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# ANNUAL REPORT
# FOR
# EL 8678
# KEEP RIVER

# NORTHERN TERRITORY

## FOR THE PERIOD ENDING OCTOBER 5, 1997



**DISTRIBUTION:** **NT DEPT. OF MINES & ENERGY (1)**
**ZEPHYR MINERALS NL (2)**


**W. GIFFORD**
**PERTH W.A.**
**MARCH 4, 1998**

## SUMMARY

THIS ANNUAL REPORT DESCRIBES THE CONDUCT AND OUTCOME OF A DIAMOND EXPLORATION PROGRAM ON EXPLORATION LICENCE EL 8678, NORTHERN TERRITORY, LOCATED IN THE KEEP RIVER AREA, ON THE WESTERN AUSTRALIA – NORTHERN TERRITORY BORDER. THE PERIOD COVERED IS OCTOBER 5, 1996 TO OCTOBER 4, 1997.

THE EXPLORATION PROGRAM CONSISTED ENTIRELY OF AN AIRBORNE GEOPHYSICAL SURVEY COVERING 639 EAST-WEST DIRECTED LINE KILOMETRES, OVER THE CENTRAL PORTION OF THE LICENCE. THE SURVEY WAS A LOW-LEVEL COMBINED EM-MAGNETIC SURVEY UTILIZING GEOTERREX'S DIGHEM$^{V}$ SYSTEM.

THE PURPOSE OF THE SURVEY WAS TO LOCATE CONDUCTOR AND MAGNETIC ANOMALIES THAT MIGHT INDICATE THE PRESENCE OF SHALLOW OR EXPOSED KIMBERLITIC PIPES. THE AREA CHOSEN COVERED THE LOCATIONS OF SIX LOAM SAMPLES CONTAINING ANOMALOUS CHROMITE GRAINS, FOUND IN THE PREVIOUS YEAR AND IT WAS HOPED THAT THE SOURCE OF THESE COULD BE FOUND WITHIN THEIR IMMEDIATE VICINITY.

THE PROCESSED AND INTERPRETED SURVEY RESULTS INDICATE THE PRESENCE OF FOUR RESISTIVITY AND FOUR MAGNETIC TARGETS FOR INVESTIGATION. THE PRIME TARGET FOR FOLLOW-UP IS A DISCRETE MAGNETIC ANOMALY, PRESENT IN THE LONG FILTER RESIDUAL PLAN, WITH AN AMPLITUDE OF 2.5nT AND MEASURING ABOUT 400m X 600m IN SIZE. IT APPEARS TO BE RELATIVELY SHALLOW AND A "GOOD" KIMBERLITE TARGET, WITH THREE POSITIVE INDICATOR MINERAL SAMPLES LOCATED CLOSE TO IT. THIS ANOMALY IS HIGHLY RECOMMENDED FOR INVESTIGATION AND DRILLING.

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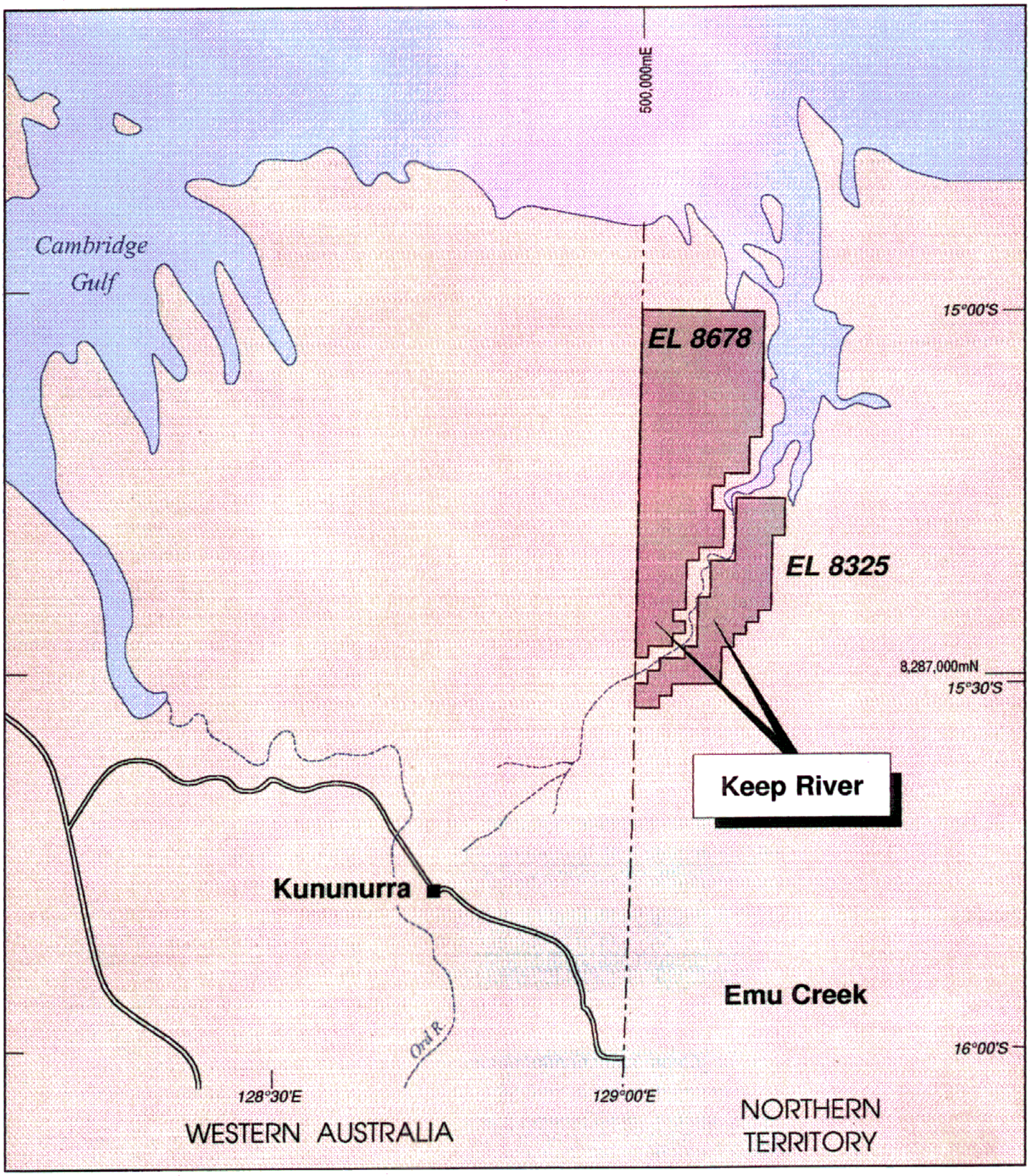



**KEY TO TENEMENT OWNERSHIP**

Zephyr 100%

ZEPHYR MINERALS N.L.

**LOCATION OF KEEP RIVER (N.T.) EXPLORATION LICENCES**

Figure 1

February 1998

# 1.0 INTRODUCTION

## 1.1 LOCATION

THE TENEMENT, EXPLORATION LICENCE EL 8678, IS LOCATED 55KM NE OF KUNUNURRA IN THE NORTHERN TERRITORY, WITH ITS WESTERN MARGIN ADJOINING THE NT-WA BORDER. THE EASTERN MARGIN FOLLOWS THE WEST BANK OF THE KEEP RIVER (FIG. 1).

ROAD ACCESS IS VIA THE WEABER PLAIN ROAD, LINKING KUNUNURRA TO LEGUNE STATION, AND THEN OLD SEISMIC LINES AND STATION TRACKS PROVIDE ACCESS WITHIN THE TENEMENT.

THE PROJECT AREA IS LOCATED IN THE AUVERGNE 1:250,000 MAP SHEET.

## 1.2 TENURE

THE TENEMENT, EL 8678 CONTAINS 199 BLOCKS AND COVERS AN AREA OF 641KM$^2$, (FIGS 1 & 2).

THE TENEMENT DETAILS ARE:

| TENEMENT NO. | GRANT DATE | EXPIRY DATE | AREA | RENTAL | MIN.ANNUAL EXPENDITURE |
|---|---|---|---|---|---|
| EL8678 | 05/10/1994 | 04/10/2000 | 641km$^2$ (199 BLOCKS) | $7,960 | $50,000 |

THE TITLE IS 100% ASSIGNED TO ZEPHYR MINERALS NL, LEVEL 1, 88 COLIN STREET, WEST PERTH, WA 6005.

## 1.3 EXPLORATION AIMS

DIAMONDS ARE THE COMMODITY SOUGHT AND THE TENEMENT IS PART OF A GROUP OF EXPLORATION LICENCES HELD BY ZEPHYR IN THE KUNUNURRA-KEEP RIVER REGION, SPECIFICALLY FOR DIAMOND EXPLORATION. THERE ARE TWO TARGETS:-

1. PALAEOCHANNELS LIKELY TO CONTAIN PLACER DIAMOND ACCUMULATIONS; AND

2. THE LOCATION OF KIMBERLITE OR LAMPROITE DIATREMES, EITHER EXPOSED OR COVERED BY THE OVERBURDEN.

DURING THE 1995-96 PERIOD, MICROPROBE RESULTS FROM CHROMITE GRAINS IN SIX LOAM SAMPLES OBTAINED WITHIN THE EL GAVE POSITIVE RESULTS ON A SOBOLEV DIAGRAM – PLOTTING IN THE DIAMOND ASSOCIATED FIELD (BEILBY 1996).

A SMALL GROUND MAGNETIC SURVEY WAS CARRIED OUT OVER THE AREA OF THE ANOMALOUS SAMPLES (U & KE4).BUT THE RESULTS WERE EQUIVOCAL.

ACCORDINGLY, IT WAS DECIDED TO CONTINUE THE INVESTIGATION OF THE CENTRAL AREA BY UTILIZING AN AIRBORNE EM/MAGNETIC SURVEY.

## 2.0 EXPLORATION COMPLETED IN 1997

EXPLORATION IN THE PRECEDING PERIOD INDICATED THAT THE CENTRAL AREA OF THE EL, IS POSSIBLY PROSPECTIVE FOR BURIED KIMBERLITIC PIPES BECAUSE OF THE PRESENCE ON THE SURFACE OF ANOMALOUS CHROMITE GRAINS.

AN AIRBORNE DIGHEM$^{V}$ GEOPHYSICAL SURVEY WAS ACCORDINGLY DESIGNED TO COVER ALL 6 ANOMALOUS CHROMITE SITES.

THE SURVEY WAS CONTRACTED TO GEOTERREX-DIGHEM PTY LIMITED-SYDNEY, WHO COMPLETED THE SURVEY IN APRIL 1997, EMPLOYING TOWED 'BIRDS' TO COLLECT THE EM AND MAGNETIC DATA. HOWEVER, ALTHOUGH THE EM DATA WAS SUCCESSFULLY ACQUIRED, THE NOISE IN MAGNETIC DATA WAS BEYOND THE SPECIFICATIONS AND THE MAGNETIC SURVEY WAS FINALLY RE-FLOWN IN SEPTEMBER 1997.

THE CONTRACTOR'S FINAL PLOTS AND LOGISTICS REPORTS WERE RECEIVED IN LATE DECEMBER 1997, WELL BEYOND THE ANNUAL REPORTING DATE FOR THE TENEMENT'S ANNIVERSARY. THE AERIAL SURVEY WAS THE ONLY FIELD WORK CARRIED OUT DURING THE PERIOD.

A CURSORY EXAMINATION OF THE GEOTERREX RESIDUAL MAGNETIC CONTOUR PLAN (APPENDIX 1) SHOWS THAT THE SURVEYED AREA HAS A GENERALLY FEATURELESS MAGNETIC IMAGE WITH A VERY 'FLAT' GRADIENT DIPPING TO THE SE, AND NO POSITIVE OR NEGATIVE ANOMALIES OF ANY SIGNIFICANCE. HOWEVER, IN THE INTERESTS OF COMPLETENESS AND BECAUSE OF THE SUBTLENESS OF THE GEOPHYSICAL SIGNATURES BEING SOUGHT, MR BILL (W.S.) PETERS, A PARTNER OF SOUTHERN GEOSCIENCE PTY LTD - PERTH, WAS CONTRACTED TO ANALYZE THE SURVEY DATA AND PROVIDE AN ASSESSMENT AND INTERPRETATION OF THE RESULTS. HIS REPORT IS CONTAINED IN APPENDIX 2.

W. S. PETERS BASICALLY CONCLUDES THAT THE MAGNETIC DATA CONTAINS FOUR POSSIBLE TARGETS OF INTEREST WITH THE LARGEST (M1) A SHALLOW DISCRETE 400M X 600M – 2.5nT AMPLITUDE ANOMALY POSSIBLY BEING A "VERY GOOD KIMBERLITE TARGET". THE M1 ANOMALY IS RANKED AS THE FIRST PRIORITY FOR INVESTIGATION.

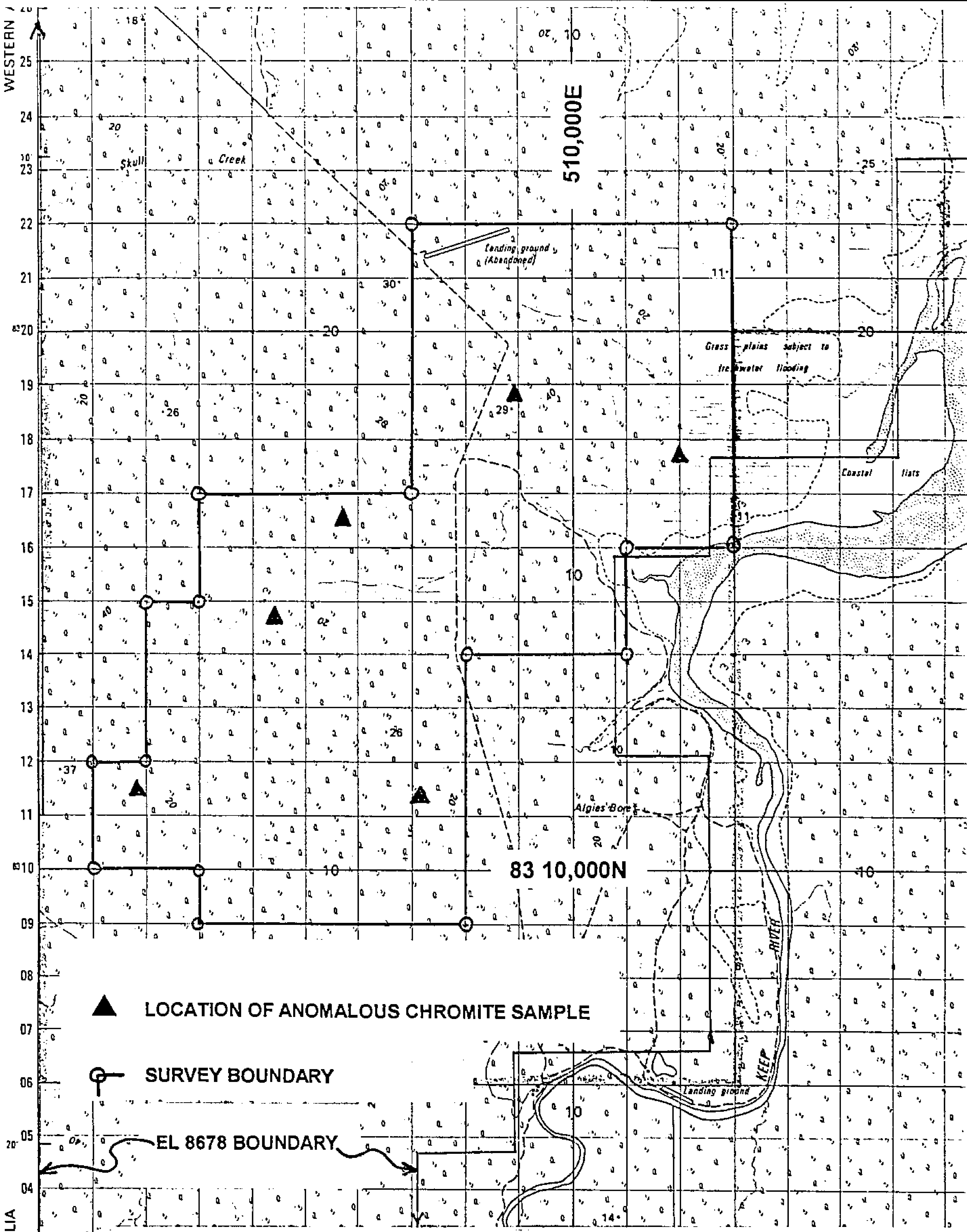
THE INTERPRETATION REVEALED FOUR RESISTIVITY TARGETS (R1-R4) WITH R1 – A 1300M DIAMETER CIRCULAR FEATURE WHICH MAY BE OF POSSIBLE INTEREST AS A KIMBERLITE TARGET.

PETERS RECOMMENDS THAT THE M1 ANOMALY SHOULD BE DRILLED AS A FIRST PRIORITY AND FOLLOWING THIS THE REMAINING MAGNETIC ANOMALIES M2-M4 AND THE RESISTIVITY ANOMALY R1 SHOULD BE DRILLED IN THAT ORDER OF RANKING.


ZEPHYR MINERALS N.L.

**LOCATIONS OF ANOMALOUS CHROMITE SAMPLES
1996 GROUND MAGNETIC SURVEY
AND 1997 AIRBORNE SURVEY**

Figure 2




SCALE 1 : 100,000

ZEPHHYR MINERALS NL

EL 8678
KEEP RIVER N.T.

LOCATION OF 1997 DIGHEM AERIAL SURVEY

FIGURE 3

# 3.0 EXPLORATION EXPENDITURE

AN ESTIMATED TOTAL OF $65,525.00 WAS EXPENDED ON THE DEVELOPMENT OF EL8678 DURING THE PERIOD IN THE FOLLOWING MAJOR CATEGORIES:-

| | |
|---|---|
| AIRBORNE GEOPHYSICAL CONTRACT | 56,150.00 |
| STAFF WAGES & GEOLOGICAL/GEOPHYSICAL CONSULTANTS | 5,050.00 |
| TENEMENT MANAGEMENT FEES | 350.00 |
| ADMINISTRATION AND OVERHEADS | 6,155.00 |
| TOTAL | $67,705.00 |

## 4.0 CONCLUSIONS AND RECOMMENDATIONS

THE RAW AIRBORNE DATA DO NOT APPEAR TO CONTAIN EVIDENCE OF ANY WORTHWHILE FOLLOW-UP TARGETS.

HOWEVER W.S. PETER'S PROCESSING AND ANALYSIS HAS REVEALED 8 POTENTIAL KIMBERLITIC TARGETS IN THE SURVEY AREA.

THE GEOTERREX RESIDUAL MAGNETIC CONTOUR PLOT SHOWS THAT THE AREA HAS A SOMEWHAT FEATURELESS MAGNETIC IMAGE WITH A VERY "FLAT" GRADIENT DIPPING TO THE SE. AND NO MAGNETIC ANOMALIES OF INTEREST.

PETERS APPLIED BOTH A SHORT AND LONG FILTER TO THE RESIDUAL MAGNETIC DATA AND FOUND THAT THE LONG FILTER ( A 301 POINT MOVING AVERAGE ) REVEALED A HIGHLY TEXTURED SURFACE THAT MAY BETTER REPRESENT BEDROCK MAGNETIC PATTERNS. FROM THIS LATTER PROCESSING HE HAS DELINEATED <u>4 MAGNETIC ANOMALIES</u>, THE LARGEST OF WHICH (M1) IS SHALLOW AND HAS A DISTINCTLY KIMBERLITIC SIGNATURE. THIS ANOMALY IS RANKED AS THE PRIME FOLLOW-UP TARGET DERIVED FROM THE SURVEY.

THE 3 REMAINING MAGNETIC ANOMALIES ARE SMALLER AND BE KIMBERLITE TARGETS OR DISCRETE SURFICIAL ANOMALIES DUE TO SMALL? FLUVIAL ACCUMULATIONS OF MAGHEMITE.

THE <u>RESISTIVITY</u> DATA ( APPARENT RESISTIVITY @ 400 Hz ) PRESENTED BY PETERS SHOWS 4 DISCRETE SUB-CIRCULAR ANOMALIES. THE LARGEST OF WHICH ( R1 ) IS 1,300m IN DIAMETER, HAS A MORE RESISTIVE CORE AND MAY BE A KIMBERLITE TARGET. THE OTHER 3 ( R2-R4 ) MAY ONLY BE AREAS OF THICKER COVER.

PETERS RECOMMENDATION IS TO CONDUCT FOLLOW-UP INVESTIGATIONS ON THE M1 ANOMALY AND DRILL IT IF SUFFICIENT ENCOURAGEMENT IS OBTAINED.
THE REMAINING MAGNETIC AND RESISTIVITY ANOMALIES COULD BE SIMILARLY INVESTIGATED IN THIS ORDER OF LISTING.

<u>IT IS RECOMMENDED THAT</u> THE ANOMALIES SHOULD FIRSTLY BE FIELD-CHECKED FOR LOCATION AND ACCESS, ANY OUTCROPS AND THEN THE M1, M2 AND R1 ANOMALIES SHOULD HAVE ONE OR TWO LINES OF CONFIRMATORY GROUND MAGNETICS COMPLETED OVER THEM.

IF SUFFICIENT FUNDS ARE AVAILABLE THE HIGHEST RANKING TARGETS COULD BE REFLOWN WITH VERY DETAILED AEROMAGNETICS SURVEY. DETAILED GROUND MAGNETIC SURVEYS ARE NOT RECOMMENDED BECAUSE THE VERY LOW AMPLITUDE OF THE ANOMALIES SOUGHT WILL ALMOST CERTAINLY BE LOST IN GROUND NOISE.

THE MAGNETIC ANOMALIES AND THE R1 RESISTIVITY ANOMALY SHOULD THEN BE TESTED BY A SHALLOW RAB-AIRCORE PROGRAM TO DETERMINE IF THEY ARE GENUINE DIAMOND PROSPECTS. THE RESULTS OF THIS PROGRAM WILL DETERMINE THE COURSE OF ANY FURTHER EXPLORATION ON THE PROPERTY.

IF ANY OF THE RESULTS OF THE ABOVE TEST ARE POSITIVE, APART FROM DESIGNING TESTS FOR THE REMAINING R CATEGORIES OF ANOMALIES CONSIDERATION SHOULD BE GIVEN TO RETURNING TO TESTING FOR ALLUVIAL DIAMONDS IN THE EARLIER PALEOCHANNEL TARGET AND THE LINEAR RESISTIVITY CHANNEL TARGETS DEFINED BY PETERS ( 1998 ).

THE PALEOCHANNEL TARGET, LOCATED IN THE SOUTHERN END OF THE EL, AS OUTLINED IN THE 1995 ANNUAL REPORT (BEILBY AND KROUPNIK 1995) APPEARS TO REMAIN AS A VALID TARGET AND COULD BE RECOMMENDED FOR DRILLING EVALUATION. THIS COULD BE ACCOMPLISHED BY BORING 3 LINES OF HOLES AT RIGHT ANGLES TO THE CHANNEL AXIS AND THROUGH THE LOCATIONS OF THE THREE BOREHOLES (29658, 29659 AND 5662) IN WHICH DIAMOND INDICATOR MINERALS HAVE BEEN IDENTIFIED.

# 5.0 PROPOSED PROGRAM FOR 1997 – 1998

| | |
|---|---|
| FIELD CHECK ANOMALIES, MINOR GRIDDING AND CONFIRMATORY GROUND MAGNETICS. APPROX. 2 WEEKS, 2 PERSONNEL, VEHICLE & EQUIP. HIRE, TRAVEL, ACCOM., FIELD SUPPLIES | $ 16,450 |
| DETAILED AEROMAGNETIC SURVEY OF MAIN TARGETS | $ 10,000 |
| SITE CLEARANCE FROM ABORIGINAL AREAS PROTECTION AUTHORITY | $ 8,000 |

RAB-AIRCORE DRILLING OF M1-M4 AND R1 ANOMALIES

50m HOLES – 40m SPACING FOR M1-M4 & 80m FOR R1, ESTIMATE $ 405/ HOLE. INCLUDES 50m RAB + ~7m AIRCORE.

M1 - 1 LINE X 500m = 13 HOLES = 650m - $ 5,265
M2, M3 & M4 1 X 200m LINE EA. = 3X6 HOLES = 900m ~ $ 7,290
R1 – 1 x LINE X 1,500m = 19 HOLES = 950m ~ $ 7,695

| | |
|---|---|
| DRILLING ESTIMATE, 50 HOLES FOR 2500+m | $20,250 |
| DRILL MOBILIZATION & SITE CLEARING | $ 4,000 |
| CONTRACT GEOLOGIST INCL. FIELD COSTS | $10,000 |
| MINERALOGY AND PETROGRAPHY | $ 4,000 |
| ESTIMATE | $72,700 |

# 6.0 REFERENCES


BEILBY, G. & KROUPNIK, V. 1995 KEEP RIVER PROJECT, EL 8676 EL 8678. ANNUAL REPORT FOR THE YEAR ENDING 5 OCTOBER 1995 Unpubl. ZEPHYR MINERALS NL

BEILBY, G 1996 KEEP RIVER PROJECT, EL 8676, EL 8677, EL 8678. ANNUAL REPORT FOR THE YEAR ENDING 5 OCTOBER 1996. Unpubl. ZEPHYR MINERALS NL

PETERS, W.S. 1998 KEEP RIVER PROJECT, DIGHEM SURVEY INTERPRETATION FOR ZEPHYR MINERALS NL. Unpubl. SOUTHERN GEOSCIENCE CONSULTANTS PTY LTD

----------- 1997 LOGISTICS OF A DIGHEM$^{V}$ SURVEY FOR ZEPHYR MINERALS NL, KEEP RIVER N.T. AUST. MAP SHEET SD-52-15 GEOTERREX-DIGHEM PTY LTD Compiled by D. NEWMAN

# APPENDIX 1

LOGISTICS REPORT OF A DIGHEM$^{V}$ SURVEY
FOR
ZEPHYR MINERALS N.L
KEEP RIVER, N.T
AUSTRALIAN MAP SHEET
SD - 52 - 15 "AUVERGNE"

JOB NO. 4-781
December, 1997

GEOTERREX-DIGHEM PTY LIMITED
7-9 GEORGE PLACE, ARTARMON NSW 2064, AUSTRALIA

Compiled by
Daniel Newman

## ABSTRACT

This report describes the logistics and results of a DIGHEM$^V$ airborne geophysical survey carried out by Geoterrex-Dighem Pty Limited for Zephyr Minerals N.L over the Keep River survey area. Total coverage of the survey block amounted to 639 line kilometres. The survey was first flown during April 1997. The magnetic data from this survey was found to be out of specification, and was subsequently re-flown during September 1997.

The purpose of the survey was to detect zones of conductive mineralisation that may indicate the presence of kimberlitic pipes and to provide information that could be used to map the geology and structure of the survey area. Data were collected with towed birds and two AS 350 B helicopters (VH - HBB) and (VH-JRO).

EM data were collected by a DIGHEM$^V$ bird with a multi-coil, multi-frequency electromagnetic system, which was towed below a magnetic bird with a highly sensitive Cesium magnetometer. The information from these sensors was processed to produce maps which display the magnetic and conductive properties of the survey area. The navigation system used GPS with real time differential corrections from a Fugro Starfix system.

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## 1. INTRODUCTION

A DIGHEM$^V$ electromagnetic / magnetic survey was flown by Geoterrex-Dighem Pty Limited for Zephyr Minerals N.L from the 22$^{nd}$ to the 27$^{th}$ of April 1997. The magnetic data was found to be out of specification, and was subsequently re-flown from the 28$^{th}$ to the 29$^{th}$ of September 1997. The survey area was located near Kununurra, Western Australia. The survey area can be located on Australian 1:250 000 Map Sheet "Auvergne", SD 52-15.

Survey coverage consisted of 639 line kilometres, flown in 6 flights. The details of the survey area are given in the table below.

The survey employed the DIGHEM$^V$ electromagnetic system. Ancillary equipment consisted of a magnetometer, radar altimeter, video camera, analogue and digital recorders and an electronic navigation system. The instrumentation was installed in AS 350 B turbine helicopters (Registration VH-HBB & VH-JRO) provided by Helicopter Resources Limited. The helicopter was flown at an average airspeed of 100 km/h with an EM bird height of approximately 30 m.

**Table 1: Survey Area**

| Area | Base of Operations | Line Kilometres | Line Direction | Line Spacing (m) |
|---|---|---|---|---|
| Keep River | Kununurra | 639 | 0°/ 180° | 150 |

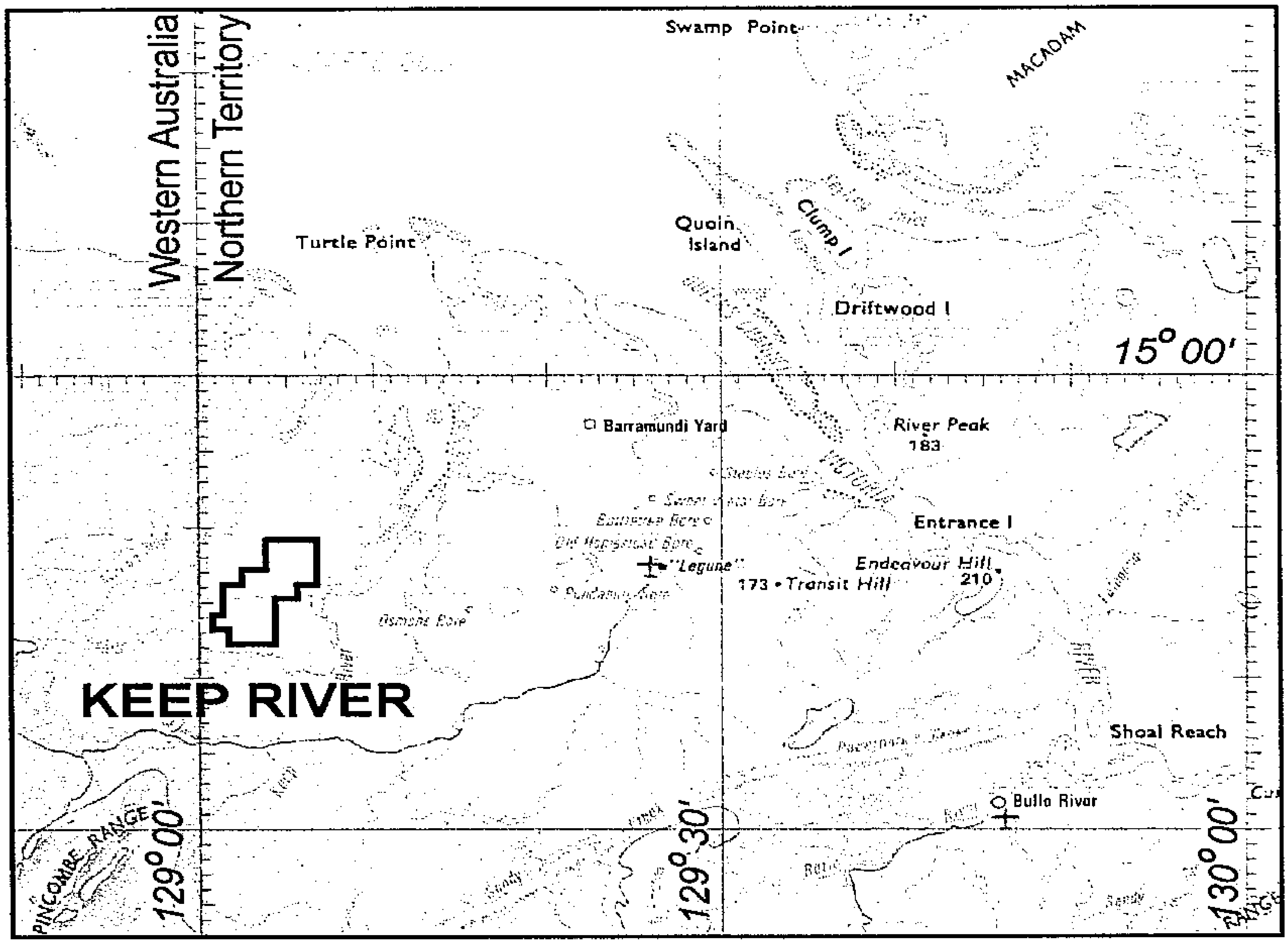



**Figure 1: Location Map: Keep River Survey Area, Northern Territory.**
Scale: 1:1,000,000

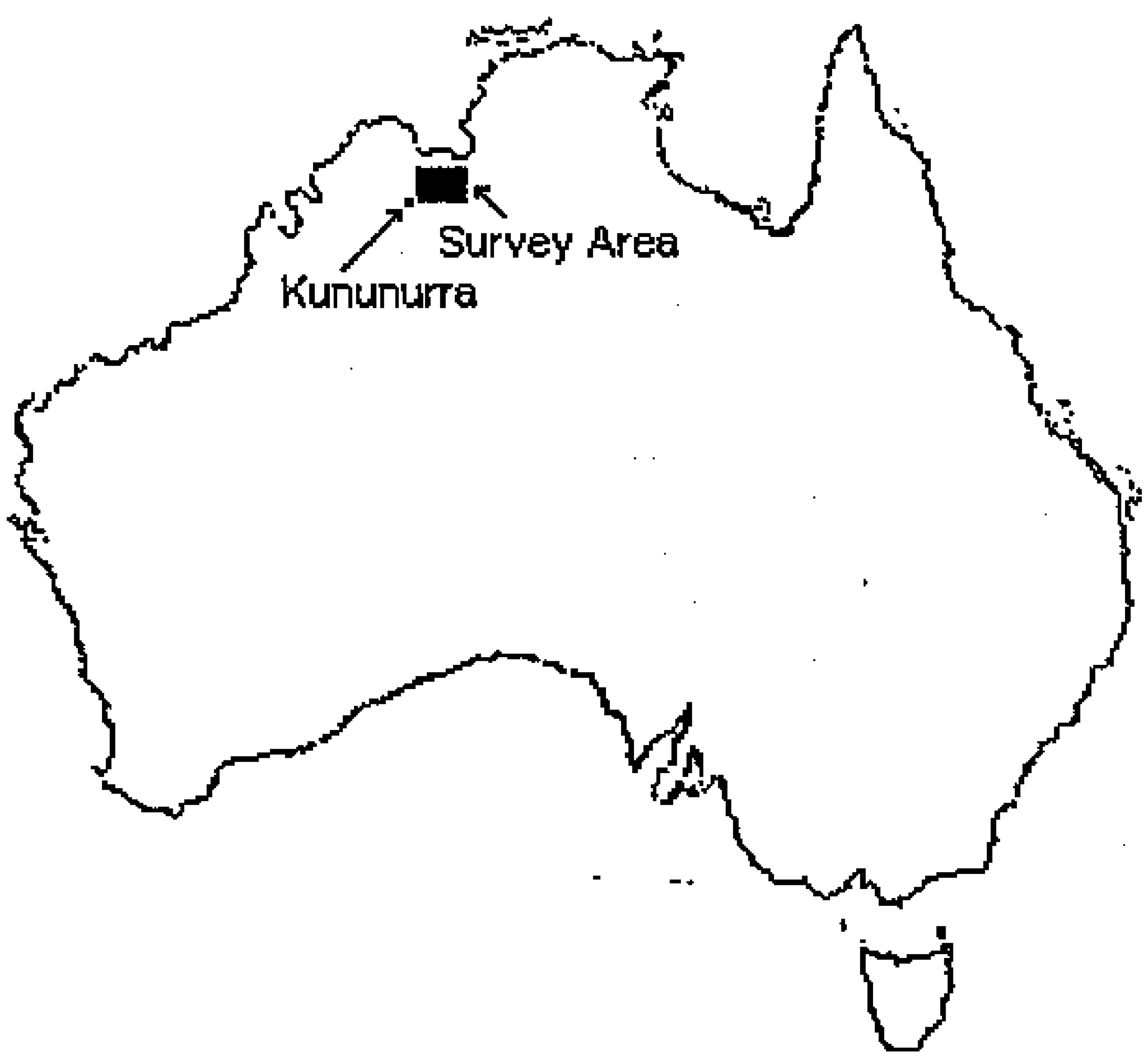


**Table 2: Survey Progress**

| Date | Progress |
|---|---|
| **April 1997** | |
| 22 | Mobilise to Kununurra |
| 23 | Equipment set-up |
| 24 | Commence survey, flight 1 |
| 25 | Flights 2,3 |
| 26 | Flights 4,5 |
| 27 | Flight 6, survey area completed |
| **September 1997** | |
| 29 | Re-Flight magnetics, flights 1,2,3,4 |
| 30 | Demobilise from Kununurra |

**Table 3: Survey Personnel**

| Position | Crew Member - DIGHEM$^{V}$ / Magnetics, April 1997 | Crew Member - Magnetics Re-flights, September 1997 |
|---|---|---|
| Crew Manager | Drewett | Drewett |
| Pilots | Phillips*, Pate* | Bitcon*, Hamilton* |
| Aircraft Engineer | Weatherley* | Tony* |
| Electronics Technician | Drewett | Eichorn |
| Geophysicist | Beckham | Pulford |

* employees of Helicopter Resources Limited.

## 2. SURVEY EQUIPMENT

This section provides a brief description of the geophysical instruments used to acquire the survey data.

**Table 4: Airborne Equipment Specifications**

| System Parameters | Specifications |
|---|---|
| Aircraft | AS-350 B |
| Navigation | Real time DGPS |
| Nominal aircraft height (m agl) | 60 |
| Aircraft speed | 100km/h (28m/s) |
| DIGHEM$^V$ bird height (m agl) | 30 |
| Magnetic bird height (m agl) | 40 |
| Geophysical data sampling rate (sec) | 0.1 (2.8m) |

### 2.1 Electromagnetic System

Model: DIGHEM$^V$
Type: Towed bird, symmetric dipole configuration operated at a nominal survey altitude of 30 metres

**Table 5: DIGHEM$^V$ Coil Specifications**

| Coil | Frequency (Hz) | Coil Separation (m) | Coil Orientation | Sensitivity (ppm) |
|---|---|---|---|---|
| 1 | 400 | 8.1 | Coplanar | 0.06 |
| 2 | 900 | 8.1 | Coaxial | 0.06 |
| 3 | 5500 | 8.1 | Coaxial | 0.10 |
| 4 | 7200 | 8.1 | Coplanar | 0.10 |
| 5 | 56000 | 6.3 | Coplanar | 0.30 |

Channels recorded: 5 in-phase channels
5 quadrature channels
2 monitor channels
Sample rate: 10 per second

The electromagnetic system utilises a multi-coil coaxial / coplanar technique to energise conductors in different directions. The coaxial coils are vertical with their axes in the flight direction. The coplanar coils are horizontal. The secondary fields are sensed simultaneously by means of receiver coils which are maximum coupled to their respective transmitter coils. The system yields an in-phase and a quadrature channel from each transmitter-receiver coil-pair.

## 2.2 Magnetometers

### 2.2.1 Survey Magnetometer

| | |
|---|---|
| Type: | Optically pumped Cesium vapour |
| Sensitivity: | 0.01 nT |
| Sample rate: | 10 per second |

The magnetometer sensor is towed in a bird 20 m below the helicopter and 40m above the ground.

### 2.2.2 Base Magnetometer

| | |
|---|---|
| Model: | G856 |
| Type: | Digital recording Proton Precession |
| Sensitivity: | 0.1 nT |
| Sample rate: | 1 each 5 seconds |

The base station is set up in an area of minimum magnetic noise and away from high magnetic gradients. A second base station is operated as a back up. The total magnetic field is recorded digitally during the survey operation. The clock of the base station is synchronised with that of the airborne system to permit removal of diurnal drift.

## 2.3 Altimeters

### 2.3.1 Radar Altimeter

| | |
|---|---|
| Manufacturer: | Honeywell/Sperry |
| Type: | AA 220 |
| Sensitivity: | 0.3 m |

The radar altimeter measures the vertical distance between the helicopter and the ground. This information is used in the processing algorithm which determines conductor depth.

### 2.3.2 Barometric Altimeter

| | |
|---|---|
| Manufacturer: | A.I.R. |
| Type: | Digital Recording Barometric Altimeter |
| Sensitivity: | 0.3 m |

## 2.4 Analogue Recorder

| | |
|---|---|
| Model: | RMS DGR33 dot-matrix graphics recorder |
| Resolution: | 4 x 4 dots / mm |
| Speed: | 1.5 mm / sec |
| Channels: | 1X9I - coaxial in-phase (900 Hz) |
| | 1X9Q - coaxial quad (900 Hz) |
| | 2P4I - coplanar in-phase (400 Hz) |
| | 2P4Q - coplanar quad (400 Hz) |
| | 3X7I - coplanar in-phase (7200 Hz) |
| | 3X7Q - coplanar quad (7200 Hz) |

4P5I - coaxial in-phase (5500 Hz)
4P5Q - coaxial quad (5500 Hz)
5P5I - coplanar inphase(56000 Hz)
5P5Q - coplanar quad (56000 Hz)
BARO - barometric altimeter
RADR - radar altimeter
CMAG - magnetics, coarse
FMAG - magnetics, fine

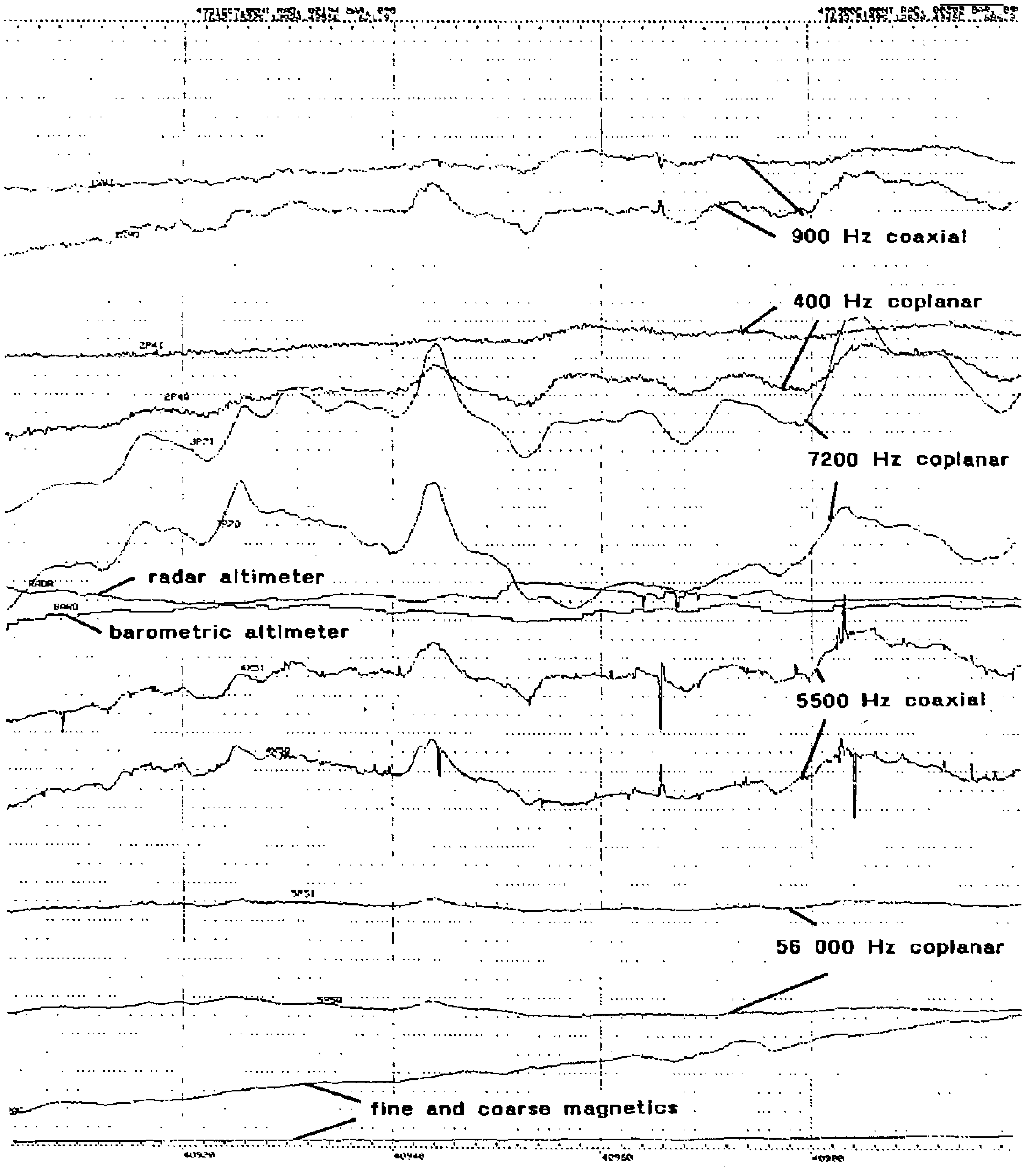
## 2.5 Navigation System (RT-DGPS)

| | |
|---|---|
| GPS Equipment: | Omnistar Plus 6500 receiver and PNAV navigation system |
| Differential Corrections: | by Fugro with the Starfix system |
| Sample rate: | 1 per second |

The Global Positioning System (GPS) is a line of sight, satellite navigation system which utilises time-coded signals from at least four of the twenty-four NAVSTAR satellites. In the differential mode, two GPS receivers are used. The Starfix system receives GPS differential corrections and transmits these to the GPS acquisition on board the helicopter, which are applied to the raw GPS data in real time. The on-board system calculates the flight path of the helicopter while providing real-time guidance. This system gives a post-survey processing accuracy of approximately 5 metres.

The GPS records data relative to the WGS84 ellipsoid, which is the basis of the revised North American Datum (NAD83). Conversion software is used to transform the WGS84 coordinates to Australian Map Grid (AMG) co-ordinates using the AGD66 datum.

**Figure 2: Sample Analogue Chart**



## 2.6 Digital Data Acquisition System

Model: Geoterrex - Dighem Pty Limited GEODAS

The GEODAS is a computer-based software system which runs multiple DOS programs in a multi-tasking environment. The modular design of the GEODAS allows for re-configuration of the system to record different types of surveys by adding, removing or changing task modules.

Data are recorded on hard disks and a cartridge tape system is used for data transfer to the field processing centre.

The following are recorded digitally using the GEODAS:

Flight number
Date
Navigation data
Total magnetic field
Fiducial number (time in seconds)
Barometric pressure
Radar altitude
Temperature outside the cabin in Celsius
5 in-phase DIGHEM$^V$ channels
5 quadrature DIGHEM$^V$ channels
2 monitor channels

## 2.7 Tracking Camera

| | |
|---|---|
| Type: | Panasonic Video |
| Model: | AG 2400 / WVCD132 |

Fiducial numbers are recorded continuously and are displayed on the margin of each image. This procedure ensures accurate correlation of analogue and digital data with respect to visible features on the ground.

## 2.8 Field Workstation

| | |
|---|---|
| Hardware: | UNIX Work station<br>3.5 Gb Hard Disk<br>Exabyte cartridge tape drive<br>Lap-top PC |
| Software: | Geoterrex-Dighem GMAPS Software |

A field workstation is used at the survey base to verify data quality and completeness. Flight tapes are dumped to a hard drive to permit the creation of a database. This process allows the geophysicist to display both the positional (flight path) and geophysical data on a screen as profiles and maps for quality control.

The field processing centre also includes a PC for additional tasks such as down loading diurnal base station files.

## 2.9 Electromagnetic System Calibrations

### 2.9.1 Ground Pre-Flight Calibrations

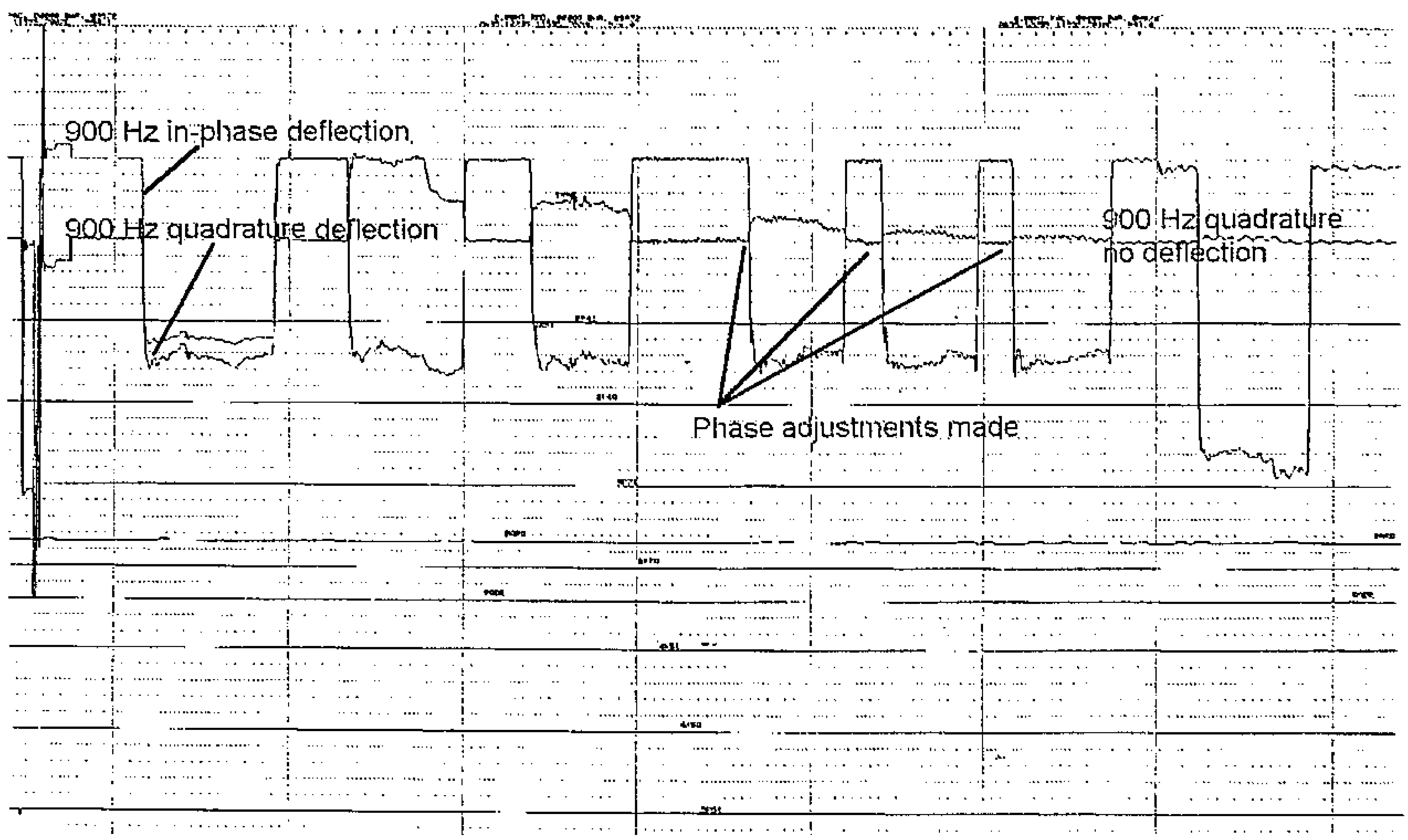
**Setting the Phase**

This procedure is carried out to ensure that the phase angle (which is used when the primary amplitude is separated into in-phase (real) and out of phase (imaginary or "quadrature") components) is correct. The procedure is carried out by presenting a ferrite bar to each coil pair in a maximum coupled position. Ferrite has the unique property that it has no quadrature response, giving a negative, totally in-phase deflection. Therefore, when the ferrite rod is placed in the correct position with reference to each transmitter / receiver coil pair, there should be no quadrature response. If there is a quadrature response, the phase is adjusted on the individual signal analyser until the quadrature response is zero. Since the in-phase and quadrature gating signals in the signal analyser are fixed at $90^0$ apart and referenced to the stable transmitter, rotation of the phase rotates both in-phase and quadrature for accurate internal reference.

The phasing of the coaxial and coplanar coils is carried out separately for each frequency so that interference does not occur between frequencies. A minimum offset for each frequency is specified so that sufficient signal is available to the acquisition system and allows accurate adjustments to be made to the phase angle. When the ferrite bar is placed in position, the in-phase offsets are to be greater than 4 cm on the analogue chart, which is equivalent to 500 mV for the 900 Hz, 400 Hz, 5500 Hz and 7200 Hz and 400 mV for the 56 000 Hz.

A sample of a phase correction can be seen below in Figure 4. In this example, there is a significant quadrature response at the start of the procedure (on the left-hand side). The phase adjustment is made gradually and each time the ferrite bar is presented to the coils, the quadrature response decreases until the last offset (on the right-hand side) where the quadrature response is effectively zero.

**Figure 3: Example of Phase adjustments (on an analogue chart).**



### 2.9.2 Gain Adjustments

Electronic gain adjustments are made for two reasons:
1) To ensure that the in-phase and quadrature responses for any given frequency correspond in amplitude to a known standard.
2) To ensure that the in-phase and quadrature responses from that known standard have a 1: 1 ratio.

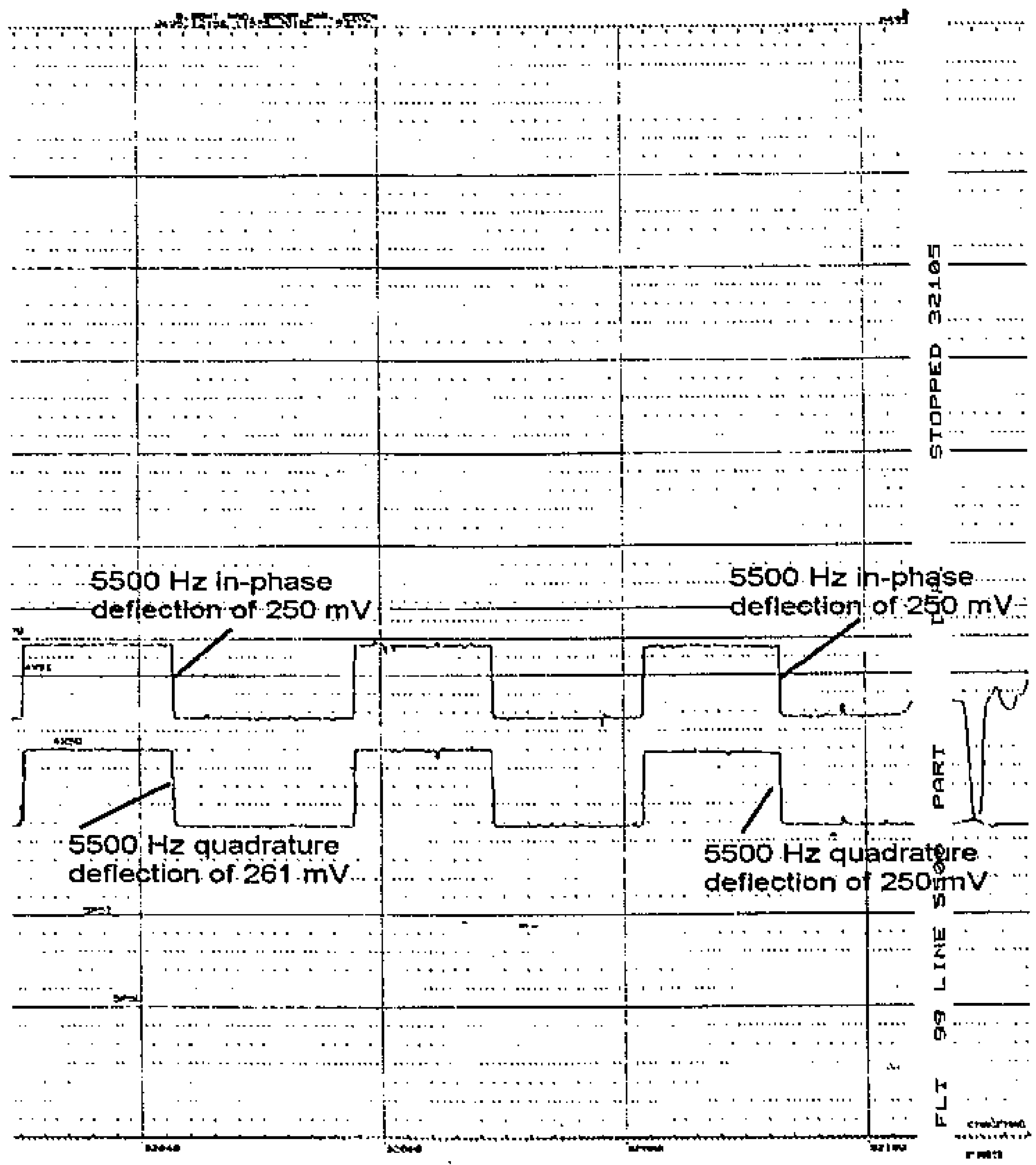
Therefore, the phase adjustments must be completed prior to the gain adjustment procedure.

The gain adjustment is determined by placing an external calibrating coil ("Q" coil) in a maximum coupled position at a specified distance equal to 100 ppm for each transmitter / receiver coil pair and reading the amplitude of each component in millivolts. If the amplitudes seen for any component on the analogue chart are different from the known response of the external Q coil, the gain is adjusted by a gain pot on the signal analyser module.

The external calibration coil has standard responses (in millivolts) for each frequency which have been established previously and are equivalent to 100 ppm for each frequency. The fixed output of a 100 ppm secondary field anomaly given by the external calibration coil for both in-phase and quadrature components automatically normalises for differing transmitter dipole moments.
The voltages corresponding to a 100 ppm anomaly are:

| | |
|---|---|
| 900 Hz Coaxial | 500 mV |
| 400 Hz Coplanar | 500 mV |
| 7200 Hz Coplanar | 250 mV |
| 5500 Hz Coaxial | 250 mV |
| 56 000 Hz Coplanar | 100 mV |

**Figure 4: Example of Gain Correction**



### 2.9.3 Airborne Calibrations

After all pre-flight tests and calibrations are complete, airborne calibrations are carried out at an altitude of greater than 300 m. This procedure is carried out the start and end of each flight and at approximately twenty minute intervals throughout survey flying. These are carried out at high altitude so that no EM effect from conductors in the ground interferes with the zero levels and calibration techniques.

**Internal "Q" Coil calibrations and Auto Nulling**

These calibrations are carried out to ensure that the system is working properly. An internal "Q" coil procedure verifies that the gain calibrations carried out on the ground are correct and repeatable in-flight. The internal "Q" coil procedure is essentially the same technique as that carried out on the ground. This procedure provides a visual reference which assures the operator that the gain levels and the ratio of in-phase to quadrature is correct. Any extreme variation from expected values suggests that the ground calibrations should be repeated or that there are errors in the internal "Q" coil.

**High altitude Zeroing**

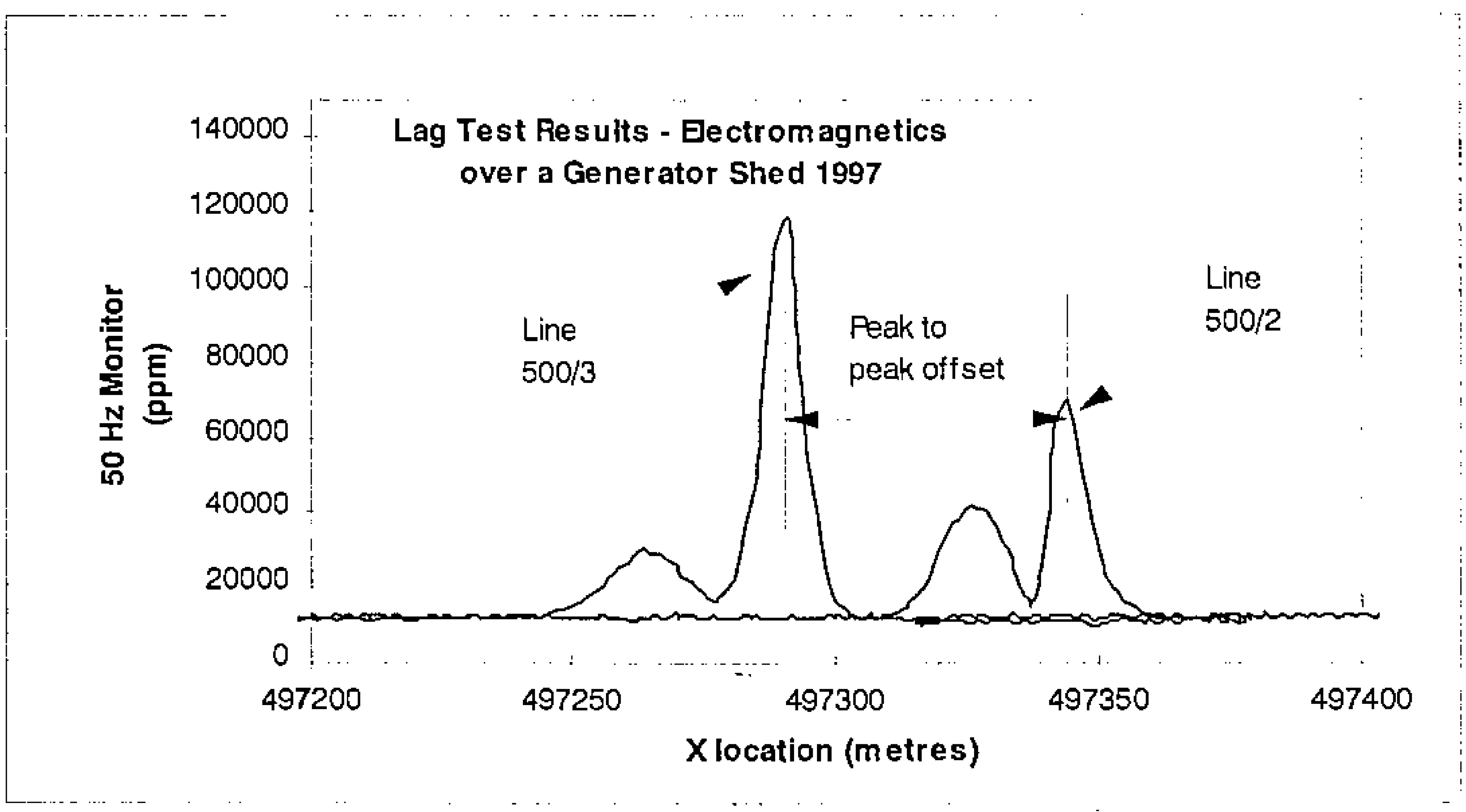
High altitude tests are recorded digitally and are also used to ascertain the quantity of drift in the electronic system. The amplitudes for each frequency in-phase and quadrature are determined and in the processing, any change in these amplitudes is removed.

**Lag Tests**

A lag test is routinely carried out to determine the lag of the DIGHEM system. The lag test is conducted by flying in two different directions over a known target with a particular signature. The response of the target for is plotted as a stacked profile. The lag test is useful for ascertaining the lag of a number of components including magnetics, electromagnetics, video, GPS lag / displacement and acquisition system lag.

A lag test was conducted by flying in two directions over a known magnetic and electromagnetic target. Lines were flown in opposite directions to calculate the magnetic and electromagnetic system lag. From this test a lag response was recorded and used to calculate the lag that was applied in processing the data. An example of this is included below:

**Figure 5: Example of an Electromagnetic Lag test**



### 2.10 Magnetometer Calibrations

The following calibration tests were carried out for the magnetometer during the survey. The standard "Figure of Merit" test, which measures aircraft effects on the measured magnetic field as the aircraft manoeuvres is not applicable to operations with a helicopter towed bird because the helicopter is approximately 30 metres from the bird and effects are negligible, consequently no compensation coils are needed on the bird to compensate for the helicopter.

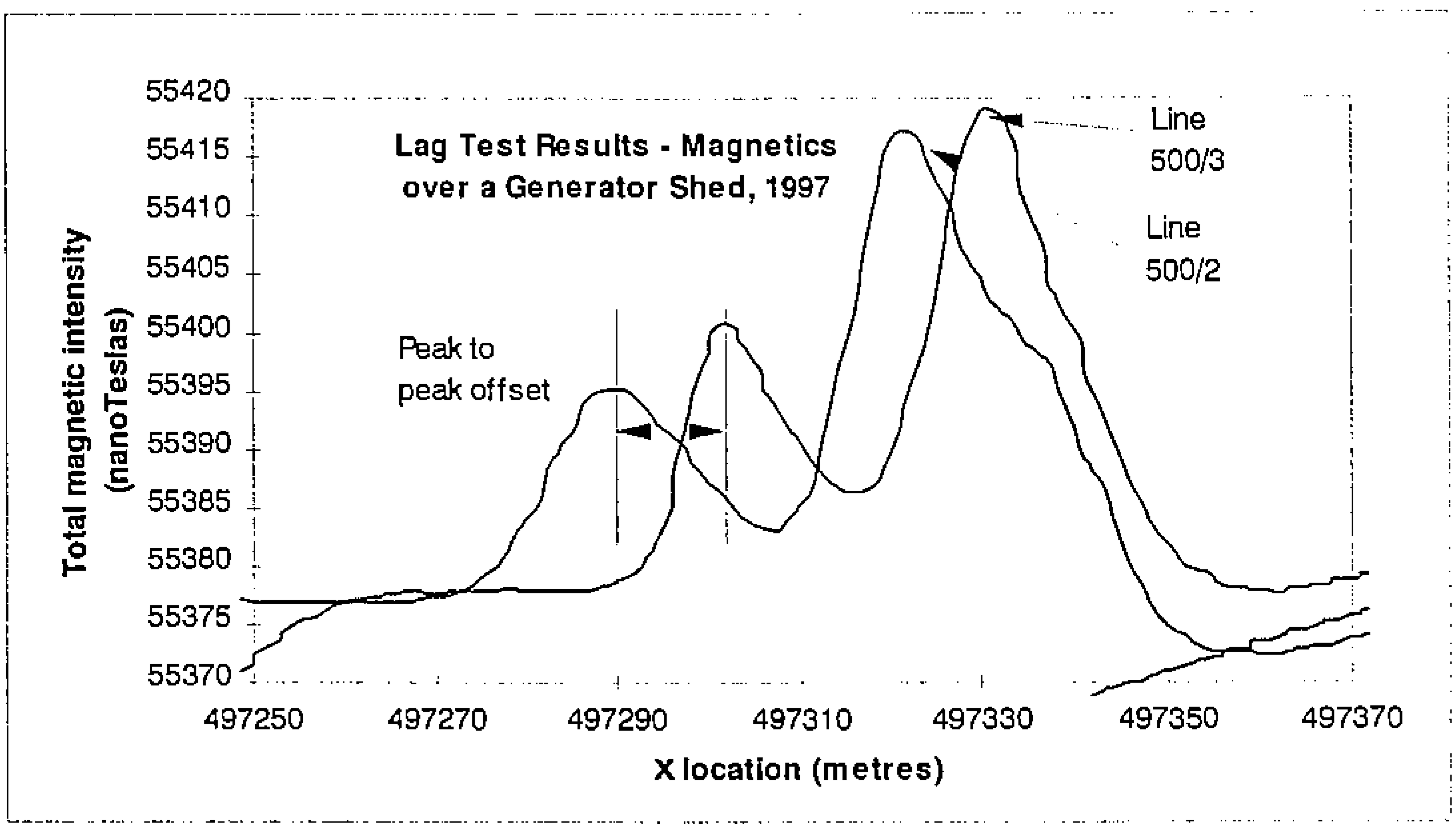
#### 2.10.1 Cloverleaf test

The magnetic heading effect was determined by flying a cloverleaf pattern oriented in the same directions as the survey lines and control lines. It was flown to determine the effect on the sensor reading, sensor heading and the associated sensor orientation relative to the direction of the earth's magnetic field. At least two passes in each direction were flown over a recognisable feature on the ground in order to obtain sufficient statistical information to estimate the heading error. The heading error was determined before survey commencement, and after any modifications or equipment additions were made to the aircraft.

#### 2.10.2 Parallax

This test is also known as a lag test. The aircraft was flown in opposite directions over a sharp magnetic anomaly with the navigation system and magnetometer operating. The position of the magnetic high is determined from the navigation system for each line direction. The numerical difference in position is the 2-way or total lag. The lag to be applied to each direction is this value divided by two. Varying lag due varying ground speed will be compensated for in the processing.

**Figure 6: Example of a Magnetic Lag test**



## 2.11 GPS Positioning tests

A position accuracy test of the real time satellite DGPS - OMNISTAR navigation system and the Sercel post-processed GPS positioning system was carried out prior to the beginning of the survey. The helicopter hovered visually over a known point.

The position of the Sercel GPS base station was located by placing the mobile Sercel unit on a known trig location and monitoring the movement of the base station at the processing centre (hotel). The position of the processing centre base station GPS was averaged for data recorded over two hours. The Z component of the positioning test can also be used to compare against the radar and barometric altimeter data.

## 2.12 Barometric Altimeter Calibrations

The Sperry radar altimeter is a high quality instrument with a factory calibrated output. It is fitted with a test function which checks the calibration of a terrain clearance of 100 feet and altitudes which are multiples of 100 feet. The barometric data are also calibrated by comparison of data recorded at the airport prior to take-off with the known altitude of the airport as well as a hover test directly above the same point or above a trig point. Calibration of the altimeter systems are routinely undertaken.

## 2.13 Radar Altimeter Calibration

Once the barometric altimeter is calibrated, the data from the radar altimeter from the same tests can be properly calibrated. This is a very straight forward procedure. Since the altitude at ground is known for both radar altimeter and barometric altimeter, the calibrated barometric altitude for a hover test over the same point is also known, then the radar altimeter data can be checked directly against this. Any variations may be due to atmospheric variations. Via hover tests at a number of different altitudes, a regression can be created to compare atmospheric pressure readings against barometric altimeter and radar altimeter data. Calibrations are performed by comparing the radar altitude with the suitable barometer during flights at altitudes of 100m, 200m and 500m above the base air strip or some other suitable location with known elevation and flat terrain.

# 3. PRODUCTS AND PROCESSING TECHNIQUES

The following products are available from the survey data. Those which are not part of the survey contract may be acquired later. Most parameters can be displayed as contours, profiles or in colour.

## 3.1 Resistivity

In-phase and quadrature EM components are processed to remove atmospheric and system noise. This processed data set is used to generate apparent resistivity for selected frequencies in ohm metres (Ωm) using a pseudo-layer half-space model.

A resistivity map portrays all the EM information for that frequency over the entire survey area. This contrasts with electromagnetic anomaly maps which provide information only over interpreted conductors. The large dynamic range makes the resistivity parameter an excellent mapping tool.

## 3.2 Magnetic Data Processing

The aeromagnetic data is corrected for diurnal variation of the earth's magnetic field using the magnetic base station data. The clock of the base station was synchronised with that of the airborne system to permit this removal of the diurnal.

The International Geomagnetic Reference Field (IGRF) 1995 model (updated for secular variation) was removed from the levelled total field magnetics. Finally an arbitrary datum of 2000 nT was added back. This procedure ensures that the residual magnetic contours will match contours from any adjacent surveys which have been processed in a similar manner.

## 3.3 Magnetic Derivatives

The total field magnetic data may be subjected to a variety of filtering techniques to yield maps of the following:

- first vertical derivative (vertical gradient)
- second vertical derivative
- upward/downward continuations

All of these techniques improve the recognition of near-surface magnetic bodies, with the exception of upward continuation. Any of these parameters can be produced on request.

Monochromatic shadow maps may be generated by employing an artificial sun to cast shadows on a surface defined by the geophysical grid. There are many variations in the shadowing technique. These techniques may be applied to total field or enhanced magnetic data, magnetic derivatives and resistivity.

## 3.4 Multi-channel Stacked Profiles

Distance based profiles of the digitally recorded geophysical data are generated and plotted by computer. These profiles also contain the calculated parameters which are used in the interpretation process. They are first produced as work copies prior to interpretation, and are also presented in the final corrected form after processing and interpretation. Table 6 lists the geophysical data channels and the vertical scale of each profile.

### 3.5 EM Magnetite

The apparent percent magnetite by weight can be calculated wherever magnetite produces a negative in-phase EM response. This calculation is more meaningful in resistive areas.

### 3.6 Conductivity-depth Sections

The apparent resistivities for all frequencies can be displayed simultaneously as coloured conductivity-depth sections. Usually, only the coplanar data are displayed as the quality tends to be higher than that of the coaxial data.
Conductivity-depth sections are generated in two formats Sengpiel* resistivity sections, where the apparent resistivity for each frequency is plotted at the depth of the centroid of the in-phase current flow*

The Sengpiel method is derived from the pseudo-layer half-space model and yields a coloured conductivity-depth section which portrays a smoothed approximation of the true resistivity distribution with depth. Conductivity-depth sections are most useful in conductive layered situations, but may be unreliable in areas of moderate to high resistivity where signal amplitudes are weak.. In areas where in-phase responses have been suppressed by the effects of magnetite, the computed resistivities shown on the sections may be unreliable.

* Approximate Inversion of Airborne EM Data from Multilayered Ground: Sengpiel, K.P., Geophysical Prospecting 36, 446-459, 1988.

Table 6: The Digital Profiles

| Channel Name | Observed parameters | Scale: units/cm* |
|---|---|---|
| **Magnetics and altimeter** | | |
| cmag | coarse magnetics | 25 nT |
| fmag | fine magnetics | 5 nT |
| alt | helicopter height | 25 m |
| **Processed amplitude data** | | |
| cxsp | Atmospheric noise monitor | 1000 ppm |
| 56ki | Horizontal coplanar coil pair; 56 000 Hz inphase | 200 ppm |
| 56kq | Horizontal coplanar coil pair; 56 000 Hz quadrature | 200 ppm |
| 720i | Horizontal coplanar coil pair; 7200 Hz inphase | 100 ppm |
| 720q | Horizontal coplanar coil pair; 7200 Hz quadrature | 100 ppm |
| 550i | Vertical coaxial coil pair; 5500 Hz inphase | 100 ppm |
| 550q | Vertical coaxial coil pair; 5500 Hz quadrature | 100 ppm |
| 900i | Vertical coaxial coil pair; 900 Hz inphase | 50 ppm |
| 900q | Vertical coaxial coil pair; 900 Hz quadrature | 50 ppm |
| 400i | Horizontal coplanar coil pair; 400 Hz inphase | 50 ppm |
| 400q | Horizontal coplanar coil pair; 400 Hz quadrature | 50 ppm |
| 50Hz | 50 Hz Powerline monitor | 1000 ppm |
| **Apparent depth** | **(of the calculated half-space)** | |
| 56000 | 56000 Hz | 25 m |
| 7200 | 7200 Hz | 25 m |
| 400 | 400 Hz | 25 m |
| qdif | difference of quadrature coplanar and coaxial responses (7200Hz and 5500Hz) | 25 ppm |
| idif | difference of inphase coplanar and coaxial responses (7200Hz and 5500Hz) | 25 ppm |
| **Apparent resistivity** | **(of the calculated half-space)** | |
| 7200 | 7200 Hz | 1 cm / decade |
| 900 | 900 Hz | 1 cm / decade |
| 400 | 400 Hz | 1 cm / decade |

* Typical scale values are shown here. When areas have different ranges of data values, scales are adjusted to best represent the data.

### 3.7 Contour and Colour Map Displays

The geophysical data is interpolated onto a regular grid using a modified Akima spline technique. The resulting grid is suitable for generating contour maps of excellent quality. The grid cell size is usually 25% of the line interval.

Colour maps are produced by interpolating the grid down to the pixel size. The parameter is then incremented with respect to specific amplitude ranges to provide colour "contour" maps. Colour maps of residual magnetic field and resistivity are useful in tracing lithologies in the survey area.

## 3.8 Office Processing System

| | |
|---|---|
| Hardware: | UNIX workstation network and peripherals (SUN and DEC equipment)<br>Multi density 9 track tape transports<br>Exabyte/DAT/QIC150 tape transports<br>High speed printers<br>Calcomp AO thermal plotter<br>HP A0 colour designjet plotter |
| Software: | GEOTERREX developed GMAPS software<br>ERMapper image processing software<br>VISION PC image processing software |

## 3.9 Survey Products

1. Final Maps @ 1:25,000

EM Flight Path with Interpretation Plan (blackline on film)
Magnetics Flight Path with Interpretation Plan (blackline on film)
Total Magnetic Intensity (blackline on film)
400 Hz Resistivity (blackline on film)
7200 Hz Resistivity (blackline on film)
56 kHz Resistivity (blackline on film)
Total Magnetic Intensity (colour image on paper)
400 Hz Resistivity (colour image on paper)
7200 Hz Resistivity (colour image on paper)
56 kHz Resistivity (colour image on paper)
Multi-parameter stacked profiles @ 1:25,000

2. Digital Products

Located data tape(EM, Magnetics) in Ascii XYZ format on CDROM
Gridded data(400, 7200, 56kHz, Magnetics) in ERMapper format on CDROM

3. Additional Products

Logistics report
Analogue chart records
Flight path video cassettes

Table 7: Located Data Tape Format - Processed Data - DIGHEM$^{V}$ / Magnetics

| Column Range | | Field | Description |
|---|---|---|---|
| 1 | 4 | 1 | Flight number |
| 5 | 10 | 2 | Line identifier |
| 11 | 18 | 3 | Fiducial |
| 19 | 26 | 4 | AMG Zone 52 Easting - metres |
| 27 | 34 | 5 | AMG Zone 52 Northing - metres |
| 35 | 42 | 6 | Final processed 400hz in-phase - ppm |
| 43 | 50 | 7 | Final processed 400hz quadrature - ppm |
| 51 | 58 | 8 | Final processed 400hz apparent resistivity - ohm metres |
| 59 | 66 | 9 | Final processed 400hz apparent depth - m |
| 67 | 74 | 10 | Final processed 900hz in-phase - ppm |
| 75 | 82 | 11 | Final processed 900hz quadrature - ppm |
| 83 | 90 | 12 | Final processed 5500hz in-phase - ppm |
| 91 | 98 | 13 | Final processed 5500hz quadrature - ppm |
| 99 | 106 | 14 | Final processed 7200hz in-phase - ppm |
| 107 | 114 | 15 | Final processed 7200hz quadrature - ppm |
| 115 | 122 | 16 | Final processed 7200hz apparent resistivity - ohm metres |
| 123 | 130 | 17 | Final processed 7200hz apparent depth - m |
| 131 | 138 | 18 | Final processed 56000hz in-phase - ppm |
| 139 | 146 | 19 | Final processed 56000hz quadrature - ppm |
| 147 | 154 | 20 | Final processed 56000hz apparent resistivity - ohm metres |
| 155 | 162 | 21 | Final processed 56000hz apparent depth - m |
| 163 | 172 | 22 | idiff (900 inphase coaxial - 400 inphase coplanar /2) - ppm |
| 173 | 182 | 23 | qdiff (900 quad coaxial - 400 quad coplanar /2) - ppm |
| 183 | 190 | 24 | Power line monitor - ppm |
| 191 | 198 | 25 | Spherics monitor - ppm |
| 199 | 208 | 26 | Processed diurnal - nanoteslas |
| 209 | 218 | 27 | Rejected processed magnetics - nanoteslas |
| 219 | 224 | 28 | Radar altimeter - metres |
| 225 | 232 | 29 | Barometric height - metres |
| 233 | 233 | 30 | <newline> |

Table 8: Located Data Tape Format - Processed Data - Magnetics Re-flights

| Column Range | | Field | Description |
|---|---|---|---|
| 1 | 4 | 1 | Flight number |
| 5 | 10 | 2 | Line identifier |
| 11 | 18 | 3 | Fiducial |
| 19 | 26 | 4 | AMG Zone 52 Easting - metres |
| 27 | 34 | 5 | AMG Zone 52 Northing - metres |
| 35 | 44 | 6 | Processed diurnal |
| 45 | 54 | 7 | Final processed magnetics - nanoteslas |
| 55 | 60 | 8 | Radar altimeter - metres |
| 61 | 61 | 9 | <newline> |

# 4. SURVEY RESULTS

## 4.1 General

Wide bedrock conductors or flat lying conductive units, whether from surficial or bedrock sources, may give rise to very broad anomalous responses on the EM profiles. These broad conductors, which more closely approximate a half space model, will be maximum coupled to the horizontal (coplanar) coil-pair and are most evident on the resistivity parameter. Resistivity maps, therefore, may be the most valuable maps, in areas where broad or flat lying conductors are considered to be of importance. Contoured resistivity maps are included with this report. The data provided from these maps may be used to discriminate structural anomalies from discrete, possibly ore-carrying anomalies.

Excellent resolution and discrimination of conductors was accomplished by using a fast sampling rate of 0.1 sec.

Resistivity lows which occur near the ends of the survey lines (ie., outside the survey area), should be viewed with caution. Some of these could be due to aerodynamic noise, ie., bird bending, which is created by abnormal stresses to which the bird is subjected during the climb and turn of the aircraft between lines. Such aerodynamic noise is usually manifest on the coaxial in-phase channel only, although severe stresses can affect the coplanar in-phase channels as well.

Noise levels of less than 2 ppm are generally maintained for wind speeds up to 35 km/h. Higher winds may cause the system to be grounded because excessive bird swinging produces difficulties in flying the helicopter. The swinging results from the 5 $m^2$ of area which is presented by the bird to broadside gusts.

In some portions of the survey area, steep topography may have forced the pilot to exceed normal terrain clearance for reasons of safety. It is possible that some weak conductors may have escaped detection if bird height exceeded 120 m. In difficult areas where near-vertical climbs were necessary, the forward speed of the helicopter was reduced to a level which permitted excessive bird swinging. This problem, combined with the severe stresses to which the bird was subjected, may give rise to aerodynamic noise levels which are slightly higher than normal. Where warranted, re-flights were carried out to minimise these adverse effects.

## 4.2 Magnetics

The residual magnetic data maps show the magnetic properties of the rock units underlying the survey area. If a specific magnetic intensity can be assigned to the rock type which is believed to host the target mineralisation, it may be possible to select areas of higher priority on the basis of the total field magnetic data. This is based on the assumption that the magnetite content of the host rocks will give rise to a limited range of contour values which will permit differentiation of various lithological units.

The magnetic results, in conjunction with the other geophysical parameters can provide valuable information which can be used to effectively map the geology and structure in the survey areas.

## 4.3 Resistivity

Resistivity can be calculated from the 400 Hz, 7200 Hz and 56 000 Hz coplanar data and from the 900 Hz and 5500 Hz coaxial data. The maximum resistivity values are 500, 1000, 6000, 8000, and 30000 $\Omega$ m for frequencies 400, 900, 5500, 7200 and 56 000 Hz respectively. These cut-offs eliminate the meaningless higher resistivity values which would result from very small EM amplitudes. The minimum resistivity value is 0.000017 times the frequency. This minimum resistivity cut-off eliminates errors due to the lack of an absolute phase control for the EM data. Many resistivity lows may be related to bedrock features, rather than conductive overburden. There are some areas, however, where contour patterns may be strongly influenced by conductive surficial material.

Other resistivity lows in the area could be quite extensive and these often reflect "formational" conductors which may be of minor interest as direct exploration targets. However, attention may be focused on areas where these zones appear to be faulted or folded or where anomaly characteristics differ along strike.

### 4.4 Electromagnetics

In areas where EM responses are evident primarily on the quadrature components, zones of poor conductivity are indicated. Where these responses are coincident with magnetic anomalies, it is possible that the in-phase component amplitudes have been suppressed by the effects of magnetite. Most of these poorly-conductive magnetic features give rise to resistivity anomalies which are only slightly below background. If it is expected that poorly-conductive economic mineralisation may be associated with magnetite-rich units, most of these weakly anomalous features will be of interest. In areas where magnetite causes the in-phase components to become negative, the apparent conductance and depth of EM anomalies may be unreliable.

It is often difficult to assess the relative merits of EM anomalies on the basis of resistivity. It is recommended that an attempt be made to compile a suite of geophysical "signatures" over areas of interest.

A complete assessment and evaluation of the survey data should be carried out by one or more qualified professionals who have access to, and can provide a meaningful compilation of, all available geophysical, geological and geochemical data.

### 4.5 Interpretation

The most appropriate method for utilising the geophysical maps in the areas discussed in this report is to compose a set of geophysical signatures for individual lithologies or members where they correspond to mapped geology. These characteristics provide information which is useful for estimating the extents of the units outside of mapped areas and for regions that may be covered by alluvial material.

# 5. BACKGROUND INFORMATION

This section provides background information on parameters which are available from the survey data. Those which have not been supplied as survey products may be generated later from raw data on the digital archive tape.

## 5.1 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 sulphides. 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 200 m would straddle these two classes.

The vertical sheet (half plane) is the most common model used for the analysis of discrete conductors. The conductive earth (half space) model is suitable for broad conductors. Resistivity contour maps result from the use of the second 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.

### 5.1.1 Conductor Analysis

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

Conductive overburden generally produces broad EM responses which may not be shown as anomalies on the EM maps. However, patchy conductive overburden in otherwise resistive areas can yield discrete anomalies for conducting clays which have resistivities as low as 50 Ω m. In areas where ground resistivities are below 10 Ω m, anomalies caused by weathering variations and similar causes can have any conductance grade.

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, Canada, yielded a well-defined , low grade 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. Conductive rock formations can also yield anomalies. The conductive materials in such rock formations can be salt water, weathered products such as clays, original depositional clays, and carbonaceous material.

A further interpretation can be presented on an EM map by means of 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.

Since discrete bodies normally are the targets of EM surveys, local base (or zero) levels are used to compute local anomaly amplitudes. This contrasts with the use of true zero levels which are used to compute true EM amplitudes. Local anomaly amplitudes are shown in the EM anomaly list and these can be used to compute the vertical sheet parameters of conductance and depth.

### 5.1.2 The Thickness Parameter

DIGHEM can provide an indication of the thickness of a steeply dipping conductor. The amplitude of the coplanar anomaly (eg., CPI channel on the digital profile) increases relative to the coaxial anomaly (eg., CXI) as the apparent thickness increases, ie., the thickness in the horizontal plane. (The 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 3 m, and thick when in excess of 10 m. For example, in base metal exploration in steeply dipping geology, thick conductors can be high priority targets because many massive sulfide ore bodies are thick, whereas non-economic bedrock conductors are often thin. The system cannot sense the thickness when the strike of the conductor is sub-parallel 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 Ω m.

### 5.1.3 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 characterised by in-phase and quadrature channels which are continuously active. Local EM 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 correct 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. The resistivity analysis also helps the interpreter to differentiate between conductive trends in the bedrock and those patterns typical of conductive overburden. For example, discrete conductors will generally appear as narrow lows on the contour map and broad conductors (eg., overburden) will appear as wide lows.

The resistivity profiles and the resistivity contour maps present the apparent resistivity using the so-called pseudo-layer (or buried) half space model defined by Fraser (1978)[1]. This model consists of a resistive layer overlying a conductive half space. The depth channels give the apparent depth below surface of the conductive material. The apparent depth is simply the apparent thickness of the overlying resistive layer. The apparent depth (or thickness) parameter will be positive when the upper layer is more resistive than the underlying material, in which case the apparent depth may be quite close to the true depth.

The apparent depth will be negative when the upper layer is more conductive than the underlying material, and will be zero when a homogeneous half space exists. 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 (eg., as caused by a dense tree cover). The inputs to the resistivity algorithm are the in-phase and quadrature components of the coplanar coil-pair. The outputs are the apparent resistivity of the

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

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. 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 can be of significant help in distinguishing between overburden and bedrock conductors.

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

(a) The resistivity map portrays the apparent value of the earth's resistivity, where: resistivity = 1/conductivity.

(b) The EM map portrays anomalies in the earth's resistivity. An anomaly by definition is a change from the normal and so the EM map displays anomalous areas (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 EM anomaly maps to a horizontal gradient in the direction of flight. The gradient analogy is only valid with regard to the identification of anomalous locations.

### 5.1.4 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 permeability. It was mentioned previously that the EM difference channels (ie., channel idif for in-phase and qdif for quadrature) tend to eliminate the response of conductive overburden. This marked a unique development in airborne EM technology, as DIGHEM 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 in-phase channels of all EM systems. Rocks containing less than 1% magnetite can yield negative in-phase anomalies caused by magnetic permeability. When magnetite is widely distributed throughout a survey area, the in-phase EM channels may continuously rise and fall, reflecting variations in the magnetite percentage, flying height, and overburden thickness. This can lead to difficulties in recognising deeply buried bedrock conductors, particularly if conductive overburden also exists. However, the response of broadly distributed magnetite generally vanishes on the in-phase difference channel idif. This feature can be a significant aid in the recognition of conductors which occur in rocks containing accessory magnetite.

### 5.1.5 EM Magnetite Mapping

The information content of DIGHEM data consists of a combination of conductive eddy current responses and magnetic permeability responses. The secondary field resulting from conductive eddy current flow is frequency-dependent and consists of both in-phase and quadrature components, which are positive in sign. On the other hand, the secondary field resulting from magnetic permeability is independent of frequency and consists of only an in-phase component which is negative in sign. When magnetic permeability manifests itself by decreasing the measured amount of positive inphase, its presence may be difficult to recognise. However, when it manifests itself by yielding a negative in-phase anomaly (eg., 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 coplanar coil-pair of DIGHEM. The technique yields a channel which displays apparent weight percent magnetite according to a homogeneous half space model.[2] 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 magnetic half space. It can individually resolve steep dipping narrow magnetite-rich bands which are separated by 60 m. Unlike magnetometry, the EM magnetite method is unaffected by remanent magnetism or magnetic latitude.

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 permeability is evident as negative in-phase responses on the data profiles.

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

### 5.1.6 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 discrete bedrock conductors. However, DIGHEM data processing techniques produce parameters which contribute significantly to the recognition of bedrock conductors. These are the resistivity and depth channels for each coplanar frequency.

The EM difference channels (idif and qdif) eliminate most of the responses from conductive ground, leaving responses from bedrock conductors, cultural features (eg., telephone lines, fences, etc.) and edge effects. Edge effects often occur near the perimeter of broad conductive zones. This can be 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 conductive environment therefore is based on the anomalous responses of the two difference channels (idif and qdif) and the resistivity channels. The most favourable situation is where anomalies coincide on all channels.

The apparent depth channels, which give the apparent depth to the conductive material, also help to determine whether a conductive response arises from surficial material or from a conductive zone in the bedrock. When these channels rise above the zero level on the digital profiles (ie., depth is negative), it implies that the EM and resistivity profiles are responding primarily to a conductive upper layer, ie., conductive overburden. If the depth channels are below the zero level, it indicates that a resistive upper layer exists, and this usually implies the existence of a bedrock conductor. If the low frequency depth channel is below the zero level and the high frequency apparent depth is above, this suggests that a bedrock conductor occurs beneath conductive cover.

---

[2] Refer to Fraser, 1981, Magnetite mapping with a multi-coil airborne electromagnetic system: Geophysics, v. 46, p. 1579-1594.

### 5.1.7 Recognition of culture

Cultural responses include all EM anomalies caused by man-made metallic objects. Such anomalies may be caused by inductive coupling or current gathering. The concern of the interpreter is to recognise when an EM response is due to culture. Points of consideration used by the interpreter, when coaxial and coplanar coil-pairs are operated at a common frequency, are as follows:

1. Channels CXP and CPP monitor 50 Hz radiation. An anomaly on these channels shows that the conductor is radiating power. Such an indication is normally a guarantee that the conductor is cultural. However, care must be taken to ensure that the conductor is not a geologic body which strikes across a power line, carrying leakage currents.

2. A flight which crosses a "line" (eg., fence, telephone line, etc.) yields a centre-peaked coaxial anomaly and an m-shaped coplanar anomaly. When the flight crosses the cultural line at a high angle of intersection, the amplitude ratio of coaxial/coplanar response is 4. Such an EM anomaly can only be caused by a line. The geologic body which yields anomalies most closely resembling a line is the vertically dipping thin dyke. Such a body, however, yields an amplitude ratio of 2 rather than 4. Consequently, an m-shaped coplanar anomaly with a CXI/CPI amplitude ratio of 4 is virtually a guarantee that the source is a cultural line.

3. A flight which crosses a sphere or horizontal disk yields centre-peaked coaxial and coplanar anomalies with a CXI/CPI amplitude ratio (ie., coaxial/coplanar) of 1/4. In the absence of geologic bodies of this geometry, the most likely conductor is a metal roof or small fenced yard. Anomalies of this type are virtually certain to be cultural if they occur in an area of culture.

4. A flight which crosses a horizontal rectangular body or wide ribbon yields an m-shaped coaxial anomaly and a centre-peaked coplanar anomaly. In the absence of geologic bodies of this geometry, the most likely conductor is a large fenced area. Anomalies of this type are virtually certain to be cultural if they occur in an area of culture.

5. EM anomalies which coincide with culture, as seen on the camera film or video display, are usually caused by culture. However, care is taken with such coincidences because a geologic conductor could occur beneath a fence, for example. In this example, the fence would be expected to yield an m-shaped coplanar anomaly as in case #2 above. If, instead, a centre-peaked coplanar anomaly occurred, there would be concern that a thick geologic conductor coincided with the cultural line.

6. The above description of anomaly shapes is valid when the culture is not conductively coupled to the environment. In this case, the anomalies arise from inductive coupling to the EM transmitter. However, when the environment is quite conductive (eg., less than 100 $\Omega$ m at 900 Hz), the cultural conductor may be conductively coupled to the environment. In this latter case, the anomaly shapes tend to be governed by current gathering. Current gathering can completely distort the anomaly shapes, thereby complicating the identification of cultural anomalies. In such circumstances, the interpreter can only rely on the radiation channels and on the camera film or video records.

## 5.2 Magnetics

In some geological environments, an EM anomaly with magnetic correlation has a greater likelihood of being produced by sulphides than one that is non-magnetic. However, sulfide ore bodies may be non-magnetic (eg., the Kidd Creek deposit near Timmins, Canada) as well as magnetic (eg., the Mattabi deposit near Sturgeon Lake, Canada). The same principle applies to kimberlite mapping.

The magnetometer data is digitally recorded in the aircraft to an accuracy of 0.01 nT for Caesium magnetometers. The digital tape is processed by computer to yield a total field magnetic contour map. When warranted, the magnetic data may also be treated mathematically to enhance the magnetic response of the near-surface geology, and an enhanced magnetic contour map is then produced.

Any of a number of filter operators may be applied to the magnetic data, to yield vertical derivatives, continuations, magnetic susceptibility, etc. These may be displayed in contour, colour or shadow.

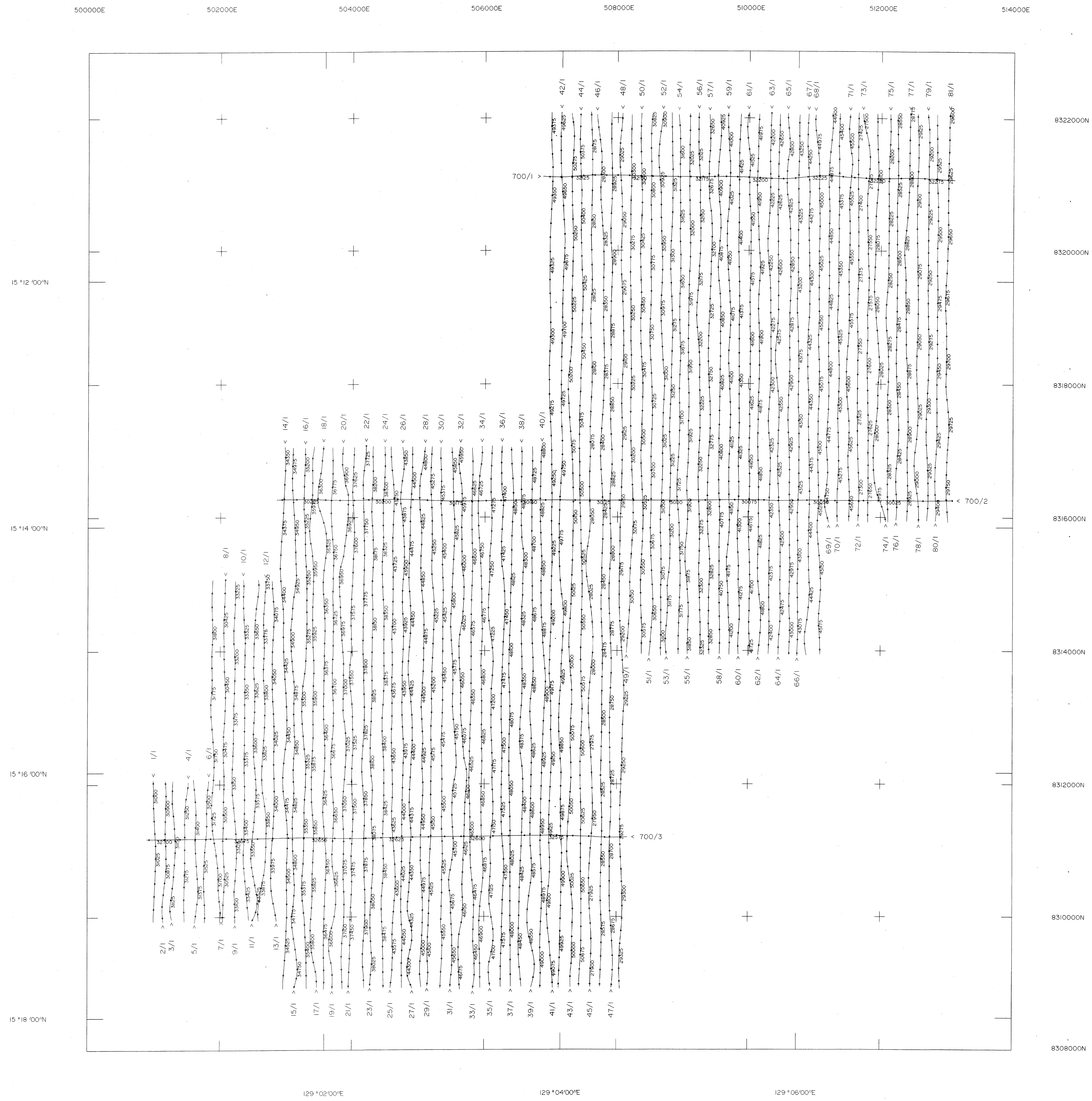
## 6. CONCLUSIONS AND RECOMMENDATIONS

This report provides a description of the survey results and describes the equipment, procedures and logistics of the survey.

The various maps included with this report display the magnetic and conductive properties of the survey area. It is recommended that the survey results be reviewed in detail, in conjunction with all available geophysical, geological and geochemical information. Particular reference should be made to the computer generated data profiles which clearly define the characteristics of the individual anomalies.

Interpreted bedrock conductors defined by the survey should be subjected to further investigation, using appropriate surface exploration techniques. Anomalies which are currently considered to be of moderately low priority may require upgrading if follow-up results are favourable.

It is also recommended that image processing of existing geophysical data be considered, in order to extract the maximum amount of information from the survey results. Current software and imaging techniques often provide valuable information on structure and lithology, which may not be clearly evident on the contour and colour maps. These techniques can yield images which define subtle, but significant structural details.




AIRBORNE SURVEY SPECIFICATIONS

| | |
|---|---|
| AIRCRAFT : | Aerospatiale AS350BA Helicopter VH-HBB |
| ELECTROMAGNETIC SYSTEM : | DIGHEM V |
| 400Hz : | 8.0 m Horizontal coplanar |
| 900Hz : | 8.0 m Vertical coaxial |
| 5500Hz : | 8.0 m Vertical coaxial |
| 7200Hz : | 8.0 m Horizontal coplanar |
| 56000Hz : | 6.4 m Horizontal coplanar |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| MAGNETOMETER : | Cesium Vapour optical absorption Sensitivity : 0.01 nT |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| DATA RECORDING : | RMS DGR33 acquisition system |
| NOMINAL TERRAIN CLEARANCE : | EM system in towed bird at 30 m Magnetometer in towed bird at 40 m |
| NOMINAL LINE SPACING : | Traverse lines 150 m |
| NOMINAL LINE DIRECTION : | Traverse lines 0/180 degrees |
| FLIGHT PATH NAVIGATION : | XY coordinates computed from WGS84 lat/long coordinates recorded by Fugro Starfix Plus real time satellite differential GPS system |

FLIGHT PATH

| | |
|---|---|
| MAP PROJECTION : | Australian Map Grid Zone 52 |
| SPHEROID : | AGD66 |
| NAVIGATION FIX : | 32768 |

GN
TN
MN

Grid Convergence = 0.02°
Declination = 3.45°

SCALE 1:25000

500 0 500 1000 1500 2000 m

CR98/221

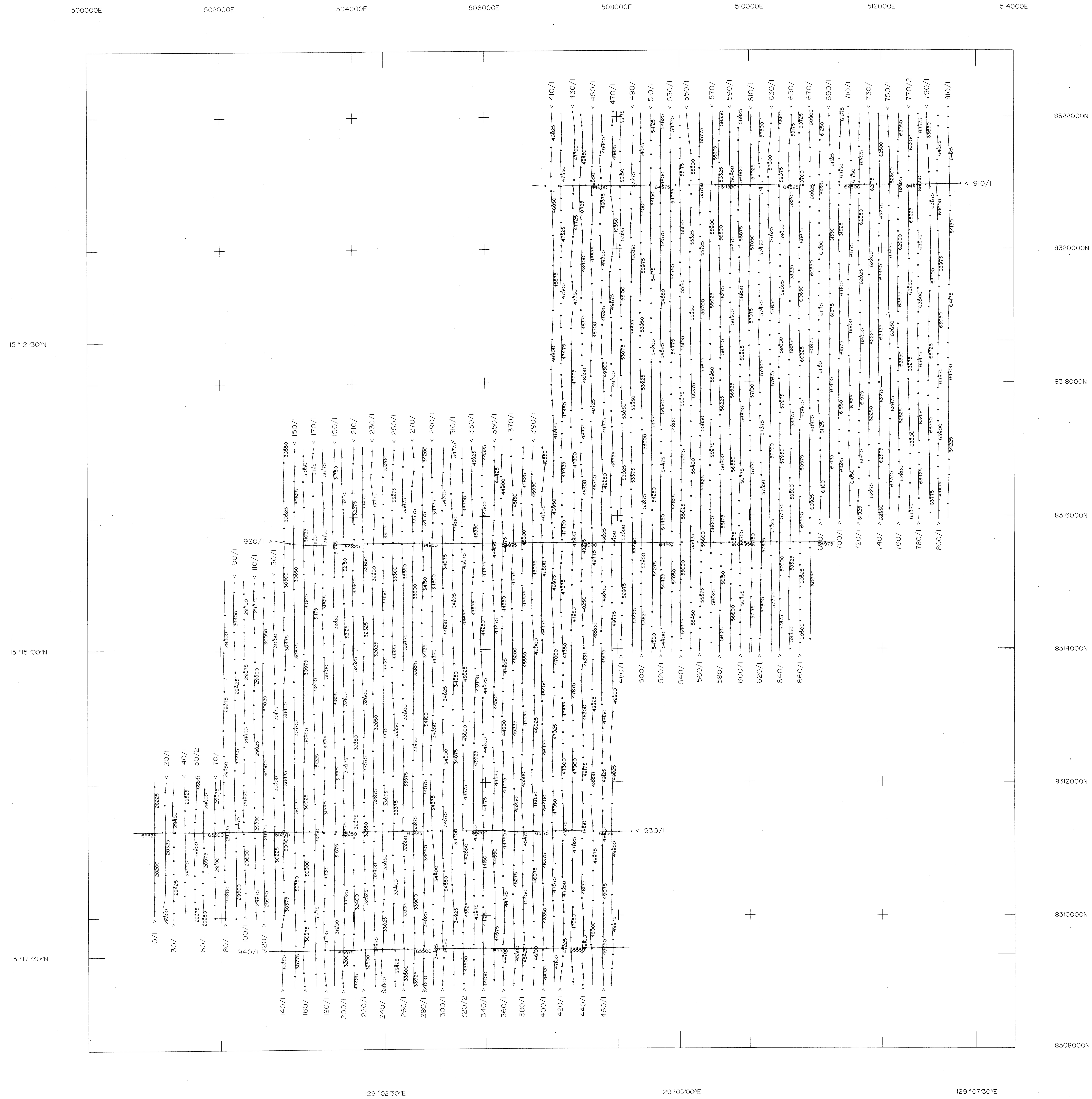
JOB NO : 4-781
Surveyed by GEOTERREX-DIGHEM PTY LTD : April 1997
Compiled by GEOTERREX-DIGHEM PTY LTD, SYDNEY
Processed by GEOTERREX-DIGHEM PTY LTD, SYDNEY

geoterrex-dighem

ZEPHYR MINERALS NL

Keep River
DIGHEM V
INTERPRETATION PLAN (EM Flight Path)
SHEET 1 OF 1

| | |
|---|---|
| CREATED : LS | DRAWING NO : |
| CHECKED : WDM | DATE : 10-DEC-1997 |




AIRBORNE SURVEY SPECIFICATIONS

| | |
|---|---|
| AIRCRAFT : | Aerospatiale AS350BA Helicopter VH-HBB |
| ELECTROMAGNETIC SYSTEM : | DIGHEM V |
| 400Hz : | 8.0 m Horizontal coplanar |
| 900Hz : | 8.0 m Vertical coaxial |
| 5500Hz : | 8.0 m Vertical coaxial |
| 7200Hz : | 8.0 m Horizontal coplanar |
| 56000Hz : | 6.4 m Horizontal coplanar |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| MAGNETOMETER : | Cesium Vapour optical absorption Sensitivity : 0.01 nT |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| DATA RECORDING : | RMS DGR33 acquisition system |
| NOMINAL TERRAIN CLEARANCE : | EM system in towed bird at 30 m Magnetometer in towed bird at 40 m |
| NOMINAL LINE SPACING : | Traverse lines 150 m |
| NOMINAL LINE DIRECTION : | Traverse lines 0/180 degrees |
| FLIGHT PATH NAVIGATION : | XY coordinates computed from WGS84 lat/long coordinates recorded by Fugro Starfix Plus real time satellite differential GPS system |

FLIGHT PATH

| | |
|---|---|
| MAP PROJECTION : | Australian Map Grid Zone 52 |
| SPHEROID : | AGD66 |
| NAVIGATION FIX : | 32768 |

GN
TN
MN

Grid Convergence = 0.02°
Declination = 3.45°

SCALE 1:25000

500 0 500 1000 1500 2000 m

**CR98/221**

JOB NO : 4-781
Surveyed by GEOTERREX-DIGHEM PTY LTD : September 1997
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Processed by GEOTERREX-DIGHEM PTY LTD, SYDNEY

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# ZEPHYR MINERALS NL

## Keep River
## DIGHEM V
## INTERPRETATION PLAN (Magnetics Flight Path)
## SHEET 1 OF 1

| | |
|---|---|
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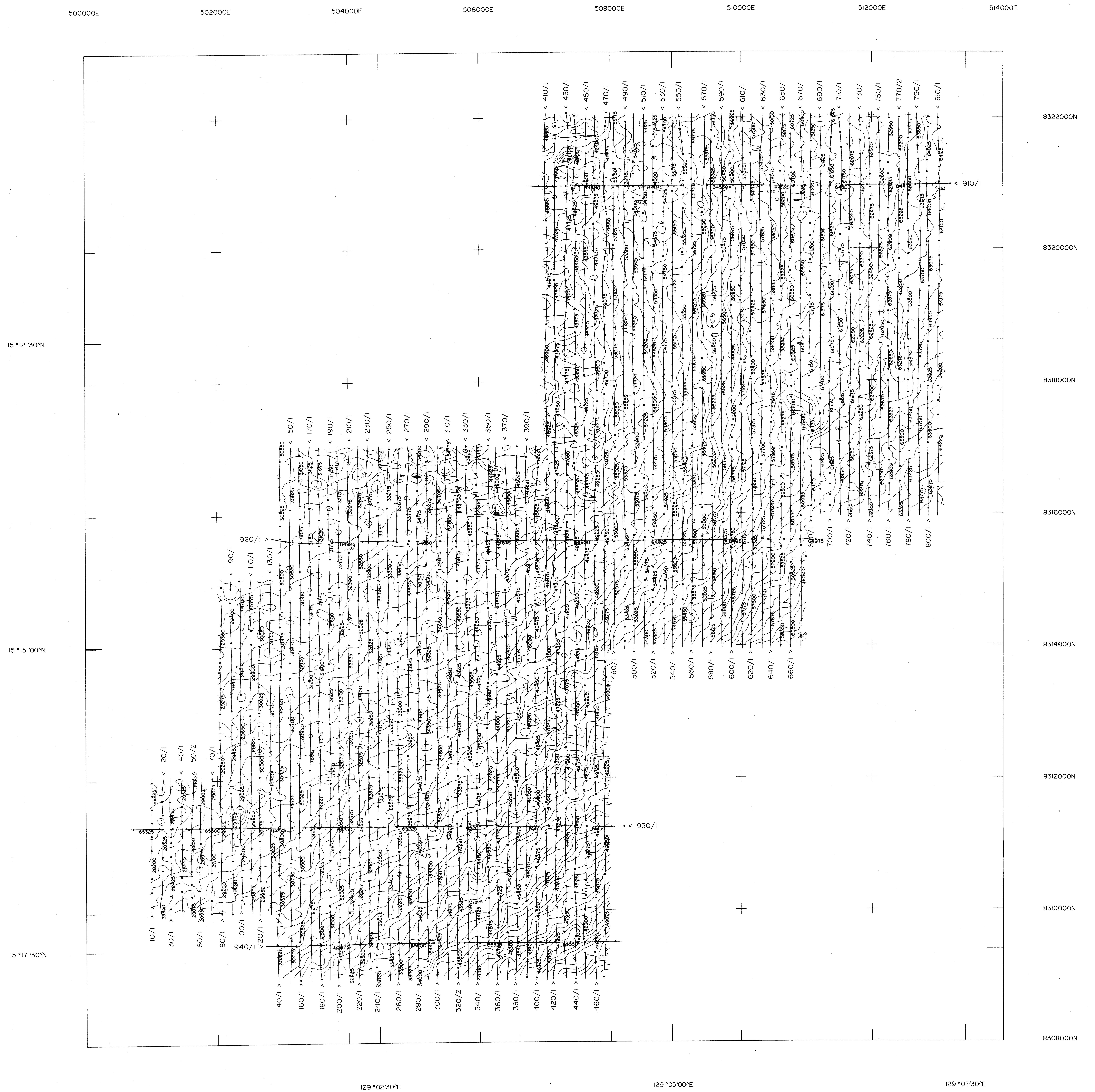
| CHECKED : WDM | DATE : 10-DEC-1997 |




AIRBORNE SURVEY SPECIFICATIONS

| | |
|---|---|
| AIRCRAFT : | Aerospatiale AS350BA Helicopter VH-HBB |
| ELECTROMAGNETIC SYSTEM : | DIGHEM V |
| 400Hz : | 8.0 m Horizontal coplanar |
| 900Hz : | 8.0 m Vertical coaxial |
| 5500Hz : | 8.0 m Vertical coaxial |
| 7200Hz : | 8.0 m Horizontal coplanar |
| 56000Hz : | 6.4 m Horizontal coplanar |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| MAGNETOMETER : | Cesium Vapour optical absorption Sensitivity : 0.01 nT |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| DATA RECORDING : | RMS DGR33 acquisition system |
| NOMINAL TERRAIN CLEARANCE : | EM system in towed bird at 30 m Magnetometer in towed bird at 40 m |
| NOMINAL LINE SPACING : | Traverse lines 150 m |
| NOMINAL LINE DIRECTION : | Traverse lines 0/180 degrees |
| FLIGHT PATH NAVIGATION : | XY coordinates computed from WGS84 lat/long coordinates recorded by Fugro Starfix Plus real time satellite differential GPS system |

RESIDUAL MAGNETIC CONTOURS

| | |
|---|---|
| MAP PROJECTION : | Australian Map Grid Zone 52 |
| SPHEROID : | AGD66 |
| MAGNETICS : | Diurnally levelled |
| GRID MESH SIZE : | 40 x 40 metres |
| GRID FILTER : | None |
| CONTOUR INTERVAL : | 0.5, 5 and 50 nT |
| TOTAL FIELD : | 48523 nT (at 15:14:00S, 129:04:00E) |
| INCLINATION : | 45.09 degrees S |
| DECLINATION : | 3.45 degrees E |
| IGRF : | 1995 model (updated for secular variation to September 1997) removed, datum 2000 nT added |

GN
TN
MN

Grid Convergence = 0.02°
Declination = 3.45°

SCALE 1:25000

500 0 500 1000 1500 2000 m

CR98/221

JOB NO : 4-781
Surveyed by GEOTERREX-DIGHEM PTY LTD : September 1997
Compiled by GEOTERREX-DIGHEM PTY LTD, SYDNEY
Processed by GEOTERREX-DIGHEM PTY LTD, SYDNEY

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# ZEPHYR MINERALS NL

## Keep River
## DIGHEM V
## RESIDUAL MAGNETIC CONTOURS
## SHEET 1 OF 1

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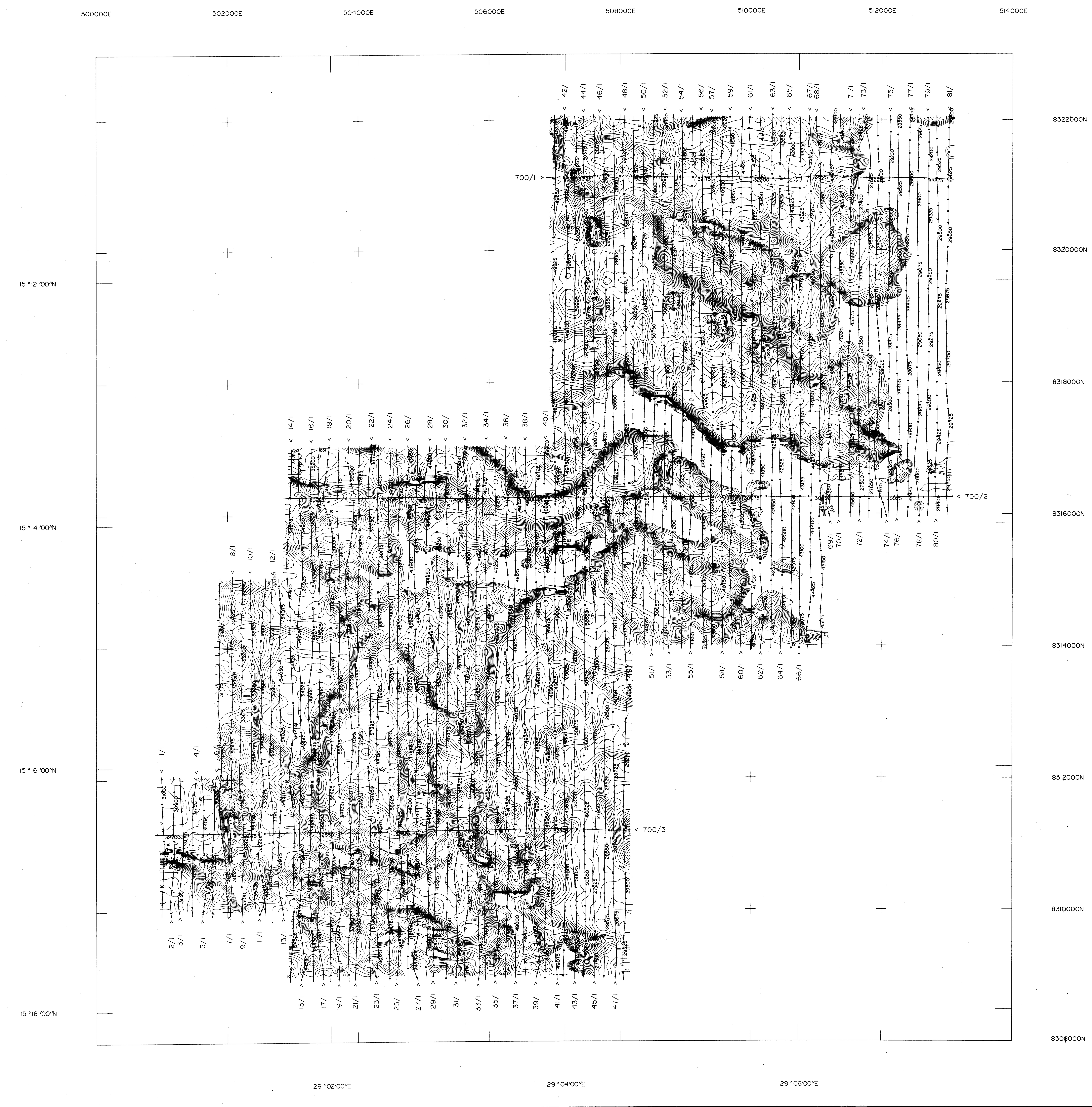
| CHECKED : | DATE : 15-DEC-1997 |




AIRBORNE SURVEY SPECIFICATIONS

| | |
|---|---|
| AIRCRAFT : | Aerospatiale AS350BA Helicopter VH-HBB |
| ELECTROMAGNETIC SYSTEM : | DIGHEM V |
| 400Hz : | 8.0 m Horizontal coplanar |
| 900Hz : | 8.0 m Vertical coaxial |
| 5500Hz : | 8.0 m Vertical coaxial |
| 7200Hz : | 8.0 m Horizontal coplanar |
| 56000Hz : | 6.4 m Horizontal coplanar |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| MAGNETOMETER : | Cesium Vapour optical absorption Sensitivity : 0.01 nT |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| DATA RECORDING : | RMS DGR33 acquisition system |
| NOMINAL TERRAIN CLEARANCE : | EM system in towed bird at 30 m Magnetometer in towed bird at 40 m |
| NOMINAL LINE SPACING : | Traverse lines 150 m |
| NOMINAL LINE DIRECTION : | Traverse lines 0/180 degrees |
| FLIGHT PATH NAVIGATION : | XY coordinates computed from WGS84 lat/long coordinates recorded by Fugro Starfix Plus real time satellite differential GPS system |

56kHz APPARENT RESISTIVITY IMAGE

| | |
|---|---|
| MAP PROJECTION : | Australian Map Grid Zone 52 |
| SPHEROID : | AGD66 |
| APPARENT RESISTIVITY : | computed for a pseudo-layer half space model using amplitude and phase data |
| Frequency | Maximum (default) Resistivity |
| 400Hz : | 460 ohm.m |
| 900Hz : | 1035 ohm.m |
| 5500Hz : | 6325 ohm.m |
| 7200Hz : | 8280 ohm.m |
| 56000Hz : | 28000 ohm.m |
| GRID MESH SIZE : | 40 x 40 metres |
| LOGARITHMIC CONTOUR INTERVAL: | 1, 1.25, 1.58, 1.99, 2.51, 3.16, 3.98, 5.11, 6.30, 7.94, 10 for each of the 7 decades between 0.01 and 100000 ohm.m |

GN
TN
MN

Grid Convergence = 0.02°
Declination = 3.45°

SCALE 1:25000

500 0 500 1000 1500 2000 m

**CR98/221**

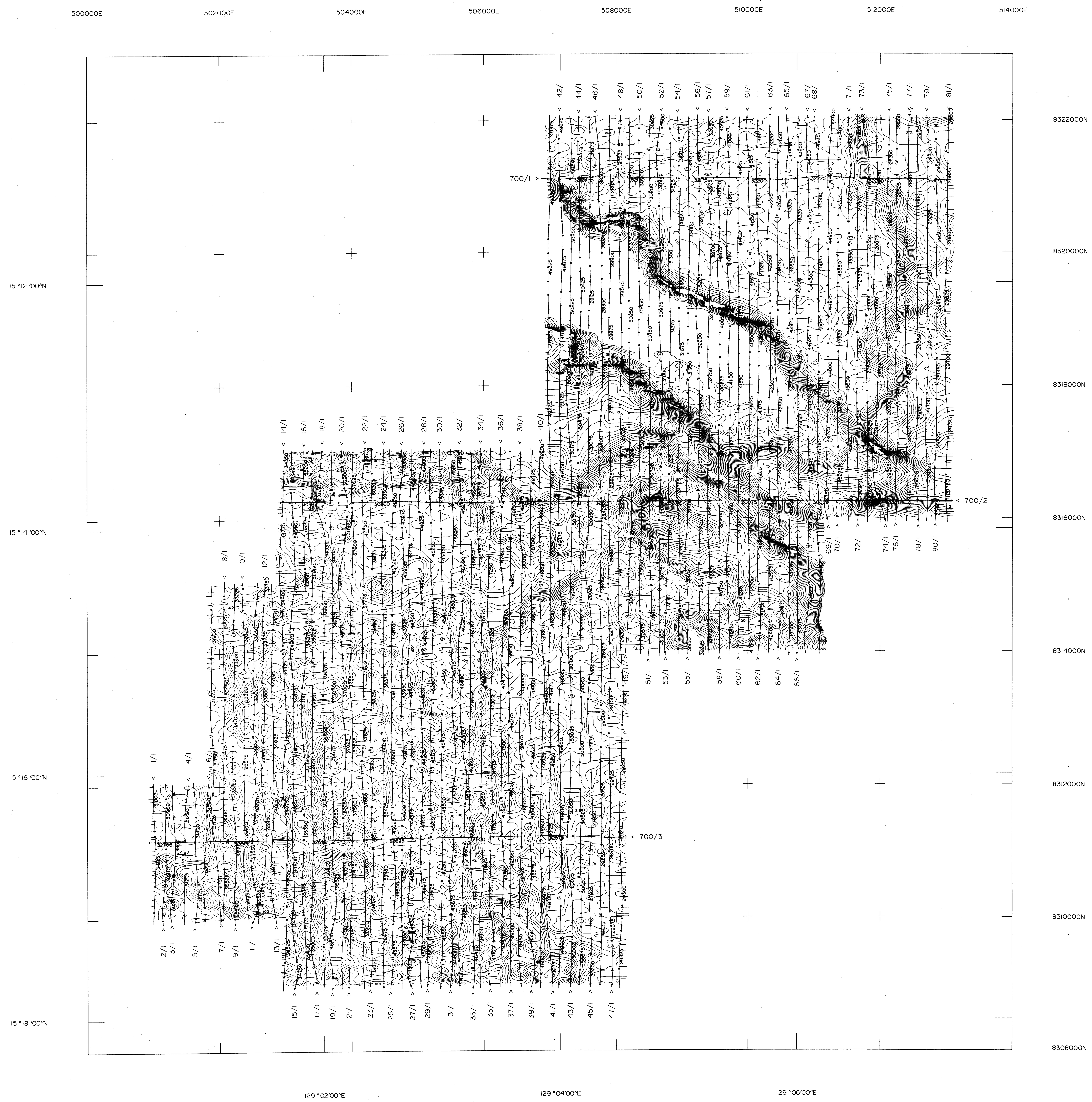
JOB NO : 4-781
Surveyed by GEOTERREX-DIGHEM PTY LTD : April 1997
Compiled by GEOTERREX-DIGHEM PTY LTD, SYDNEY
Processed by GEOTERREX-DIGHEM PTY LTD, SYDNEY

geoterrex-dighem

# ZEPHYR MINERALS NL

## Keep River
## DIGHEM V
## 56kHz APPARENT RESISTIVITY CONTOURS
## SHEET 1 OF 1

| | |
|---|---|
| CREATED : LS | DRAWING NO : |
| CHECKED : WDM | DATE : 10-DEC-1997 |

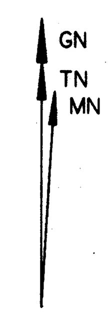



AIRBORNE SURVEY SPECIFICATIONS

| | |
|---|---|
| AIRCRAFT : | Aerospatiale AS350BA Helicopter VH-HBB |
| ELECTROMAGNETIC SYSTEM : | DIGHEM V |
| 400Hz : | 8.0 m Horizontal coplanar |
| 900Hz : | 8.0 m Vertical coaxial |
| 5500Hz : | 8.0 m Vertical coaxial |
| 7200Hz : | 8.0 m Horizontal coplanar |
| 56000Hz : | 6.4 m Horizontal coplanar |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| MAGNETOMETER : | Cesium Vapour optical absorption Sensitivity : 0.01 nT |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour |
| DATA RECORDING : | RMS DGR33 acquisition system |
| NOMINAL TERRAIN CLEARANCE : | EM system in towed bird at 30 m Magnetometer in towed bird at 40 m |
| NOMINAL LINE SPACING : | Traverse lines 150 m |
| NOMINAL LINE DIRECTION : | Traverse lines 0/180 degrees |
| FLIGHT PATH NAVIGATION : | XY coordinates computed from WGS84 lat/long coordinates recorded by Fugro Starfix Plus real time satellite differential GPS system |

400Hz APPARENT RESISTIVITY IMAGE

| | |
|---|---|
| MAP PROJECTION : | Australian Map Grid Zone 52 |
| SPHEROID : | AGD66 |
| APPARENT RESISTIVITY : | computed for a pseudo-layer half space model using amplitude and phase data |
| Frequency | Maximum (default) Resistivity |
| 400Hz : | 460 ohm.m |
| 900Hz : | 1035 ohm.m |
| 5500Hz : | 6325 ohm.m |
| 7200Hz : | 8280 ohm.m |
| 56000Hz : | 28000 ohm.m |
| GRID MESH SIZE : | 40 x 40 metres |
| LOGARITHMIC CONTOUR INTERVAL: | 1, 1.25, 1.58, 1.99, 2.51, 3.16, 3.98, 5.11, 6.30, 7.94, 10 for each of the 7 decades between 0.01 and 100000 ohm.m |




Grid Convergence = 0.02°
Declination = 3.45°

SCALE 1:25000

500 0 500 1000 1500 2000 m

**CR98/221**

JOB NO : 4-781
Surveyed by GEOTERREX-DIGHEM PTY LTD : April 1997
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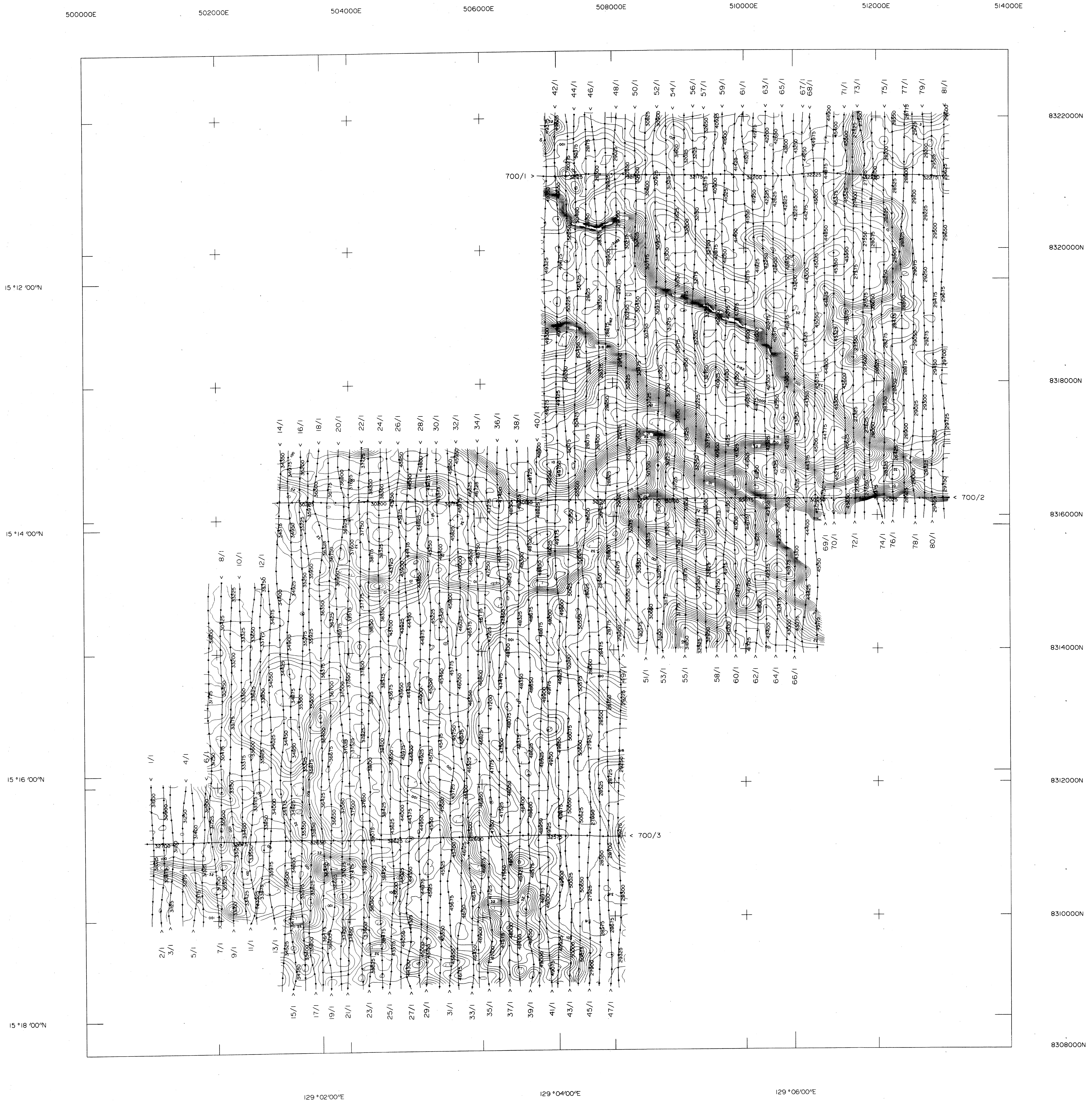
# ZEPHYR MINERALS NL

## Keep River
## DIGHEM V
## 400Hz APPARENT RESISTIVITY CONTOURS
## SHEET 1 OF 1

| | |
|---|---|
| CREATED : LS | DRAWING NO : |
| CHECKED : WDM | DATE : 10-DEC-1997 |

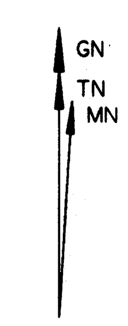



AIRBORNE SURVEY SPECIFICATIONS

| | | |
|---|---|---|
| AIRCRAFT : | Aerospatiale AS350BA Helicopter VH-HBB | |
| ELECTROMAGNETIC SYSTEM : | DIGHEM V | |
| 400Hz : | 8.0 m | Horizontal coplanar |
| 900Hz : | 8.0 m | Vertical coaxial |
| 5500Hz : | 8.0 m | Vertical coaxial |
| 7200Hz : | 8.0 m | Horizontal coplanar |
| 56000Hz : | 6.4 m | Horizontal coplanar |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour | |
| MAGNETOMETER : | Cesium Vapour optical absorption Sensitivity : 0.01 nT | |
| RECORDING INTERVAL : | 0.1 sec (approx 3 m sampling) at mean ground speed of 100 km/hour | |
| DATA RECORDING : | RMS DGR33 acquisition system | |
| NOMINAL TERRAIN CLEARANCE : | EM system in towed bird at 30 m Magnetometer in towed bird at 40 m | |
| NOMINAL LINE SPACING : | Traverse lines 150 m | |
| NOMINAL LINE DIRECTION : | Traverse lines 0/180 degrees | |
| FLIGHT PATH NAVIGATION : | XY coordinates computed from WGS84 lat/long coordinates recorded by Fugro Starfix Plus real time satellite differential GPS system | |

7200Hz APPARENT RESISTIVITY IMAGE

| | |
|---|---|
| MAP PROJECTION : | Australian Map Grid Zone 52 |
| SPHEROID : | AGD66 |
| APPARENT RESISTIVITY : | computed for a pseudo-layer half space model using amplitude and phase data |
| Frequency | Maximum (default) Resistivity |
| 400Hz : | 460 ohm.m |
| 900Hz : | 1035 ohm.m |
| 5500Hz : | 6325 ohm.m |
| 7200Hz : | 8280 ohm.m |
| 56000Hz : | 28000 ohm.m |
| GRID MESH SIZE : | 40 x 40 metres |
| LOGARITHMIC CONTOUR INTERVAL: | 1, 1.25, 1.58, 1.99, 2.51, 3.16, 3.98, 5.11, 6.30, 7.94, 10 for each of the 7 decades between 0.01 and 100000 ohm.m |




Grid Convergence = 0.02°
Declination = 3.45°

SCALE 1:25000

500 0 500 1000 1500 2000 m

**CR98/221**

JOB NO : 4-781
Surveyed by GEOTERREX-DIGHEM PTY LTD : April 1997
Compiled by GEOTERREX-DIGHEM PTY LTD, SYDNEY
Processed by GEOTERREX-DIGHEM PTY LTD, SYDNEY

geoterrex-dighem

# ZEPHYR MINERALS NL

## Keep River
## DIGHEM V
## 7200Hz APPARENT RESISTIVITY CONTOURS
## SHEET 1 OF 1

| | |
|---|---|
| CREATED : LS | DRAWING NO : |
| CHECKED : WDM | DATE : 10-DEC-1997 |

# APPENDIX 2

# APPENDIX 2

# ZEPHYR MINERALS NL

# KEEP RIVER PROJECT

# DIGHEM SURVEY
# INTERPRETATION REPORT

W.S.PETERS
FEBRUARY 1998

SOUTHERN GEOSCIENCE CONSULTANTS
PROPRIETARY LIMITED
A.C.N. 067 552 461

8 KEARNS CRESCENT,
ARDROSS, WESTERN AUSTRALIA 6153

## TABLE OF CONTENTS

# 1. SUMMARY

A DIGHEM electromagnetic and magnetic survey has been flown over the Keep River area and the data have been processed and interpreted at 1:25000 scale to try and locate kimberlite or other diamond bearing features.

The area is quite highly conductive, presumably due to extensive alluvial cover. There are several semi-discrete resistivity low features that may possibly be due to the upper tuffaceous, crater collapse zone of large kimberlite but are more likely to be areas of thicker cover or similar. In addition there are a number of sinuous conductive zones which have been interpreted as possible paleochannels. Four resistivity targets have been selected for follow up.

The area has very low magnetic relief with a range of only 20nT across the entire survey and individual anomalous features are mainly less than 3nT in amplitude. Filtered residual profiles and contours have delineated shallow responses which are mostly due to surficial magnetic material interpreted as either laterite or detrital magnetic material in drainages.

Four magnetic targets have been interpreted. The largest of the targets has an amplitude of 2.5nT and an area of about 25ha making it a very attractive target. The other three magnetic targets are much smaller in size (less than 1ha) and are shallow, dipolar, anomalies that may well be due to magnetic detritus unrelated to kimberlites.

The main magnetic target has been highly recommended for follow up and drilling if no obvious uneconomic explanation is apparent. The other three magnetic targets and the resistivity targets, have been recommended for follow up on a lower priority basis. The interpreted low resistivity ' channels' have been suggested as possible targets areas for alluvial diamonds.

## 2. LIST OF FIGURES

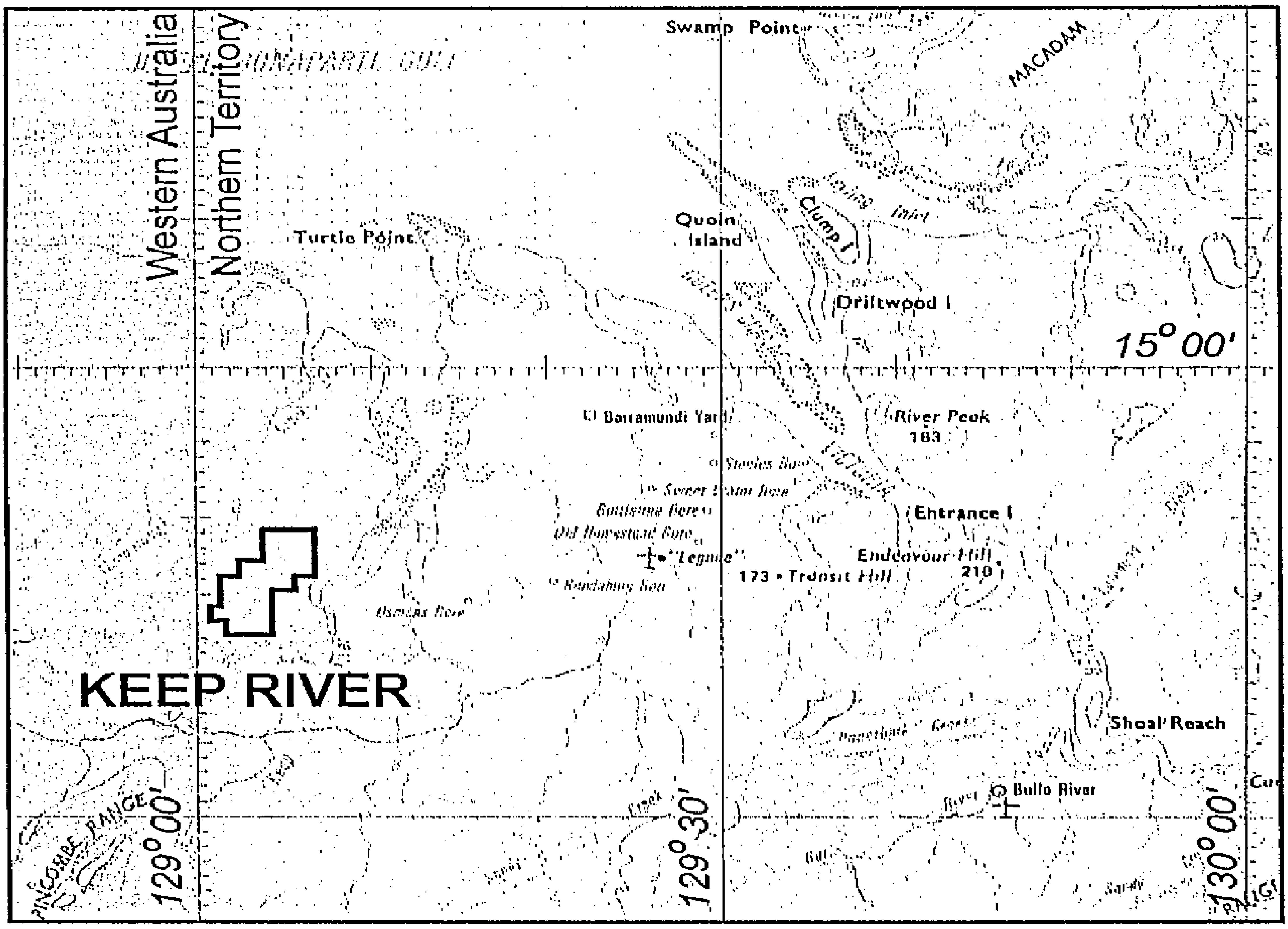



**Figure 1:** **Location Map: Keep River Survey Area, Northern Territory.**
Scale: 1:1,000,000

# 3. INTRODUCTION

Airborne electromagnetic and magnetic data have been acquired with the DIGHEM helicopter system over the Keep River Project area which is in the Northern Territory north east of Kununurra and just east of the WA / NT border (Figure 1).

It was requested to process and image the data and carry out an interpretation at 1:25000 scale. The main aims of the exercise are to delineate target areas that may represent kimberlites, lamproites or other diamond-bearing bodies. Sampling has located indicator minerals in the area.

Geoterrex flew the survey and provided a combined logistics and interpretation report which is included as an appendix.

# 4. GEOLOGY

The Auvergne 1:250 000 geology map suggests that there is unlikely to be any significant outcrop. The area is part of the Keep River drainage and is probably mainly covered with alluvial sediments. The probable underlying geology is Carboniferous and Devonian sandstones, siltstones, shales and limestones. Dips are probably shallow.

## 5. SURVEY DETAILS

- Contractor: Geoterrex
- Aircraft: AS350B VH-HBB & VH-JRO
- Date: April – September 1997
- Line kms: 639
- DIGHEM-V Towed Bird EM System
- 400Hz, 7200Hz, 56000Hz horizontal coplanar
- 900Hz, 5500Hz vertical coaxial
- Magnetometer: Caesium vapour, towed bird sensor
- Flight Line Spacing: 150 metres
- Flight Line Direction: North-south
- Survey Height: Magnetics: 40m, EM: 30m
- Magnetics & EM Data Interval: 3m, 0.1 seconds
- Navigation: Sercel NR106 GPS, real time differential mode

## 6. DATA PROCESSING

The data were provided by Geoterrex as a series of 1:25 000 maps, multi-plot charts for each survey line, and in digital form.

SGC reprocessed the digital data to produce 1:25000 scale maps as follows:

- Total magnetic intensity contour plan (Figure 2)
- Total magnetic intensity profiles (Figure 3)
- Residual magnetic intensity contour plan (short filter) (Figure 4)
- Residual magnetic intensity profiles (short filter) (Figure 5)
- Residual magnetic intensity contour plan (long filter) (Figure 6)
- Residual magnetic intensity profiles (long filter) (Figure 7)
- Apparent resistivity (56000Hz) colour shadowed image (Figure 8)
- Apparent resistivity (400Hz) colour shadowed image (Figure 9)

The residual magnetic data were derived initially by passing a 51 point moving average through the data and subtracting this average from the original data (Figures 4-5). This procedure enhanced shallow features in areas dominated by long wavelength anomalies. It was found that because of the very small sample interval of 3m, the relatively short filter length only produced very shallow, short wavelength features. A longer filter of 301 points was then used to produce a second set of maps (Figures 6-7) which better showed what may be bedrock information.

The 56000hz resistivity data and 400hz resistivity data were used to make image maps as these two frequencies adequately show shallow and deeper conductivity patterns (Figures 8-9).

# 7. INTERPRETATION

## *7.1 General Discussion:*

Kimberlite intrusives in the adjacent Kimberley block are known to have varying geophysical properties.

Magnetically they range from completely non-magnetic through to well defined magnetic bodies giving anomalies of 50nT or more. More commonly they are, however, weakly magnetic, and also only in parts of the overall intrusive, thus giving isolated anomalies that do not necessarily reflect the shape of the body. The bodies are younger than the host rocks and should thus be at relatively shallow depth giving short wavelength dipolar anomalies.

Narrow, shallow, linear magnetic anomalies may be of interest as kimberlite dykes occur in the Kimberley.

Electromagnetic data over a number of known kimberlites in the Kimberley tend to show a more or less consistent pattern of weakly conductive material. This is due to water-saturated alluvium and crater fill at the top of the breccia pipe. If the surrounding rocks are resistive, the resistivity pattern should show low zones over such features.

The magnetic data (Figures 2-3) show an area with a very low magnetic relief of 20nT across the entire survey. The magnetic gradient due to deep magnetic sources is from high in the west to low in the east. The filtering process (Figures 4-7) has delineated some bedrock magnetic sources as well as extensive areas of shallow, magnetic surficial material. These areas of surficial material have been outlined on the interpretation plan (Figure 10) and may represent laterite or drainages (present or paleo).

The resistivity plans (Figures 8-9) show that the area has resistivities ranging up to 1000 ohm.m. but is mainly very conductive with average resistivities of less than 50 ohm.m. An examination of the individual multiplot profiles was made, however, the high conductivities have caused a multitude of anomalous peaks, most of which are due to terrain clearance variations. It was decided that selecting individual anomalies from the multiplots was not worthwhile. Instead, the resistivity patterns have been interpreted directly.

There is significant variation in resistivity across the area with well developed patterns. The shallow resistivities (56000hz – Figure 8) show relatively similar patterns to the deep resistivities (400hz – Figure 9). The main sinuous resistivity low zones have been interpreted and classified as major or minor. They are thought to be present or paleo drainage systems filled with damp alluvial material. The more extensive resistivity high zones have also been outlined and these are thought to represent areas of outcrop or shallower cover. They are probably rock type related. Several other resistivity features of possible interest have been interpreted and are discussed under targets.

## *7.2 Targets:*

The interpretation plan (Figure 10) shows the various selected targets classified into different types. Also shown are locations where definite or probable indicator minerals have been located.

### *7.2.1 Magnetic Targets:*

The magnetic targets M1-M4 vary from small dipolar features to a larger diameter body, M1. By far the most interesting target is M1 which is a discrete anomaly on the long filter residual plans (Figures 6-7). It has an amplitude of 2.5nT and is about 400m x 600m in size. It looks to be relatively shallow and is a very good kimberlite target. There are also three positive indicator mineral locations in close proximity.

The other magnetic targets, M2-M4, are all very similar, being about 100m in diameter and having amplitudes of about 2nT. They are similar to other magnetic surficial responses but are unusually isolated and have good dipolar shapes.

### *7.2.2 Resistivity Targets:*

The resistivity targets, R1-R4, are semi-discrete areas of low resistivity selected from the apparent resistivity plans (Figure 8-9).

Possibly the most interesting of the resistivity targets is R1. This is a circular feature about 1300m in diameter which is very large (but possible) for a kimberlite. It has a more resistive core. The other resistivity targets, R2-R4, are mainly about 800m in diameter. They may simply be areas of thicker cover.

The various resistivity low axes delineated may be due to paleochannels which could be targets for alluvial diamond concentrations. No particular 'channel' is recommended as correlation with other geological and topographical information is required.

## 8. CONCLUSIONS AND RECOMMENDATIONS

The resistivity data show that the area is quite highly conductive, presumably due to extensive alluvial cover. The resistivity contour maps show several resistivity low features that may be due to the upper tuffaceous, crater collapse zone of large kimberlite but are more likely to be areas of thicker cover or similar. The resistivity plans also show a number of sinuous conductive zones which are interpreted as possible paleochannels.

There are four resistivity targets. The most discrete of the resistivity targets is R1 which is, however, rather large to be a kimberlite. The other resistivity targets are lower priority features which may well be due to thick, damp cover.

The magnetic data have very low magnetic relief with a range of only 20nT across the area. Individual anomalous features are mainly less than 3nT in amplitude. The residual profiles and contours tend to delineate shallow responses which are mainly due to surficial magnetic material interpreted as either laterite or detrital magnetic material in drainages.

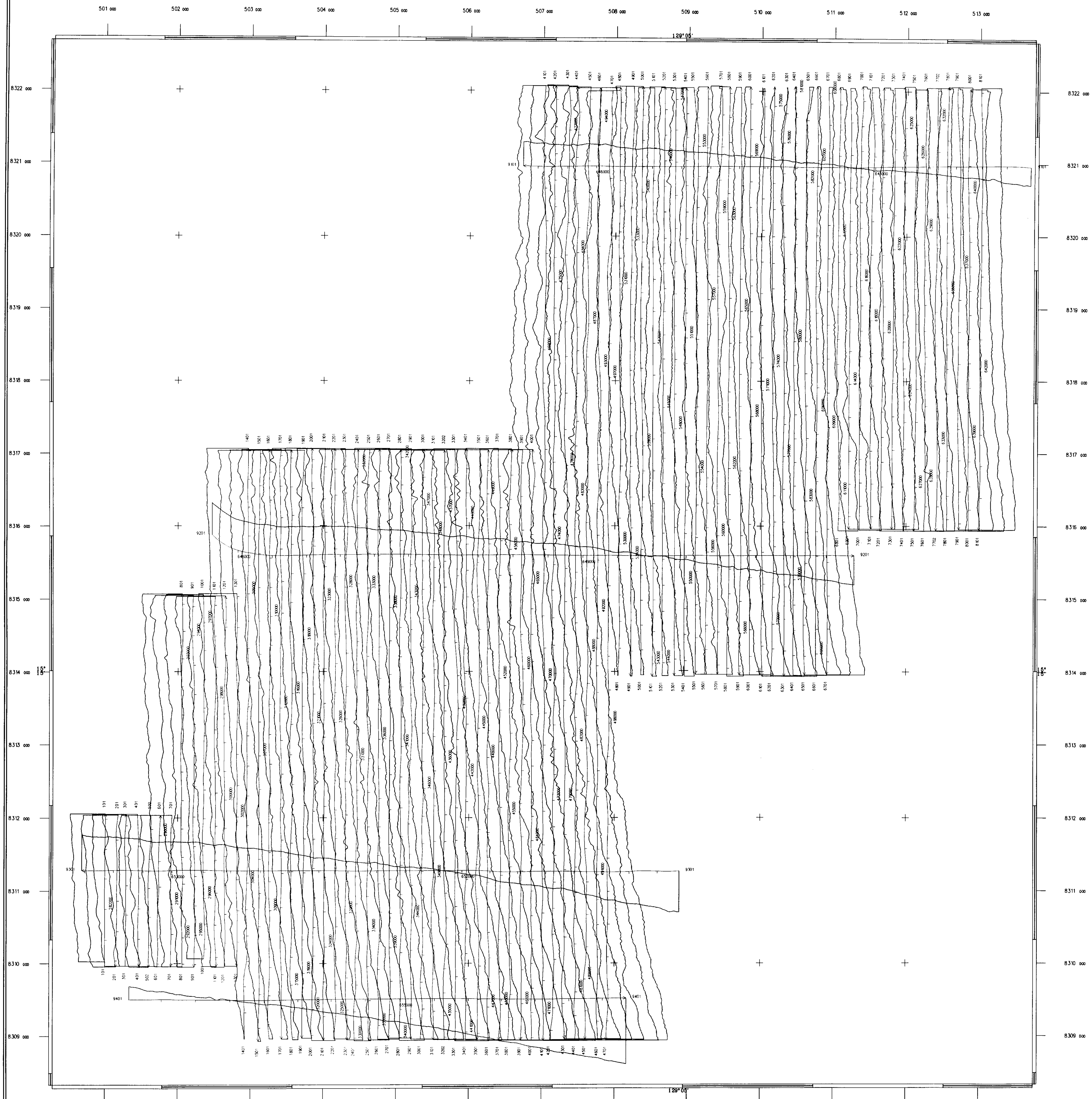
There are four magnetic targets. The largest of the targets, M1, has an amplitude of 2.5nT and an area of about 25ha making it a very attractive target. The other three magnetic targets are much smaller in size (less than 1ha) and are shallow, dipolar, anomalies that may be due to magnetic detritus unrelated to kimberlites.

The magnetic target, M1, is highly recommended for follow up and drilling if no obvious uneconomic explanation is apparent. The other three magnetic targets and the resistivity targets, particularly, R1, are recommended for follow up on a lower priority basis.

The interpreted low resistivity ' channels' could be tested if alluvial diamond concentrations are sought.

Image 7.

See image file
Attached.



SURVEY SPECIFICATIONS

| | | |
|---|---|---|
| Contractor | : | Geoterrex Pty Ltd. |
| Aircraft | : | Aerospatiale AS350BA |
| Instrumentation | : | Cesium Vapour |
| Survey Date | : | September 1997 |
| Sample Interval | : | approx. 3 metres |
| Flight Line Spacing | : | 150 metres |
| Flight Line Direction | : | 000-180 degrees |
| Tie Line Spacing | : | |
| Mean Terrain Clearance | : | 40 metres |
| Navigation | : | Differential GPS |

PROCESSING DETAILS

| | | |
|---|---|---|
| Processing | : | Southern Geoscience |
| Composition | : | S. R. M. |
| Supervision | : | W. S. Peters |

PLOT SPECIFICATIONS

| | | |
|---|---|---|
| Base Value Removed | : | 1630 nT |
| Vertical Scale | : | 5 nT/cm |

N

500 0 500 1000 1500

SCALE 1: 25000

AUSTRALIAN MAP GRID ZONE 52
AGD 84 SPHEROID
SOUTHERN HEMISPHERE

CR98/221

SOUTHERN GEOSCIENCE CONSULTANTS
PTY. LTD.
A. C. N. 067 552 461

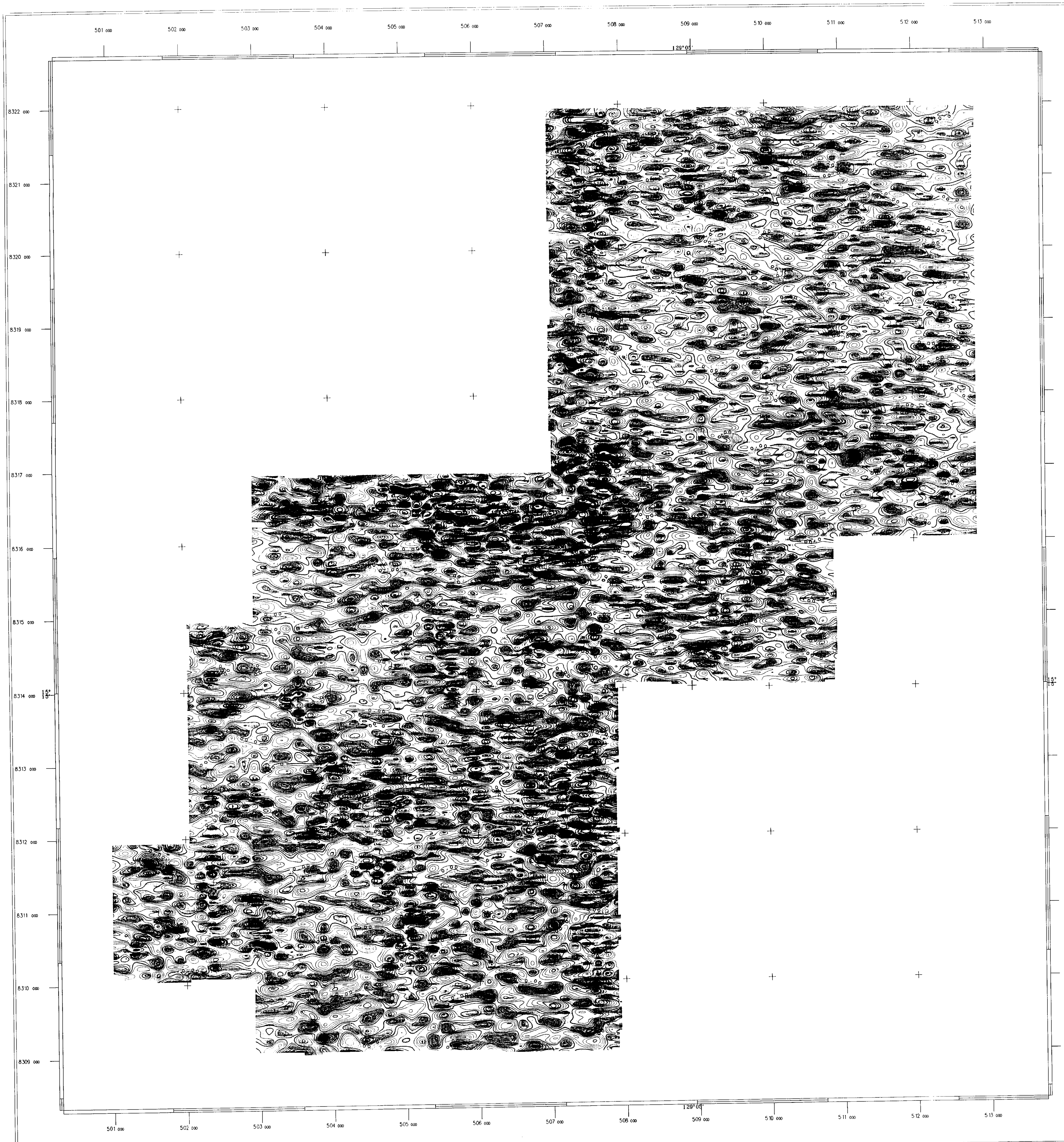
ZEPHYR MINERALS NL

KEEP RIVER, NT

AIRBORNE GEOPHYSICAL SURVEY

TOTAL MAGNETIC INTENSITY PROFILES

| | |
|---|---|
| SCALE: 1: 25, 000 | W. S. PETERS |
| DATE: 21-01-1998 | FIGURE: 3 |




SURVEY SPECIFICATIONS

| | | |
|---|---|---|
| Contractor | : | Geoterrex Pty Ltd. |
| Aircraft | : | Aerospatiale AS350BA |
| Instrumentation | : | Cesium Vapour |
| Survey Date | : | September 1997 |
| Sample Interval | : | approx. 3 metres |
| Flight Line Spacing | : | 150 metres |
| Flight Line Direction | : | 000–180 degrees |
| Tie Line Spacing | : | |
| Mean Terrain Clearance | : | 40 metres |
| Navigation | : | Differential GPS |

PROCESSING DETAILS

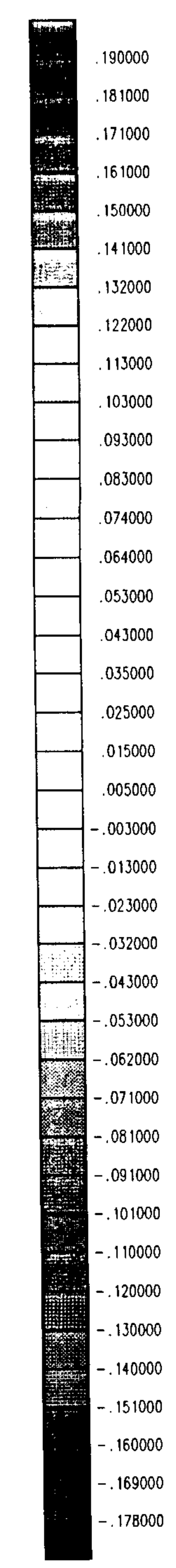
Filtered data = (5pt moving – 51pt moving)

Processing : Southern Geoscience
Composition : S. R. M.
Supervision : W. S. Peters

PLOT SPECIFICATIONS

| | | |
|---|---|---|
| First Level Contours | : | 0.02 nT |
| Second Level Contours | : | 0.10 nT |
| Third Level Contours | : | 0.50 nT |

Grid Cell Size : 35 mE x 35 mN




N

500 0 500 1000 1500

SCALE 1: 25000

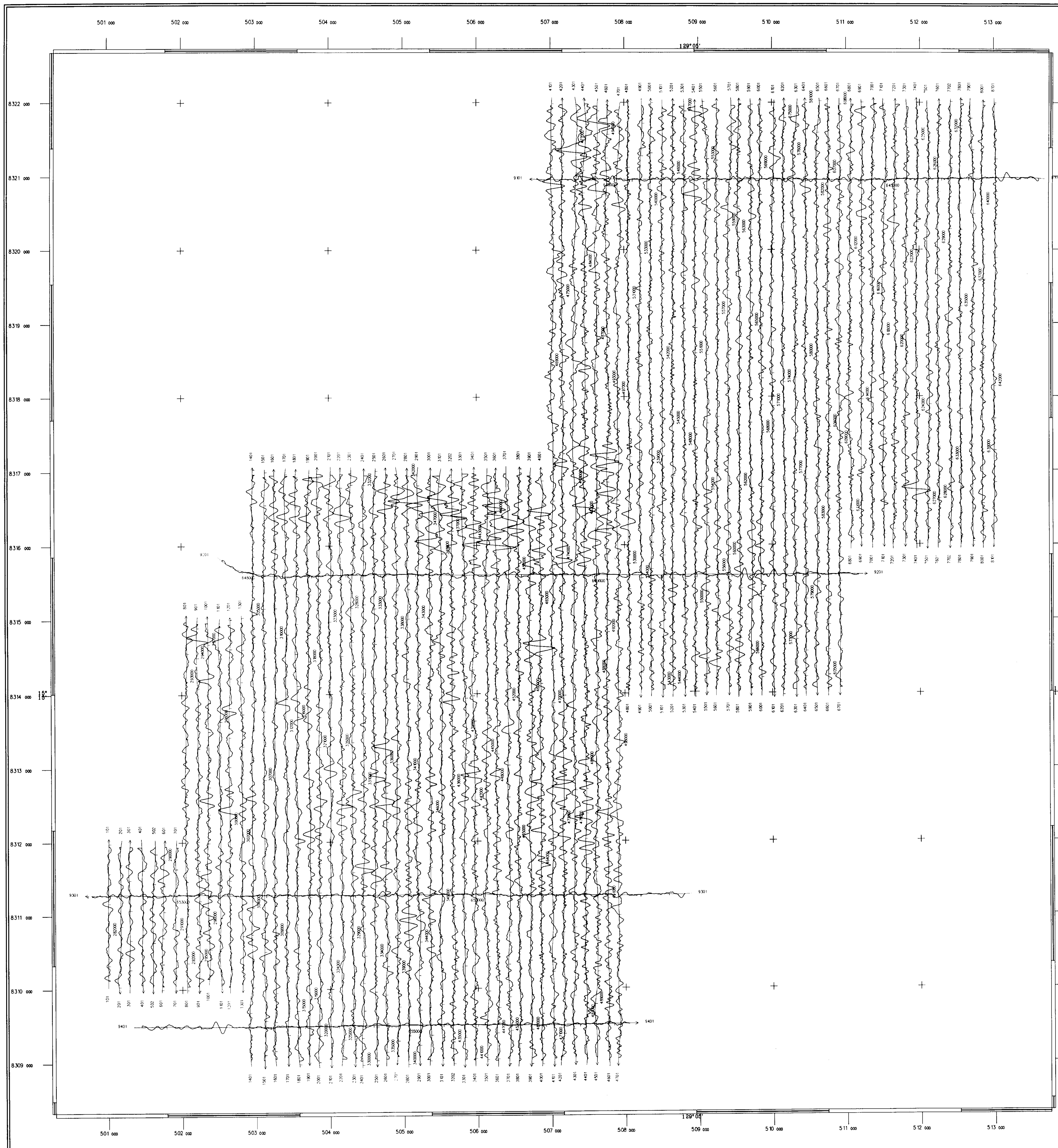
AUSTRALIAN MAP GRID ZONE 52
AGD 84 SPHEROID
SOUTHERN HEMISPHERE

CR98/221

SOUTHERN GEOSCIENCE CONSULTANTS
PTY. LTD.
A. C. N. 067 552 461

ZEPHYR MINERALS NL
KEEP RIVER, NT
AIRBORNE GEOPHYSICAL SURVEY
TOTAL MAGNETIC INTENSITY IMAGE
LINEAR STRETCH
TOTAL MAGNETIC INTENSITY CONTOURS
FILTERED DATA

| | |
|---|---|
| SCALE: 1: 25,000 | W. S. PETERS |
| DATE: 21-01-1998 | FIGURE: 4 |




SURVEY SPECIFICATIONS

| | | |
|---|---|---|
| Contractor | : | Geoterrex Pty Ltd. |
| Aircraft | : | Aerospatiale AS350BA |
| Instrumentation | : | Cesium Vapour |
| Survey Date | : | September 1997 |
| Sample Interval | : | approx. 3 metres |
| Flight Line Spacing | : | 150 metres |
| Flight Line Direction | : | 000–180 degrees |
| Tie Line Spacing | : | |
| Mean Terrain Clearance | : | 40 metres |
| Navigation | : | Differential GPS |

PROCESSING DETAILS

Filtered data = (5pt moving – 51pt moving)

Processing : Southern Geoscience
Composition : S. R. M.
Supervision : W. S. Peters

PLOT SPECIFICATIONS

Base Value : 0.0 nT
Vertical Scale : 1.0 nT/cm

N

500 0 500 1 000 1 500

SCALE 1: 25000

AUSTRALIAN MAP GRID ZONE 52
AGD 84 SPHEROID
SOUTHERN HEMISPHERE

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ZEPHYR MINERALS NL

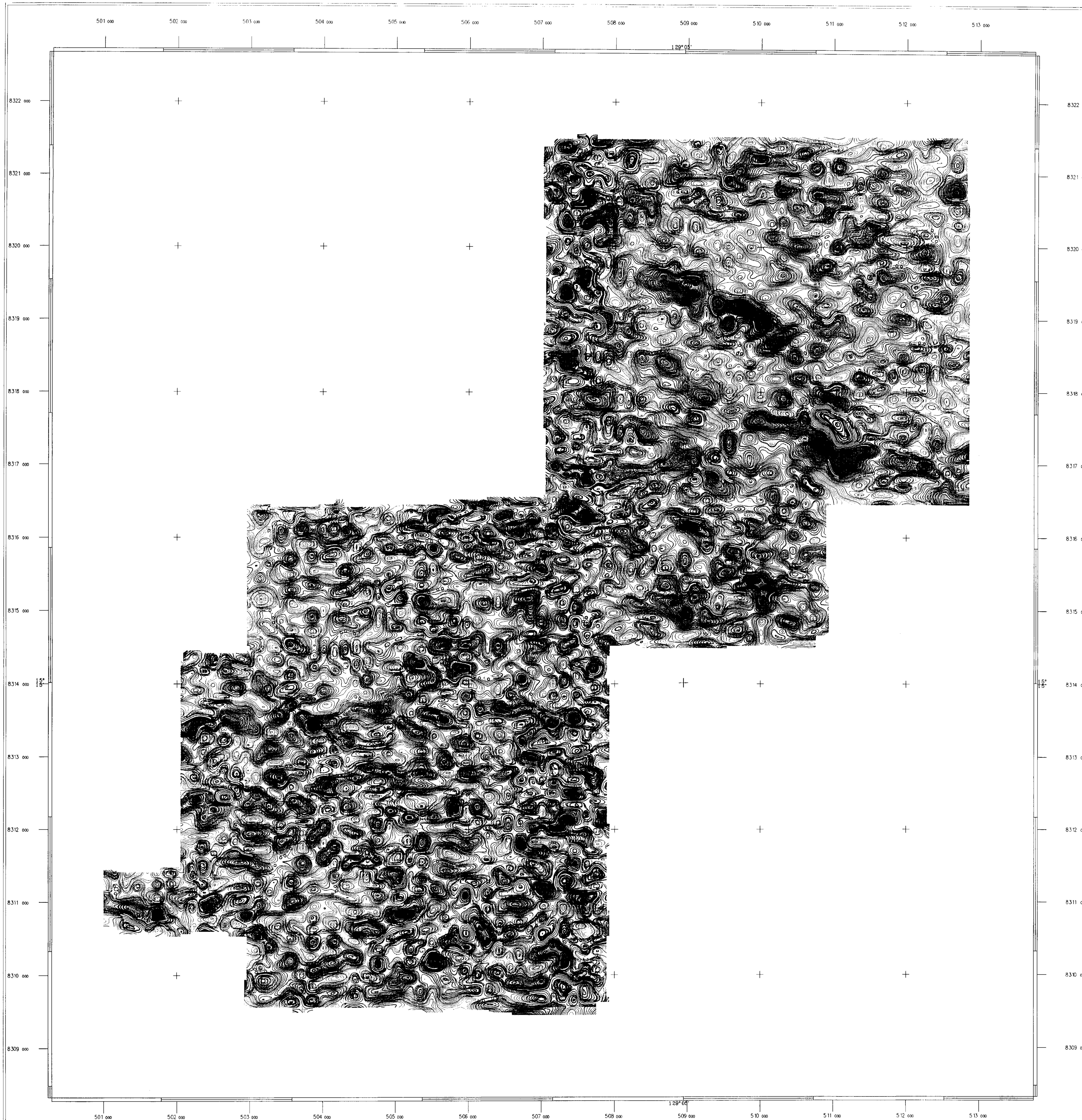
KEEP RIVER, NT

AIRBORNE GEOPHYSICAL SURVEY

TOTAL MAGNETIC INTENSITY PROFILES

FILTERED DATA

| | |
|---|---|
| SCALE: 1: 25, 000 | W. S. PETERS |
| DATE: 21-01-1998 | FIGURE: 5 |




SURVEY SPECIFICATIONS

| | | |
|---|---|---|
| Contractor | : | Geoterrex Pty Ltd. |
| Aircraft | : | Aerospatiale AS350BA |
| Instrumentation | : | Cesium Vapour |
| Survey Date | : | September 1997 |
| Sample Interval | : | approx. 3 metres |
| Flight Line Spacing | : | 150 metres |
| Flight Line Direction | : | 000-180 degrees |
| Tie Line Spacing | : | |
| Mean Terrain Clearance | : | 40 metres |
| Navigation | : | Differential GPS |

PROCESSING DETAILS

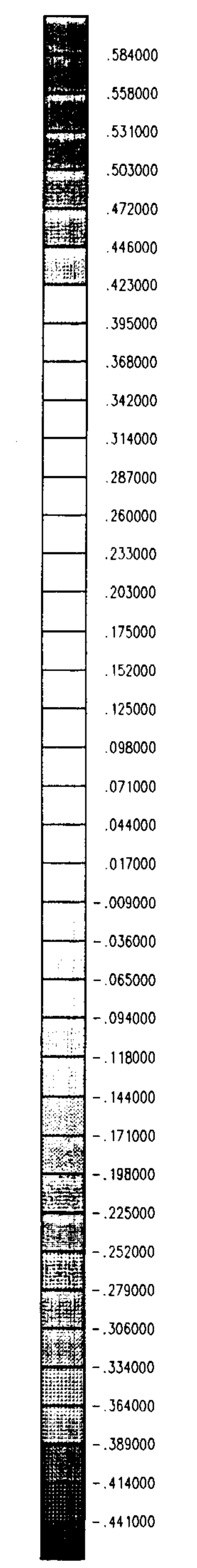
Filtered data = (11pt moving - 301pt moving)

Processing : Southern Geoscience
Composition : S. R M.
Supervision : W. S. Peters

PLOT SPECIFICATIONS

First Level Contours : 0.02 nT
Second Level Contours : 0.10 nT
Third Level Contours : 0.50 nT

Grid Cell Size : 35 mE x 35 mN




N

500 0 500 1000 1500

SCALE 1: 25000

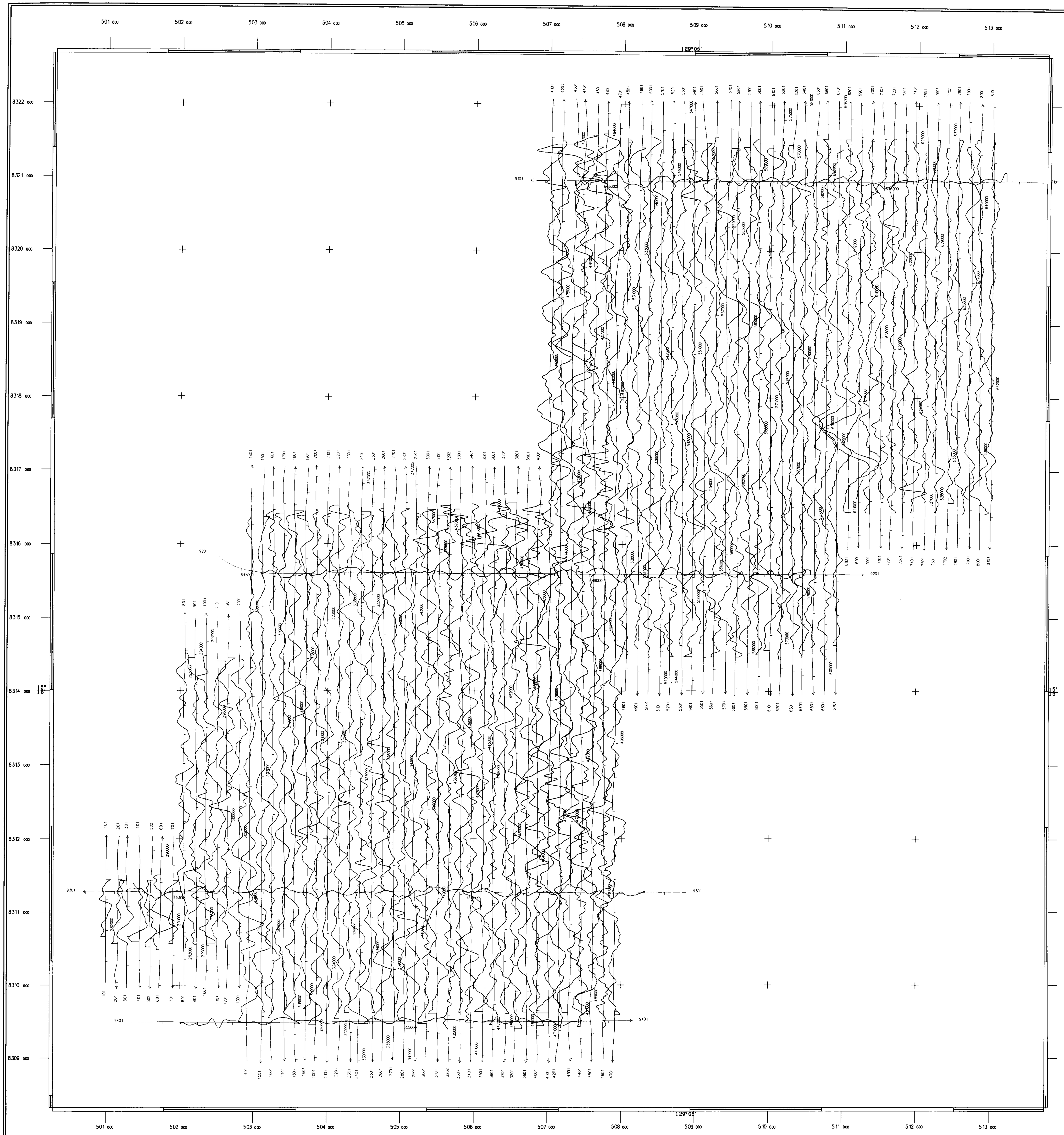
AUSTRALIAN MAP GRID ZONE 52
AGD 84 SPHEROID
SOUTHERN HEMISPHERE

CR98/221

SOUTHERN GEOSCIENCE CONSULTANTS
PTY. LTD.
A. C. N. 067 552 461

ZEPHYR MINERALS NL
KEEP RIVER, NT
AIRBORNE GEOPHYSICAL SURVEY
TOTAL MAGNETIC INTENSITY IMAGE
LINEAR STRETCH
TOTAL MAGNETIC INTENSITY CONTOURS
FILTERED DATA

| | |
|---|---|
| SCALE 1: 25, 000 | W. S. PETERS |
| DATE: 21-01-1998 | FIGURE: 6 |



## SURVEY SPECIFICATIONS

| | | |
|---|---|---|
| Contractor | : | Geoterrex Pty Ltd. |
| Aircraft | : | Aerospatiale AS350BA |
| Instrumentation | : | Cesium Vapour |
| Survey Date | : | September 1997 |
| Sample Interval | : | approx. 3 metres |
| Flight Line Spacing | : | 150 metres |
| Flight Line Direction | : | 000-180 degrees |
| Tie Line Spacing | : | |
| Mean Terrain Clearance | : | 40 metres |
| Navigation | : | Differential GPS |

## PROCESSING DETAILS

Filtered data = (11pt moving - 301pt moving)

Processing : Southern Geoscience
Composition : S. R. M
Supervision : W. S. Peters

## PLOT SPECIFICATIONS

Base Value : 0.0 nT
Vertical Scale : 1.0 nT/cm

500 0 500 1000 1500

SCALE 1: 25000

AUSTRALIAN MAP GRID ZONE 52
AGD 84 SPHEROID
SOUTHERN HEMISPHERE

CR98/221

SOUTHERN GEOSCIENCE CONSULTANTS PTY. LTD.
A. C. N. 067 552 461

ZEPHYR MINERALS NL

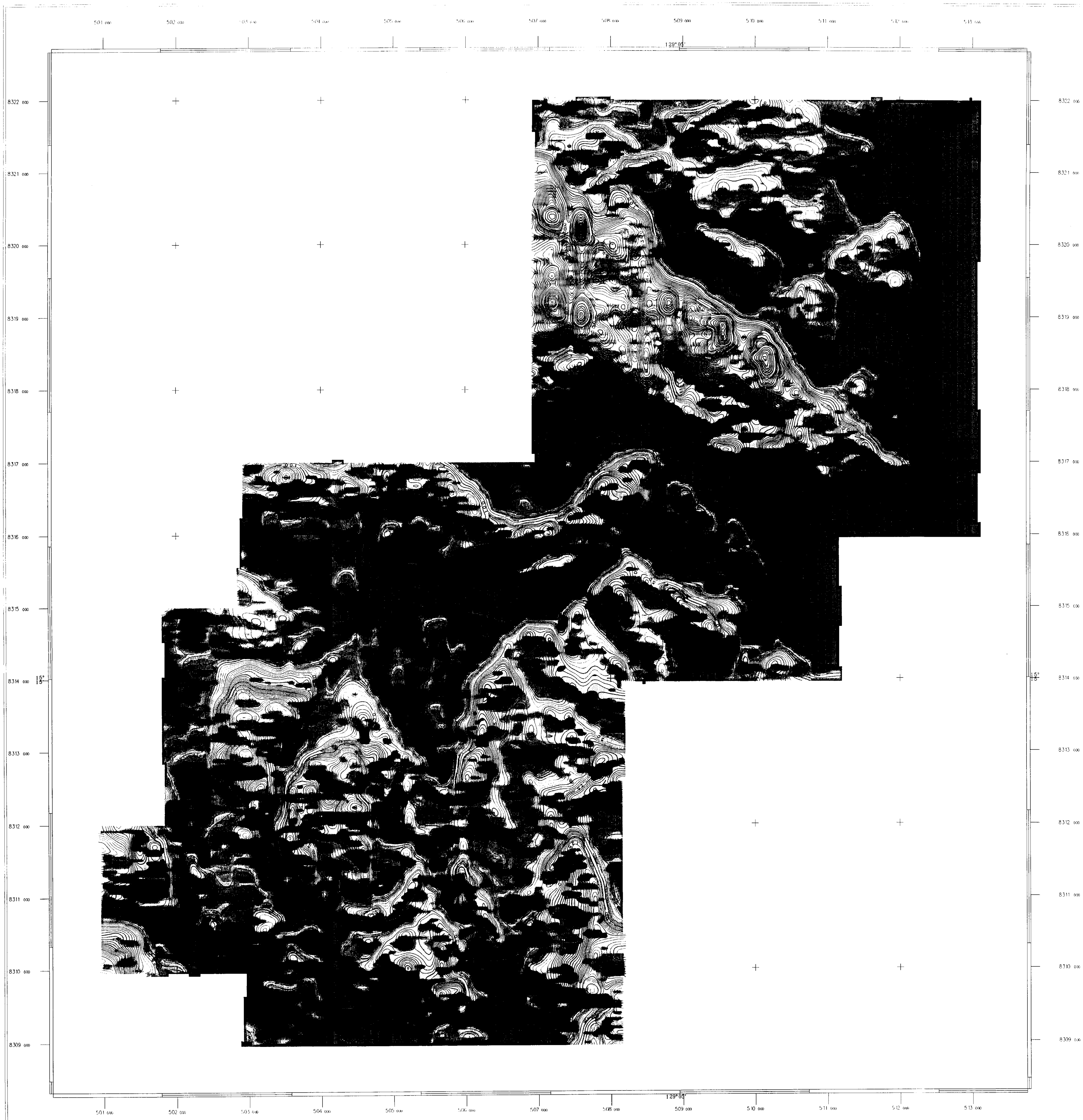
KEEP RIVER, NT

AIRBORNE GEOPHYSICAL SURVEY

TOTAL MAGNETIC INTENSITY PROFILES

FILTERED DATA

| | |
|---|---|
| SCALE: 1: 25, 000 | W. S. PETERS |
| DATE: 21-01-1998 | FIGURE 7 |




SURVEY SPECIFICATIONS

| | |
|---|---|
| Contractor | : Geoterrex Pty Ltd. |
| Aircraft | : Aerospatiale AS350BA |
| Instrumentation | : DIGHEM V |
| Survey Date | : April 1997 |
| Sample Interval | : approx. 3 metres |
| Flight Line Spacing | : 150 metres |
| Flight Line Direction | : 000-180 degrees |
| Tie Line Spacing | : |
| Mean Terrain Clearance | : 30 metres |
| Navigation | : Differential GPS |

PROCESSING DETAILS

| | |
|---|---|
| Processing | : Southern Geoscience |
| Composition | : S. R. M. |
| Supervision | : W. S. Peters |

PLOT SPECIFICATIONS

| | |
|---|---|
| First Level Contours | : 5 ohmm |
| Second Level Contours | : 25 ohmm |
| Third Level Contours | : 100 ohmm |
| Fourth Level Contours | : 500 ohmm |

Grid Cell Size : 40 mE x 40 mN

N

500 0 500 1 000 1 500

SCALE 1: 25000

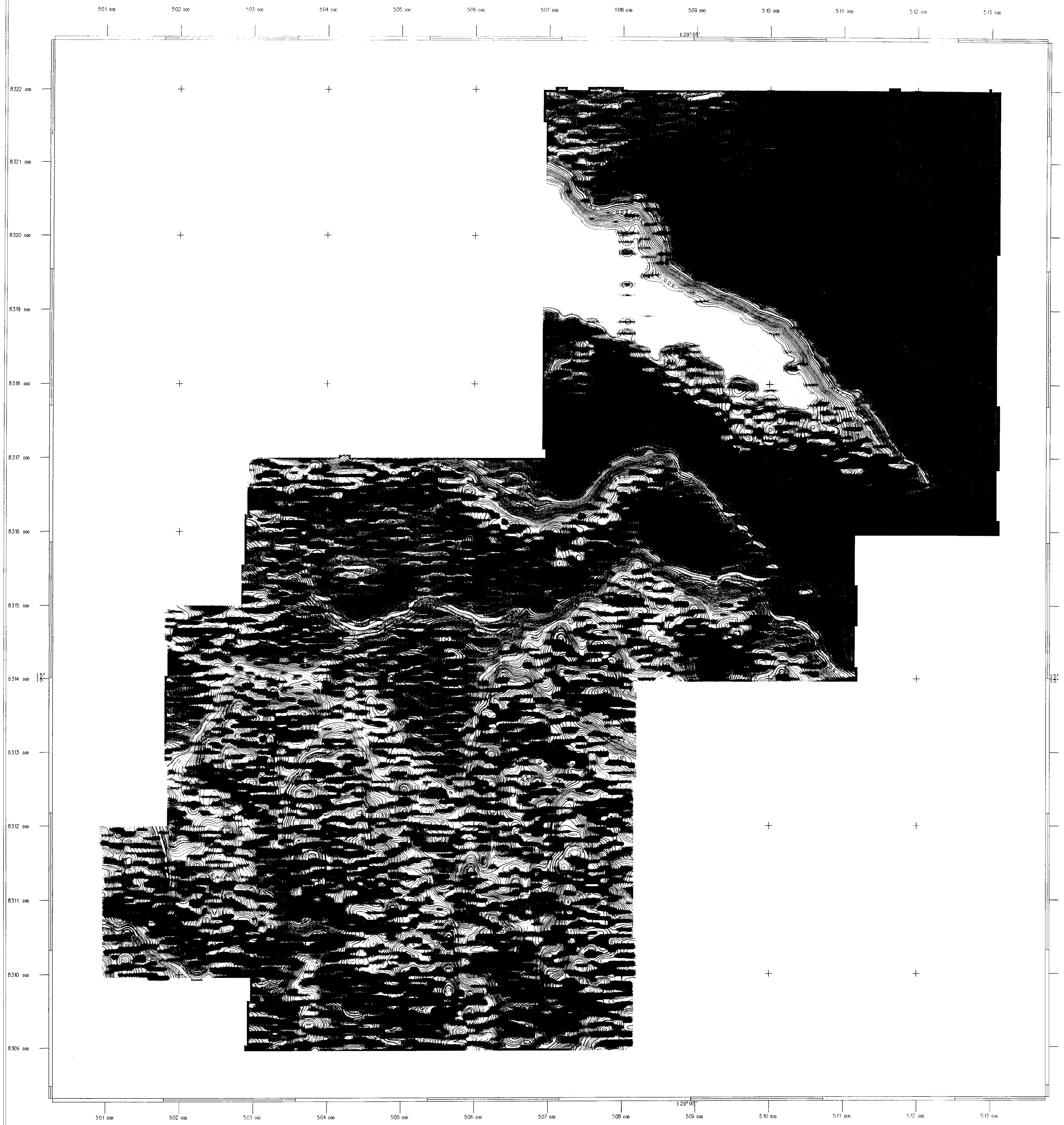
AUSTRALIAN MAP GRID ZONE 52
AGD 84 SPHEROID
SOUTHERN HEMISPHERE

CR98/221

SOUTHERN GEOSCIENCE CONSULTANTS
PTY. LTD.
A. C. N. 067 552 461

ZEPHYR MINERALS NL
KEEP RIVER, NT
AIRBORNE GEOPHYSICAL SURVEY
IMAGE OF APPARENT RESISTIVITY (NL)
SHADED WITH 50% NORTH GRADIENT
CONTOURS OF APPARENT RESISTIVITY
56000 Hz

| | |
|---|---|
| SCALE: 1: 25, 000 | W. S. PETERS |
| DATE: 21-01-1998 | FIGURE: 8 |




SURVEY SPECIFICATIONS

| | | |
|---|---|---|
| Contractor | : | Geoterrex Pty Ltd. |
| Aircraft | : | Aerospatiale AS350BA |
| Instrumentation | : | DIGHEM V |
| Survey Date | : | April 1997 |
| Sample Interval | : | approx. 3 metres |
| Flight Line Spacing | : | 150 metres |
| Flight Line Direction | : | 000-180 degrees |
| Tie Line Spacing | : | |
| Mean Terrain Clearance | : | 30 metres |
| Navigation | : | Differential GPS |

PROCESSING DETAILS

| | | |
|---|---|---|
| Processing | : | Southern Geoscience |
| Composition | : | S. R. M. |
| Supervision | : | W. S. Peters |

PLOT SPECIFICATIONS

| | | |
|---|---|---|
| First Level Contours | : | 5 ohm |
| Second Level Contours | : | 25 ohm |
| Third Level Contours | : | 100 ohm |

Grid Cell Size : 40 mE x 40 mN

N

500 0 500 1000 1500

SCALE 1: 25000

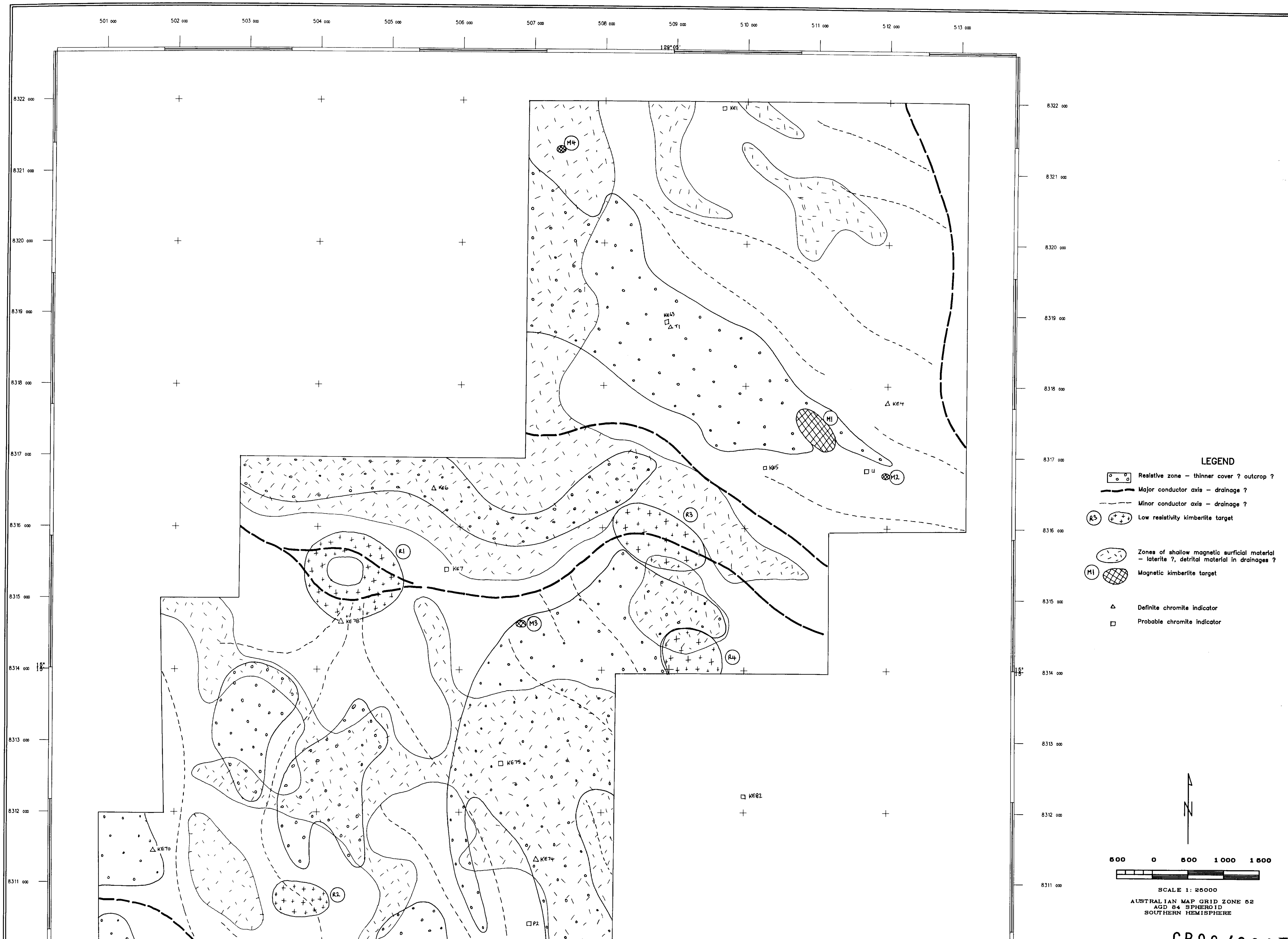
AUSTRALIAN MAP GRID ZONE 52
AGD 84 SPHEROID
SOUTHERN HEMISPHERE

CR98/221

SOUTHERN GEOSCIENCE CONSULTANTS
PTY. LTD.
A. C. N. 067 552 461

ZEPHYR MINERALS NL
KEEP RIVER, NT
AIRBORNE GEOPHYSICAL SURVEY
IMAGE OF APPARENT RESISTIVITY (NL)
SHADED WITH 50% NORTH GRADIENT
CONTOURS OF APPARENT RESISTIVITY
400 Hz

| | |
|---|---|
| SCALE: 1: 25, 000 | W. S. PETERS |
| DATE: 21-01-1998 | FIGURE: 9 |

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ZEPHYR MINERALS NL

KEEP RIVER, NT

AIRBORNE GEOPHYSICAL SURVEY

INTERPRETATION PLAN

| | |
|---|---|
| SCALE: 1: 25, 000 | W. S. PETERS |
| DATE: 21-01-1998 | FIGURE: 10 |