

Report on a Helicopter-Borne Magnetic Gradiometer Survey



**Aeroquest Job # 07053
Kitsault Project**

For

Cambria Geosciences

By

 *AEROQUEST LIMITED*

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Report Date: January 2007

Report on a Helicopter-Borne Magnetic Gradiometer Survey

Aeroquest Job # 07053
Kitsault Project
Anyox Area, British Columbia
NTS 103P05,06

For

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Report Date: November, 2006



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1.2. Appendices

- Appendix 1: Survey Block Co-ordinates
- Appendix 2: Description of Database Fields

1.3. List of Maps (1:20,000)

The report includes a set of two (2) 1:20,000 maps. The geophysical products are listed below:

- **RTP** – RTP (Reduced to Pole) Magnetic Field (IGRF removed) with line contours
- **M3DAS** – Measured 3D Analytic Signal with line contours

INTRODUCTION

This report describes a helicopter-borne geophysical survey carried out on behalf of Cambria Geosciences Inc. on the Kitsault Project, in northern British Columbia. The principal geophysical sensor is Aeroquest's HELI-MAG tri-directional magnetic gradiometer (towed-bird) system which employs four (4) optically pumped Cesium magnetometer sensors. Ancillary equipment includes a real-time differential GPS navigation system, radar altimeter, barometric altimeter, air temperature sensor, digital video acquisition system, and a base station magnetometer.

The airborne survey was flown at 100 m line spacing with a line kilometer total of 2057.0. The survey block boundaries are defined in Appendix 1. Survey flying described in this report took place between October 27th and November 11th, 2006.

This report describes the survey logistics, the data processing, and provides an overview of the results.

2. SURVEY AREA

The survey area is located in northern British Columbia approximately 100 km northwest of Terrace and 60km southeast of Stewart. (Figure 1) The nearest settlements are Anyox and Alice Arm, both just to the north of the project area.

The survey is made up of two irregular shaped blocks; Area 1,2,4 (170km²) and Area 3 (20km²). The blocks cover mountainous terrain. The northwest section of Area 1,2,4 is transected by the upper reaches of the Portland Inlet fjord. Area 3 lies on a small headland also on the Portland Inlet. As a result there is a portion of the survey over water. There are over 300 mining claims in the area with various owners (Figure 3).

The base of operations and crew accommodation was at the Anyox Camp.

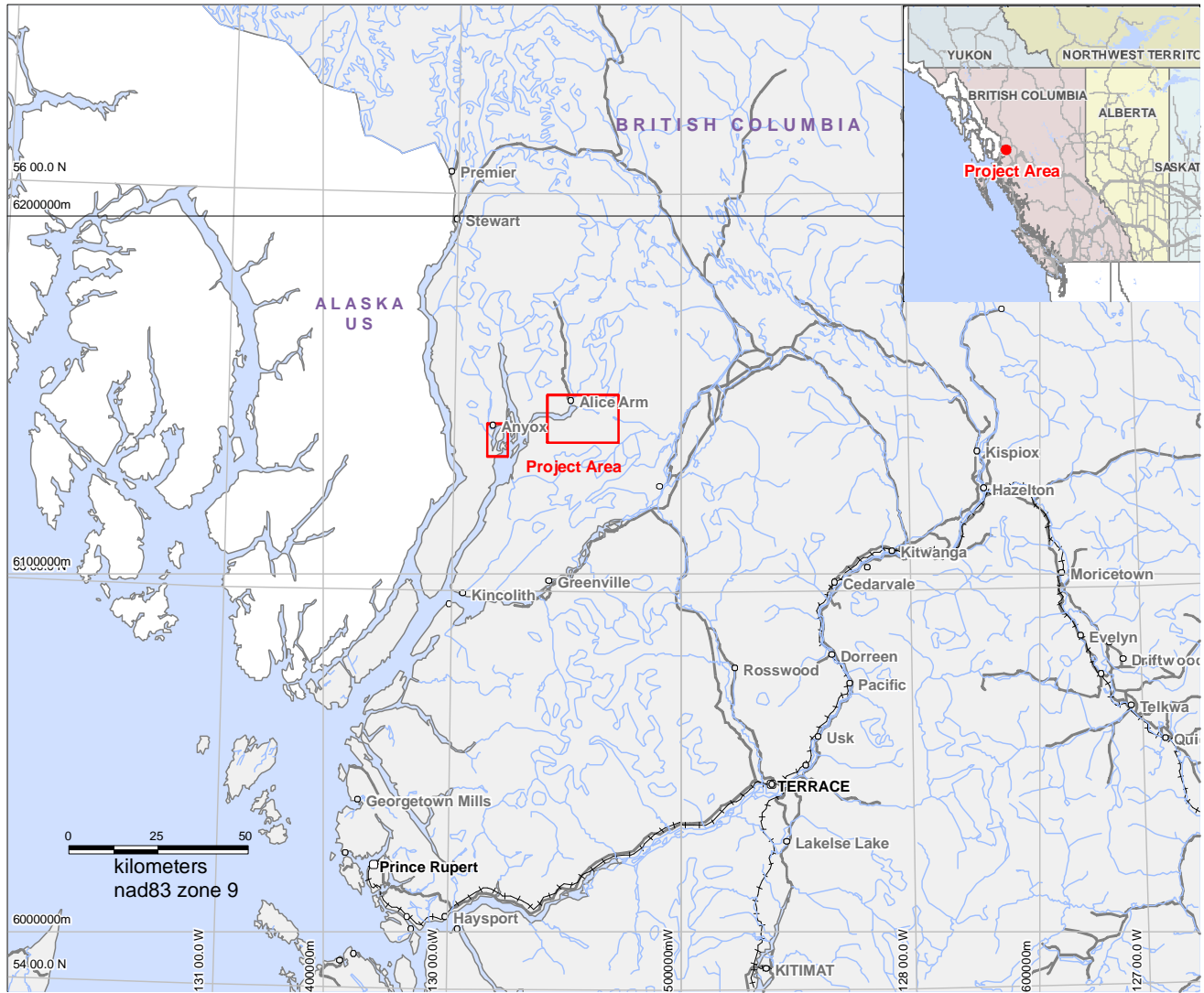


Figure 1. Project Location

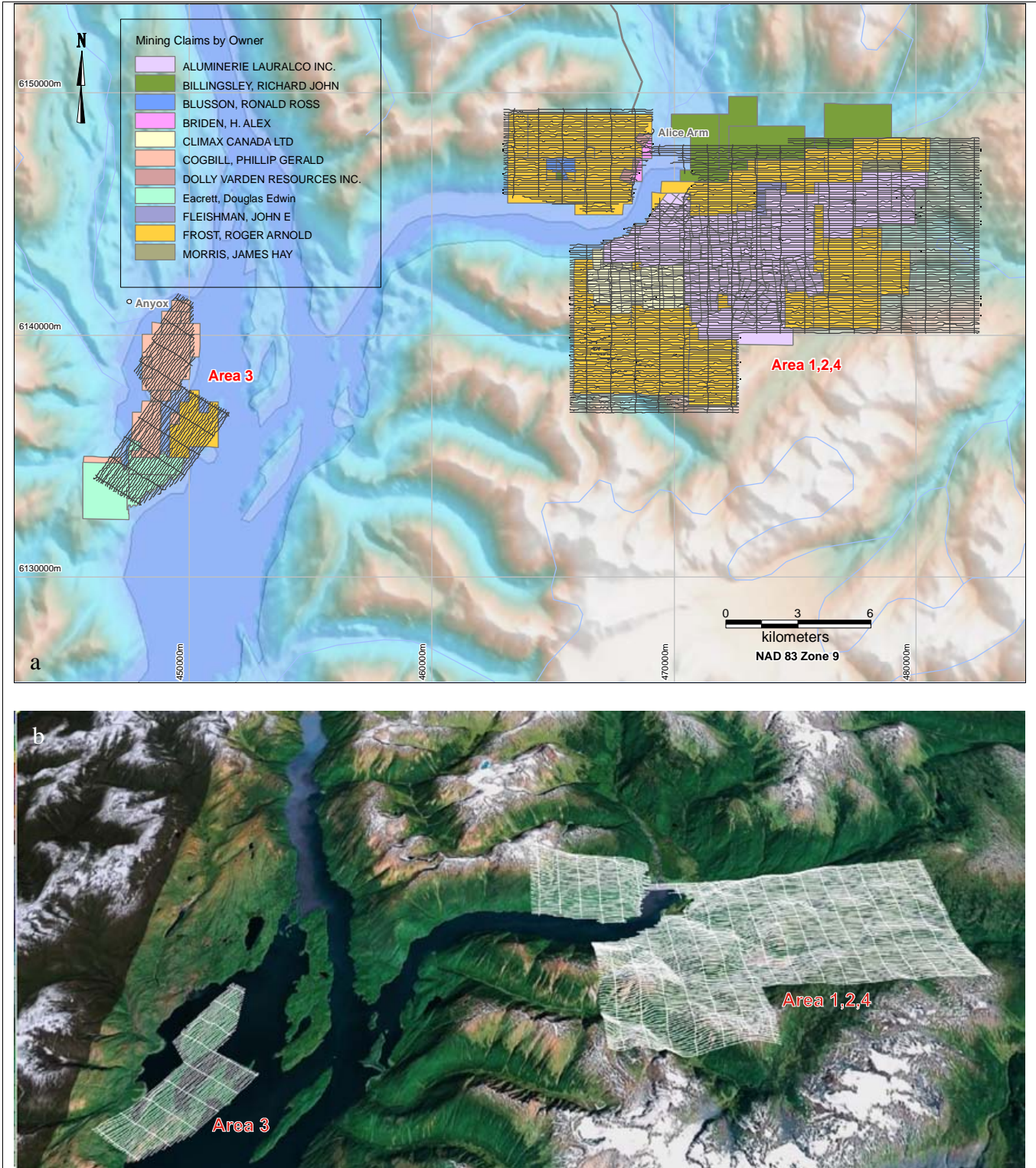


Figure 2 Project Flight path over mining claims (a) and Google Earth imagery (b).



3. SURVEY SPECIFICATIONS AND PROCEDURES

3.1. Flight Path and Survey Coverage Specifications

The general survey flying specifications are summarised in the following table:

Survey Block Name	Line Spacing (m)	Line Direction (azimuth)	Survey Coverage (line-km)	Date(s) Flown
Area 1,2,4	100	90° (E-W)	1,823.5	October 28 th . November 13 th , 2006
Area 3	100	36° (NE-SW)	233.5	October 27 th , 2006
		Total	2057.0	

The presented survey coverage was calculated by adding up the survey and control (tie) line lengths as presented in the final Geosoft database.

The nominal gradiometer bird terrain clearance was 50 m but was periodically higher or lower over due to the rugged terrain and the capability of the aircraft. Nominal survey speed over relatively flat terrain is 100 km/hr and is generally lower in rougher terrain. Scan rates for gradiometer data acquisition is 0.10 seconds. The 10 samples per second translates to a gradiometer reading about every 1.5 to 3.0 metres along the flight path.

3.2. Navigation

Navigation is carried out using a GPS receiver installed on the gradiometer bird, an AGNAV2 system for navigation control. The Pico Envirotec acquisition system is used for GPS data recording. The x-y-z position of the aircraft, as reported by the GPS, is recorded at 0.2 second intervals. The system has a published accuracy of under 3 metres. A recent static ground test of the Mid-Tech WAAS GPS yielded a standard deviation in x and y of under 0.6 metres and for z under 1.5 metres over a two-hour period.

4. AIRCRAFT AND EQUIPMENT

4.1. Aircraft

A Eurocopter (Aerospatiale) AS350B2 "A-Star" helicopter - registration C-FPTG was used as survey platform (Figure 3). The helicopter was owned and operated by Hi-Wood Helicopters, Okotose, Alberta. The survey aircraft was flown at a nominal terrain clearance of 55 m.



Figure 3. Survey Helicopter (C-FPTG)

4.2. Magnetic Gradiometer System

Overview

The Aeroquest HELI-MAG magnetic gradiometer system (Figure 5) employs four (4) Geometrics G-823A optically pumped Cesium-vapor sensors. The Mag bird consists of 4 sensors allowing for measurements of the total field, vertical gradient and horizontal gradients both along and cross flight lines (Figure 4). Three sensors are configured in a tri-axial configuration at the rear of the bird and the fourth sensor is located in the nose of the bird to provide a longitudinal (horizontal) gradient measurement. The magnetic data is collected at a rate of 10Hz, and recorded by a dedicated Windows-based computer.

Magnetic Sensors

The specifications of the cesium vapour magnetic sensors are as follows*:

Sensitivity:	<0.004 nT/Hz
Absolute Accuracy:	< +/- 1.5 nT throughout operating range
Sampling Rate:	10 Hz
Dynamic Range:	20,000 - 100,000 nT
Operating Range:	6° to 84° and 96° to 174° from long axis, 360° full rotation about short axis
Heading Error:	less than 0.15 nT combined for sensor spins on all axes
Operating Temperature:	-35°C to +50°C

*Specifications are provided by the sensor manufacturer

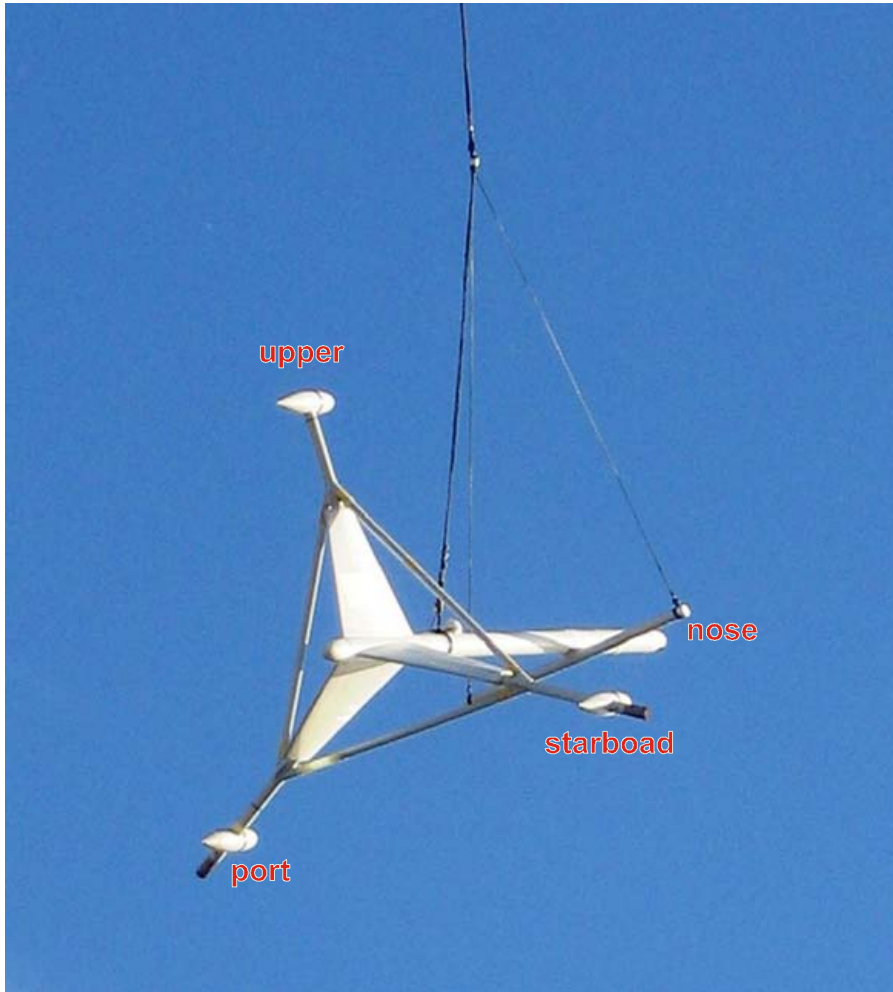


Figure 4. HELI-MAG magnetic gradiometer showing locations of 4 sensors

Bird Design

Sensor Standoffs:

- Horizontal: 3.00 metres
- Vertical: 3.00 metres
- Longitudinal: 3.00 metres

Tow Cable: 45 metres long, with Kevlar strain member and weak-link

Terrain Clearance: 30 metres (nominal)

GPS Lag: 0.00 sec (antenna mounted in centre of bird)



Figure 5. HELI-MAG Magnetic Gradiometer Bird and helicopter on survey.

4.3. Magnetometer Base Station

An integrated GPS and magnetometer base station is set up to monitor and record the diurnal variations of the Earth's magnetic field. The sensor, GPS and magnetic, receiver/signal processor is a dedicated unit for purposes of instrument control and/or data display and recording. The unit uses a common recording reference using the GPS clock.

The base station was a Geometrics G858 optically pumped Caesium vapour magnetometer coupled with a Garmin GPS18 GPS sensor. Data logging and magnetometer control was provided by the unit's internal software. The logging was configured to measure at 1.0 second intervals. Digital recording resolution was 0.01



nT. The sensor was placed on a tripod away from potential noise sources near the camp. A continuously updated profile plot of the magnetometer value is available for viewing on the unit's display.

4.4. Radar Altimeter

A Terra TRA 3500/TRI-30 radar altimeter is used to record terrain clearance. The antenna was mounted on the outside of the helicopter beneath the cockpit. Therefore, the recorded data reflect the height of the helicopter above the ground. The Terra altimeter has an altitude accuracy of +/- 1.5 metres.

4.5. Video Tracking and Recording System

A high resolution digital colour video camera is used to record the helicopter ground flight path along the survey lines. The video is recorded digitally and annotated with GPS position and time and can be used to verify ground positioning information and cultural causes of anomalous geophysical responses.

4.6. GPS Navigation System

The navigation system consists of an Ag-Nav Incorporated AG-NAV2 GPS navigation system comprising a PC-based acquisition system, navigation software, a deviation indicator in front of the aircraft pilot to direct the flight, a full screen display with controls in front of the operator, a Mid-Tech RX400p WAAS-enabled GPS receiver mounted on the instrument rack and an antenna mounted on the magnetometer bird. WAAS (Wide Area Augmentation System) consists of approximately 25 ground reference stations positioned across the United States that monitor GPS satellite data. Two master stations, located on the east and west coasts, collect data from the reference stations and create a GPS correction message. This correction accounts for GPS satellite orbit and clock drift plus signal delays caused by the atmosphere and ionosphere. The corrected differential message is then broadcast through one of two geostationary satellites, or satellites with a fixed position over the equator. The corrected position has a published accuracy of under 3 metres. A recent static ground test of the Mid-Tech WAAS GPS yielded a standard deviation in x and y of under 0.6 metres and for z under 1.5 metres over a two-hour period.

Survey co-ordinates are set up prior to the survey and the information is fed into the airborne navigation system. The co-ordinate system employed in the survey design was WGS84 [World] using the UTM zone 9W projection. The real-time differentially corrected GPS positional data was recorded by the RMS DGR-33 in geodetic coordinates (latitude and longitude using WGS84) at 0.2 s intervals.

5. PERSONNEL

The following AeroQuest personnel were involved in the project:

- É Manager of Operations: Troy Will
- É Field Data Processor: Guido Tocci
- É Field Operator: Chris Brown, Theo Corcioba
- É Data Interpretation and Reporting: Matthew Pozza, Eric Steffler, Marion Bishop

The Survey Pilot, Colby Tyrrell, was employed directly by the helicopter company, Hi-Wood Helicopters, Okotose, Alberta.

6. DELIVERABLES

6.1. Hardcopy Map Products

The report includes a set of two (2) 1:20,000 maps. The geophysical products are listed below:

- **RTP** – RTP (Reduced to Pole) Magnetic Field (igrf removed) with line contours
- **M3DAS** – Measured 3D Analytic Signal with line contours

All the maps show flight path trace and survey line and flight numbers. Topographic line contours and claim boundaries are overlain for reference on all maps.

6.2. Digital Deliverables

Final Database of Survey Data

The geophysical profile data is archived digitally in Geosoft GDB binary format database(s). The databases has also been exported into Geosoft XYZ format, which is text file format offering greater compatibility with other viewing software. A description of the contents of the individual channels in the database can be found in Appendix 2. A copy of this digital data is archived at the Aeroquest head office in Milton.

Geosoft Grid files (GRD)

Leveled Grid products used to generate the geophysical map images and additional grid products. Cell size for all grid files is 25 meters. Area 1,2,4 and Area 3 each have the following grid products:

- TMI.grd : Total Magnetic Intensity
- MVG.grd: Measured Vertical Gradient
- 1VD.grd: First vertical Derivative of the TMI (Calculated Vertical Gradient)
- TDR.grd: Tilt derivative of the TMI Grid
- M3DAS: Measured 3-D analytic signal grid
- RTP.grd: Reduced to Pole Magnetic Field

Digital Versions of Final Maps

Map files in Geosoft .map and Adobe PDF format

Free Viewing Software

- Geosoft Oasis Montaj Viewing Software
- Adobe Acrobat Reader

Digital Copy of this Document

- Adobe PDF format

7. DATA PROCESSING AND PRESENTATION

All in-field and post-field data processing was carried out using Aeroquest proprietary data processing software, and Geosoft Oasis montaj software. Maps were generated using a 48-inch wide Hewlett Packard 4000ps plotter.

7.1. Base Map

The geophysical maps accompanying this report are based on positioning in the WGS84 datum. The survey geodetic GPS positions have been projected using the Universal Transverse Mercator projection in Zone 9N. A summary of the map datum and projection specifications is as follows:

É Ellipse: GRS 1980
É Ellipse major axis: 6378137m eccentricity: 0.081819191
É Datum: North American 1983 - Canada Mean
É Datum Shifts (x,y,z) : 0, 0, 0 metres
É Map Projection: Universal Transverse Mercator Zone 9 (Central Meridian 129°W)
É Central Scale Factor: 0.9996
É False Easting, Northing: 500,000m, 0m

For reference, the latitude and longitude in WGS84 are also noted on the maps.

7.2. Flight Path & Terrain Clearance

The position of the survey helicopter was directed by use of the Global Positioning System (GPS). Positions were updated five times per second (5Hz) and expressed as WGS84 latitude and longitude calculated from the raw pseudo range derived from the C/A code signal. The instantaneous GPS flight path, after conversion to UTM co-ordinates, is drawn using linear interpolation between the x/y positions. The terrain clearance was maintained with reference to the radar altimeter.

A digital terrain model profiles were calculated using the available GPS altitude and radar altitude data.

7.3. Magnetic Gradient Data

Initial Processing – Total Field

The total field was calculated using an average reading of all the magnetometers (Mag_TF channel in database). This process provides a more accurate reading of the total field in comparison to a single sensor measurement. Diurnal variation was removed using the base magnetometer data. Further leveling was carried out by using the intersections of the tie-lines (tie-line leveling). The data was then micro-leveled using a directional spatial filtering technique. This process removes other very small systematic errors in the data. The regional magnetic field (IGRF) was then removed from the survey data. The data was then interpolated onto a grid using a minimum curvature gridding algorithm with a cell size of 25m.

Due to the significant magnetic declination at the survey area the total field grid was reduced to the magnetic pole (RTP) prior to presentation on the maps.



Measured Gradients

The three magnetic gradient components were calculated by various differencing of the four measured total field readings and then dividing by the distance between the measurements. The measured vertical gradient (MVG) is calculated by differencing the average of the port and starboard sensors from the upper sensor. The measured transverse (across-track) gradient (MTG) is calculated by differencing the port and starboard sensors (corrected for line direction). The measured longitudinal gradient (MLG) is calculated using an average of the port, starboard and upper sensor subtracted from the nose sensor (corrected for line direction).

The baselines of the gradient measurements are described in section 5.2. Further levelling of the gradient components was then carried out using tie-line levelling if required. The measured vertical gradient profiles were interpolated into a grid and included in the digital archive.

Total Magnetic Gradient

The total magnetic gradient (MAG_3DAS channel in database), or 3-D analytic signal, is a high resolution magnetic data form. Its primary advantage is that positive peaks in the data will directly correlate with the centre of the magnetic source, regardless of the Earth's magnetic field orientation, or possible remanent magnetism effects in the source body.

Mathematically it is described as:

$$TG = \sqrt{\frac{dT^2}{dx} + \frac{dT^2}{dy} + \frac{dT^2}{dz}}$$

Where:

TG is the magnitude of the total gradient vector and

T is the observed magnetic field at location (x,y)

Since the HeliMag system directly measures the three gradient components, the total gradient is effectively measured. The above formula is applied to the three gradient channels to provide a measured total gradient profile. Again, due to the short baseline design of the gradiometer system, the TG greatly enhances near surface magnetic sources. The TG can be thought of as magnetisation in the ground.

Respectfully submitted,

Matt Pozza, M.Sc.
Geophysicist
Aeroquest Limited
January 2007



APPENDIX 1 – SURVEY BLOCK CORNER COORDINATES

The approximate outline of the data collected for this project is defined in the following table. Positions are in WGS84 / UTM zone 9N.

Area 1, 2, 4

X	Y
472667.3	6140071.8
472666.6	6139912.0
472666.2	6136782.0
465691.5	6136782.0
465692.3	6143979.3
465703.9	6145251.3
462975.1	6145273.4
462986.2	6149355.4
469099.7	6149355.4
469094.1	6147858.8
474701.5	6147826.5
474701.6	6148108.5
482583.9	6148108.5
482583.0	6140079.1

Area 3

X	Y
449492.24	6141733.85
450135.34	6141354.23
450217.70	6138960.87
449637.74	6137922.46
451686.63	6136771.34
449638.05	6133988.4
447897.86	6132964.63
446027.78	6134049.22
448460.50	6137418.47
447679.97	6138518.06



APPENDIX 2 - DESCRIPTION OF DATA BASE FIELDS

In the database, the Survey lines and Tie Lines are prefixed with an "L" for "Line" and "T" for "Tie". Database (Area124_HeliMag_Cambria_final.gdb, Area3_HeliMag_Cambria_final.gdb):

Column	Units	Description
Line		Survey Line #
Flight		Helicopter Flight #
utctime	hh:mm:ss.s	UTC time
X	m	UTM Easting (NAD83) Z9N
Y	m	UTM Northing (NAD83) Z9N
basemagf	nT	base magnetometer readings
ralt	m	radar altitude of aircraft
bheight	m	calculated height of gradiometer bird
galtf	m	elevation of GPS antenna (AMSL) (WGS84)
dtm	m	Calculated Digital terrain model
Mag_Tf	nT	Leveled total magnetic field (Average of Upper, Starboard and Port and Nose)
MTGf	nT/m	Measured Transverse Gradient (Cross Track) corrected for flight direction and leveled
MVGf	nT/m	Measured Vertical magnetic Gradient (Leveled)
MLGf	nT/m	Measured Longitudinal Gradient (Along Track) corrected for flight direction and leveled
Mag_3DAS	nT/m	Measured Total Gradient (3D Analytic Signal)
MagU	nT	Uncorrected Upper (Top) sensor magnetic field reading
MagP	nT	Uncorrected Port sensor, magnetic field reading
MagS	nT	Uncorrected Starboard sensor, magnetic field reading
MagN	nT	Uncorrected Nose (Front) sensor , magnetic field reading
IGRF_B	nT	International Geomagnetic Reference Field (2006) . total field
IGRF_I	degrees	International Geomagnetic Reference Field (2006) - inclination
IGRF_D	degrees	International Geomagnetic Reference Field (2006) - declination

STATEMENT OF COSTS

Aeroquest AeroTEM survey

- Airborne magnetics and time domain EM survey
- 2057.0 line kilometre flown
- Compilation of data, interpretation

\$238,130

Support

- Lodging, meals, transport,

\$31,000

Fuel

\$9,000

TOTAL: \$278,130

EXPENDITURES PER PROJECT AREA

Roundy Creek (1) (3601 Ha, 23.79% of area covered)
(510205, 510226, 517362, 527089)

\$66,169

Tide Water (2) (2064 Ha, 13.64% of area covered)
(Tidewater 1-6)

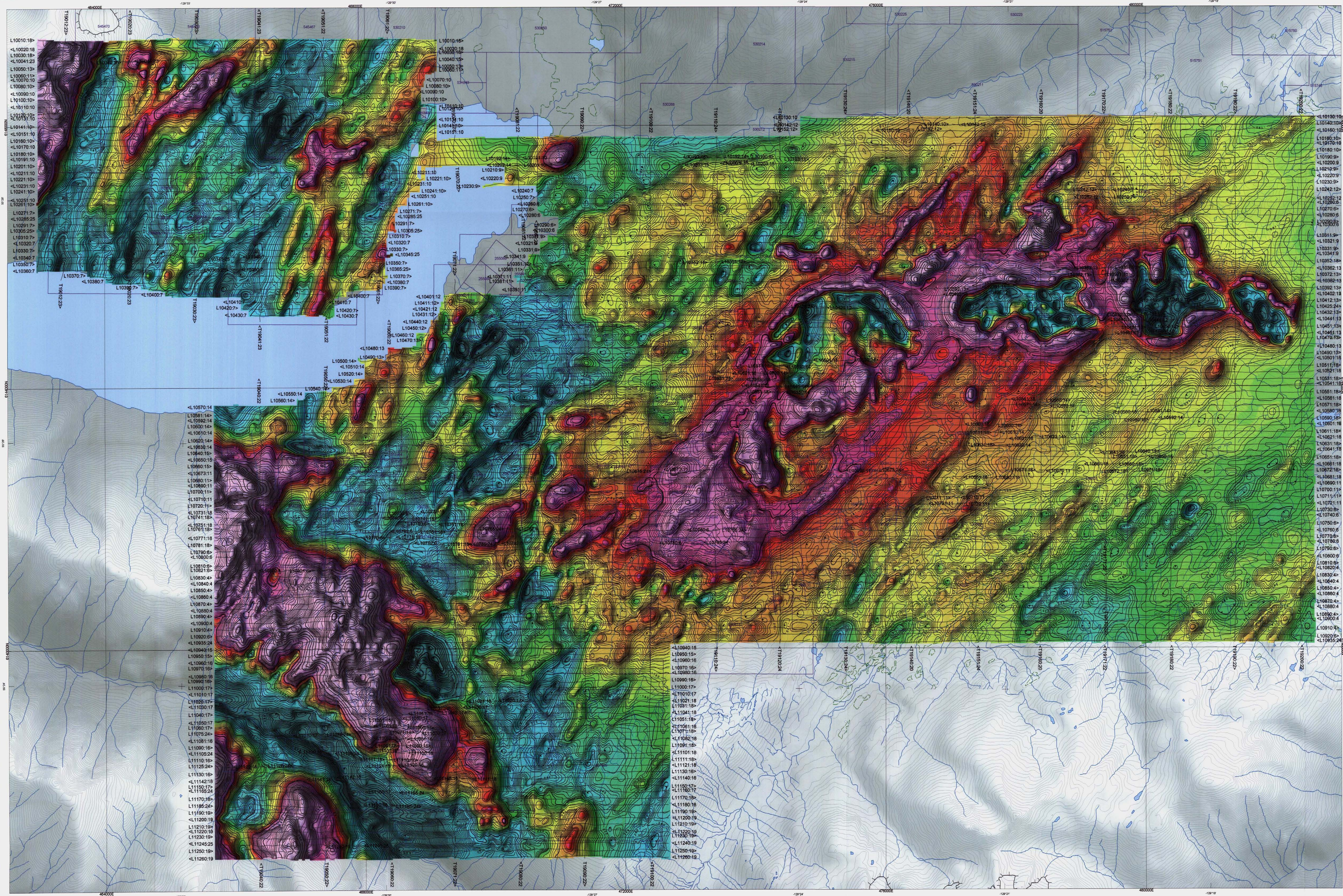
\$37,930

Granby Point (3) (2352 Ha, 15.54% of area covered)
(369886, 519974, 522522, 522531, 522976)

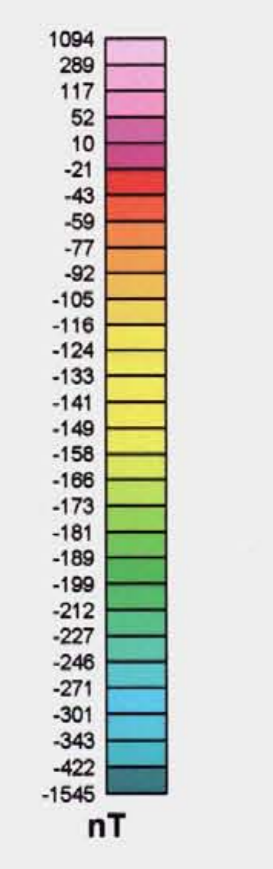
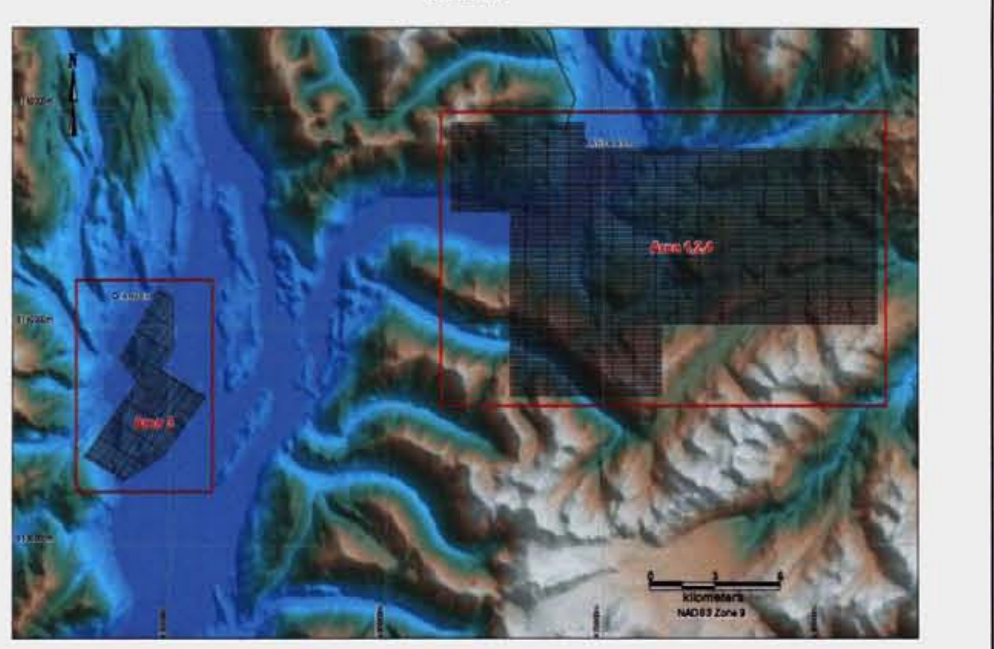
\$43,214

Kitsault East (4) (7120 Ha, 47.03% of area covered)
(530826, 530827, 530888, 530889, 530890, 530891, 530892, 530593)

\$130,817



The topographic data base was derived from BCOS 1:20K TRM Data. The topographic data was acquired by the client. Inset data derived from Natural Resources Canada Atlas of Canada Base Map. This map accompanies the technical report entitled Report on a Helicopter-Borne Magnetic Gradienter Survey, Klaskan & Arjox Properties Arjox Area, British Columbia, by Aeroquest Limited, January 2007.



RTP Magnetic Field
Contour Interval: 5.20 nT
100, 200 nT
1000 nT

SURVEY SPECIFICATIONS:
Survey from: October 28 to November 20, 2006
Traverse line spacing: 100 metres
Traverse line direction: 90° Azimuth (E-W)
Normal SIA and height: 30 metres
Arcs: Aerospacelab A-Star 3502 (C-FPTG)

INSTRUMENTATION:
Data acquisition: HEMAG - Tri-Directional Total Field/Gradient Magnetometers: 4 x Geometrics G-823A optically pumped Caesium-vapour sensors
Installation: Tower and 30m normal ground clearance
Sensitivity: .04 nanoTesla/Hz
Sampling Rate: 10Hz

NAVIGATION:
Navigation: Differential Global Positioning System (DGPS)
Navigation equipment: AGNAV with MID-TECH RX400p receiver
Radio Altimeter: Terra TR3000/FR-30

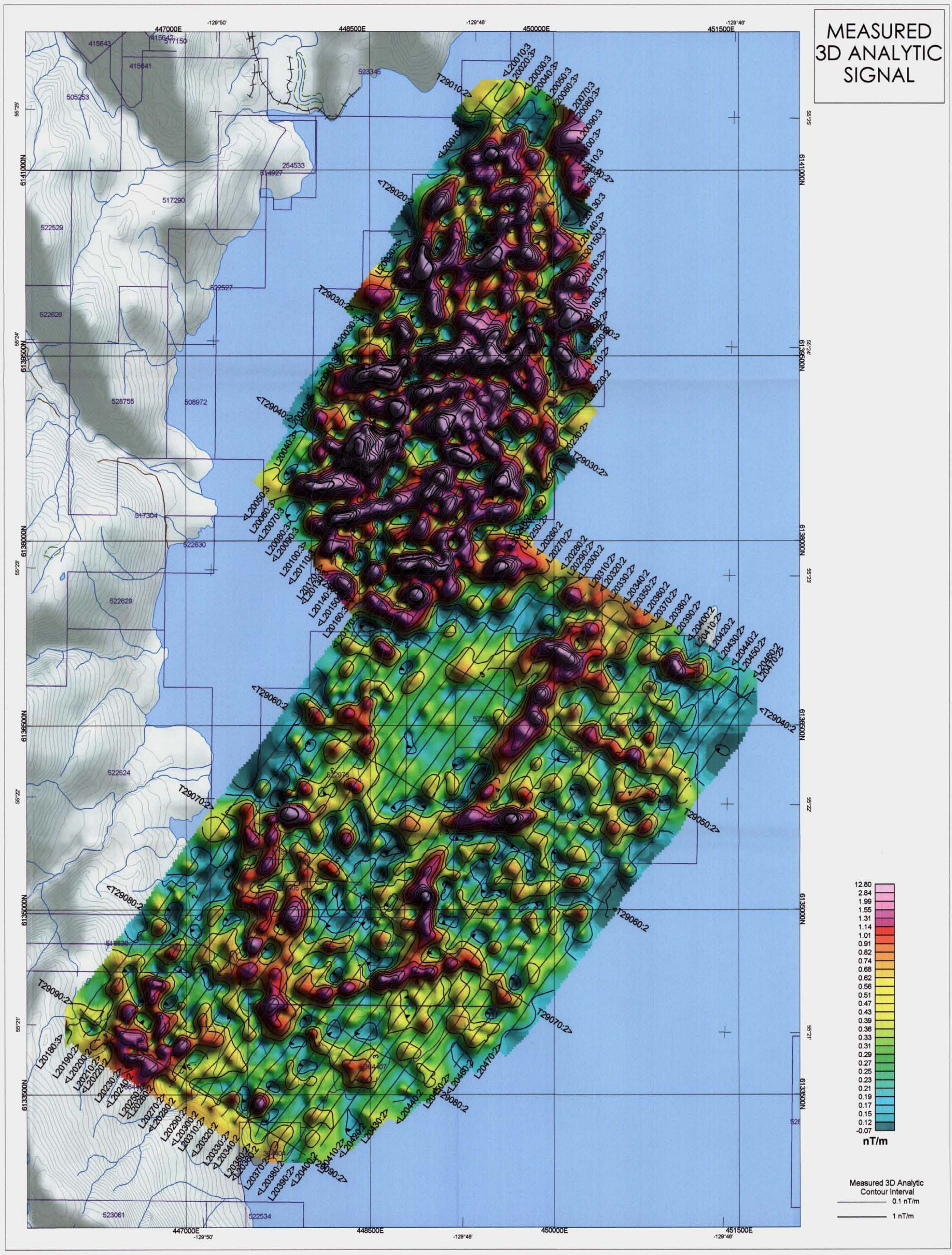
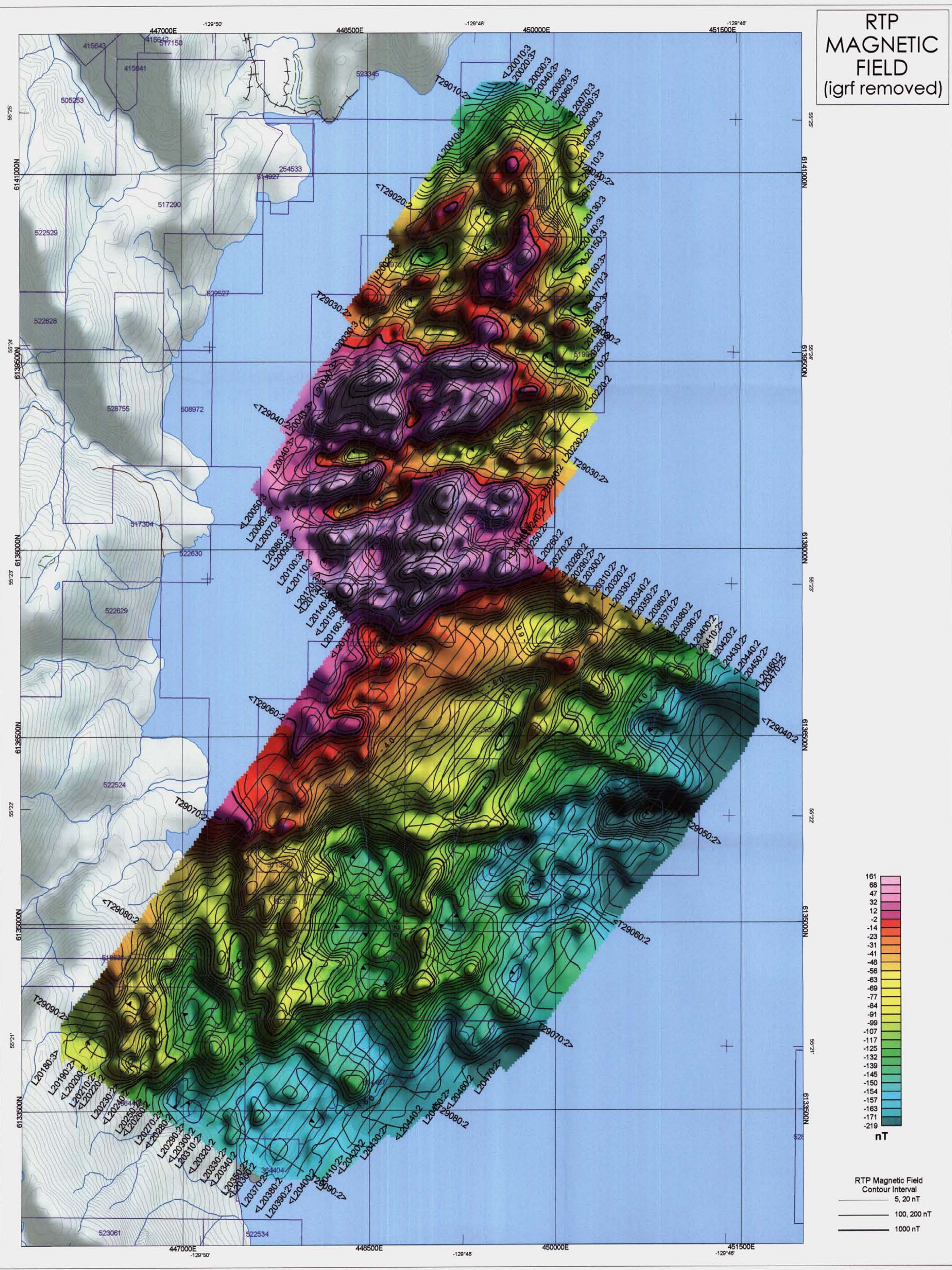
DATA PROCESSING:
Magnetic: diurnal, tidal and micro-leveling corrections
POSITIONING:
Datum: NAD83
Major Area: 6378137.000
Elevation: 0.081819191

MAP PROJECTION:
Projection: Universal Transverse Mercator
Central Meridian: 120°W (Zone 09)
Central Scale Factor: 0.9996
False Easting/Northing: 500,000m/0m

Cambria Geosciences
Arjox Area, British Columbia

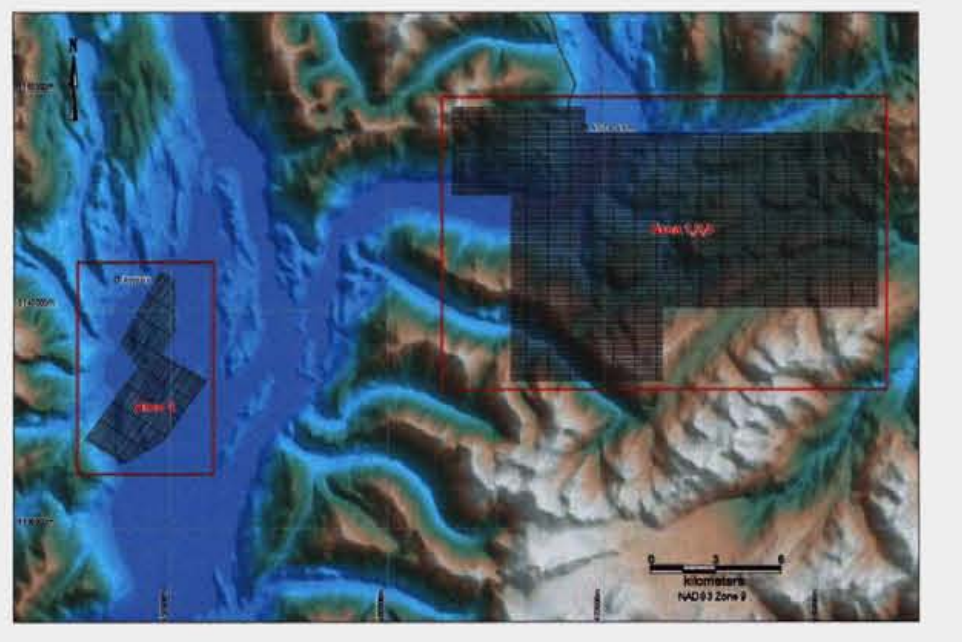
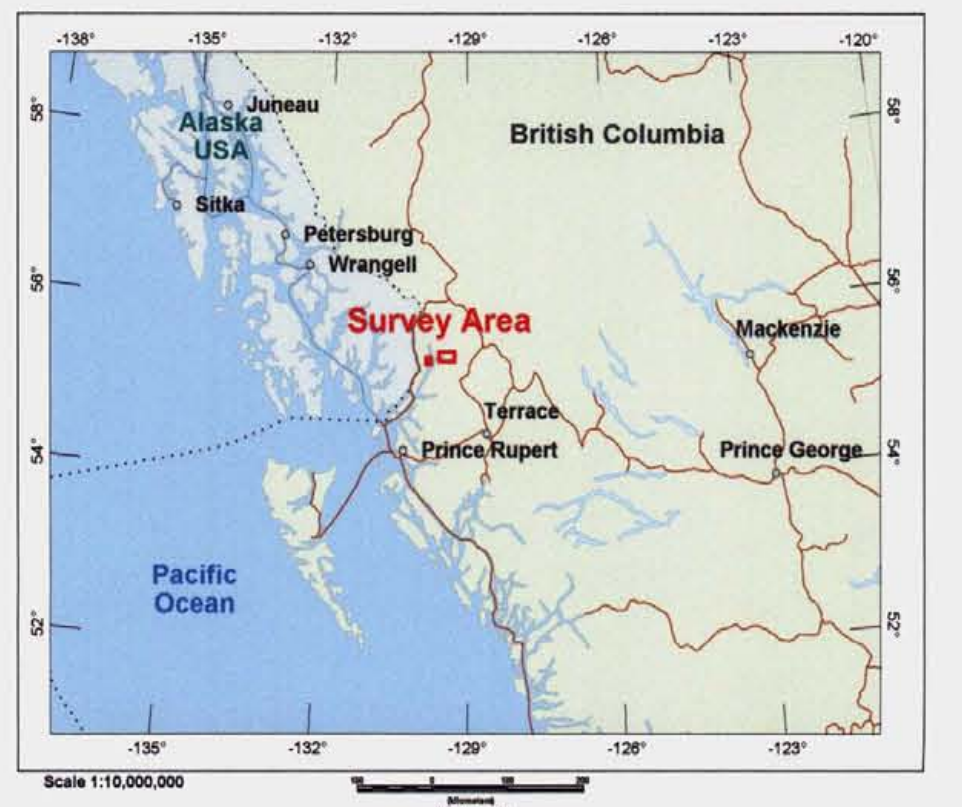
RTP MAGNETIC FIELD (IGRF REMOVED)
Area 1, 2, 4, Plate 1
NTS 103P06, 103P05

Survey flown by:
AEROQUEST LIMITED
4-845 Main St. East
Milton, Ont., CANADA L7T 3Z3
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January 2007



The topographic data base was derived from DCGS 1:20K TRIM Data
The topographic data was supplied by the client
Inset data derived from Natural Resources Canada 'Atlas of Canada Base Maps'
This map accompanies the technical report entitled 'Report on a
Helicopter-Borne Magnetic Gradiometer Survey, Kluait & Anyox Properties
Anyox Area, British Columbia', by Aeroquest Limited, January 2007

Grid North
NAD83 - Zone 09



SURVEY SPECIFICATIONS:
Survey from: November 27, 2006
Traverse line spacing: 100 metres
Traverse line direction: 36° Azimuth (SW-NE)
Nominal EM bird height: 30 metres
Aircraft: Aerospatiale A-Star 350B2 (C-FPTG)

INSTRUMENTATION:
Data acquisition: HelimAG - Tri-Directional Total Field/Gradient
Magnetometers: 4 x Geometrics G-823A optically pumped Cesium-vapour sensors
Installation: Towed bird (30m nominal ground clearance)
Sensitivity: 0.04 nanoTesla/Hertz
Sampling Rate: 10Hz

NAVIGATION:
Navigation: Differential Global Positioning System (DGPS)
Navigation equipment: AGNAV with MID-TECH RX400p receiver
Radar Altimeter: Terra TRA3000TRI-30

DATA PROCESSING:
Magnetics: diurnal, tie-line and micro-leveling corrections

POSITIONING:
Datum: NAD83
Major Axis: 6378137.000
Eccentricity: 0.081819191

MAP PROJECTION:
Projection: Universal Transverse Mercator
Central Meridian: 129°W (Zone 09)
Central Scale Factor: 0.9996
False Easting/Northing: 500,000m/0m

Scale 1:20,000

Cambrisa Geosciences
Anyox Area, British Columbia

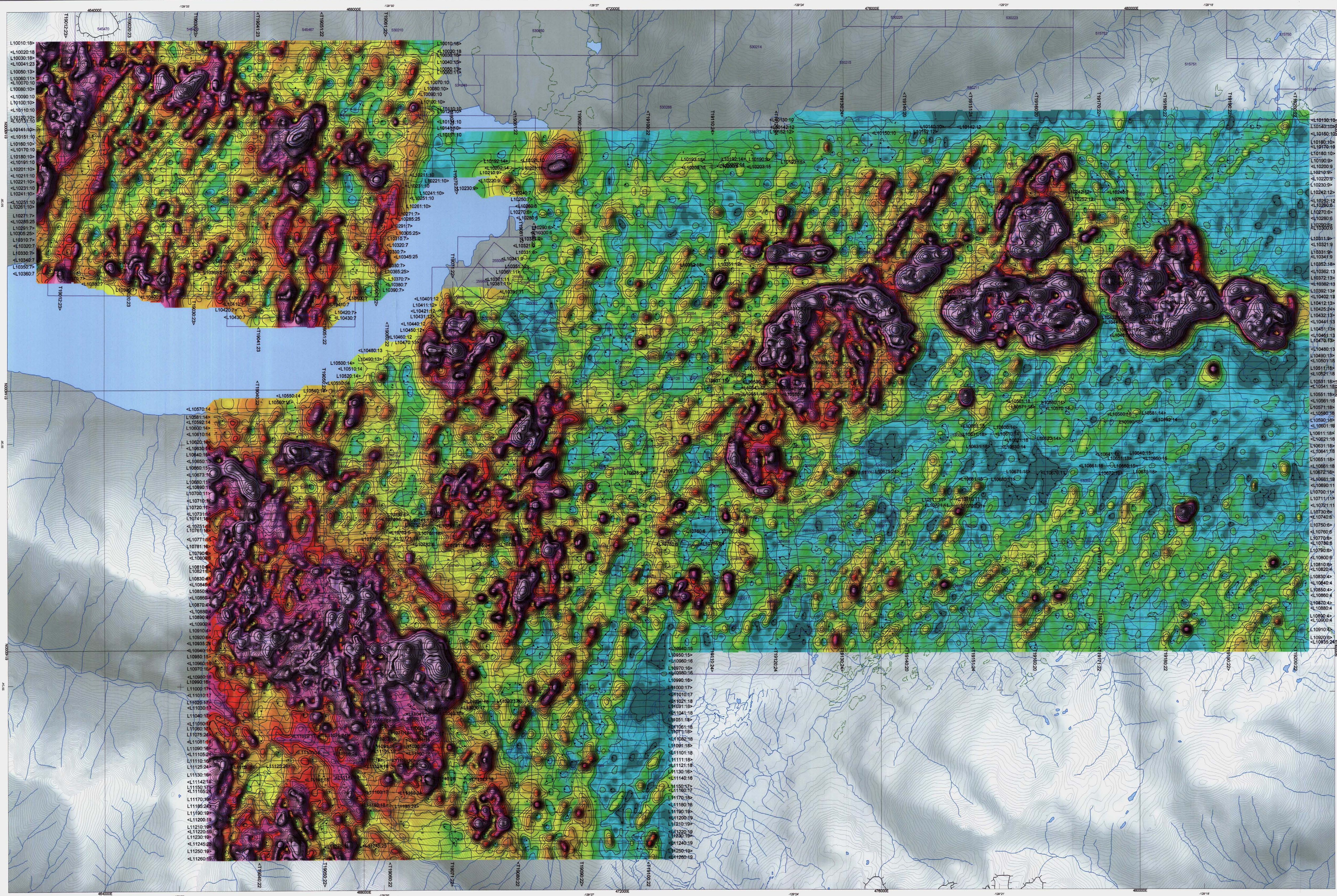
**MAGNETIC GRADIOMETER
PRODUCTS**

Area 3, Plate 2

NTS 103P05

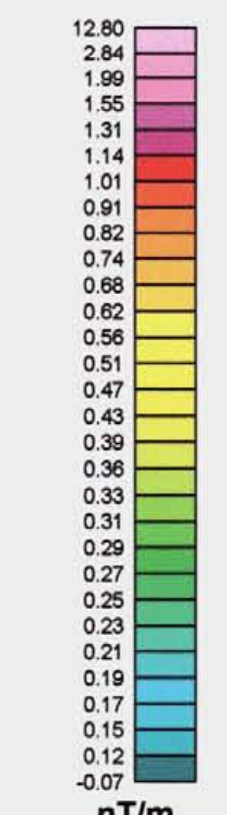
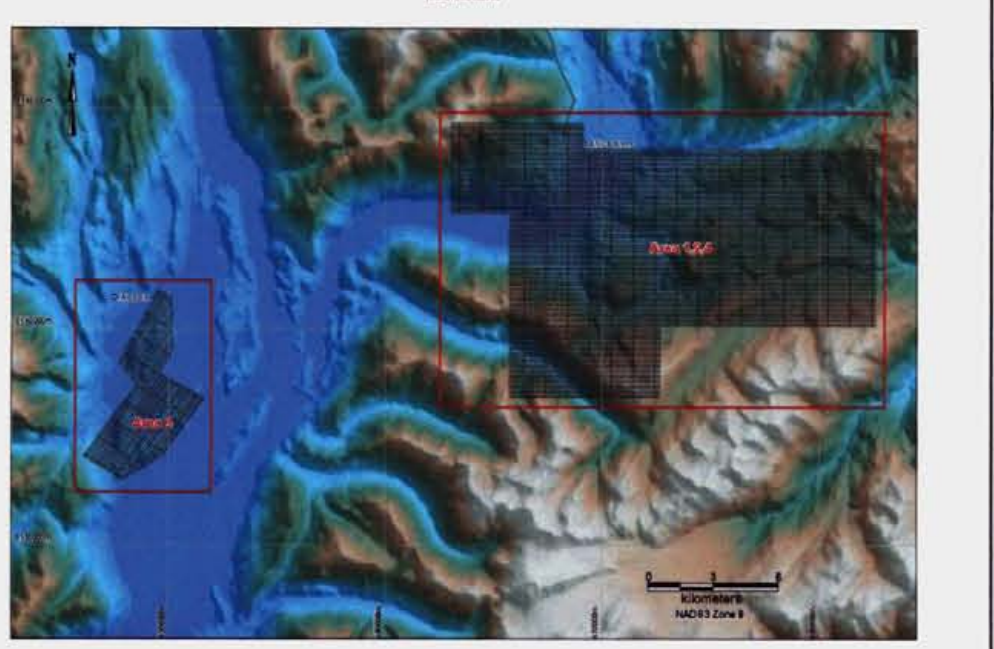
Survey flown by:
AEROQUEST LIMITED
4-845 Main St. East
Milton, Ont., CANADA L9T 3Z3
Tel: (905) 893-8120 Fax: (905) 893-8128
www.aeroquestlimited.com

January 2007



Grid North
NAD83 Zone 10

The topographic data base was derived from BCOSM 1:20K TRM Data.
The topographic data was compiled by the user.
Inset data derived from Natural Resources Canada Atlas of Canada Base Map.
This map accompanies the technical report entitled Report on a
Helicopter-Borne Magnetic Gradient Survey, Alsea & Anyox Properties
Anyox Area, British Columbia, by Aeroquest Limited, January 2007.



Measured 3D Analytic
Contour Interval
0.1 nT/m

SURVEY SPECIFICATIONS:
Survey from: October 28 to November 20, 2006
Traverse line spacing: 100 metres
Traverse line direction: 90° Azimuth (E-W)
Normal Sd and height: 30 metres
Aircraft: Aerospacelab A-Star 350S2 (C-FPPT)

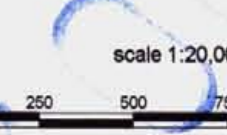
INSTRUMENTATION:
Data acquisition: HEMAG - Tri-Directional Total Field/Gradient Magnetometers, 4 x Geometrics G-823A optically pumped Caesium-vapour sensors
Installation: Towed bird (30m nominal ground clearance)
Sensitivity: .004 nanoTesla
Sampling Rate: 10Hz

NAVIGATION:
Navigation: Differential Global Positioning System (DGPS)
Navigation equipment: AGNAV with MD-TECH RX4000 receiver
Radar Altimeter: Terra TRA3000TRI-30

DATA PROCESSING:
Magnetic: diurnal, diurnal and micro-leveling corrections
Datum: NAD83

POSITIONING:
Datum: NAD83
Map Scale: 6378137.000
Elevation: 0.081819191

MAP PROJECTION:
Projection: Universal Transverse Mercator
Griding: UTM Zone 12N
Datum: NAD83
Scale Factor: 0.9996
False Easting/Northing: 500,000.00m



Cambria Geosciences
Anyox Area, British Columbia

MEASURED 3D ANALYTIC SIGNAL
Area 1, 2, 4, Plate 1
NTS 103P06, 103P05

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