581

6

4170

402 000 E
404 000 E
406 000 E
408 000 E
5 410 000 N
5 408 000 N
5 406 000 N

LOCATION MAP



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

Flight line

Fiducials and numbers

Plan No 5555 S/B

9461°0

DIGHEM^{II} SURVEY

RESISTIVITY

31-1581 Vol 2/2

5cm

GEOPEKO LIMITED
KING ISLAND GROUP

SCALE 1:10,000

No KTI0/74-1

E L 10/74
BLACK BLUFF, TASMANIA

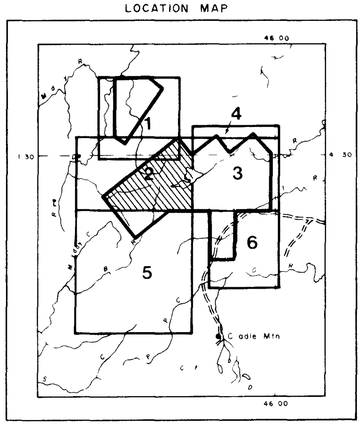
KTI0/74
KTO 4 ✓ L 4

DATE
GEOLOGIST
DRAWN G
CHECKED M C R

REGISTERED PROFESSIONAL ENGINEER
R.C. FRASER
PROVINCE OF ONTARIO

4171

LOCATION MAP



Scale 1 250,000

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

Flight line

Fiducials and numbers

946091

DIGHEM^{II} SURVEY

RESISTIVITY

81-1581 Vol 2/2 2

Plan No 5559 S/B

GEOPEKO LIMITED

KNOLS AND GROUP

No KT10/74-2

10/74

TASMANIA

SHEET 2

4172

LEGEND

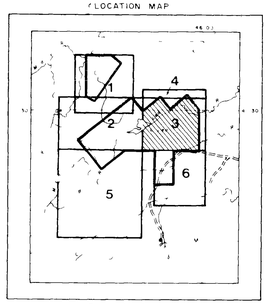
Contours in ohm m at eight intervals per decade

100
75
56
42
31
23
17
13
10

Note

The numbers face north of the anomalous value

LOCATION MAP



Scale 1:250 000

Flight line

Fiducials and numbers

946092

DIGHEM^{II} SURVEY

RESISTIVITY

6 cm

GEOPEKO

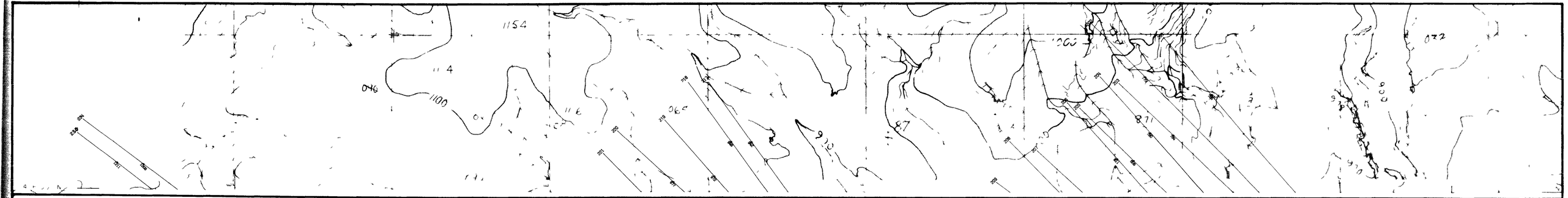
E L 10/74
BLACK BLUFF TASMAN

SHEET 3

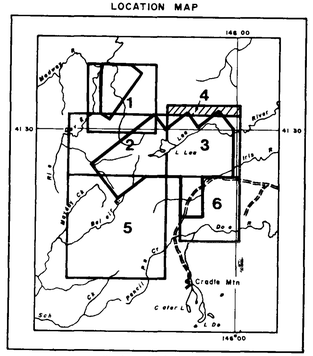
Plan No 5563 S/B

81-1581 Vol 2/2 3

4173



LOCATION MAP



REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

DIGHEM^{II} SURVEY

BLACK BLUFF, TASMANIA

RESISTIVITY

FOR

GEOPEKO LIMITED

SCALE 1 10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

946093

SHEET 4

5 cm

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

Plan No 5567 S/B

4

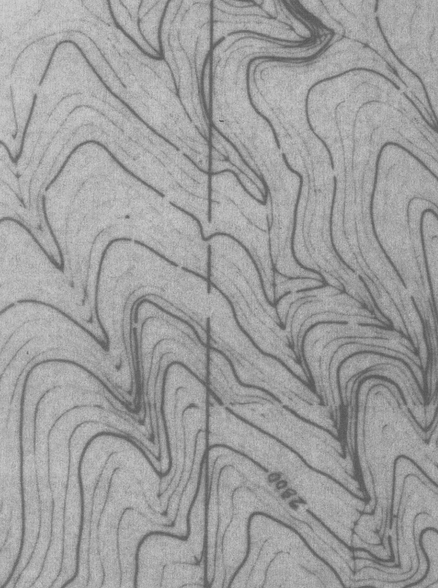
81-1581 Vol 2/2 4

4174

MT MAYDAY
Trig 46C
3747

E.L. 2/70 BOUNDARY

LOCATION MAP



Scale: 1:250,000

REGISTERED PROFESSIONAL ENGINEER
D.C. FRASER
PROVINCE OF ONTARIO

DIGHEM^{II} SURVEY

MAGNETICS

FOR

GEOPEKO LIMITED

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

946100

5 cm

ISOMAGNETIC LINES
(total field)

1000 ..... 1000 gammas
200 ..... 200 gammas
..... 50 gammas
..... 25 gammas
..... magnetic depression

Flight line

Fiducials and numbers

Magnetic Inclination within the survey area: 72°

GEOPEKO
DEVONPORT BASE, TASMANIA

SCALE TS

DATE

GEOLOGIST

DRAWN

BLACK BLUFF, SHEET 5

Plan No. 5569 S/B

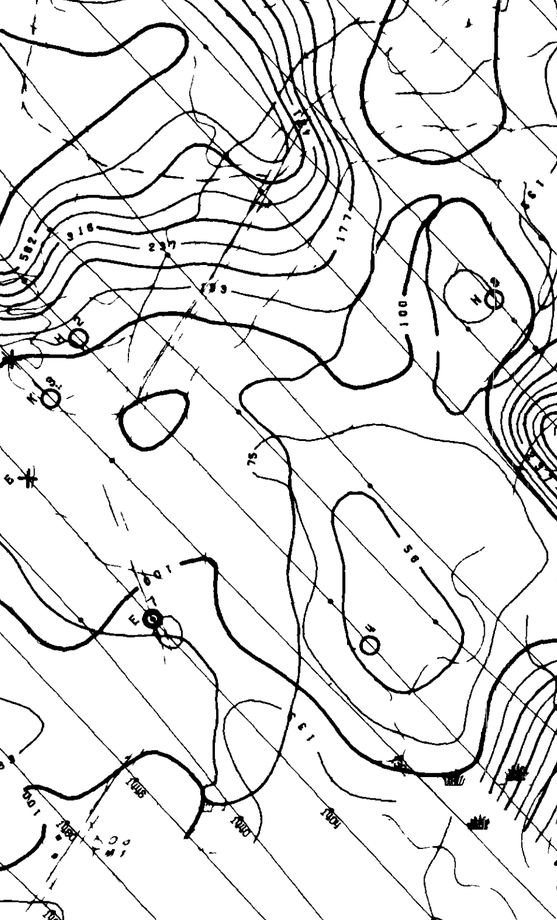
81-1581

Vol 2/2

5

4181

LOCATION MAP



Scale 1 250,000

Flight line

Fiducials and numbers

DIGHEM^{II} SURVEY

BLACK BLUFF, TASMANIA

RESISTIVITY

FOR

GEOPEKO LIMITED

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

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

SCALE 1 10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

946095

5 cm

SHEET 6

Plan No 5575 S/B

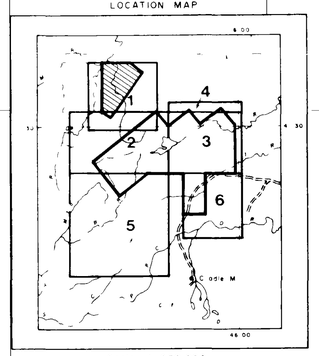
81-1581

6

4176

402 000 E
404 000 E
406 000 E
408 000 E
5 410 000 N
5 408 000 N
5 406 000 N

LOCATION MAP



Scale 1 250 000

Flight line

Fiducials and numbers

Plan No 5553 S/B

94 G 9 E 6

DIGHEM^{II} SURVEY

MAGNETICS

31-1581 Vol 2/2 1

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

DATE
GEOLOGIST
DRAWN L.G.
CHECKED M.C.R.

GEOPEKO LIMITED
KING ISLAND GROUP

SCALE 1:10,000

No KT10/74-1

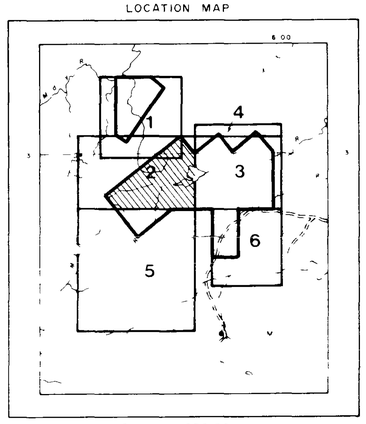
E L 10/74
BLACK BLUFF, TASMANIA

5 cm

KT10/74 1
KT10/74 2 | KT10/74 3

4177

LOCATION MAP



Scale 250 000

ISOMAGNETIC LINES

(total field)

1000 — 1000 gammas

200 — 200 gammas

50 gammas

25 gammas

magnetic depression

Magnetic Inclination within the survey area 72°

Flight line

Fiducials and numbers

94609

DIGHEM^{II} SURVEY

MAGNETICS

Plan No 5557 S/B

81-1581 Vol 2/2 2

GEOPEKO LIMITED

KING IS. AND GROUP

No KT10/74-2

DATE 10/74

GEOLOGIST

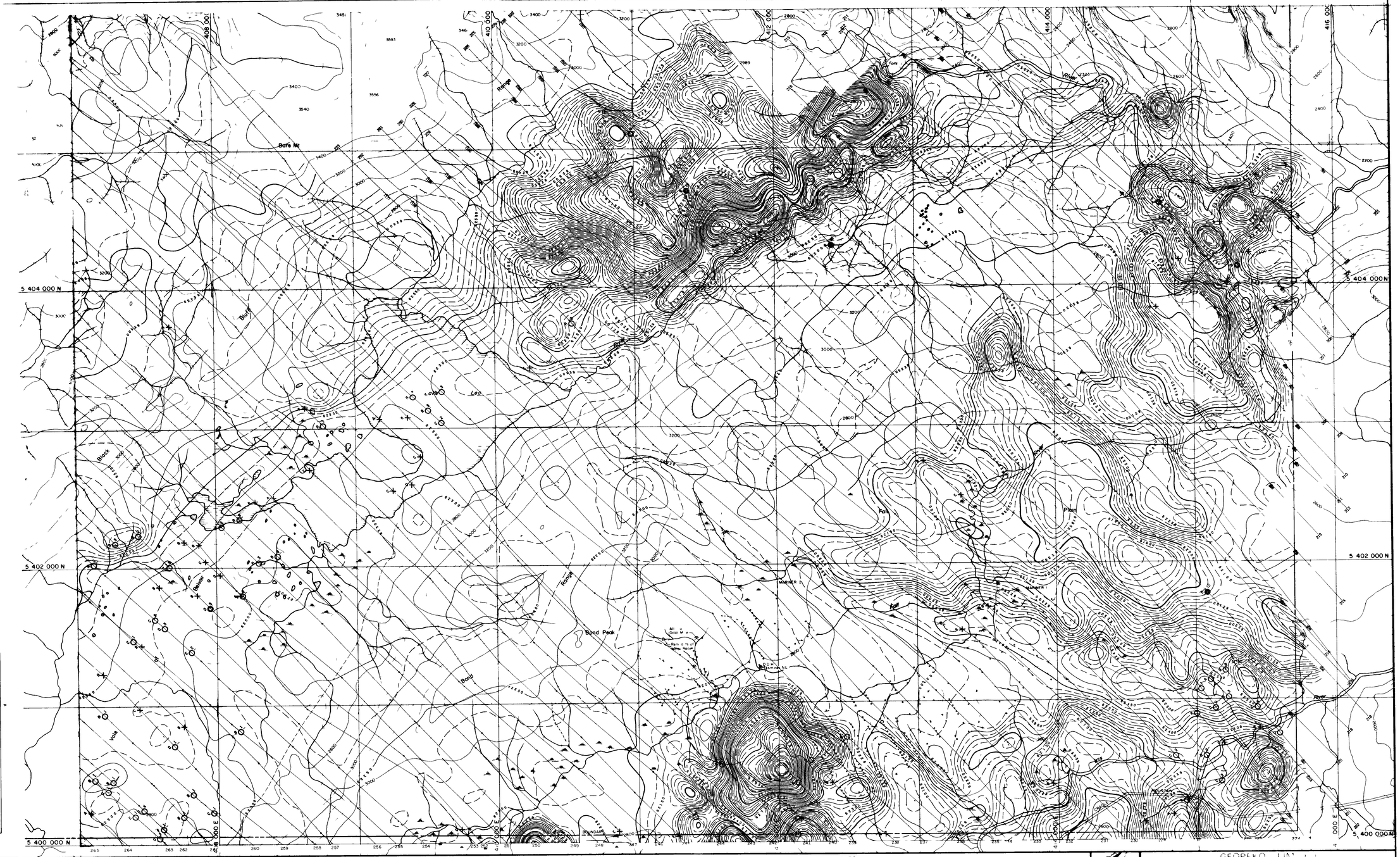
DRAWN

CHECKED

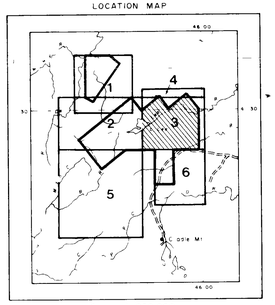
BLACK BLUFF TASMANIA

SHEET 2

4178



LOCATION MAP



Scale 1 250 000

Flight line

Fiducials and numbers

DIGHEM^{II} SURVEY

MAGNETICS

5cm

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

GEOPEKO LIMITED

EL 10/74
BLACK BLUFF, TASMANIA

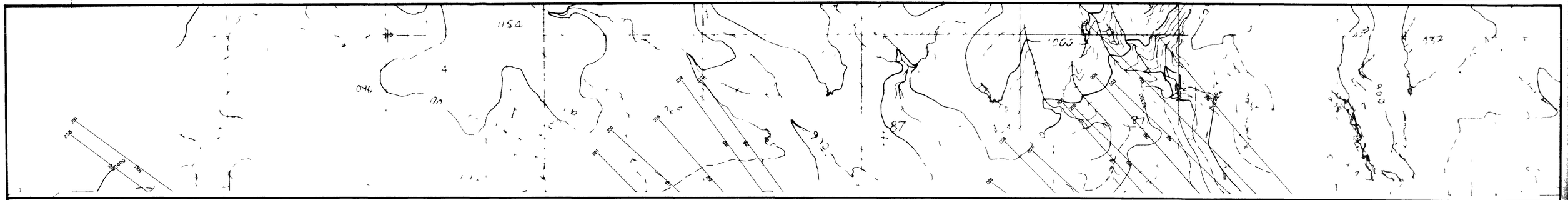
SHEET 3

DATE
GEOLOGIN
DRAWN
CHKD

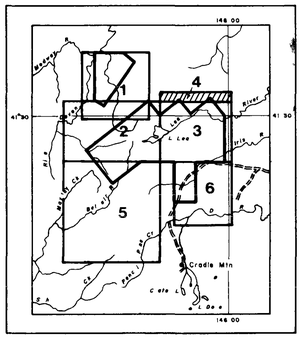
Plan No 5561 S/B

81-1581 Vol 2/2 3

4179



LOCATION MAP



Scale 1 250 000

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

DIGHEM^{II} SURVEY

BLACK BLUFF, TASMANIA

MAGNETICS

FOR

GEOPEKO LIMITED

SCALE 1 10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

946099

5 cm

SHEET 4

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°

Plan No 5565 S/B

81-1581 Vol 2/2

4

4750

MT MAYDAY
Trig 4.6C
3747

E.L. 2/70 TO BOUNDARY

E.L. 2/70 BOUNDARY

DIGHEM^{II} SURVEY

MAGNETICS

FOR

GEOPEKO LIMITED

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

946100

5 cm

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

TS

BLACK BLUFF, SHEET 5

Plan No. 5569 S/B

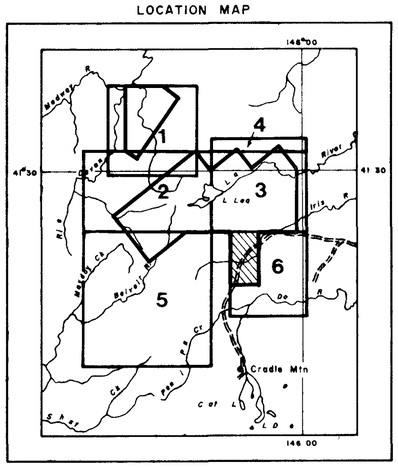
81-1581

Vol 2/2

5

4181

LOCATION MAP



Scale 1 250,000

Flight line

Fiducials and numbers

DIGHEM^{II} SURVEY

BLACK BLUFF, TASMANIA

MAGNETICS

FOR

GEOPEKO LIMITED

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

SCALE 1 10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

ISOMAGNETIC LINES

(total field)

1000 gammas

200 gammas

50 gammas

25 gammas

magnetic depression

Magnetic Inclination within the survey area 72°

946101

SHEET 6

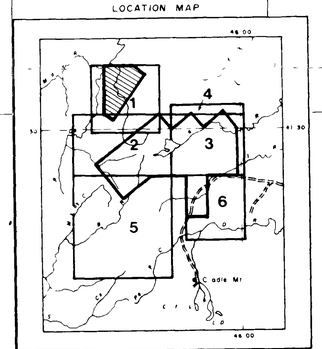
Plan No 5573 S/B

81-1581 Vol 2/2 6

4182

402 000 E
404 000 E
406 000 E
408 000 E
5 410 000 N
5 408 000 N
5 406 000N

LOCATION MAP



Scale 1 250,000

Flight line

Fiducials and numbers

REGISTERED PROFESSIONAL ENGINEER
D.C. FRASER
PROVINCE OF ONTARIO

DIGHEM^{II} SURVEY

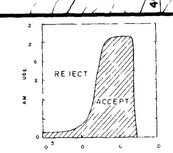
ENHANCED MAGNETICS

946162

81-1581 Vol 2/2

ISOMAGNETIC LINES
(enhanced field)

5000 gammas
1000 gammas
200 gammas
100 gammas
magnetic depression



Frequency response of magnetic apparatus

DATE
GEOLOGIST
DRAWN L.G.
CHECKED M.C.R.

GEOPEKO LIMITED
KING ISLAND GROUP

SCALE 1:10,000

No KT10/74-1

E.L. 10/74
BLACK BLUFF, TASMANIA

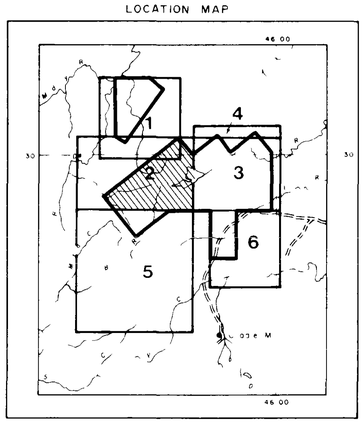
5 cm

KT10/4
K 0 74 / K d

Plan No 5554 S/B

4193

LOCATION MAP



Scale 1 250 000

ISOMAGNETIC LINES

(enhanced field)

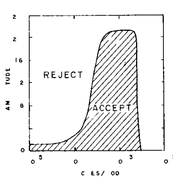
5000 gammas

1000 gammas

200 gammas

100 gammas

magnetic depression



Frequency response of magnetic operator

Flight line

Fiducials and numbers

Plan No 5558 S/B

946103

DIGHEM^{II} SURVEY

ENHANCED MAGNETICS

81-1581 Vol 2/2

2

GEOPEKO LIMITED

KING ISLAND GROUP

No KT10/74-2

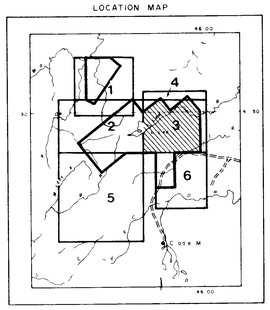
10/74

BLACK BLUFF, TASMANIA

SHEET 2

4184

LOCATION MAP



Scale 1 250 000

Flight line

Fiducials and numbers

Plan No 5562 S/B

DIGHEM^{II} SURVEY

ENHANCED MAGNETICS

94610?

81-1581 Vol 2/2

3

ISOMAGNETIC LINES
(enhanced field)

400 gammas
1000 gammas
200 gammas
100 gammas
magnetic dip

5cm

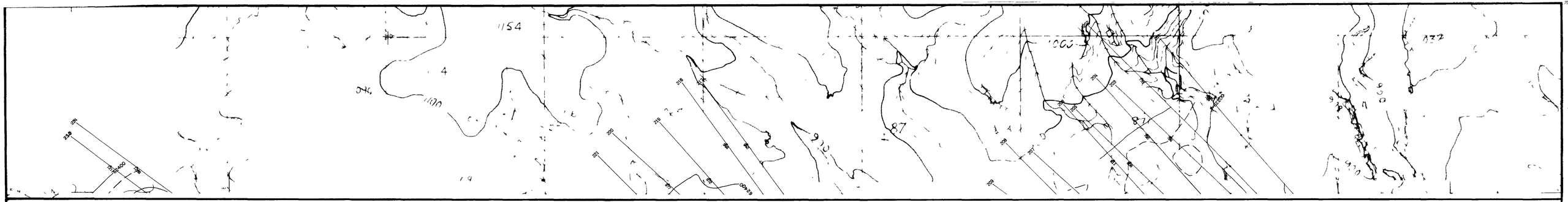
GEOPEKO LIMITED

EL 10/84
BLACK BLUFF TASMANIA

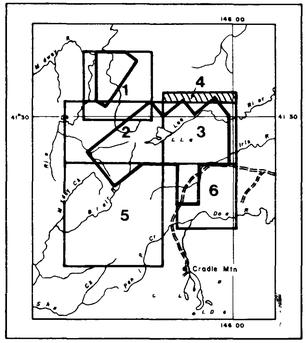
SHEET 3

VERTICAL

4185



LOCATION MAP



Scale 1 250 000

DIGHEM^{II} SURVEY

BLACK BLUFF, TASMANIA

ENHANCED MAGNETICS

FOR

GEOPEKO LIMITED

SCALE 1 10,000

1/2 0 1/2 Kilometres

1/4 0 1/4 1/2 miles

946105

5 cm

SHEET 4

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

Flight line

Fiducials and numbers

ISOMAGNETIC LINES

(enhanced field)

5000 gammas

1000 gammas

200 gammas

100 gammas

magnetic depression

Plan No 5566 S/B

81-1581 Vol 2/2

4

4186

MT. MAYDAY
Trig 460
3747

E.L. 270 BOUNDARY

LOCATION MAP



Scale: 1:250,000

DIGHEM[II] SURVEY

ENHANCED MAGNETICS

FOR

GEOPEKO LIMITED

SCALE 1:10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

946106

5 cm

Flight line

Fiducials and numbers

ISOMAGNETIC LINES

(enhanced field)

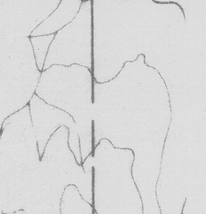
5000 ..... 5000 gammas

1000 ..... 1000 gammas

200 ..... 200 gammas

100 ..... 100 gammas

..... magnetic depression



Frequency response of magnetic operator

GEOPEKO
DEVONPORT BASE, TASMANIA

TS

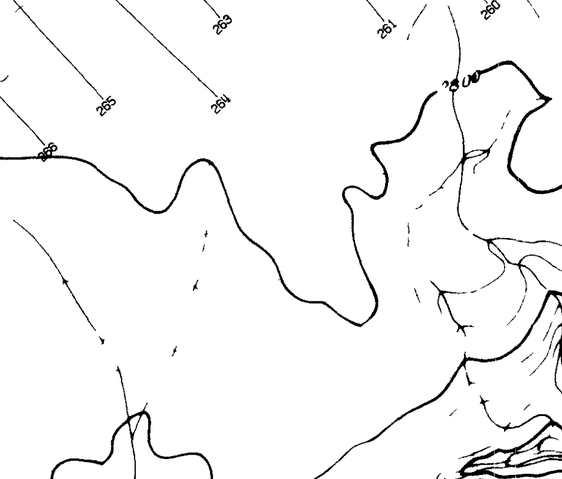
BLACK BLUFF, SHEET 5

4187

Plan No. 5570 S/B

81-1581 vol 2/2 S

LOCATION MAP



Scale 1 250,000

Flight line

Fiducials and numbers

DIGHEM^{II} SURVEY

BLACK BLUFF, TASMANIA

ENHANCED MAGNETICS

FOR

GEOPEKO LIMITED

946107

REGISTERED PROFESSIONAL ENGINEER
D. C. FRASER
PROVINCE OF ONTARIO

SCALE 1 10,000

1/2 0 1/2 1 Kilometres

1/4 0 1/4 1/2 Miles

5 cm

SHEET 6

ISOMAGNETIC LINES

(enhanced field)

5000 gammas

1000 gammas

200 gammas

100 gammas

magnetic depression

Frequency response of magnetic operator

Plan No 5574 S/B

81-1581

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