Helicopterborne EM, Magnetic and VLF Survey

on the

093867

Fire 1-12
Char 1-30
and
Tree 1-56 Claims

Long. 132°25'W; Lat. 61°38'N
NTS 105F/9
Watson Lake Mining District

for

Atna Resources Ltd.
Vancouver , B.C.

Survey: November 11, 1997
Report: February 27, 1998

by

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introduction by

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Atna Resources Ltd.
May 21, 1998

Table of Contents

List of Tables

List of Figures

This report has been examined by
the Geological Evaluation Unit
under Section 53 (4) Yukon Quartz
Mining Act and is allowed as
representation work in the amount
of $ 6000.00 .

for Regional Manager, Exploration and
Geological Services for Commissioner
of Yukon Territory.

1. Introduction

In 1997 Atna Resources Ltd. discovered a massive sulphide deposit within Mississippian volcanics in Pelly-Cassiar Platform rocks, central Yukon Territory. The deposit contains a significant thickness of zinc, lead, and silver bearing massive sulphide over the 500m strike length and 250m down dip extent tested to-date. As a follow-up to this discovery, Atna acquired several other properties along the volcanic belt including the Fire-Char-Tree property. The property was surveyed by airborne geophysics and the results of that survey is the subject of this report.

1.1 Claims

The Fire-Char claims are on option to Atna Resources Ltd. from Eagle Plains Resources and Miner River Resources Ltd. The claims are a re-staking of the Chzerpnough property, worked in the late 1970's by Cyprus Anvil Mining Corporation. The Tree claims are 100% owned by Atna Resources Ltd. Figure 1 shows the claim locations.

The following table lists relevant data concerning the property over which the airborne was flown.

Table 1: Claim Data

Claim	Tenure.	Expiry	Pending	Mining Div	NTS
Char 01	YB84517	20-Jun-00	P*	Watson Lake	105F/09
Char 02	YB84518	20-Jun-00	P*	Watson Lake	105F/09
Char 03	YB84519	20-Jun-00	P*	Watson Lake	105F/09
Char 04	YB84520	20-Jun-00	P*	Watson Lake	105F/09
Char 05	YB84521	20-Jun-00	P*	Watson Lake	105F/09
Char 06	YB84522	20-Jun-00	P*	Watson Lake	105F/09
Char 07	YB84523	20-Jun-00	P*	Watson Lake	105F/09
Char 08	YB84524	20-Jun-00	P*	Watson Lake	105F/09
Char 09	YB84525	20-Jun-00	P*	Watson Lake	105F/09
Char 10	YB84526	20-Jun-00	P*	Watson Lake	105F/09
Char 11	YB84527	20-Jun-00	P*	Watson Lake	105F/09
Char 12	YB84528	20-Jun-00	P*	Watson Lake	105F/09
Char 13	YB84529	20-Jun-00	P*	Watson Lake	105F/09
Char 14	YB84530	20-Jun-00	P*	Watson Lake	105F/09
Char 15	YB84531	20-Jun-00	P*	Watson Lake	105F/09
Char 16	YB84532	20-Jun-00	P*	Watson Lake	105F/09
Char 17	YB84533	20-Jun-00	P*	Watson Lake	105F/09
Char 18	YB84534	20-Jun-00	P*	Watson Lake	105F/09
Char 19	YB84535	20-Jun-00	P*	Watson Lake	105F/09
Char 20	YB84536	20-Jun-00	P*	Watson Lake	105F/09
Char 21	YB84537	20-Jun-00	P*	Watson Lake	105F/09
Char 22	YB84538	20-Jun-00	P*	Watson Lake	105F/09

Char 23	YB84539	20-Jun-00	P*	Watson Lake	105F/09
Char 24	YB84540	20-Jun-00	P*	Watson Lake	105F/09
Char 25	YB84541	20-Jun-00	P*	Watson Lake	105F/09
Char 26	YB84542	20-Jun-00	P*	Watson Lake	105F/09
Char 27	YB84543	20-Jun-00	P*	Watson Lake	105F/09
Char 28	YB84544	20-Jun-00	P*	Watson Lake	105F/09
Char 29	YB84545	20-Jun-00	P*	Watson Lake	105F/09
Char 30	YB84546	20-Jun-00	P*	Watson Lake	105F/09
Fire 01	YB74411	02-Feb-02		Watson Lake	105F/09
Fire 02	YB74412	02-Feb-02		Watson Lake	105F/09
Fire 03	YB74413	02-Feb-02		Watson Lake	105F/09
Fire 04	YB74414	02-Feb-02		Watson Lake	105F/09
Fire 05	YB74415	02-Feb-02		Watson Lake	105F/09
Fire 06	YB74416	02-Feb-02		Watson Lake	105F/09
Fire 07	YB74417	02-Feb-02		Watson Lake	105F/09
Fire 08	YB74418	02-Feb-02		Watson Lake	105F/09
Fire 09	YB74419	02-Feb-02		Watson Lake	105F/09
Fire 10	YB74420	02-Feb-02		Watson Lake	105F/09
Fire 11	YB74421	02-Feb-02		Watson Lake	105F/09
Fire 12	YB74422	02-Feb-02		Watson Lake	105F/09
Tree 01	YB70076	11-Oct-05	P	Watson lake	105F/09
Tree 02	YB70077	11-Oct-05	P	Watson Lake	105F/09
Tree 03	YB70078	11-Oct-05	P	Watson Lake	105F/09
Tree 04	YB70079	11-Oct-05	P	Watson Lake	105F/09
Tree 05	YB70080	11-Oct-05	P	Watson Lake	105F/09
Tree 06	YB70081	11-Oct-05	P	Watson lake	105F/09
Tree 07	YB70082	11-Oct-05	P	Watson Lake	105F/09
Tree 08	YB70083	11-Oct-05	P	Watson Lake	105F/09
Tree 09	YB70084	11-Oct-05	P	Watson Lake	105F/09
Tree 10	YB70085	11-Oct-05	P	Watson Lake	105F/09
Tree 11	YB70086	11-Oct-05	P	Watson Lake	105F/09
Tree 12	YB70087	11-Oct-05	P	Watson Lake	105F/09
Tree 13	YB70088	11-Oct-05	P	Watson Lake	105F/09
Tree 14	YB70089	11-Oct-05	P	Watson Lake	105F/09
Tree 15	YB70090	11-Oct-05	P	Watson Lake	105F/09
Tree 16	YB70091	11-Oct-05	P	Watson Lake	105F/09
Tree 17	YB88907	23-Dec-02	P	Watson Lake	105F/09
Tree 18Fr	YB88908	23-Dec-02	P	Watson Lake	105F/09
Tree 19	YB88909	23-Dec-02	P	Watson Lake	105F/09
Tree 20	YB88910	23-Dec-02	P	Watson Lake	105F/09
Tree 21	YB88911	23-Dec-02	P	Watson Lake	105F/09
Tree 22	YB88912	23-Dec-02	P	Watson Lake	105F/09
Tree 23	YB88913	23-Dec-02	P	Watson Lake	105F/09
Tree 24	YB88914	23-Dec-02	P	Watson Lake	105F/09
Tree 25	YB88915	23-Dec-02	P	Watson Lake	105F/09
Tree 26	YB88916	23-Dec-02	P	Watson Lake	105F/09

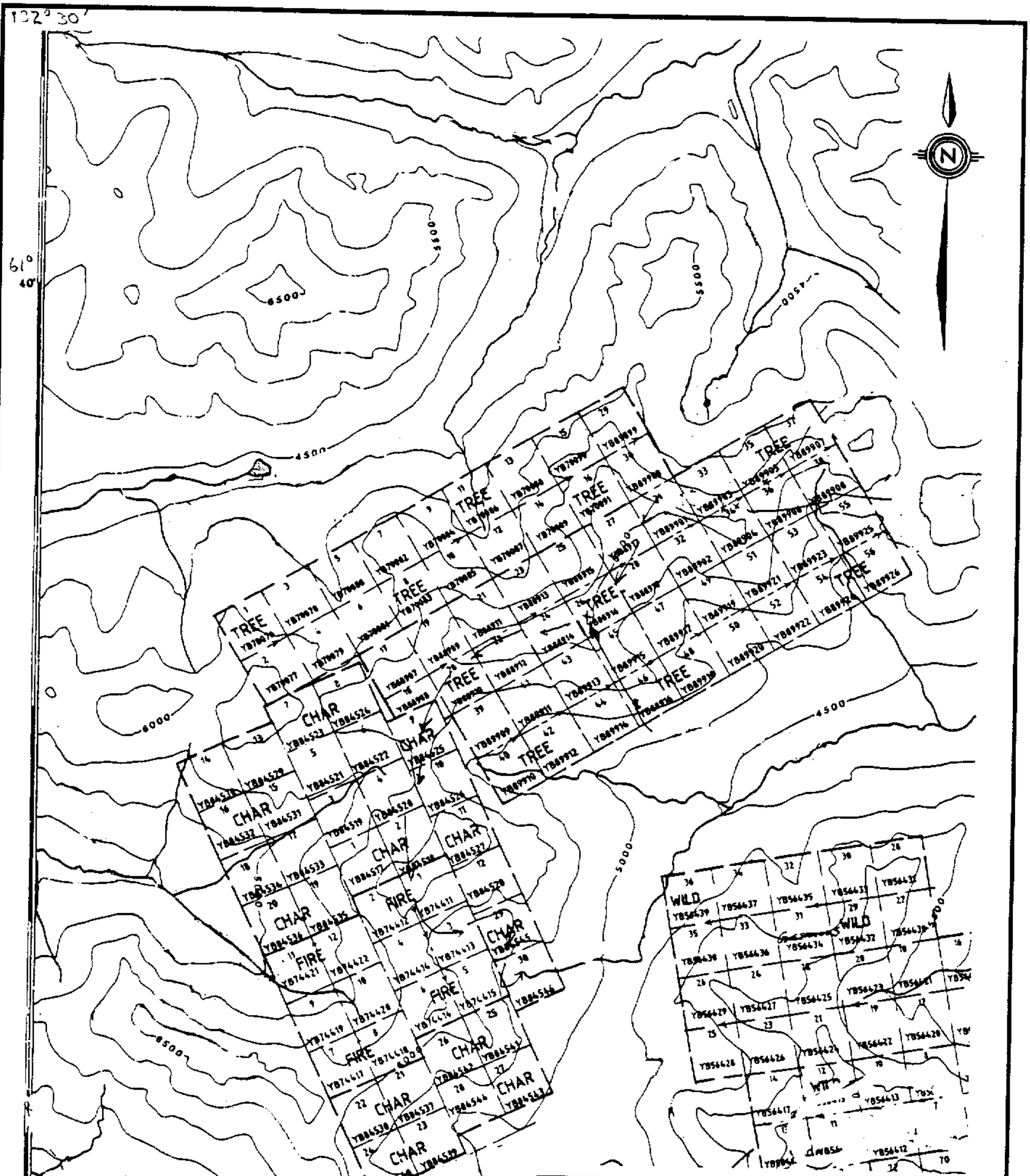
Tree 27	YB88917	23-Dec-02	P	Watson Lake	105F/09
Tree 28	YB88918	23-Dec-02	P	Watson Lake	105F/09
Tree 29	YB89899	12-Sep-98		Watson Lake	105F/09
Tree 30	YB89900	12-Sep-98		Watson Lake	105F/09
Tree 31	YB89901	12-Sep-98		Watson Lake	105F/09
Tree 32	YB89902	12-Sep-98		Watson Lake	105F/09
Tree 33	YB89903	12-Sep-98		Watson Lake	105F/09
Tree 34	YB89904	12-Sep-98		Watson Lake	105F/09
Tree 35	YB89905	12-Sep-98		Watson Lake	105F/09
Tree 36	YB89906	12-Sep-98		Watson Lake	105F/09
Tree 37	YB89907	12-Sep-98		Watson Lake	105F/09
Tree 38	YB89908	12-Sep-98		Watson Lake	105F/09
Tree 39	YB89909	12-Sep-98		Watson Lake	105F/09
Tree 40	YB89910	12-Sep-98		Watson Lake	105F/09
Tree 41	YB89911	12-Sep-98		Watson Lake	105F/09
Tree 42	YB89912	12-Sep-98		Watson Lake	105F/09
Tree 43	YB89913	12-Sep-98		Watson Lake	105F/09
Tree 44	YB89914	12-Sep-98		Watson Lake	105F/09
Tree 45	YB89915	12-Sep-98		Watson Lake	105F/09
Tree 46	YB89916	12-Sep-98		Watson Lake	105F/09
Tree 47	YB89917	12-Sep-98		Watson Lake	105F/09
Tree 48	YB89918	12-Sep-98		Watson Lake	105F/09
Tree 49	YB89919	12-Sep-98		Watson Lake	105F/09
Tree 50	YB89920	12-Sep-98		Watson Lake	105F/09
Tree 51	YB89921	12-Sep-98		Watson Lake	105F/09
Tree 52	YB89922	12-Sep-98		Watson Lake	105F/09
Tree 53	YB89923	12-Sep-98		Watson Lake	105F/09
Tree 54	YB89924	12-Sep-98		Watson Lake	105F/09
Tree 55	YB89925	12-Sep-98		Watson Lake	105F/09
Tree 56	YB89926	12-Sep-98		Watson Lake	105F/09

P = Pending acceptance of previously submitted report.
P* = Pending acceptance of this report.

1.2 Survey

Work on the Fire-Char-Tree claims consisted of a helicopter borne ElectroMagnetometer-Magnetometer-VLF survey. Aerodat Ltd. of Toronto was originally contracted to complete the work but was placed into receivership subsequent to acquiring the raw data but before the interpretation and reporting was completed. The assets of Aerodat were bought out by High-Sense Geophysics Ltd. who contracted GCT Consulting Services Ltd. of Toronto to complete processing and prepare the report.

The complete report is included as Appendix I to this introduction. That document is a stand alone report for assessment purposes save for the claim information listed in the previous section.



ATNA RESOURCES LTD.

PELLY PROJECT

Fire - Char - Tree Claims
Claims Location

NTS Yukon			Date May /98
Scale As Shown	DWG by		Figure 1

Appendix I

Report on a Helicopterborne Five-Frequency Electromagnetic, High Sensitivity Magnetic and VLF-EM Survey.

REPORT

ON A HELICOPTERBORNE FIVE-FREQUENCY ELECTROMAGNETIC, HIGH SENSITIVITY MAGNETIC AND VLF-EM SURVEY FINLAYSON LAKE AREA, YUKON TERRITORY NTS: 105 F/9

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February 27, 1998

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J9797

TABLE OF CONTENTS

MAPS

Survey results are presented on a series of black line and colour maps at a scale of 1:20,000. The logistics report is presented in three copies. Black line maps are presented in one mylar and three white print copies. Colour maps are presented in three copies.

Map types include:

Black Line Maps Scale 1:20,000

1. Topographic base map
2. Interpretation map
3. Total magnetic intensity
4. Vertical magnetic gradient
5. Apparent Resistivity
   a) 864 Hz coplanar
   b) 4781 Hz coplanar
6. Total field VLF-EM

Colour Maps Scale 1:20,000

1. Total magnetic intensity
2. Vertical magnetic gradient
3. EM profiles
   a) 915 Hz coaxial / 864 Hz coplanar
   b) 4382 Hz coaxial / 4781 Hz coplanar
   c) 33.07 kHz coplanar
4. Apparent Resistivity
   a) 864 Hz coplanar
   b) 4781 Hz coplanar
5. Total field VLF-EM

Derivative Colour Maps Scale 1:20,000

1. Shadow enhanced total magnetic intensity
2. Digital elevation model

All maps show survey area boundaries and a UTM grid with latitude/longitude crosses. Colour maps show colour fill plus superimposed line contours, flight path, EM anomaly centres, planimetry digitised from 1:50,000 scale NTS topographic maps and digital elevation model contours plotted in white. Black line maps are photocombined with topographic information enlarged from 1:50,000 NTS maps.

REPORT ON A
HELICOPTERBORNE FIVE-FREQUENCY ELECTROMAGNETIC, HIGH SENSITIVITY MAGNETIC AND VLF-EM SURVEY
FINLAYSON LAKE AREA
YUKON TERRITORY
NTS: 105 F/9

1. INTRODUCTION

1.1 Scope

This report documents the instrumentation, data collection, data processing, presentation and interpretation of the geophysical data collected from a helicopterborne electromagnetic, magnetic and VLF-EM survey in the Yukon Territory.

The survey was conducted as part of Atna Resources' exploration efforts for economic mineralisation. The Wolf Property, where a VMS deposit has been located, is some 55 kilometres southeast of this survey and along the general strike of the belt. The geophysical data has been interpreted to yield possible lithology and to outline anomalous conductive areas which may be caused by VMS mineralisation or alteration.

1.2 Background

The survey covers one survey block located in the Finlayson Lake area of the Yukon Territory. The survey was conducted as per an agreement between Atna Resources Limited and Aerodat Inc. dated November 10, 1997.

Between the time of data collection and the completion of this report, Aerodat Inc. was placed into receivership. High-Sense Geophysics Limited purchased the assets of Aerodat, and contracted GCT Consulting Services of Toronto to complete processing of the data and prepare this report.

2. LOCATION , ACCESS AND TOPOGRAPHY

The survey area is located at a latitude of 61 degrees 38 minutes north and a longitude of 132 degrees 25 minutes west. The survey areas is covered by the 1:50,000 scale NTS sheet 105 F/9. The survey boundary is summarised below:

Survey Boundary in UTM co-ordinates (NAD 1927)		
Point	Easting	Northing
A	633350	6837300
B	638900	6839300
C	639800	6836250
D	637150	6835250
E	637850	6833450
F	635400	6832450

Topographic relief in the survey area is very rugged, with elevations ranging from approximately 1500 m to 2100 m above sea level. There is no road access to the survey area.

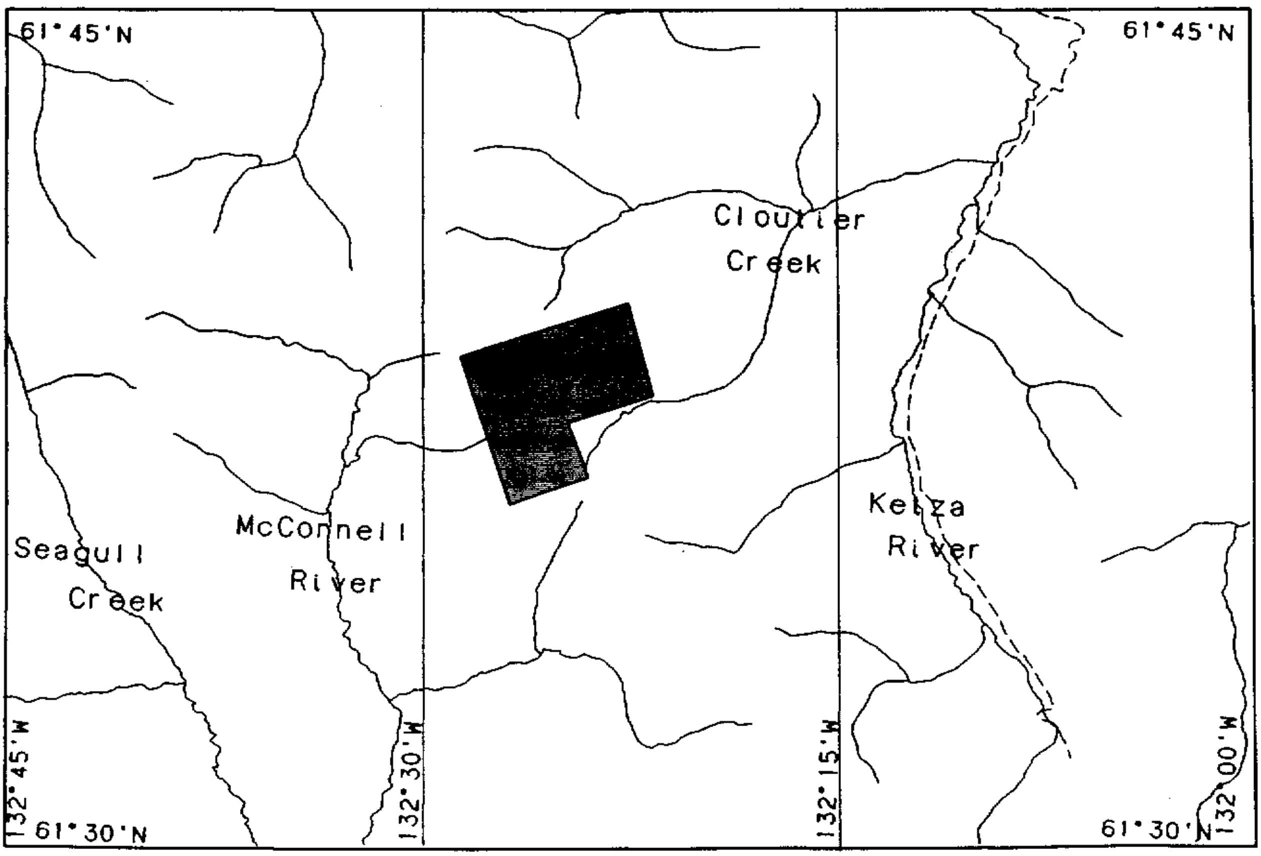

Figure 1 : Location Map: Aerodat Survey, Yukon Territory

3. THE PHYSICAL SURVEY

3.1 Survey Specifications and Tolerances

Total survey coverage is 131 line kilometres. The survey was flown on November 11, 1997. Survey specifications are detailed below:

Traverse line direction:	165° azimuth
Tie line direction:	75° azimuth
Line spacing:	200 m
Nominal helicopter terrain clearance:	60 m
Nominal helicopter ground speed:	60 knots (31 m/s)
Scan rate:	0.1 seconds

Because the boundary coordinates supplied to the field crew were incorrect, the survey was flown with a flight line direction of 165° azimuth instead of 160° azimuth. The survey area is still completely covered by the lines flown. The correct survey boundary appears on all maps.

<u>Tolerances</u>

1. A sensor-ground clearance deviation in excess of 25% of the specified clearance for a distance of more than 2 kilometres, with due consideration for crew and aircraft safety, would have resulted in a reflight.
2. A gap in excess of 125% of the nominal line spacing for a distance of greater than 1 kilometre or a gap exceeding 2.0 times the line spacing at any point would have resulted in a reflight.
3. A noise envelope of more than ± 0.2 nT for a distance of more than 1 kilometre along line would have resulted in a reflight. Culturally induced noise beyond the control of Aerodat is excluded from this specification.
4. A diurnal variation in excess of 10 nT per 2 minute chord would have resulted in a reflight.
5. EM noise levels above 2 ppm (low frequency), 3 ppm (mid frequency) or 6 ppm (high frequency) for a coil spacing of 6.5 m for a distance of more than 2 kilometres along line would have resulted in a reflight. Excessive spheric activity would also have resulted in a reflight.

3.2 Survey Procedures

The survey was flown on November 11, 1997. Four survey flights were needed to complete the project. The base of operations was Ross River.

The flight line spacing was 200 m. Aircraft ground speed was maintained at an average of approximately 60 knots (30 metres per second). The average helicopter terrain clearance was approximately 75 metres.

Navigation was assisted by a GPS receiver and data acquisition system which translates GPS co-ordinates as WGS 84 latitude/longitude into UTM x/y co-ordinates. The GPS directs the pilot over a pre-programmed survey grid and records current on line position. A base station recorded static GPS positions for later differential correction of the airborne record.

The operator calibrates the geophysical systems at the beginning, middle (if required) and end of every survey flight. During calibration the helicopter is flown away from ground effects to record electromagnetic zero levels to aid in the removal of the effects of instrument drift.

Electromagnetic data was not collected on the tie lines.

3.3 *Survey Personnel*

The following Aerodat personnel were involved in the project:

Field Personnel:

Operator:	Jason Cunningham
Pilot:	Bill Karman
Field Data Processor:	Greg Zimmer

Office Personnel:

Data Processor:	Darcy McGill
Report:	Darcy McGill
Interpretation:	Bob Lo

4. AIRCRAFT AND EQUIPMENT

4.1 *Helicopter*

An Aerospatiale AS350B1 with Canadian registration C-GKHS owned and operated by Kluane Helicopters was used for the survey. Geophysical and ancillary equipment was installed by Aerodat.

4.2 *Equipment Rack and Installation*

The electronic equipment is mounted in a standard 19 inch rack which is mounted in a floor board and secured to the helicopter. The rack contains the following:

RMS Data Acquisition System/Graphic Recorders

Data Tape Recorder Unit

Video Recording Unit

Flight Path Recording Unit

Power Distribution Unit

Magnavox MX9212 GPS Receiver

Aerodat Magnetometer Console

DSCP-99 EM Console

Herz Totem 2A VLF-EM Console

4.3 *Electromagnetic System*

The electromagnetic system is an Aerodat five frequency configuration. The survey was flown with the Aerodat bird designated Kestrel. Two vertical coaxial coil pairs and three horizontal coplanar coil pairs are operated at the frequencies and coil separations described below.

	Coax 1	Coax 2	Copl 1	Copl 2	Copl 3
Frequency (Hz)	915	4382	864	4781	33070
Coil Spacing (m)	6.4	6.4	6.4	6.4	6.4

Inphase and quadrature signals are measured simultaneously for the five frequencies with a time constant of 0.1 seconds. System noise levels are generally less than 1 ppm excluding spherics. Digital despiking and filtering of the EM signals permit rejection of the spheric noise to less than 1 ppm. The HEM bird is towed 30 metres below the helicopter.

4.4 *Magnetometer*

A Scintrex cesium vapour, optically pumped magnetometer sensor was used with a proprietary Aerodat magnetometer console. The sensitivity of this instrument is 0.001 nanoTeslas. Data was recorded every 0.1 seconds. The sensor was mounted in a bird towed 15 m below the helicopter.

4.5 *VLF-EM System*

The VLF-EM system is a Herz Totem 2A, towed 10 m below the helicopter. The sensor measures the total field and quadrature components of two selected frequencies.

The two VLF stations recorded are designated “Line” and “Ortho.” Ideally, the line station is in a direction parallel to the strike direction of the targets sought, and the ortho station is 90° in azimuth from the line station.

The two stations used were:

Line: NSS, Annapolis, Maryland, broadcasting at 21.4 kHz.
Approximate direction from survey: 147° azimuth

Ortho: NLK, Jim Creek, Washington, broadcasting at 24.8 kHz.
Approximate direction from survey: 161° azimuth

4.6 *Navigation System*

GPS Navigation System

The navigation system consisted of:

1. A Magnavox MX9212 GPS receiver in the helicopter
2. A Novatel 3151R GPS receiver operated as a base station with laptop PCs to log data for post-flight differential correction of airborne data.
3. Navpilot navigation console to provide guidance to the pilot
4. Position information from the airborne GPS receiver is recorded on tape at an update rate of 1.0 seconds. The survey lines are programmed into the navigation console, which receives position information from the airborne receiver and provides left/right guidance information to the pilot.

4.7 *Data Recording Systems*

Analog Recorder

A RMS dot matrix recorder was used to display the data during the survey. The analog record allows the geophysical crew to monitor the data quality of the system during the survey. Record contents are as follows:

Label	Contents	Scale
	GEOPHYSICAL SENSOR DATA	
MAGF	Total Magnetic Intensity, Fine	2.5 nT/mm
MAGC	Total Magnetic Intensity, Coarse	25 nT/mm
L9XI	915 Hz, Coaxial, Inphase	2.5 ppm/mm
L9XQ	915 Hz, Coaxial, Quadrature	2.5 ppm/mm

Label	Contents	Scale
M4XI	4382 Hz, Coaxial, Inphase	2.5 ppm/mm
M4XQ	4382 Hz, Coaxial, Quadrature	2.5 ppm/mm
L8PI	864 Hz, Coplanar, Inphase	10 ppm/mm
L8PQ	864 Hz, Coplanar, Quadrature	10 ppm/mm
M4PI	4781 Hz, Coplanar, Inphase	10 ppm/mm
M4PQ	4781 Hz, Coplanar, Quadrature	10 ppm/mm
H3PI	33.07 kHz, Coplanar, Inphase	20 ppm/mm
H3PQ	33.07 kHz, Coplanar, Quadrature	20 ppm/mm
VLT	VLF-EM, Line Station, Total Field	2.5 %/mm
VLQ	VLF-EM, Line Station, Quadrature	2.5 %/mm
VOT	VLF-EM, Ortho Station, Total Field	2.5 %/mm
VOQ	VLF-EM, Ortho Station, Quadrature	2.5 %/mm
	ANCILLARY DATA	
RALT	Radar Altimeter	10 ft/mm
BALT	Barometric Altimeter	50 ft/mm
GALT	GPS Elevation	50 ft/mm
PWRL	60 Hz Power Line Monitor	-
VREF	Voltage Reference	-

The zero of the radar altimeter is 5 cm (5 large divisions) from the top of the analog chart. The full analog range for the radar altimeter is therefore 500 feet. For altitudes above 500 feet, the radar altimeter trace wraps to the bottom of the analog. A flying height of 60 m (197 feet) gives an analog trace which is approximately three large divisions (3.03 cm) below the top of the analog record.

The zero of the barometric altimeter and GPS elevation traces is the bottom of the analog chart.

The chart speed is 2 mm/second. The 24 hour clock time is printed every 20 seconds. The total magnetic field value is printed every 30 seconds.

Manual fiducials entered by the operator appear as vertical lines crossing the entire analog chart. The start of any survey line is identified by two closely spaced manual fiducials. The end of any survey line is identified by three closely spaced manual fiducials. Manual fiducials are numbered in order. Every tenth manual fiducial is numbered and printed at the bottom of the record.

Digital Recorder

An RMS data acquisition system digitised and recorded the survey data on magnetic media. The principal data recorded was as follows:

DATA TYPE	SAMPLE RATE	RESOLUTION
Fiducials (Manual and Camera)		
Clock Time		
Magnetics	0.1 s	0.001 nT
Radar Altimeter	0.2 s	0.3 m
Barometric Altimeter	0.2 s	0.3 m
VLF-EM Data	0.2 s	0.01 %
Electromagnetic Data	0.1 s	0.1 ppm
Position (Latitude / Longitude)	1.0 s	1 m

4.8 Ancillary Systems

Base Station Magnetometer

A base station magnetometer was set up at the base of operations to record temporal variations of the Earth's magnetic field. The sensor was a Scintrex cesium vapour optically pumped magnetometer. The clock of the base station was synchronised with that of the airborne system to facilitate the removal of the Earth's temporal variations. Digital recording resolution was 0.001 nT. The update rate was 1 second.

Radar Altimeter

A Terra TRA 3000 radar altimeter was used to record terrain clearance. The working range is 0 to 2500 feet with an accuracy of ± 5 percent.

Barometric Altimeter

A Rosemount 1241M 3 B1 barometric altimeter recorded elevation above sea level in feet. This unit is factory calibrated based on a standard atmosphere of about 1 millibar per 10 metres. Since normal daily pressure variations are on the order of ± 10 millibars, the absolute accuracy of the barometric elevation is about ± 100 m. The relative accuracy is better.

Tracking Camera

A Panasonic colour video camera was used to record flight path on VHS video tape. The camera was operated in continuous mode. The flight number, 24 hour clock time (to 0.1 second), and manual fiducial number are encoded on the video tape.

Field Processing Equipment

Morex Pentium 133 MHz PC

14" SVGA Monitor

Epson Stylus Pro XL Inkjet Colour Printer

TDC-3660 Tape Drive

APC Backup 700 UPS

5. DATA PROCESSING AND PRESENTATION

5.1 Flight Path

The flight path is drawn using linear interpolation between x,y positions from the navigation system. WGS 1984 latitudes and longitudes are converted to the NAD 1927 datum for Canada, which uses the Clarke 1866 spheroid with local datum shifts of dx=-10 m, dy=158 m and dz=187 m. The positioning data are then converted to the UTM coordinate system using Zone 8, which uses a central meridian of 135°W. Processing includes speed checks to identify spikes and offsets which are removed. Positions are updated every second and expressed as eastings (x) and northings (y) in metres in the UTM projection, NAD 1927 (Canada) datum.

5.2 Registration

Despite advances in absolute positioning systems such as GPS, the registration of the flight path to the local topographic maps is ultimately based on a reasonable fit between manual fiducials or points picked from the video tape and local topographic maps. In countries with reliable topographic maps, the theoretical registration (based on an assumed datum and translation from WGS 84 co-ordinates) and the registration based on a best fit with local topographic features are commonly identical.

Where the local topographic maps, particularly the datum on which they are based, are more uncertain, differences in these two types of registration can occur.

5.3 *Electromagnetic Data*

The electromagnetic data are recorded digitally at a sample rate of 10 per second with a time constant of 0.1 seconds. A two stage digital filtering process rejects major spheric events and reduces system noise.

Local spheric activity can produce sharp, large amplitude events that cannot be removed by conventional frequency domain filtering procedures. Smoothing or stacking will reduce their amplitude but may leave a broader residual response that can be confused with geological phenomena. A computer algorithm, similar to surgical mutes in digital signal processing, searches out and rejects the major spheric events.

The signal to noise ratio is further enhanced by the application of a low pass digital filter. This filter has zero phase shift which prevents any lag or peak displacement from occurring, and it suppresses only variations with a wavelength less than about 0.25 seconds. This low effective time constant gives minimal profile distortion.

Following the filtering process, a base level correction is made using EM zero levels determined during high altitude calibration sequences. The correction applied is a linear function of time that ensures the corrected amplitude of the various inphase and quadrature components is zero when no conductive or permeable source is present. The filtered and levelled data is the basis for the determination of apparent conductivity (see below).

The profile EM data are presented at 1:20,000 scale as profiles offset from the flight path with superimposed planimetry and EM anomaly centres.

Apparent Conductivity

The apparent conductivity is calculated by assuming a 200 metre thick conductive layer over resistive bedrock. The computer determines the conductivity that would be consistent with the sensor elevation and recorded inphase and quadrature response amplitudes at the selected frequency. The apparent conductivity profile data is re-interpolated onto a regular grid at a 50 metre true scale interval using an Akima spline technique and contoured using logarithmically arranged contour intervals. Due to de facto standards in the industry, the apparent conductivity values are presented in terms of resistivity -- the inverse of conductivity. The minimum contour interval depends on the selected frequency and is in units of log(ohm•m) in logarithmic intervals of 0.1, 0.5, 1.0, 5.0 etc. The colour image palette is terms of conductivity with reds denoting high conductivity and blue denoting low conductivity.

A good rule of thumb is that the lowest measurable conductivity is approximately equal to the inverse of the transmitter frequency.

The profile resistivity data are interpolated onto square grids using an Akima spline technique. The grid cell size is 50 m. A 5 x 5 Hanning grid filter is passed over the final grids. The final grids provide the basis for threading the presented contours. The minimum contour interval is 0.1 log(ohm•m).

Hanning profile and grid filters are used extensively in processing airborne geophysical data. These are cosine shaped low pass or smoothing filters which reduce noise with minimal signal distortion.

The 1:20,000 scale presentation of the apparent resistivity shows colour fill and superimposed line contours plus flight path and superimposed planimetry and EM anomaly centres.

5.4 *Electromagnetic Anomaly Selection*

The main purpose of EM anomaly selection is to identify possible targets. The Aerodat automated EM picking algorithm is tuned to vertical conductors. Flat lying or shallowly dipping responses are weighed less because EM responses due to gradual changes from near surface horizontal sources are assumed to be due to lateral variation in overburden thickness or conductivity.

The EM picking algorithm seeks local maximums in the coaxial responses as the coaxial response is a single peak over a vertical conductor. In addition, the width of the conductor must be such that it is due to a discrete source – a conductor, instead of being due to broad lateral variations in near surface conductivity. The depth and the conductance of the anomaly is then derived from a computer subroutine using the assumptions of steep vertical conductivity.

For flat lying targets, the EM anomalies should either be interpreted manually or from geoelectric sections. The contours of apparent resistivity may also be used to outline this type of target. However, the apparent resistivity maps use a uniform Earth as the model for the derivations of the apparent resistivities. The conductance of discrete conductors are "diluted" in this manner and little depth information is obtained.

This is the reason why the steeply dipping conductor models are still used in areas of shallowly dipping conductivity. The automated picks still provide for, admittedly somewhat less precise than one would want, an quantitative estimate of conductance and depth of conductivity which is useful in the relative sense. The EM picks are also listed in digital form with the coordinates in the digital archive.

Characteristic EM responses to a number of simple conductor types are shown in Appendix III.

Anomaly Selection

Electromagnetic anomalies were selected from the 4382 Hz coaxial inphase data using an automatic algorithm. The automatic picks were then manually verified, and anomalies were added or deleted as necessary. Magnetite response anomalies were also selected manually from the 915 Hz coaxial traces.

Analysis

The remaining anomalies are characterised by the conductance and depth of burial using a thin vertical sheet like source. A numerical lookup table representing the nomograms presented in Appendix III is used to derive the conductance and depth of burial. Note that if the conductive source is not close to being a vertical sheet like body, the quantitative estimates of this analysis will be incorrect as the wrong model Earth will have been used.

All EM anomalies are catalogued in anomaly listings in Appendix II. The anomaly letter, survey line, location, 4382 Hz response amplitudes and conductance and depth estimates are also presented in Appendix II.

5.5 Magnetic Data

Total Magnetic Intensity

The raw magnetic data are examined for any spikes or magnetometer dropouts, which are removed. The data are corrected for temporal variations by adjustment with the recorded base station magnetic values. After the base station corrections are applied, the International Geomagnetic Reference Field (IGRF) is subtracted from the data and a base value of 58004 nT is replaced. IGRF removal is followed by fine tie line levelling using residuals at tie line intersections.

The corrected profile data are interpolated onto square grids using an Akima spline technique. The grid cell size is 50 m. A 5 x 5 Hanning grid filter is passed over the final grids. The final grids provide the basis for threading the presented contours. The minimum contour interval is 1 nT.

The 1:20,000 scale presentation of the total magnetic intensity shows colour fill and superimposed line contours plus flight path and superimposed planimetry and EM anomaly centres.

Vertical Magnetic Gradient

The vertical magnetic gradient is calculated from the gridded total magnetic intensity data using a 17 x 17 point convolution operator in the space domain. The resulting grid is contoured using a minimum contour interval of 0.01 nT/m.

The 1:20,000 scale presentation of the vertical magnetic gradient shows colour fill and superimposed line contours plus flight path and superimposed planimetry and EM anomaly centres.

5.6 VLF-EM Data

The VLF-EM total field data from the line station is levelled using a high-pass roll-off filter applied in the Fourier domain. The filter roll-off begins at a wavelength of 100 seconds and ends at a wavelength of 200 seconds.

The filtered profile data are interpolated onto square grids using an Akima spline technique. The grid cell size is 50 m. A 5 x 5 Hanning grid filter is passed over the final grids. The final grids provide the basis for threading the presented contours. The minimum contour interval is 1 %.

The 1:20,000 scale presentation of the VLF-EM total field shows colour fill and superimposed line contours plus flight path and superimposed planimetry and EM anomaly centres.

5.7 *Digital Elevation Model*

A digital elevation model is calculated by subtracting the radar altimeter values from the barometric altimeter values. The digital elevation model is then used to calculate corrections to the barometric altimeter required to remove the effects of daily pressure variations. The levelled barometric altimeter is then used to calculate a final model. The final model is self-consistent, and provides an accurate relative picture of topographic relief. The levelled model may be used to accurately determine the position of the geophysical data with respect to terrain features and to register data with respect to published topographic maps.

The line data are interpolated using an Akima spline technique onto a 50 metre grid which provides the basis for threading the presented contours. The minimum contour interval is 10 metres.

The 1:20,000 scale presentation of the digital elevation model shows colour fill and superimposed line contours plus flight path and digitised planimetry.

6. DELIVERABLES

Survey results are presented on a series of black line and colour maps at a scale of 1:20,000. The report is presented in three copies. Black line maps are presented in one mylar and three white print copies. Colour maps are presented in three copies.

Map types include:

Black Line Maps Scale 1:20,000

1. Topographic base map
2. Total magnetic intensity
3. Vertical magnetic gradient
4. Apparent Resistivity
    a) 864 Hz coplanar
    b) 4781 Hz coplanar
5. Total field VLF-EM

Colour Maps Scale 1:20,000

1. Total magnetic intensity
2. Vertical magnetic gradient
3. EM profiles
    a) 915 Hz coaxial / 864 Hz coplanar
    b) 4382 Hz coaxial / 4781 Hz coplanar
    c) 33.07 kHz coplanar
4. Apparent Resistivity
    a) 864 Hz coplanar
    b) 4781 Hz coplanar
5. Total field VLF-EM

Derivative Colour Maps Scale 1:20,000

1. Shadow enhanced total magnetic intensity
2. Digital elevation model

All maps show survey area boundaries and a UTM grid with latitude/longitude crosses. Colour maps show colour fill plus superimposed line contours, flight path, EM anomaly centres, planimetry digitised from 1:50,000 scale NTS topographic maps and digital elevation model contours plotted in white. Black line maps are photocombined with topographic information enlarged from 1:50,000 scale NTS maps.

Digital Archive

A CD ROM (ISO 9660) contains a digital archive of the profile and gridded data.

The profile data are written as Geosoft format .XYZ files.

The profile archives contain the following data, written with a sample rate of 0.2 seconds:

XYZ COLUMN	FORMAT	UNITS	DESCRIPTION
1	f10.1	metres	X = easting (NAD27, Zone 8)
2	f10.1	metres	Y = northing (NAD27, Zone 8)
3	f10.2	nanoTeslas	final processed total field

XYZ COLUMN	FORMAT	UNITS	DESCRIPTION
			magnetics
4	f10.1	metres	radar altimeter
5	f10.1	metres	barometric altimeter
6	f10.1	metres	digital elevation model
7	f10.1	millivolts	power line monitor
8	f10.1	ppm	864 Hz coplanar EM inphase
9	f10.1	ppm	864 Hz coplanar EM quadrature
10	f10.1	ppm	4781 Hz coplanar EM inphase
11	f10.1	ppm	4781 Hz coplanar EM quadrature
12	f10.1	ppm	33070 Hz coplanar EM inphase
13	f10.1	ppm	33070 Hz coplanar EM quadrature
14	f10.1	ppm	915 Hz coaxial EM inphase
15	f10.1	ppm	915 Hz coaxial EM quadrature
16	f10.1	ppm	4382 Hz coaxial EM inphase
17	f10.1	ppm	4382 Hz coaxial EM quadrature
18	f10.4	log 10 ohm-metres	resistivity (from 864 coplanar EM)
19	f10.4	log 10 ohm-metres	resistivity (from 4781 coplanar EM)
20	f10.1	%	total field line VLF
21	f10.1	%	quadrature Line VLF
22	f10.2	seconds past midnight	time
23	f10.3	units	manual fiducials
24	I6	units	flight number

The gridded data are written as standard Geosoft format grids. The gridded archive contains the following grids with 50 metre cell size:

- Total magnetic intensity
- Vertical magnetic gradient
- 864 Hz coplanar apparent resistivity
- 4781 Hz coplanar apparent resistivity
- Total field VLF-EM
- Digital elevation model

6. GEOLOGY

On published geological maps, the survey area is located on the west side of the Tintina Fault in the Pelly-Cassiar Platform (Mortensen and Jilson, 1985). The Pelly-Cassiar Platform is thought to be coeval, and possibly correlative with Yukon-Tanana Terrane in the Finlayson Lake district which hosts the Kudz ze Kayah polymetallic deposit of Cominco, and the Wolverine deposit of Westmin/Atna.

In September of 1997, Atna Resources announced significant drill results on the Wolf Property which is located in the Pelly-Cassiar Platform. The best intersection, in WF97-07, was 25.2 metres grading 6.94% Zn, 2.78% Pb, and 138.6 g/t Ag. Massive sulphide mineralisation on the Wolf Property is hosted by pyritised felsic tuffs. The felsic tuffs are part of a unit of intermediate to felsic volcanic rocks of Mississipian age which define a northwest trending belt approximately 80 kilometres long and up to 25 kilometres wide.

6.1 Project Targets

The Wolf deposit is on-strike and in similar host rocks some 55 kilometres to the southeast. It is assumed that the project targets would be economic mineralisation of a similar nature to the Wolf deposit. It is believed that the Wolf deposit is a Kuroko type VMS deposit. The Kudz ze Kayah and the Wolverine deposits are also Kuroko type VMS.

The Ketza River Mine occurs between the survey area and the Wolf Deposit. Details on the Ketza River Mine were not readily available to the report writers. It is an oxide gold mine and may be a secondary target.

7. INTERPRETATION

VMS deposits are amenable to direct detection by electromagnetic methods as the massive sulphides are conductive. The nearby Kudz ze

Kayah deposit was easily detected by helicopter EM systems (Holroyd and Klein, 1998). The geophysical response of the Kudz ze Kayah Deposit is that of a good EM, short strike length conductor situated to the south of a band of conductive sediments. It is also magnetic. Therefore, any reasonable conductor located by the survey should be carefully considered.

Magnetics

The magnetic variation measured over the property varies only by approximately 75 nT. This subdued magnetic intensity is indicative of sediments and felsic volcanics. There also appears to be a correlation of magnetic intensity with topography. The correlation of the magnetics to topography may be interpreted to be due to flat, or near flat lying stratigraphy with felsic volcanics over non-magnetic sediments.

The calculated vertical gradient is also subdued.

Magnetic linears are interpreted from the maps. These linears may represent faults, and if so, these faults would be high angle faults as the region appears to be flat lying.

The more magnetic areas are interpreted to be due to thicker felsic volcanics. A magnetic anomaly towards the bottom of the map sheet is interpreted to be due to either a mafic or ultramafic body. This magnetic feature is near surface as EM negatives are detected over the body.

Apparent Resistivity

There is a large variation in the apparent resistivities, with variations of 5 to 1588 ohm-metres in the 864 Hz data, and 10 to 3,162 ohm-metres in the 4781 data. The overall pattern is somewhat similar to the magnetics, with low resistivities at lower elevations, and high resistivities on the mountains. This may be due to thicker overburden which are conductive, in the valleys. More likely, it is due to conductive sediments such as mudstones, or perhaps shales. Felsic volcanics are typically more resistive.

VLF

The VLF data reflects topography with the total field VLF maximums correlating with topographic highs. The general trend of the VLF is in an east-northeast, west-southwest direction.

EM Anomalies

Appendix II provides a listing of the individual EM anomalies and estimates of the conductance and depth of burial of these bodies.

Some twenty-six groups of EM anomalies have been interpreted and ranked based on their geophysical characteristics.

Anomaly 1 is a linear anomaly, portions of which, have a conductance between 4 to 8 Siemens. It is located in magnetic low area and is parallel to a ridge top. It is a second ranked anomaly.

Anomaly 2 is a short two line anomaly. On line 10060, it is near vertical with perhaps a slight dip to the north. It is in a magnetic area. It is a second ranked anomaly.

Anomaly 3 is also a two line anomaly in an magnetic area. It is a bit broader (laterally more extensive) than anomaly 2 and is in a conductive area. It is a third ranked anomaly.

Anomaly 4 is a linear anomaly within a conductive region. On line 10040, the conductance is estimated to be between 4 and 8 Siemens. It is subparallel to a magnetic linear and is a third ranked anomaly.

Anomaly 5 is a curved feature in a magnetic low area. Its highest conductance is between 8 and 16 Siemens and due to the high conductance and unusual shape, is a top ranked anomaly.

Anomaly 6 is weak conductive anomaly which is subparallel to anomaly 5. It is on the flanks of a hill and more or less follows the topographic contours indicating a flat lying feature. It is a second ranked anomaly.

Anomaly 7 is a short two line feature similar to anomaly 8. It is a third ranked anomaly.

The EM responses of anomaly 8 has indications of near vertical dip. It consists of moderate to weak responses, with the highest conductance of between 4 to 8 Siemens. It is a second ranked anomaly.

Located at the sediments/felsic volcanics contact (as determined by the magnetics), anomaly 9 is a weak, three line anomaly. It is a third ranked anomaly.

Anomaly 10 is a longish, seven line conductor at the northern edge of the survey. It is mostly on the flank of a slope. It is a second ranked anomaly.

Anomaly 11 and 12 are short EM anomalies which has reasonable conductances in the 4 to 8 Siemens category. They are located in an area of widespread conductivity and are both second ranked anomalies.

Anomaly 13 is a double conductor which trends into the magnetic high area with good conductance in the magnetic high area. It is a top ranked anomaly.

Anomaly 14 trends from the magnetic area into the sediments. It is located in a conductive area and is a third ranked anomaly.

Anomaly 15 is similar to 14, but has much higher conductances. It is a top ranked anomaly based on its conductance.

Anomaly 16 consists of a couple of higher conductance (4 to 8 S) responses. It is a top ranked anomaly as it has strike extent and good conductance.

Anomaly 17 is a broad response which is indicative of being due to overburden. It is a third ranked anomaly.

Anomaly 18 has two good, 4 to 8 S responses. It trends into the magnetic area and is in a conductive region. It is a second ranked anomaly.

Anomaly 19 is a broad anomaly in a conductive region. It is a third ranked anomaly.

Anomaly 20 is a short conductor in a conductive area. It is a third ranked anomaly.

Anomaly 21 trends into the magnetic high to the east. One EM response has a 4-8 S conductance. It is a third ranked anomaly.

Anomaly 22 is a short strike length response in the area interpreted to be due to sediments. It is in a river valley and one response has a conductance between 4 and 8 S. It is a top ranked anomaly based on its relatively isolated location.

Anomaly 23 is a very weak EM conductor located on the magnetic contact of the sediments and volcanics. It is a third ranked anomaly.

Anomaly 24 is a short strike length response in a conductive region. It is a third ranked anomaly.

Anomaly 25 may be the continuation of anomaly 8. It has a higher conductance portion in the middle of the conductor and may be related to a good 4 to 8 S response off to the side of the conductor. It is a second ranked anomaly.

Anomaly 26 is a weak to moderate set of EM responses. It may be subparallel to the magnetic trends. It is a second ranked anomaly.

8. CONCLUSIONS

The geophysical results have been processed from a helicopterborne five-frequency electromagnetic, high-sensitivity magnetic and VLF-EM survey in the Finlayson Lake area of the Yukon Territory. The survey has been completed over a total of 131 line kilometres. The results of the survey have been presented on 1 map sheet at a scale of 1:20,000. Map types include colour EM profiles and black line and colour contour maps of the total magnetic field, vertical magnetic gradient, apparent resistivity, VLF-EM total field and digital elevation model.

All noise levels were within contract specifications. The collected data is of high quality and accurately represents the geophysical response of the Earth over the survey area.

The targets are assumed to be VMS deposits of the Kuroko type. As such, the EM responses are of importance as they may be directly due to the massive sulphides. Some 26 anomalies have been examined in further detail in this report. The top ranked of those (anomalies 5, 13, 15, 16, and 22) should be immediately followed up on the ground to determine the source of the anomalies. The others should be correlated to known geological information to determine whether the geological setting will change their ranking.

Ground geophysical methods such as horizontal loop should be considered to find those blind conductors which are of interest.

The most promising of the conductors should then be considered for drill testing.

Respectfully submitted,

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February 27, 1998

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APPENDIX I - FLIGHT LINE INDEX

LINE	FLT	TYPE	DATE M/D/Y	START TIME	END TIME	MANUAL FIDUCIAL START	END
10290	1	TRAV	11/11/97	17:27:38	17:32:43	6	10
10280	1	TRAV	11/11/97	17:32:44	17:36:43	11	15
10270	1	TRAV	11/11/97	17:36:44	17:39:25	16	20
10271	1	TRAV	11/11/97	17:39:26	17:42:03	21	25
10260	1	TRAV	11/11/97	17:42:04	17:50:17	26	30
10250	1	TRAV	11/11/97	17:50:18	17:59:21	31	35
10240	1	TRAV	11/11/97	17:59:22	18:01:53	36	40
10241	1	TRAV	11/11/97	18:01:54	18:05:03	41	45
10230	1	TRAV	11/11/97	18:05:04	18:12:19	46	50
10220	1	TRAV	11/11/97	18:17:18	18:21:45	56	60
10210	1	TRAV	11/11/97	18:21:46	18:25:23	61	66
10200	1	TRAV	11/11/97	18:25:24	18:29:41	67	71
10190	1	TRAV	11/11/97	18:29:42	18:36:53	72	76
10191	1	TRAV	11/11/97	18:36:54	18:46:37	77	81
10192	1	TRAV	11/11/97	18:46:38	18:50:07	82	86
10180	1	TRAV	11/11/97	18:50:08	18:55:57	87	91
10170	2	TRAV	11/11/97	19:23:43	19:30:12	6	10
10160	2	TRAV	11/11/97	19:30:13	19:35:54	11	15
10150	2	TRAV	11/11/97	19:35:55	19:41:20	16	20
10140	2	TRAV	11/11/97	19:41:21	19:43:50	21	25
10141	2	TRAV	11/11/97	19:43:51	19:51:44	26	30
10130	2	TRAV	11/11/97	19:51:45	19:59:54	31	35
10120	2	TRAV	11/11/97	19:59:55	20:01:28	36	40
10121	2	TRAV	11/11/97	20:01:29	20:09:14	41	45

LINE	FLT	TYPE	DATE M/D/Y	START TIME	END TIME	MANUAL FIDUCIAL START	END
10110	2	TRAV	11/11/97	20:09:15	20:16:52	46	50
10100	2	TRAV	11/11/97	20:16:53	20:26:00	51	55
10090	3	TRAV	11/11/97	20:54:07	21:02:08	6	10
10080	3	TRAV	11/11/97	21:02:09	21:10:12	11	15
10070	3	TRAV	11/11/97	21:10:13	21:16:50	16	20
10060	3	TRAV	11/11/97	21:16:51	21:24:02	21	25
10050	3	TRAV	11/11/97	21:24:03	21:30:22	26	30
10040	3	TRAV	11/11/97	21:31:41	21:39:18	36	40
10030	3	TRAV	11/11/97	21:39:19	21:45:32	41	45
10020	3	TRAV	11/11/97	21:45:33	21:52:00	46	50
10010	3	TRAV	11/11/97	21:52:01	21:58:50	51	55
81070	4	TIE	11/11/97	22:43:54	22:51:25	11	15
81020	4	TIE	11/11/97	22:51:26	23:00:21	16	20

APPENDIX II - ELECTROMAGNETIC ANOMALY LISTING

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
3	10010	A	Normal	46.7	93.7	0.7	0	25	633817	6836751
3	10010	B	Normal	65.2	69.6	1.8	0	29	633773	6836886
3	10020	A	Normal	11.0	42.8	0.1	1	21	633962	6836956
3	10020	B	Normal	21.4	55.2	0.3	6	17	633988	6836829
3	10020	C	Normal	20.8	68.4	0.2	3	17	634058	6836571
3	10020	D	Normal	28.3	64.9	0.5	6	17	634145	6836325
3	10020	E	Normal	42.3	36.0	2.1	0	37	634192	6836147
3	10020	F	Normal	124.2	101.0	3.1	0	27	634235	6836039
3	10020	G	Normal	141.7	135.3	2.7	0	20	634241	6835999
3	10020	H	Normal	57.8	47.5	2.4	0	34	634247	6835888
3	10020	J	Normal	86.4	22.8	11.9	27	6	634285	6835729
3	10020	K	Normal	131.0	123.3	2.6	0	40	634356	6835303
3	10030	A	Normal	61.7	44.7	2.9	0	43	634936	6833883
3	10030	B	Normal	114.2	56.8	5.7	0	33	634913	6833962
3	10030	C	Normal	98.2	44.3	6.1	0	36	634891	6834035
3	10030	D	Normal	73.0	33.4	5.5	0	40	634863	6834116
3	10030	E	Normal	14.6	11.3	1.6	12	38	634785	6834357
3	10030	F	Normal	8.5	11.2	0.6	0	55	634635	6835057
3	10030	G	Normal	18.8	21.2	1.0	0	46	634580	6835326
3	10030	H	Normal	64.3	65.3	1.9	1	26	634505	6835531
3	10030	J	Normal	101.3	93.4	2.5	4	20	634498	6835580
3	10030	K	Normal	4.7	97.1	0.0	0	14	634406	6835837
3	10030	M	Normal	25.0	17.6	2.2	0	82	634377	6836186
3	10030	N	Normal	24.1	38.3	0.7	0	46	634324	6836371
3	10030	O	Normal	24.3	29.9	1.0	0	44	634248	6836689
3	10030	P	Normal	38.6	43.9	1.4	0	33	634216	6836874
3	10040	A	Normal	6.9	34.9	0.0	7	15	634328	6837029
3	10040	B	Normal	24.8	43.3	0.6	0	36	634383	6836857
3	10040	C	Normal	85.5	52.1	4.0	0	35	634432	6836709
3	10040	D	Normal	45.2	36.0	2.3	0	37	634459	6836489
3	10040	E	Normal	96.0	52.5	4.8	1	28	634496	6836382
3	10040	F	Normal	85.3	56.7	3.6	4	24	634521	6836330

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
3	10040	G	Normal	75.7	63.5	2.6	2	25	634527	6836306
3	10040	H	Normal	127.6	116.6	2.7	0	29	634589	6836045
3	10040	J	Normal	108.4	93.2	2.8	0	31	634590	6836023
3	10040	K	Normal	53.5	38.6	2.8	0	37	634625	6835934
3	10040	M	Normal	27.9	69.9	0.4	0	25	634691	6835613
3	10040	N	Normal	38.9	75.3	0.7	0	29	634735	6835507
3	10040	O	Normal	15.4	23.6	0.6	0	45	634815	6835053
3	10040	P	Normal	185.9	146.1	3.7	0	23	635196	6833720
3	10040	Q	Normal	94.8	68.7	3.3	8	19	635225	6833644
3	10040	R	Normal	104.5	52.7	5.4	1	27	635242	6833557
3	10040	S	Normal	69.2	56.0	2.6	0	37	635306	6833196
3	10040	T	Normal	73.9	54.1	3.0	0	37	635385	6832915
3	10040	U	Normal	76.0	87.4	1.7	0	27	635446	6832713
3	10040	V	Normal	129.3	240.1	1.1	0	26	635464	6832588
3	10040	W	Normal	110.8	195.1	1.1	0	21	635483	6832550
3	10040	X	Normal	287.1	490.2	1.6	0	17	635506	6832502
3	10040	Y	Normal	139.9	255.6	1.2	0	16	635519	6832474
3	10040	Z	Normal	199.9	295.5	1.7	0	16	635526	6832458
3	10050	A	Normal	26.2	18.8	2.2	3	39	635683	6832550
3	10050	B	Normal	35.4	26.7	2.3	0	45	635670	6832619
3	10050	C	Normal	43.3	40.7	1.8	0	45	635650	6832662
3	10050	D	Normal	176.4	457.0	0.8	0	36	635566	6832851
3	10050	E	Normal	232.4	441.4	1.3	0	34	635550	6832906
3	10050	F	Normal	70.9	31.1	5.8	0	48	635463	6833112
3	10050	G	Normal	65.3	26.2	6.3	0	51	635436	6833249
3	10050	H	Normal	74.6	36.3	5.1	0	46	635408	6833368
3	10050	J	Normal	61.5	35.1	3.9	0	35	635339	6833600
3	10050	K	Normal	32.4	21.1	2.7	2	39	635323	6833716
3	10050	M	Normal	8.2	16.1	0.3	3	36	634937	6835358
3	10050	N	Normal	25.2	54.9	0.5	0	30	634708	6836318
3	10050	O	Normal	26.6	13.3	3.6	0	58	634642	6836564
3	10050	P	Normal	208.9	148.7	4.3	0	34	634620	6836750

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
3	10050	Q	Normal	311.8	299.4	3.4	0	24	634611	6836819
3	10050	R	Normal	55.0	143.9	0.5	2	14	634409	6837547
3	10060	A	Normal	601.6	309.7	8.7	0	22	634657	6837521
3	10060	B	Normal	281.2	150.8	6.7	3	17	634670	6837480
3	10060	C	Normal	14.0	63.5	0.1	2	16	634792	6837001
3	10060	D	Normal	36.3	112.2	0.3	3	14	634817	6836884
3	10060	E	Normal	94.0	75.9	2.9	0	29	634905	6836680
3	10060	F	Normal	74.5	42.2	4.2	0	35	634944	6836586
3	10060	G	Normal	10.4	14.1	0.6	7	38	634993	6836319
3	10060	H	Normal	5.2	3.7	1.2	0	88	635016	6836181
3	10060	J	Normal	22.1	31.3	0.8	0	46	635230	6835403
3	10060	K	Normal	7.0	27.8	0.1	0	33	635285	6835300
3	10060	M	Normal	5.2	16.2	0.1	0	38	635302	6835248
3	10060	N	Normal	19.2	36.7	0.5	0	44	635631	6833698
3	10060	O	Normal	30.0	65.3	0.5	0	26	635664	6833551
3	10060	P	Normal	19.8	36.0	0.5	0	34	635673	6833446
3	10060	Q	Normal	26.9	33.9	1.0	0	36	635673	6833347
3	10060	R	Normal	43.5	31.5	2.6	4	31	635711	6833120
3	10060	S	Normal	159.6	166.3	2.5	0	27	635884	6832676
3	10070	A	Normal	129.5	43.0	9.9	0	30	636077	6832802
3	10070	B	Normal	10.2	85.2	0.0	0	14	635985	6833017
3	10070	C	Normal	8.8	31.2	0.1	0	46	635878	6833345
3	10070	D	Normal	9.1	35.7	0.1	0	46	635743	6833762
3	10070	E	Normal	9.2	95.8	0.0	0	28	635621	6834370
3	10070	F	Normal	13.8	35.8	0.3	0	27	635590	6834500
3	10070	G	Normal	17.7	19.4	1.1	0	60	635351	6835356
3	10070	H	Normal	38.9	26.8	2.6	0	50	635104	6836743
3	10070	J	Normal	37.2	70.5	0.7	0	31	635049	6836990
3	10070	K	Normal	54.3	142.2	0.5	0	24	634945	6837349
3	10070	M	Normal	170.6	155.5	3.0	0	23	634939	6837486
3	10070	N	Normal	1081.3	575.4	9.8	0	21	634927	6837547
3	10080	A	Normal	92.8	24.0	12.4	0	45	635088	6837681

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
3	10080	B	Normal	30.6	23.3	2.1	2	37	635074	6837446
3	10080	C	Normal	10.6	12.7	0.8	22	25	635108	6837382
3	10080	D	Normal	11.6	19.6	0.5	0	44	635211	6836976
3	10080	E	Normal	11.5	25.7	0.3	0	49	635906	6834014
3	10080	F	Normal	11.3	30.6	0.2	0	40	636040	6833575
3	10080	G	Normal	32.3	28.7	1.8	0	57	636215	6832854
3	10090	A	Normal	24.5	148.3	0.1	0	12	636430	6832964
3	10090	B	Normal	10.4	27.7	0.2	0	62	636235	6833603
3	10090	C	Normal	39.1	38.8	1.6	4	29	636148	6833961
3	10090	D	Normal	16.9	38.6	0.4	0	32	636135	6834110
3	10090	E	Normal	5.6	13.1	0.2	0	55	635625	6836106
3	10090	F	Normal	8.8	18.7	0.3	0	80	635593	6836212
3	10090	G	Normal	10.6	13.8	0.7	0	57	635433	6836951
3	10090	H	Normal	67.6	47.6	3.1	0	40	635275	6837488
3	10090	J	Normal	33.2	11.5	6.3	0	77	635223	6837807
2	10100	A	Normal	37.6	60.7	0.8	5	20	635415	6837646
2	10100	B	Normal	62.8	133.2	0.7	2	16	635430	6837601
2	10100	C	Normal	19.4	95.9	0.1	6	9	635439	6837496
2	10100	D	Normal	4.4	16.0	0.1	15	18	635465	6837400
2	10100	E	Normal	5.7	9.8	0.3	3	45	635512	6837208
2	10100	F	Normal	6.5	10.9	0.4	0	47	635515	6837190
2	10100	G	Normal	13.1	16.0	0.8	0	47	635605	6836888
2	10100	H	Normal	8.2	15.6	0.3	6	34	635658	6836733
2	10110	A	Normal	12.0	20.2	0.5	0	39	636737	6833414
2	10110	B	Normal	16.6	19.2	1.0	0	56	635851	6836832
2	10110	C	Normal	10.1	23.8	0.3	0	54	635815	6836966
2	10110	D	Normal	10.8	13.5	0.7	2	43	635725	6837226
2	10110	E	Normal	22.1	32.2	0.8	0	57	635608	6837651
2	10121	A	Normal	50.0	67.0	1.2	0	26	635833	6837596
2	10121	B	Normal	91.2	145.9	1.2	0	22	635830	6837549
2	10121	C	Normal	28.7	60.7	0.5	3	21	635845	6837457
2	10121	D	Normal	27.1	45.6	0.7	0	28	635883	6837300

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
2	10121	E	Normal	12.7	13.5	1.0	0	57	635986	6837116
2	10121	F	Normal	6.1	17.0	0.1	0	46	636136	6836692
2	10121	G	Normal	5.6	26.6	0.0	2	23	636376	6835733
2	10130	A	Magnetite	-1.4	32.5	0.0	0	17	637213	6833202
2	10130	B	Magnetite	-1.0	8.0	0.0	0	26	637161	6833420
2	10130	C	Normal	2.9	23.7	0.0	0	68	636325	6836591
2	10130	D	Normal	3.0	20.1	0.0	0	58	636310	6836642
2	10130	E	Normal	50.4	65.4	1.3	0	45	636226	6836995
2	10130	F	Normal	42.6	196.3	0.2	0	51	636222	6837031
2	10130	G	Normal	8.3	62.1	0.0	0	39	636217	6837072
2	10130	H	Normal	20.5	38.5	0.5	1	28	636148	6837332
2	10130	J	Normal	43.8	26.9	3.2	0	46	636102	6837567
2	10130	K	Normal	4.0	12.5	0.1	0	58	636060	6837887
2	10130	M	Normal	6.6	4.3	1.5	0	101	636065	6838165
2	10140	A	Normal	135.3	69.5	5.7	0	39	636073	6838189
2	10140	B	Normal	28.2	23.3	1.9	0	57	636138	6837954
2	10140	C	Normal	31.9	30.0	1.6	0	52	636156	6837836
2	10140	D	Normal	46.1	31.7	2.8	0	37	636227	6837546
2	10141	A	Normal	19.8	6.9	5.3	0	71	636328	6837340
2	10141	B	Normal	15.1	9.9	2.0	0	67	636349	6837266
2	10141	C	Normal	68.0	36.6	4.4	0	41	636424	6837005
2	10141	D	Normal	13.9	23.1	0.5	0	43	636520	6836728
2	10141	E	Normal	5.3	8.8	0.3	27	23	636582	6836561
2	10141	F	Normal	7.7	28.1	0.1	0	34	637214	6834024
2	10141	G	Magnetite	-11.6	4.2	0.0	0	25	637331	6833609
2	10150	A	Magnetite	0.0	9.9	0.0	0	34	637607	6833712
2	10150	B	Normal	5.8	34.3	0.0	0	25	637521	6833829
2	10150	C	Normal	8.3	44.4	0.0	0	23	637384	6834169
2	10150	D	Normal	7.6	26.8	0.1	4	23	637342	6834309
2	10150	E	Normal	0.9	69.7	0.0	0	33	636723	6836614
2	10150	F	Normal	8.8	143.4	0.0	0	29	636715	6836655
2	10150	G	Normal	33.7	24.0	2.4	0	54	636625	6836975

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
2	10150	H	Normal	44.1	25.5	3.5	11	26	636481	6837498
2	10150	J	Normal	86.6	52.5	4.0	1	28	636454	6837613
2	10150	K	Normal	36.1	67.7	0.7	0	31	636445	6837665
2	10150	M	Normal	14.9	24.9	0.5	0	48	636384	6837911
2	10150	N	Normal	14.2	29.0	0.4	6	25	636347	6838051
2	10150	O	Normal	50.1	28.5	3.7	0	53	636309	6838305
2	10160	A	Normal	8.5	5.7	1.6	0	89	636490	6838262
2	10160	B	Normal	12.7	21.5	0.5	3	33	636652	6837751
1	10180	A	Normal	41.4	45.9	1.4	0	54	636903	6838452
1	10180	B	Normal	61.7	54.7	2.2	0	51	636887	6838513
1	10190	A	Normal	10.8	4.6	3.3	0	97	637039	6838609
1	10190	B	Normal	12.0	8.4	1.7	0	67	637081	6838524
1	10200	A	Normal	18.1	11.1	2.4	0	102	637293	6838662
1	10210	A	Normal	11.3	6.3	2.3	0	91	637418	6838757
1	10210	B	Normal	13.3	11.2	1.4	0	56	637441	6838584
1	10220	A	Normal	9.6	32.4	0.1	3	23	638331	6836075
1	10220	B	Normal	28.8	22.8	2.0	0	43	637647	6838525
1	10220	C	Normal	30.1	22.2	2.2	4	36	637635	6838636
1	10220	D	Normal	23.0	18.7	1.8	0	44	637584	6838801
1	10230	A	Normal	12.9	7.3	2.4	0	71	637801	6838910
1	10230	B	Normal	18.3	46.3	0.3	0	33	638496	6836166
1	10240	A	Normal	40.8	44.4	1.5	0	34	638847	6835910
1	10240	B	Normal	20.1	27.5	0.8	13	22	638818	6836026
1	10240	C	Normal	10.7	31.6	0.2	16	11	638773	6836206
1	10240	D	Normal	20.5	26.8	0.9	6	29	638697	6836466
1	10240	E	Normal	20.7	20.4	1.3	0	44	638667	6836524
1	10240	F	Normal	15.3	19.6	0.8	3	37	638575	6836684
1	10241	A	Normal	12.3	15.2	0.8	0	73	638196	6838191
1	10241	B	Normal	35.0	28.9	2.0	0	71	638150	6838373
1	10241	C	Normal	59.6	59.3	1.9	0	40	638032	6838733
1	10241	D	Normal	40.3	29.0	2.5	1	35	637995	6838831
1	10250	A	Normal	28.8	13.0	4.2	0	50	638245	6838931

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
1	10250	B	Normal	38.4	17.4	4.6	0	50	638272	6838711
1	10250	C	Normal	31.7	20.0	2.8	0	44	638314	6838413
1	10250	D	Normal	42.4	20.2	4.4	0	49	638376	6838231
1	10250	E	Normal	26.9	22.1	1.8	14	26	638491	6837832
1	10250	F	Normal	23.3	35.2	0.8	5	27	638517	6837770
1	10250	G	Normal	9.0	5.4	1.9	0	88	638756	6836790
1	10250	H	Normal	27.2	11.6	4.5	0	78	638841	6836520
1	10250	J	Normal	43.2	42.8	1.7	0	49	638875	6836413
1	10250	K	Normal	49.4	61.5	1.3	0	35	638887	6836354
1	10260	A	Normal	83.1	97.7	1.7	0	32	639138	6836068
1	10260	B	Normal	43.7	24.4	3.6	0	48	639053	6836495
1	10260	C	Normal	54.6	32.8	3.5	0	36	639025	6836558
1	10260	D	Normal	29.5	28.7	1.5	19	17	638955	6836817
1	10260	E	Normal	34.7	31.8	1.7	15	20	638928	6836875
1	10260	F	Normal	13.6	155.9	0.0	0	13	638824	6837449
1	10260	G	Normal	29.1	91.6	0.3	9	9	638781	6837547
1	10260	H	Normal	37.4	68.9	0.7	3	21	638743	6837688
1	10260	J	Normal	33.0	51.1	0.8	3	24	638694	6837801
1	10260	K	Normal	35.8	68.7	0.7	0	30	638656	6837874
1	10260	M	Normal	26.0	24.8	1.5	0	59	638604	6838013
1	10260	N	Normal	12.5	11.5	1.2	0	90	638582	6838209
1	10260	O	Normal	15.3	7.5	3.1	0	81	638562	6838315
1	10260	P	Normal	17.7	8.7	3.2	0	89	638532	6838458
1	10260	Q	Normal	55.1	26.1	4.8	0	58	638415	6838804
1	10260	R	Normal	45.9	24.7	3.9	0	58	638415	6838903
1	10270	A	Normal	17.8	6.1	5.2	0	82	638546	6839185
1	10270	B	Normal	21.0	17.0	1.7	0	46	638572	6838978
1	10270	C	Normal	31.4	18.4	3.1	5	36	638601	6838874
1	10270	D	Normal	42.3	28.4	2.8	0	43	638631	6838726
1	10270	E	Normal	64.7	33.3	4.6	0	46	638690	6838524
1	10271	A	Normal	10.3	7.6	1.5	0	66	638776	6838289
1	10271	B	Normal	57.4	71.2	1.4	0	38	638891	6837935

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
1	10271	C	Normal	63.9	64.1	1.9	0	42	638893	6837885
1	10271	D	Normal	17.4	20.4	1.0	0	42	638939	6837632
1	10271	E	Normal	46.4	24.1	4.1	0	44	638984	6837421
1	10271	F	Normal	52.0	47.1	2.0	0	36	639071	6837139
1	10271	G	Normal	61.0	61.9	1.9	0	37	639162	6836826
1	10271	H	Normal	70.6	90.4	1.4	0	32	639170	6836773
1	10271	J	Normal	52.9	40.9	2.5	0	51	639199	6836586
1	10271	K	Normal	38.7	45.8	1.3	0	40	639279	6836290
1	10271	M	Normal	41.0	46.3	1.4	0	36	639333	6836139
1	10280	A	Normal	75.4	111.0	1.2	0	21	639527	6836253
1	10280	B	Normal	50.3	40.8	2.3	0	40	639447	6836458
1	10280	C	Normal	116.9	132.5	2.0	1	19	639410	6836611
1	10280	D	Normal	151.7	169.2	2.2	1	17	639404	6836645
1	10280	E	Normal	134.8	141.3	2.3	3	17	639398	6836705
1	10280	F	Normal	62.2	67.3	1.7	3	24	639357	6836901
1	10280	G	Normal	70.9	93.3	1.4	0	27	639283	6837072
1	10280	H	Normal	92.7	93.7	2.1	0	27	639230	6837274
1	10280	J	Normal	115.5	101.0	2.8	0	23	639194	6837401
1	10280	K	Normal	58.8	19.5	7.9	0	55	639109	6837820
1	10280	M	Normal	64.4	22.8	7.4	0	49	639102	6837844
1	10280	N	Normal	75.4	68.1	2.3	0	33	639071	6837922
1	10280	O	Normal	19.4	98.0	0.1	2	13	639005	6838161
1	10280	P	Normal	26.4	16.4	2.7	0	73	638938	6838386
1	10280	Q	Normal	43.5	24.3	3.6	0	133	638917	6838519
1	10280	R	Normal	49.0	37.1	2.5	0	58	638873	6838664
1	10280	S	Normal	29.5	31.6	1.3	0	35	638821	6838837
1	10280	T	Normal	22.1	20.9	1.4	0	57	638793	6838942
1	10280	U	Normal	33.3	19.3	3.2	0	56	638718	6839231
1	10290	A	Normal	19.4	13.2	2.1	1	47	639177	6838612
1	10290	B	Normal	46.4	32.6	2.7	0	36	639185	6838507
1	10290	C	Normal	79.4	69.5	2.5	0	27	639206	6838440
1	10290	D	Normal	68.2	71.1	1.9	0	30	639212	6838374

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

Flight	Line	Label	Type	Inphase (ppm)	Quad. (ppm)	Cond. (mhos)	Depth (m)	EM bird ht. (m)	UTM Easting (m)	UTM Northing (m)
1	10290	E	Normal	24.3	35.4	0.8	8	23	639250	6838281
1	10290	F	Normal	22.2	19.6	1.6	0	67	639281	6838081
1	10290	G	Normal	39.0	15.4	5.5	0	53	639315	6837919
1	10290	H	Normal	37.5	13.0	6.5	0	60	639333	6837871
1	10290	J	Normal	38.2	15.5	5.3	0	59	639446	6837467
1	10290	K	Normal	47.3	22.4	4.6	0	64	639470	6837292
1	10290	M	Normal	48.8	33.0	2.9	0	60	639499	6837134
1	10290	N	Normal	56.2	48.6	2.2	0	51	639545	6836971
1	10290	O	Normal	144.1	175.0	2.0	0	28	639596	6836812
1	10290	P	Normal	100.4	135.3	1.5	0	23	639631	6836716
1	10290	Q	Normal	91.9	106.3	1.8	0	27	639692	6836574
1	10290	R	Normal	34.5	25.7	2.3	0	48	639770	6836361
1	10290	S	Normal	43.4	31.5	2.6	0	55	639766	6836225

Anomaly parameters are calculated from the response of a vertical half plane in free space using the 4382 Hz coaxial coil amplitudes.

APPENDIX III - GENERAL INTERPRETATION CONSIDERATIONS

Magnetometer Data

The application for magnetometer surveys is the recognition and delineation of structural or stratigraphic environments favourable for mineral deposits. Specifically, this may involve the delineation of volcanic-sedimentary contacts, intrusive bodies, faults, shears and alteration zones.

The physical parameter which the magnetic method maps is based is magnetic susceptibility and/or remanent magnetisation. Generally, magnetic susceptibility is lowest in sedimentary and metasedimentary rocks. The average susceptibility of metamorphic rocks is slightly higher, being about 10 times that of sedimentary rocks. Acid igneous rocks are about twice as susceptible on average as metamorphic rocks. Ultrabasic igneous rocks have the highest susceptibilities and are about 100 times more susceptible than sedimentary rocks. The possible range of susceptibilities for any one rock type is very large and dependent upon the actual concentration of magnetic minerals, chiefly magnetite, contained within the rock.

Faults are recognised as linears and by offsets of other magnetic features. Shears and sericitic alteration zones are areas where ground water flow or alteration may have destroyed the magnetite of the host rocks. This can create areas of lower magnetic susceptibility.

The magnetometer data can be further processed in different ways. It is often filtered to produce a calculated vertical gradient map. Hood, (1965), demonstrated that in areas of steep magnetic inclination, the zero vertical gradient contour level defines the contacts of steeply dipping bodies. Vertical gradient is used to help map contacts and near surface features.

Electromagnetic data

Most sulphides (sphalerite is one exception) are many orders of magnitude more conductive than the surrounding host rocks. A time varying electromagnetic field can induce electrical currents in the sulphides. The secondary electromagnetic field from the induced currents can be measured in a receiver coil which provides a detection method for conductive sulphides (Grant and West, 1965). Other sources can produce a conductive response which mimics the response due to sulphides. Graphite, clays, and water filled shears are examples. Helicopter EM responses from coplanar and coaxial coils over simplified targets are shown in this Appendix.

One of the criteria for the volcanogenic massive sulphide targets to be economically viable is a minimum size. A tabular body of 500 by 500 metres by 10 metres thickness representing an idealised and simplified massive sulphide deposit contains approximately 10 million tonnes of sulphides. Given these dimensions, flight lines spaced 200 metres will cross the hypothetical ore body twice—which is sufficient for confirmation of the EM response.

Apparent resistivity data

A resistivity map portrays all of the EM information for that frequency over the survey area. This is in contrast to an EM anomaly map which only shows the interpreted anomalies from the survey. By representing the response in the form of contour plans, a large dynamic range is represented. Having the values in terms of a physical parameter (resistivity) instead of a field value (ppm of primary field), makes the resistivity parameter a better mapping tool.

In general, sedimentary rocks and unconsolidated materials are more conductive than most of the igneous rocks. This is primarily due to the higher porosity and moisture content of the former. Metamorphic rocks are highly variable due in part to their wide range of porosities and moisture content. Clays and hydrous minerals such as serpentine are generally good conductors and minor amounts of these material will decrease the resistivities. Apparent resistivity data is used in much the way as magnetometer data - that is, to delineate structural or stratigraphic environments favourable for mineral deposits.

VLF data

The **V**ery **L**ow **F**requency (VLF) method is an electromagnetic method which uses the military radio transmitters as the EM source. The receiver is a Herz Totem system which measures the amplitude of the total horizontal electromagnetic field and the vertical quadrature electromagnetic field.

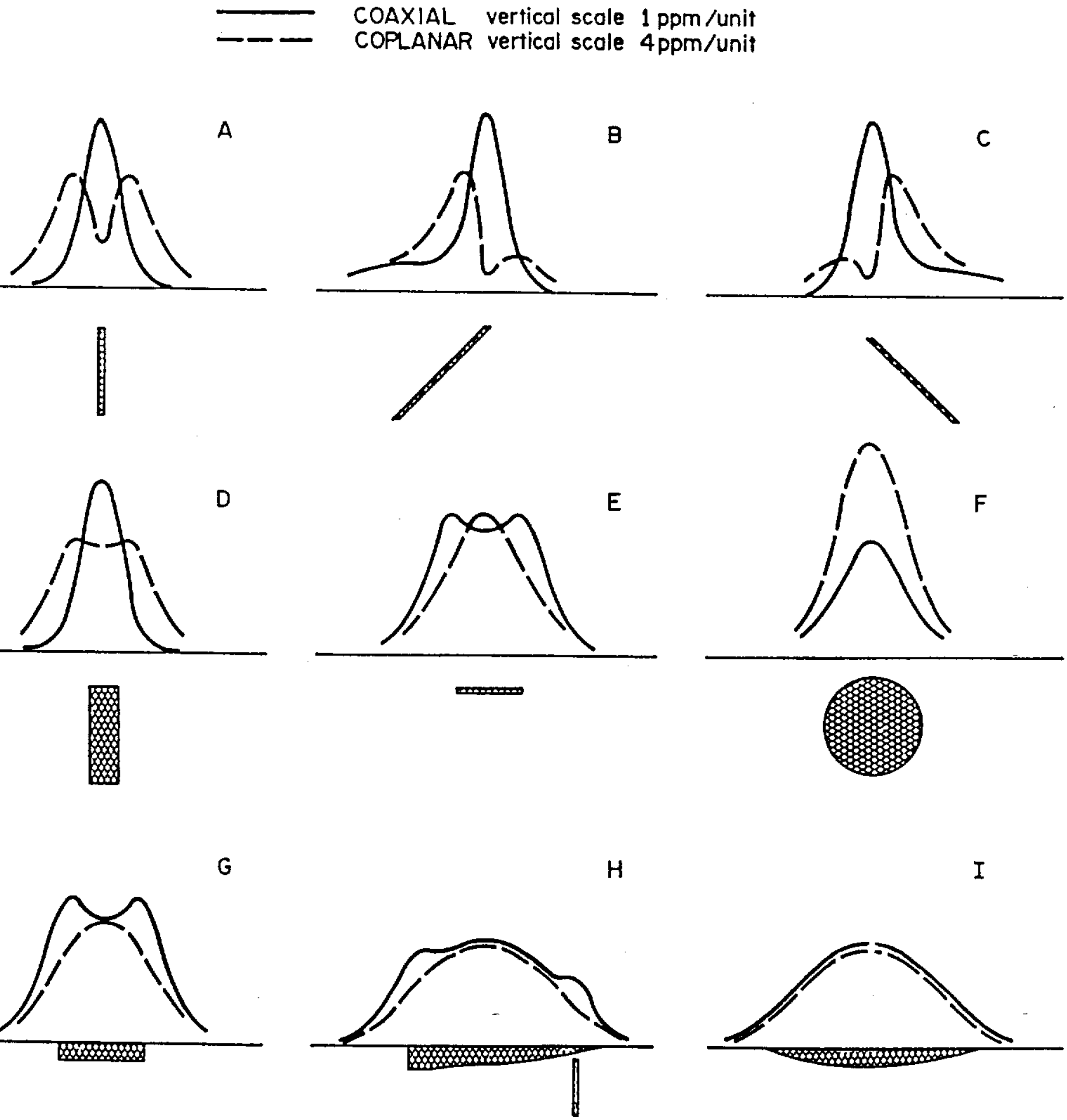
The best signals are from features which are perpendicular to the time varying magnetic field. For VLF, this is the horizontal direction normal to the direction between the survey area and the transmitting station.

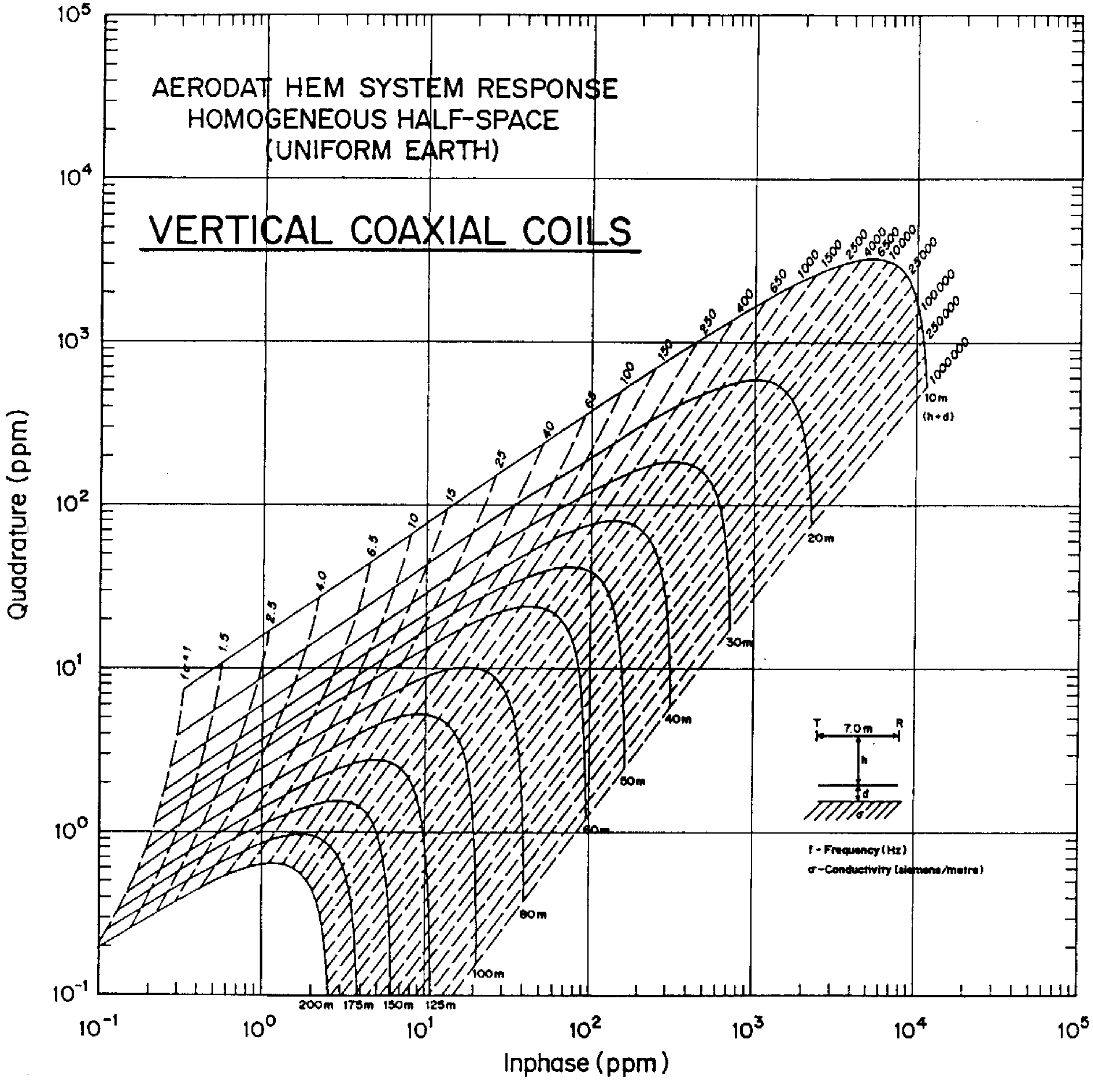
Ideally, a transmitting station can be found which is on strike with the features of interest. This is the Line Station. The VLF station which produces a direction perpendicular to the Line Station is the Ortho Station.

Due to the relatively high frequencies of the VLF field, and to the uniform nature of the field, large regional features respond well to the method. If the ground is weakly conductive, the topography influences the VLF data to a significant degree.

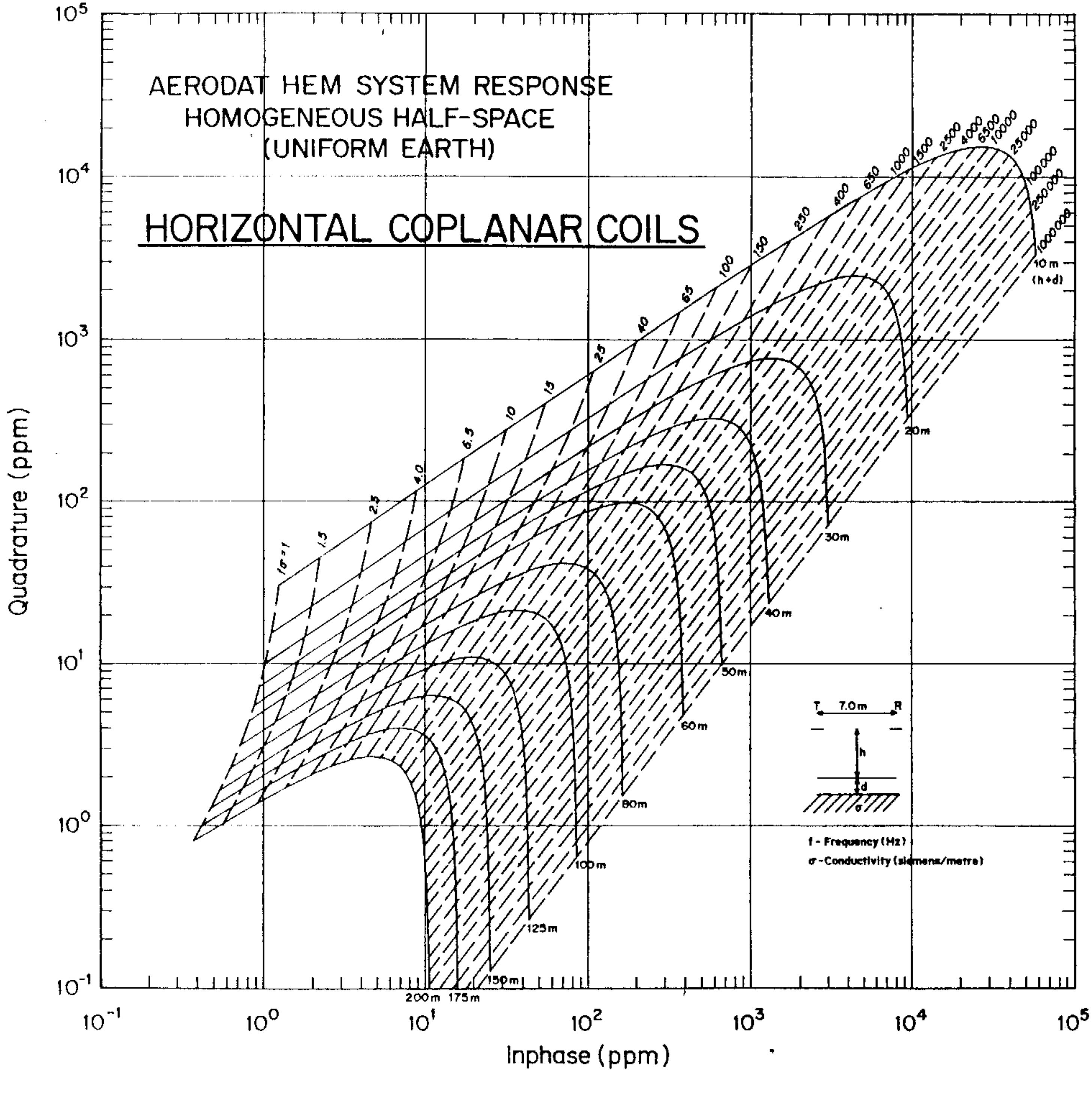
The VLF data is typically presented as contours of the total (EM) field. The VLF total field response to a steeply dipping conductor is a local maximum over the conductor.

HEM RESPONSE PROFILE SHAPE AS AN INDICATOR OF CONDUCTOR GEOMETRY

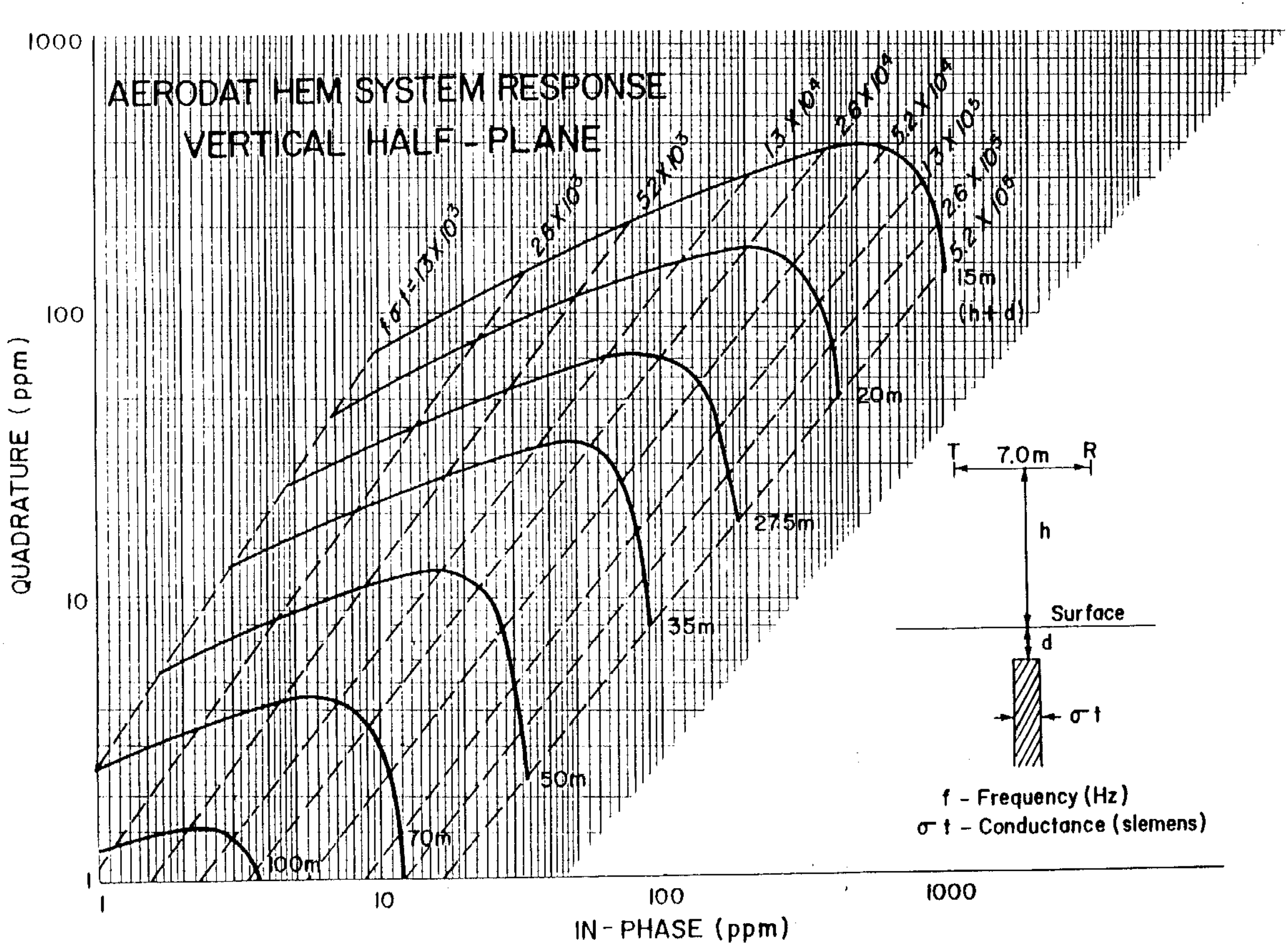




AERODAT HEM SYSTEM RESPONSE
HOMOGENEOUS HALF-SPACE
(UNIFORM EARTH)
VERTICAL COAXIAL COILS
Quadrature (ppm)
Inphase (ppm)
10m (h+d)
20m
30m
40m
50m
60m
80m
100m
125m
150m
175m
200m
7.0 m
T
R
h
d
f - Frequency (Hz)
σ - Conductivity (siemens/metre)



AERODAT HEM SYSTEM RESPONSE
HOMOGENEOUS HALF-SPACE
(UNIFORM EARTH)
HORIZONTAL COPLANAR COILS
Quadrature (ppm)
Inphase (ppm)
10 m
(h+d)
20m
30m
40m
50m
60m
80m
100m
125m
150m
200m 175m
T 7.0m R
h
d
σ
f - Frequency (Hz)
σ - Conductivity (siemens/metre)



AERODAT HEM SYSTEM RESPONSE
VERTICAL HALF-PLANE
fσt=1.3X10³
2.6X10³
5.2X10³
1.3X10⁴
2.6X10⁴
5.2X10⁴
1.3X10⁵
2.6X10⁵
5.2X10⁵
15m
(h+d)
20m
27.5m
35m
50m
70m
100m
QUADRATURE (ppm)
IN-PHASE (ppm)
1000
100
10
1
T
7.0m
R
h
Surface
d
σ t
f - Frequency (Hz)
σ t - Conductance (siemens)

APPENDIX IV - STATEMENT OF QUALIFICATIONS

I, Bob B.H. Lo, am a Consulting Geophysicist with BHL Earth Sciences at 28 Nottinghill Road, Markham, Ontario, Canada, L3T 4X9. At the time of the data collection, I was the Chief Geophysicist of Aerodat Inc.

I graduated from the University of Toronto with a Bachelor of Applied Science degree in the Geophysics option of Engineering Science in 1981 and obtained a Masters of Science degree in Physics, also from the University of Toronto in 1985. In 1992, I obtained a Masters of Business Administration degree from Laurentian University in Sudbury, Ontario.

I am a member in good standing of the Professional Engineers of Ontario.

I am a member in the Society of Exploration Geophysicists—SEG (Tulsa), a member of the Canadian Exploration Geophysical Society—KEGS (Toronto), a founding member of the Environmental and Engineering Geophysical Society—EEGS (Denver), and a member of the Prospectors and Developers Association of Canada—PDAC (Toronto).

Since 1981, I have been involved in the use of geophysics for mineral exploration, geothermal site detection, and various engineering and environmental applications. I have either planned, supervised, conducted, interpreted, and reported on geophysical surveys from Canada, the United States of America, South America, South East Asia, Europe and Africa.

The statements contained in this report and the conclusions reached are based upon evaluation and review of maps and information supplied by Aerodat Inc., and High-Sense Geophysics.

I have not visited the property nor hold any financial interest in the property.

Signed,

J9797

Mississauga, Ontario

Bob Lo, M.Sc., MBA., P.Eng.

February 27, 1998

Appendix II

Cost Statement

Statement of Costs

Event Dates

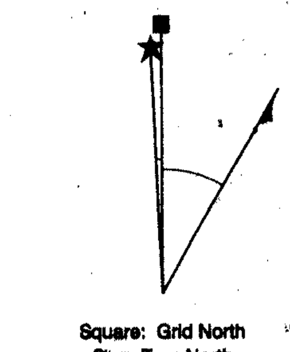
Survey by Aerodat:	November 11, 1997
Report By High Sense:	February 27, 1998
Assessment Report:	May 21, 1998

Geophysical Survey

Aerodat-High Sense Airborne Geophysical Survey	$15,000.00

Report Preparation

Assessment report additions	$ 400.00
Total Expenditures	$15,400.00



FLIGHT PATH

North American Datum 1927
Clarke 1866 Ellipsoid
Local Transformation: DX=-10.0 DY=158.0 DZ=187.0
UTM Projection
Central Meridian: 135 °W
Navigation and flight path recovery was conducted using a Global Positioning System (GPS) satellite navigation system.

Lines were flown at an azimuth of 165 - 345°, with an average line spacing of 200m.

Average helicopter-terrain clearance of 60m was monitored by radar and barometric altimeters.

Square: Grid North
Star: True North
Arrow: Magnetic North

Angles presented are approximate mean deviations for centre of NTS sheet. Use diagram for reference only.

Grid North - True North : -2.4°
Grid North - Magnetic North : 30.2°
Annual change : 0.08°

EM ANOMALIES

EM anomalies selected manually. Selection is based on the response correlation to theoretical sources such as a steeply dipping conductor.

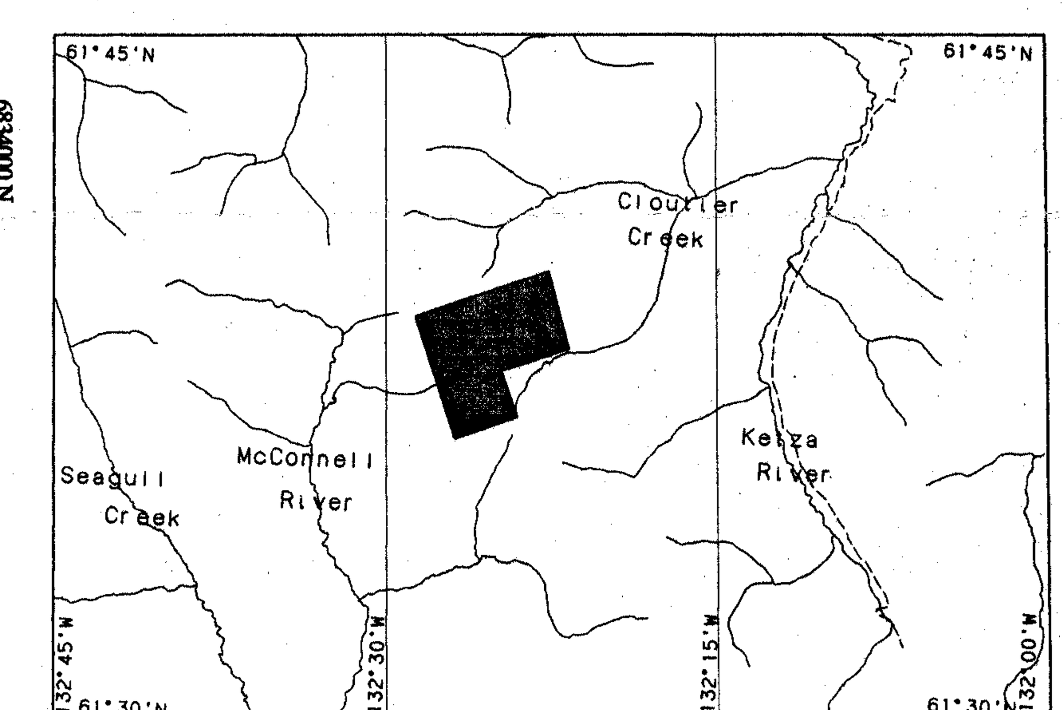
Calculation of conductance is based on the response of the 4382 Hz coaxial data, and forms the basis for anomaly classification.

Letter codes are used to identify individual anomalies on a line, and the inphase amplitude of the 4382 Hz response is annotated opposite.

○	0 - 1 mhos
○	1 - 2 mhos
⊖	2 - 4 mhos
◉	4 - 8 mhos
◒	8 - 16 mhos
●	16 - 32 mhos
●	> 32 mhos
M	Magnetite

INTERPRETATION

— 2 —	Conductor axes
▨	Area of thicker volcanics ?
▧	Mafic volcanics or ultramafic body ?
— —	Magnetic linear



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INTERPRETATION

093867

FINLAYSON LAKE AREA

YUKON TERRITORY

SCALE 1:20 000

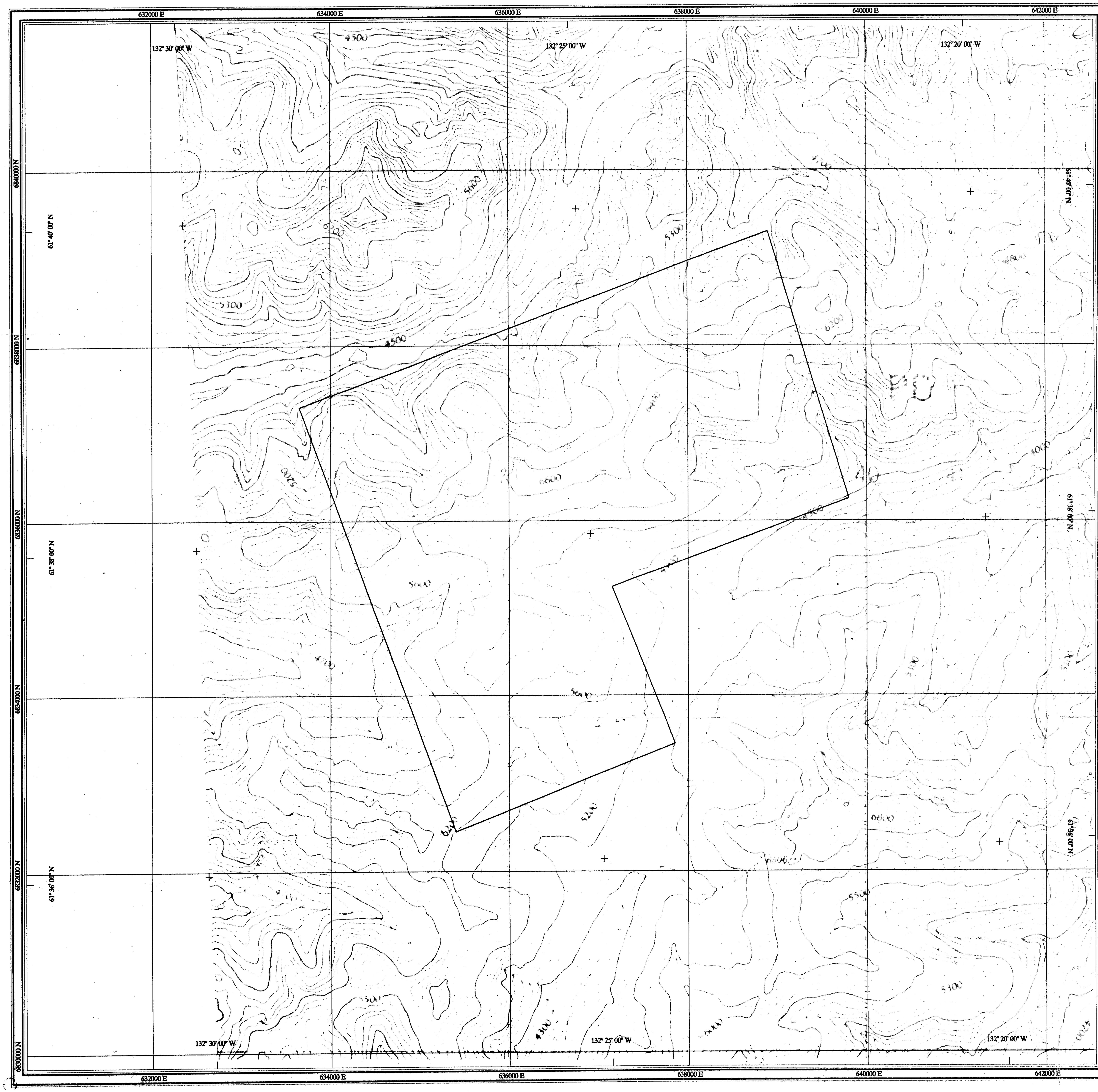
500 0 200 400 1000 2000 metres

aerodat
AERODAT INC.

Date Flown : NOVEMBER 1997

NTS : 105 F/9 Dwb (1)

Project : J9797 Map Ref : 1 - 2



FLIGHT PATH

North American Datum 1927
Clarke 1866 Ellipsoid
Local Transformation: DX=-10.0 DY=158.0 DZ=187.0
UTM Projection
Central Meridian: 135 °W
Navigation and flight path recovery was conducted using a Global Positioning System (GPS) satellite navigation system.

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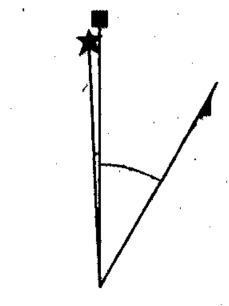
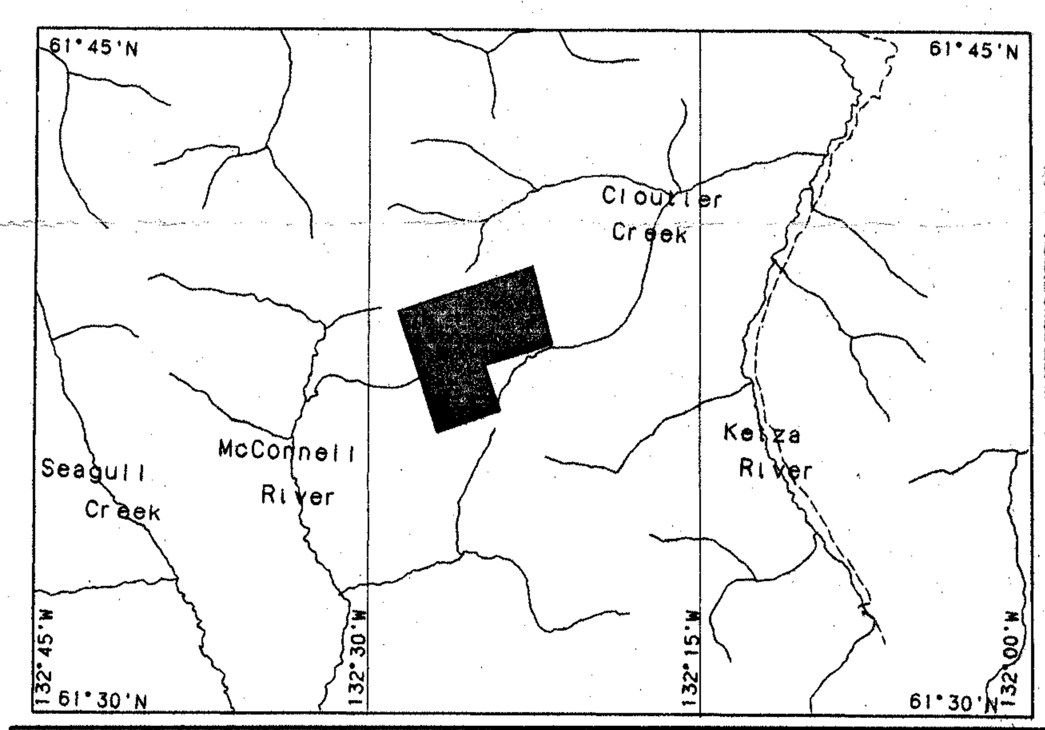
Average helicopter-terrain clearance of 60m was monitored by radar and barometric altimeters.



Square: Grid North
Star: True North
Arrow: Magnetic North

Angles presented are approximate mean deviations for centre of NTS sheet. Use diagram for reference only.

Grid North - True North : -2.4°
Grid North - Magnetic North : 30.2°
Annual change : 0.08°



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BASE MAP

093867

FINLAYSON LAKE AREA

YUKON TERRITORY

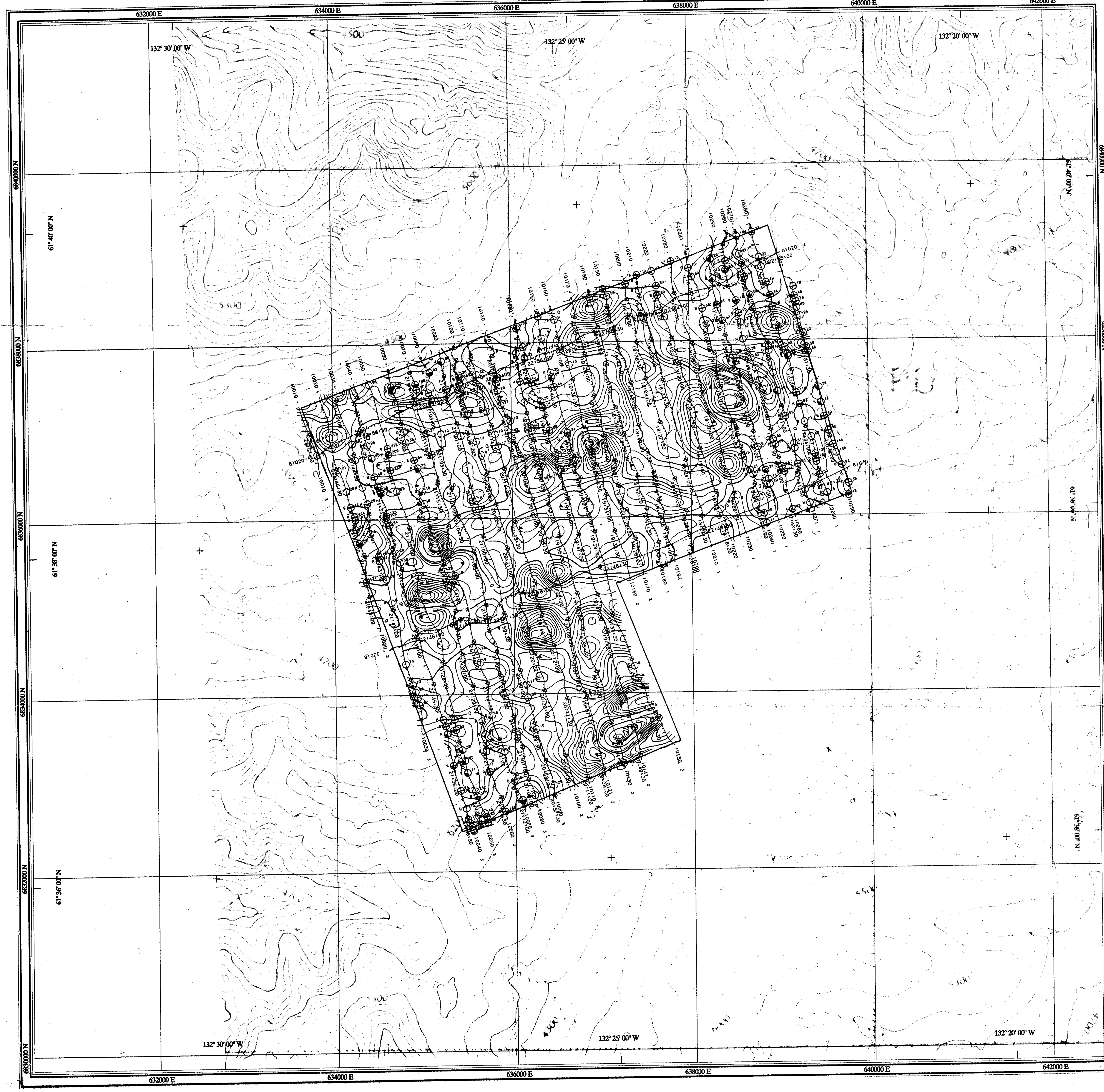
SCALE 1:20 000

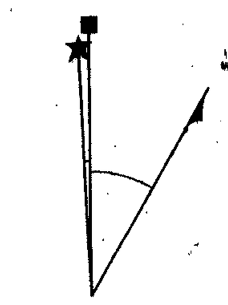
500 0 200 400 1000 2000 metres

aerodat
AERODAT INC.

Date Flown : NOVEMBER 1997
NTS : 105 F/9
Project : J9797
Map Ref : 1 - 1

Dwg (2)





VERTICAL GRADIENT

Vertical magnetic gradient contour data, calculated from the gridded total magnetic intensity data by a 17 x 17 point convolution operator.

Map contours are in nanoTeslas/metre, and are multiples of those listed below:

0.01 nT/m
0.05 nT/m
0.25 nT/m
1.00 nT/m
5.00 nT/m

Square: Grid North
Star: True North
Arrow: Magnetic North

Angles presented are approximate mean deviations for centre of NTS sheet. Use diagram for reference only.

Grid North - True North : -2.4°
Grid North - Magnetic North : 30.2°
Annual change : 0.08°

FLIGHT PATH

North American Datum 1927
Clarke 1866 Ellipsoid
Local Transformation: DX=-10.0 DY=158.0 DZ=187.0
UTM Projection
Central Meridian: 135 °W
Navigation and flight path recovery was conducted using a Global Positioning System (GPS) satellite navigation system.

Lines were flown at an azimuth of 165 - 345°, with an average line spacing of 200m.

Average helicopter-terrain clearance of 60m was monitored by radar and barometric altimeters.

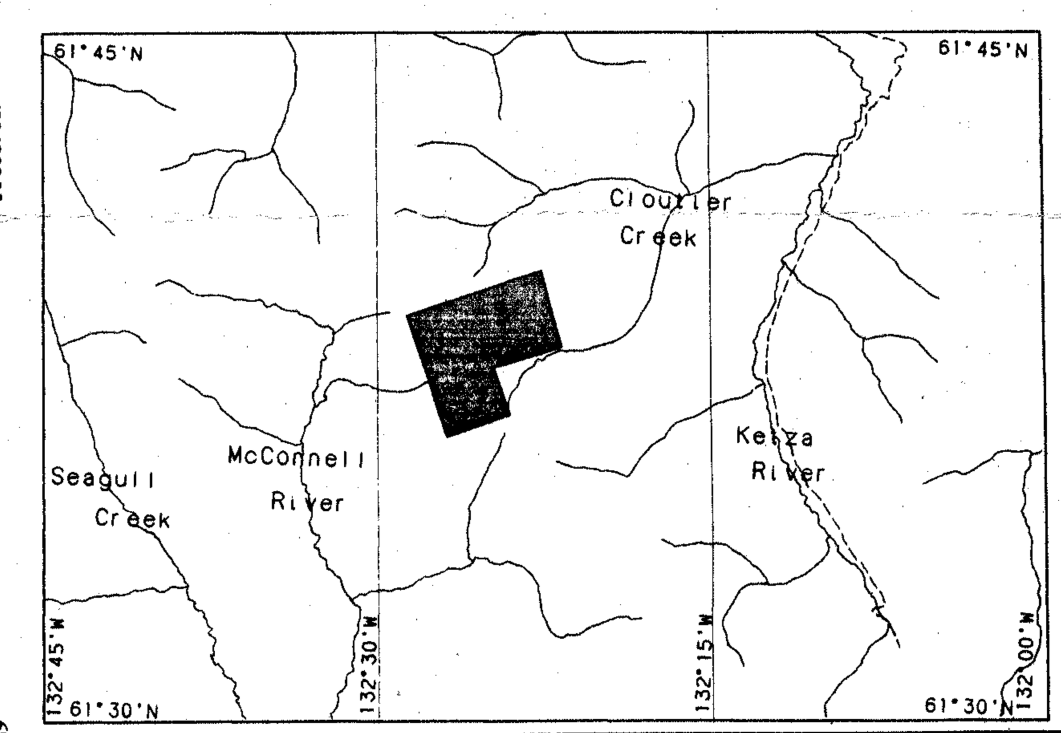
EM ANOMALIES

EM anomalies selected manually. Selection is based on the response correlation to theoretical sources such as a steeply dipping conductor.

Calculation of conductance is based on the response of the 4382 Hz coaxial data, and forms the basis for anomaly classification.

Letter codes are used to identify individual anomalies on a line, and the inphase amplitude of the 4382 Hz response is annotated opposite.

0 - 1 mhos
1 - 2 mhos
2 - 4 mhos
4 - 8 mhos
8 - 16 mhos
16 - 32 mhos
> 32 mhos
M Magnetite



ATNA RESOURCES LTD. 093 867

VERTICAL MAGNETIC GRADIENT

FINLAYSON LAKE AREA

YUKON TERRITORY

SCALE 1:20 000

500 0 200 400 1000 2000 metres

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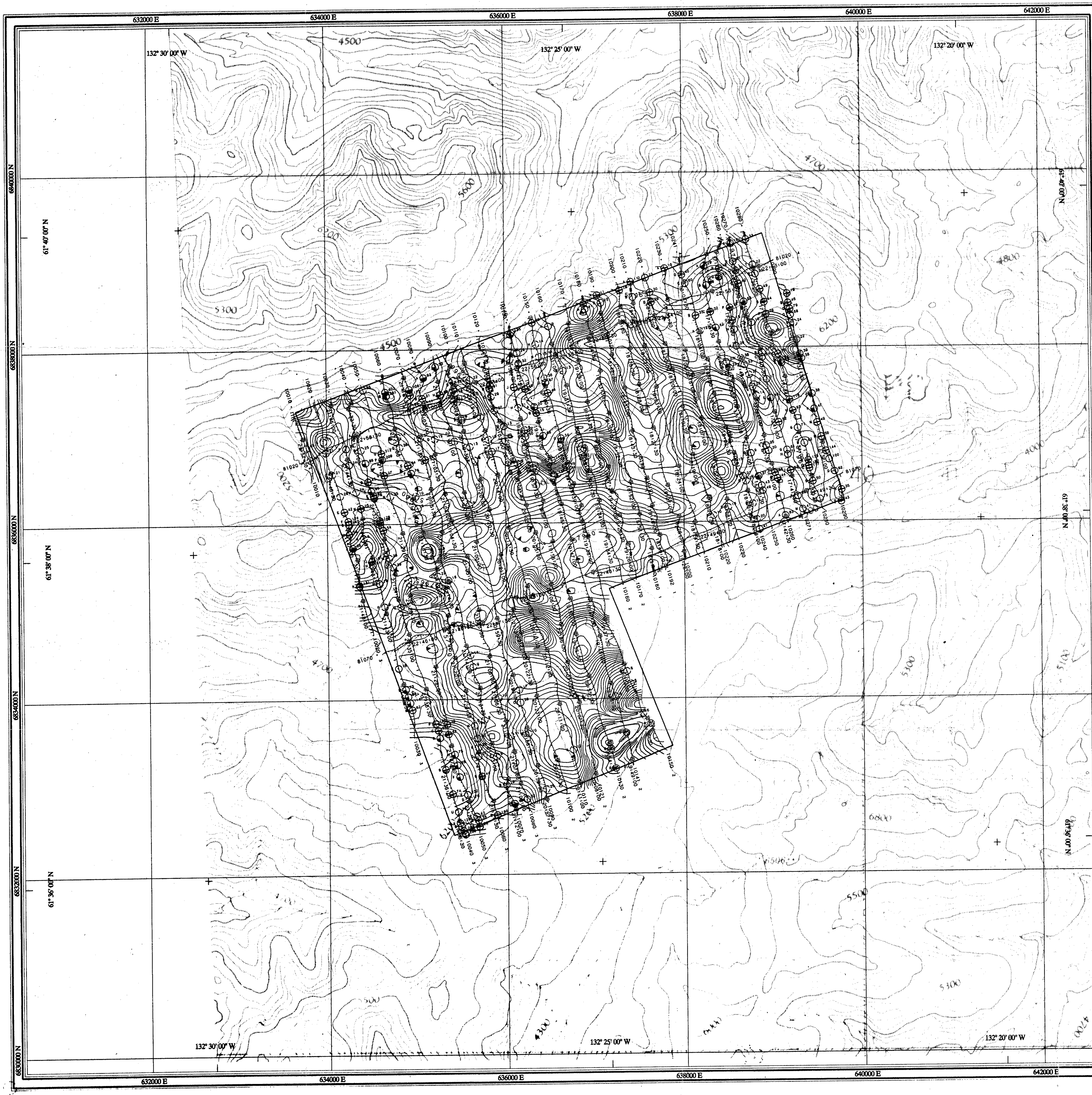
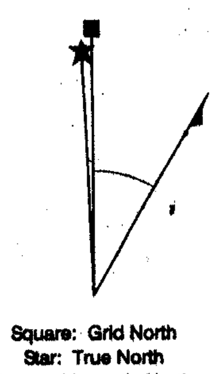
AERODAT INC.

Date Flown : NOVEMBER 1997
NTS : 105 F/9 Dwh (3)
Project : J9797 Map Ref : 1 - 4





TOTAL FIELD MAGNETICS

Total field magnetic intensity contour data, measured by a cesium high sensitivity magnetometer at an average sensor elevation of 45m, and corrected for diurnal variation.

Map contours are in nanoTeslas, and are multiples of those listed below:

- 1 nT
- 5 nT
- 25 nT
- 100 nT
- 500 nT

Square: Grid North
Star: True North
Arrow: Magnetic North

Angles presented are approximate mean deviations for centre of NTS sheet. Use diagram for reference only.

Grid North - True North : -2.4°
Grid North - Magnetic North : 30.2°
Annual change : 0.08°

FLIGHT PATH

North American Datum 1927
Clarke 1866 Ellipsoid
Local Transformation: DX=-10.0 DY=158.0 DZ=187.0
UTM Projection
Central Meridian: 135 °W
Navigation and flight path recovery was conducted using a Global Positioning System (GPS) satellite navigation system.

Lines were flown at an azimuth of 165 - 345°, with an average line spacing of 200m.

Average helicopter-terrain clearance of 60m was monitored by radar and barometric altimeters.

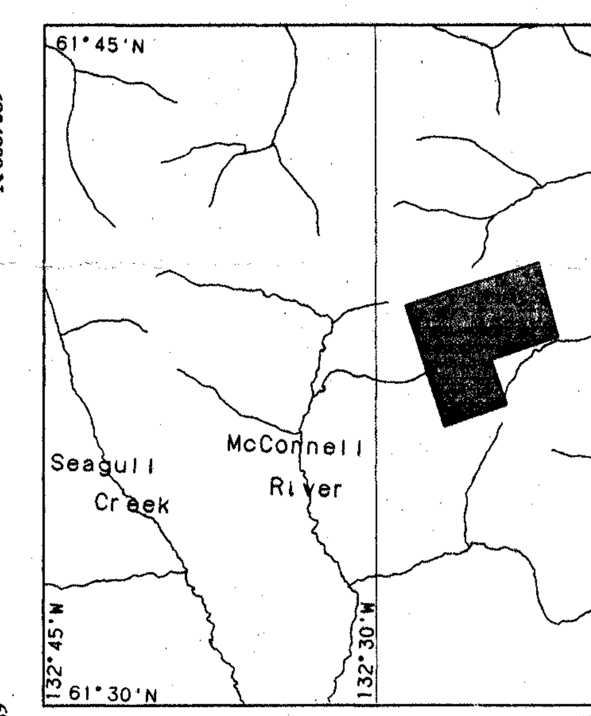
EM ANOMALIES

EM anomalies selected manually. Selection is based on the response correlation to theoretical sources such as a steeply dipping conductor.

Calculation of conductance is based on the response of the 4382 Hz coaxial data, and forms the basis for anomaly classification.

Letter codes are used to identify individual anomalies on a line, and the inphase amplitude of the 4382 Hz response is annotated opposite.

- 0 - 1 mhos
- 1 - 2 mhos
- 2 - 4 mhos
- 4 - 8 mhos
- 8 - 16 mhos
- 16 - 32 mhos
- > 32 mhos
- M Magnetite



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TOTAL MAGNETIC INTENSITY

093867

FINLAYSON LAKE AREA

YUKON TERRITORY

SCALE 1:20 000

500 0 200 400 1000 2000 metres

aerodat

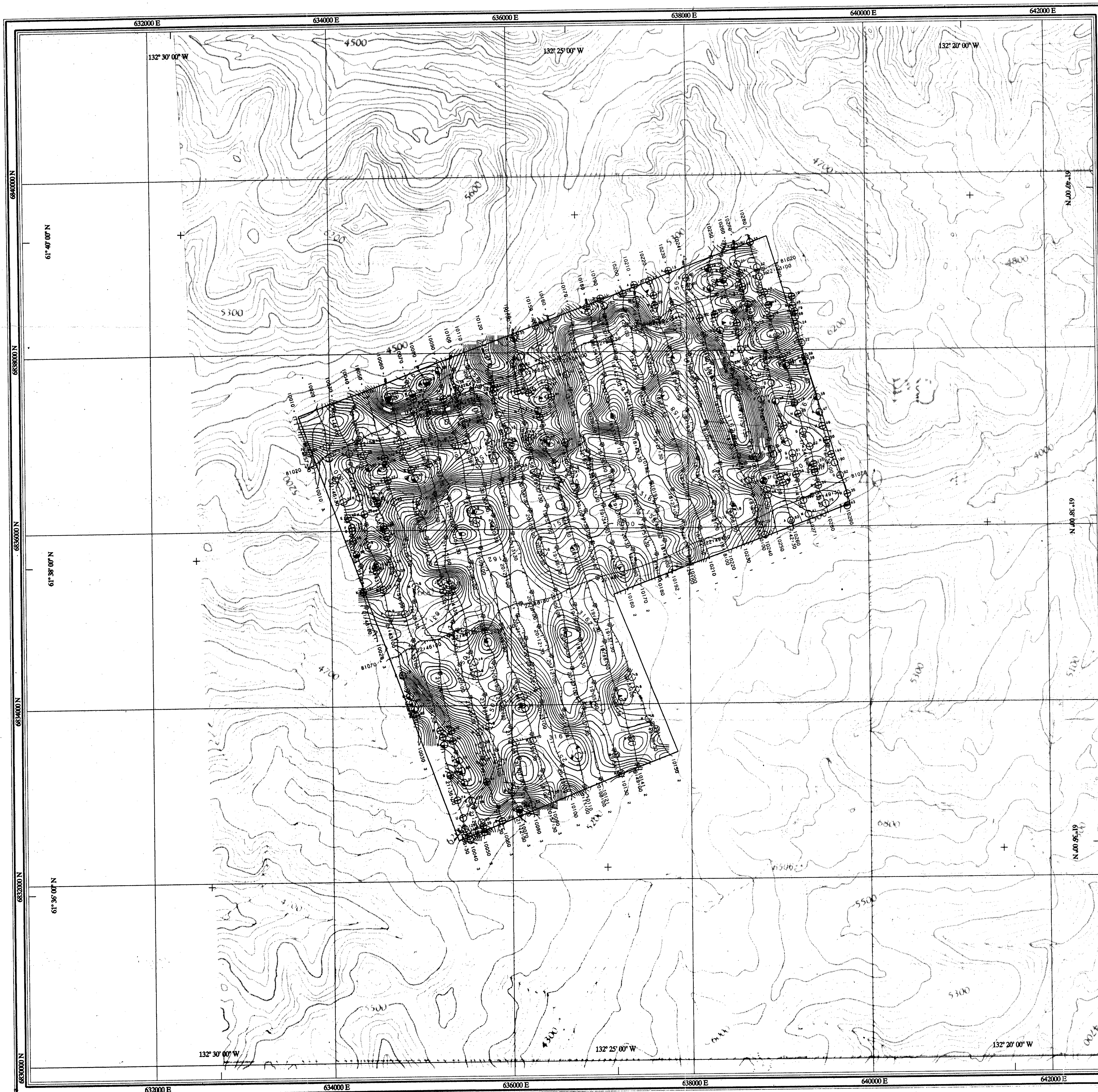
AERODAT INC.

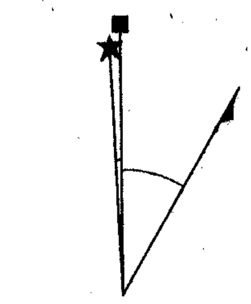
Date Flown : NOVEMBER 1997

NTS : 105 F/9

Dwg 4

Project : J9797 Map Ref : 1 - 3





APPARENT RESISTIVITY

Apparent resistivity calculated from the measured 4781 Hz coplanar EM response, assuming a 200m conductive layer over a resistive half-space. Average sensor elevation was 30m.

Map contours are in ohm·m, at logarithmic intervals, in multiples of those listed below:

- 0.1 log(ohm·m)
- 0.5 log(ohm·m)
- 1.0 log(ohm·m)

Square: Grid North
Star: True North
Arrow: Magnetic North

Angles presented are approximate mean deviations for centre of NTS sheet. Use diagram for reference only.

Grid North - True North : -2.4°
Grid North - Magnetic North : 30.2°
Annual change : 0.08°

FLIGHT PATH

North American Datum 1927
Clarke 1866 Ellipsoid
Local Transformation: DX=-10.0 DY=158.0 DZ=187.0
UTM Projection
Central Meridian: 135 °W
Navigation and flight path recovery was conducted using a Global Positioning System (GPS) satellite navigation system.

Lines were flown at an azimuth of 165 - 345°, with an average line spacing of 200m.

Average helicopter-terrain clearance of 60m was monitored by radar and barometric altimeters.

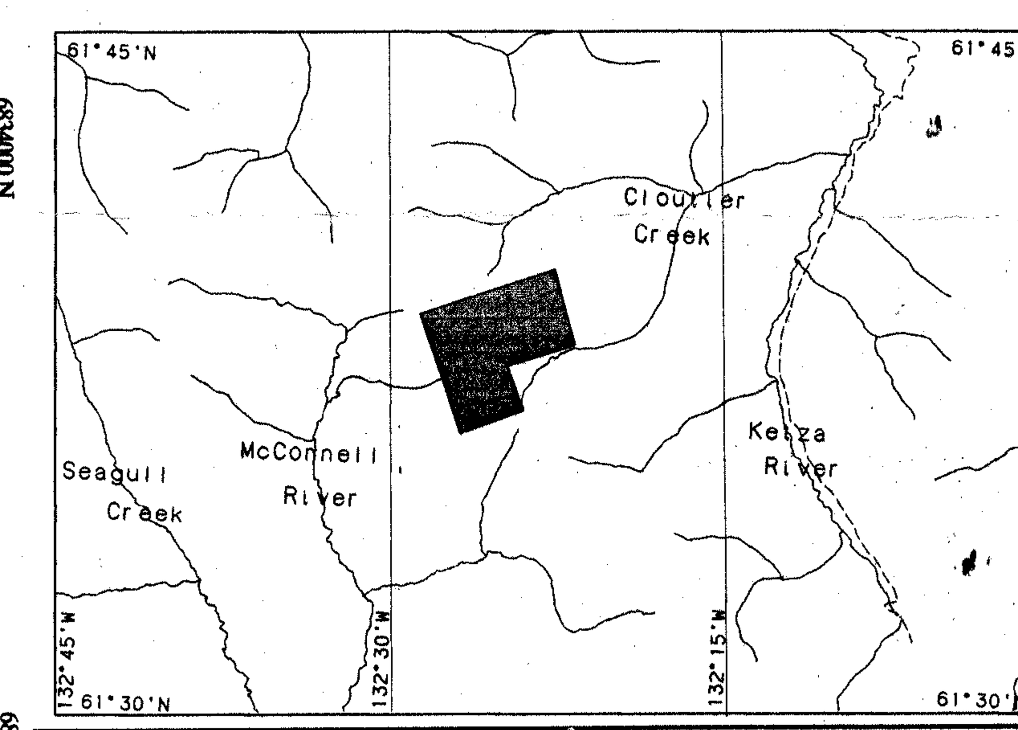
EM ANOMALIES

EM anomalies selected manually. Selection is based on the response correlation to theoretical sources such as a steeply dipping conductor.

Calculation of conductance is based on the response of the 4382 Hz coaxial data, and forms the basis for anomaly classification.

Letter codes are used to identify individual anomalies on a line, and the inphase amplitude of the 4382 Hz response is annotated opposite.

- 0 - 1 mhos
- 1 - 2 mhos
- 2 - 4 mhos
- 4 - 8 mhos
- 8 - 16 mhos
- 16 - 32 mhos
- > 32 mhos
- M Magnetite



ATNA RESOURCES LTD.

APPARENT RESISTIVITY

4781 Hz COPLANAR

FINLAYSON LAKE AREA

YUKON TERRITORY

SCALE 1:20 000

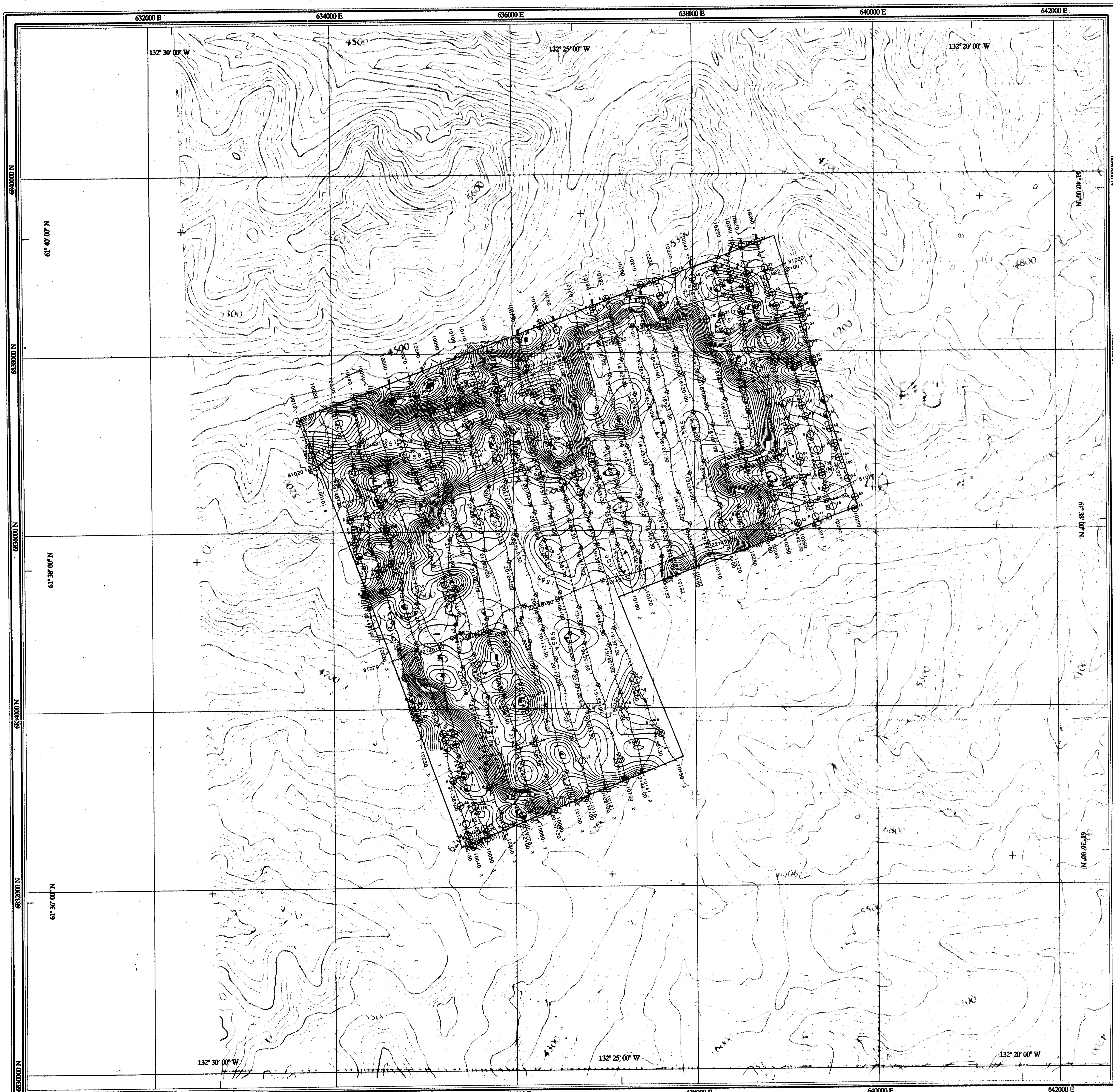
500 0 200 400 1000 2000 metres

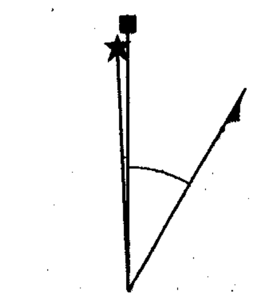
AERODAT INC.

Date Flown : NOVEMBER 1997

NTS : 105 F/9 DWG (5)

Project : J9797 Map Ref : 1 - 5B





APPARENT RESISTIVITY

Apparent resistivity calculated from the measured 864 Hz coplanar EM response, assuming a 200m conductive layer over a resistive half-space. Average sensor elevation was 30m.

Map contours are in ohm·m, at logarithmic intervals, in multiples of those listed below:

- 0.1 log(ohm·m)
- 0.5 log(ohm·m)
- 1.0 log(ohm·m)

Angles presented are approximate mean deviations for centre of NTS sheet. Use diagram for reference only.

Grid North - True North : -2.4°
Grid North - Magnetic North : 30.2°
Annual change : 0.08°

FLIGHT PATH

North American Datum 1927
Clarke 1866 Ellipsoid
Local Transformation: DX=-10.0 DY=158.0 DZ=187.0
UTM Projection
Central Meridian: 135 °W
Navigation and flight path recovery was conducted using a Global Positioning System (GPS) satellite navigation system.

Lines were flown at an azimuth of 165 - 345°, with an average line spacing of 200m.

Average helicopter-terrain clearance of 60m was monitored by radar and barometric altimeters.

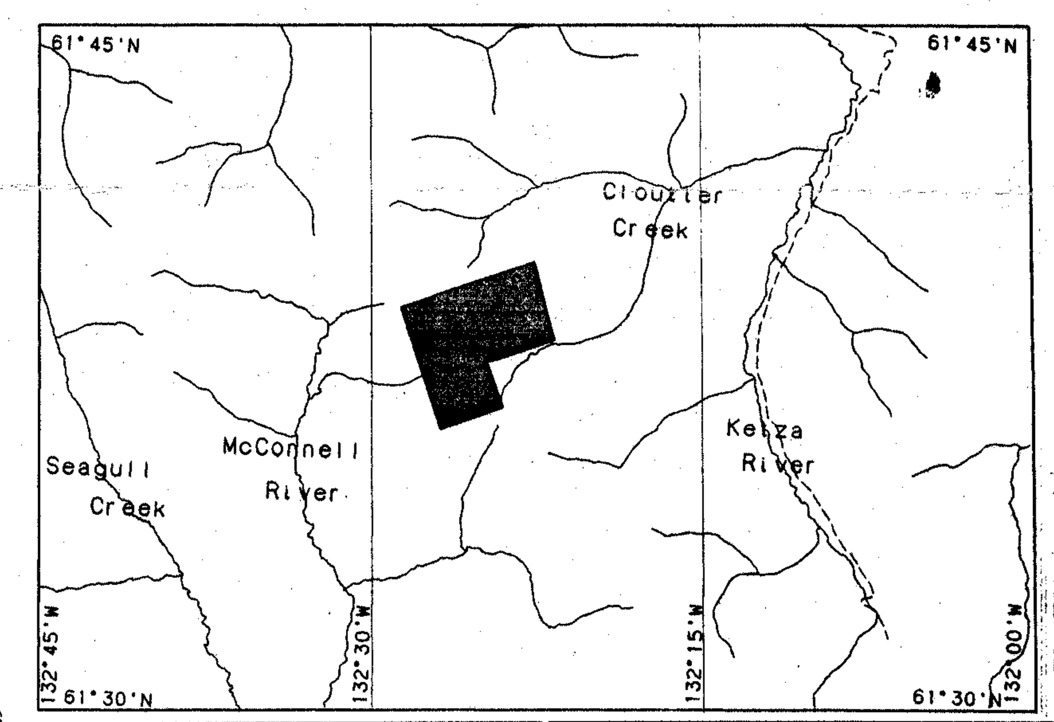
EM ANOMALIES

EM anomalies selected manually. Selection is based on the response correlation to theoretical sources such as a steeply dipping conductor.

Calculation of conductance is based on the response of the 4382 Hz coaxial data, and forms the basis for anomaly classification.

Letter codes are used to identify individual anomalies on a line, and the inphase amplitude of the 4382 Hz response is annotated opposite.

ᴬo²	0 - 1 mhos
o	1 - 2 mhos
⊖	2 - 4 mhos
⊙	4 - 8 mhos
◒	8 - 16 mhos
◉	16 - 32 mhos
●	> 32 mhos
M	Magnetite



ATNA RESOURCES LTD.

APPARENT RESISTIVITY
864 Hz COPLANAR

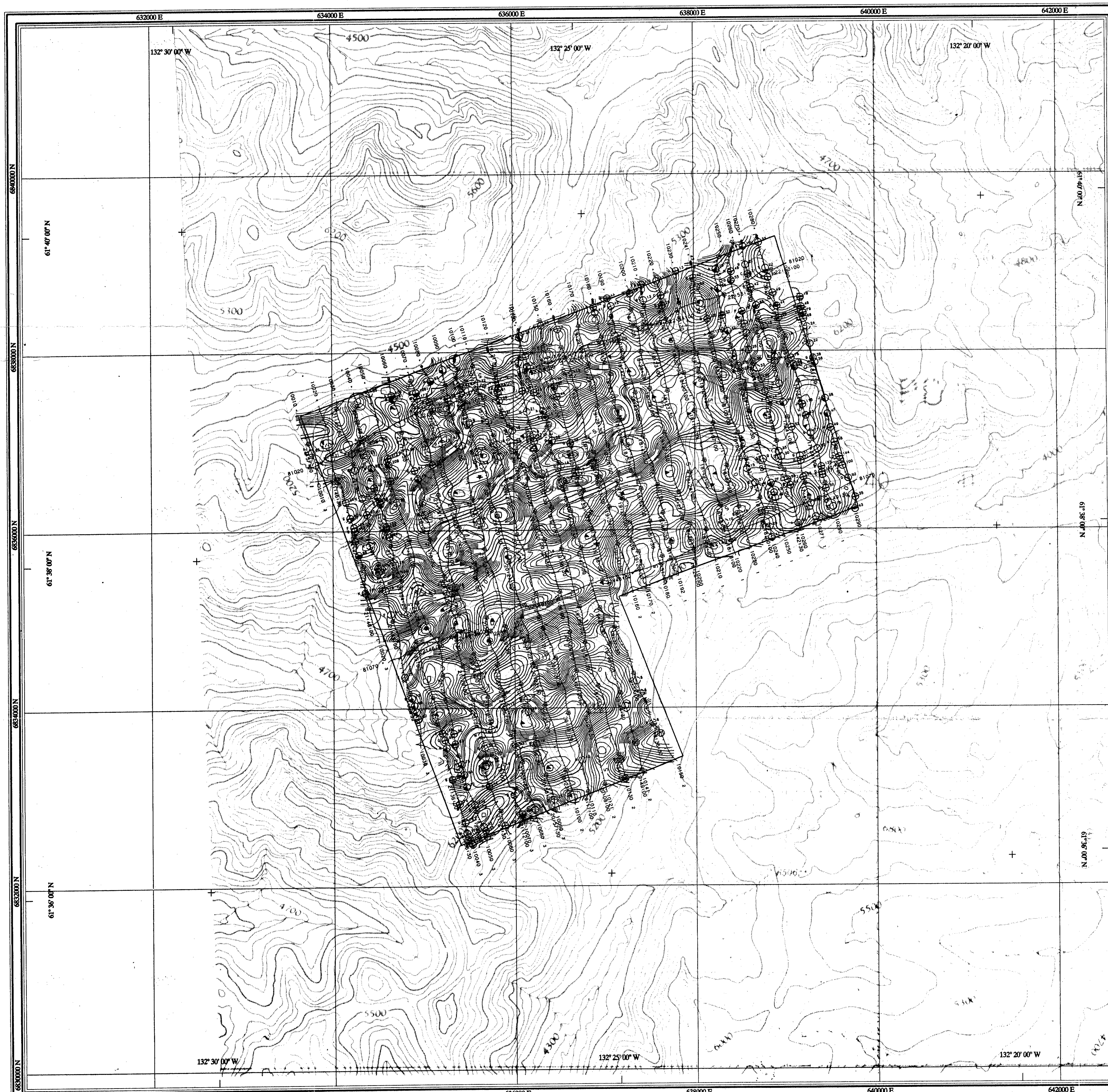
FINLAYSON LAKE AREA
YUKON TERRITORY

SCALE 1:20 000

500 0 200 400 1000 2000 metres

aerodat
AERODAT INC.

Date Flown : NOVEMBER 1997
NTS : 105 F/9 Dwg(6)
Project : J9797 Map Ref : 1 - 5A



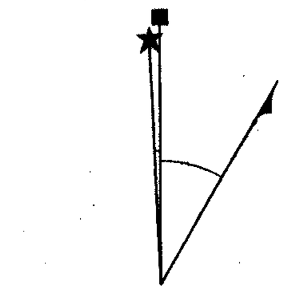
TOTAL FIELD VLF-EM

Total field VLF-EM contour data, measured by a Herz Totem 2A sensor at an average elevation of 45m.

Flights 1-4 utilized station: NSS, Annapolis, Maryland, 21.4 kHz.

Map contours are in percent, and are multiples of those listed below:

1 %
5 %
25 %



Square: Grid North
Star: True North
Arrow: Magnetic North

Angles presented are approximate mean deviations for centre of NTS sheet. Use diagram for reference only.

Grid North - True North : -2.4°
Grid North - Magnetic North : 30.2°
Annual change : 0.08°

FLIGHT PATH

North American Datum 1927
Clarke 1866 Ellipsoid
Local Transformation: DX=-10.0 DY=158.0 DZ=187.0
UTM Projection
Central Meridian: 135 °W
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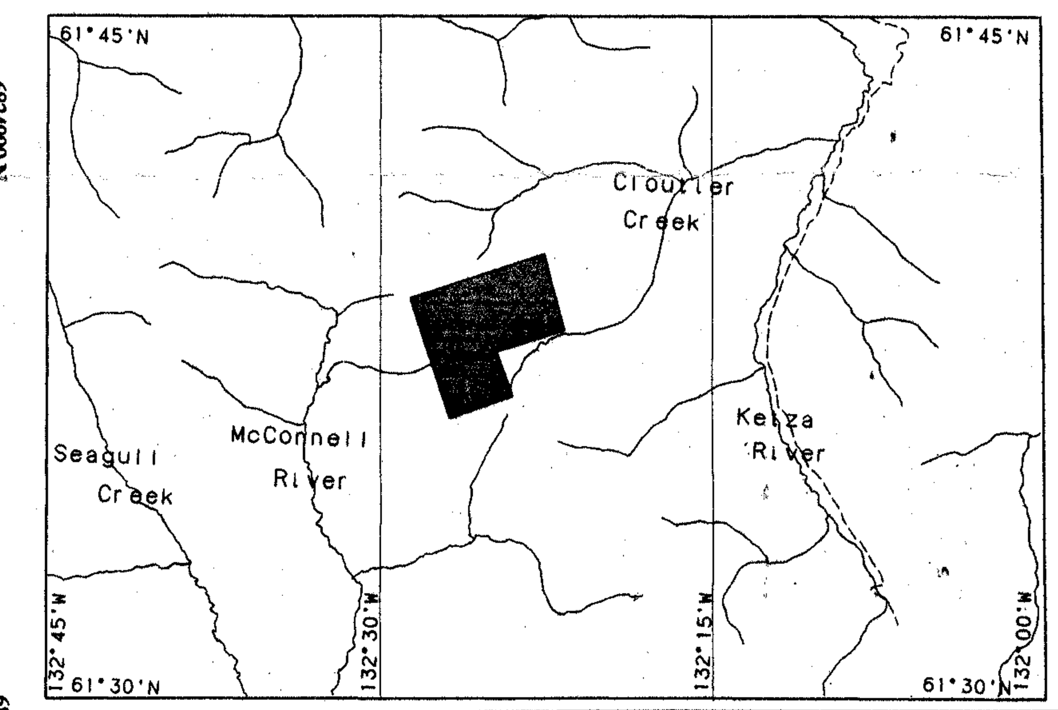
Calculation of conductance is based on the response of the 4382 Hz coaxial data, and forms the basis for anomaly classification.

Letter codes are used to identify individual anomalies on a line, and the inphase amplitude of the 4382 Hz response is annotated opposite.

○	0 - 1 mhos
○	1 - 2 mhos
⊖	2 - 4 mhos
◐	4 - 8 mhos
◒	8 - 16 mhos
●	16 - 32 mhos
●	> 32 mhos
M	Magnetite



ATNA RESOURCES LTD.

TOTAL FIELD VLF-EM

FINLAYSON LAKE AREA

YUKON TERRITORY

SCALE 1:20 000

500 0 200 400 1000 2000 metres

aerodat
AERODAT INC.

Date Flown : NOVEMBER 1997

NTS : 105 F/9 Dwg 17

Project : J9797 Map Ref : 1 - 6