GM 66877

Heliborne high resolution aeromagnetic survey, final technical report, Plex, La Grande-Sud and Corvet-Est properties

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SERVICES TECHNIQUES GEONORDIC INC.

HELIBORNE HIGH RESOLUTION AEROMAGNETIC SURVEY

Plex, La Grande Sud and Corvet Est Properties
James-Bay Area, Québec

Project Ref.: P11-039

FINAL TECHNICAL REPORT

December 2011

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1.0 INTRODUCTION

On October 15th, 2011, **GEO DATA SOLUTIONS GDS INC.** (GDS) was awarded project P11-039 by **Services Techniques Geonordic Inc.** (STG). The project entailed **GDS** to carry out a high-resolution helicopter borne magnetic survey on three properties (Plex, La Grande Sud and Corvet Est) located in the James-Bay Region, Quebec.

The base of operations was set up at the **STG**'s Camp, which is located at the KM 174 of Trans-Taïga road, in the middle of the Plex survey area. This place offered accommodation for the crew, air strip facilities, including Jet fuel and flight planning.

Total number of line-km needed to cover the survey areas was 10 679 line-km.

The survey was executed from October 24th to November 22nd, 2011. Excluding calibration and test flights, 40 production flights were needed to cover the requested blocks. Stable weather conditions were observed during the data acquisition period.

Table 1 presents survey specifications, tables 2, 3 and 4 present block co-ordinates and figure 1 outline the three properties. Lengths of any traverse or tie-line were adjusted to a minimum of 3 km.

In terms of altitude, topography in the survey areas is classed as gentle.

The magnetometer sensor was mounted in a stinger fixed to the helicopter (figure 2).

This report describes survey procedures and data verification, which were carried out in the field, and data processing, which followed at the office.

Table 1: Survey Specifications							
Area	Traverse Line			Tie Lines			Total
	Azimuth	Line-km	Spacing	Azimuth	Line-km	Spacing	
Corvet Est	N051°E	1 355 km	50 m	N141°E	143 km	500 m	**1 498 km**
La Grande Sud	N168°E	3 839 km	75 m	N078°E	402 km	750 m	**4 241 km**
Plex	N000°E	4 466 km	75 m	N090°E	474 km	750 m	**4 940 km**
						TOTAL	**10 679 km**

Table 2: Corvet Est, Block Co-ordinates (NAD83 UTM zone 18)				
Vertex	Latitude	Longitude	X (UTM)	Y (UTM)
1	53.19.32.63	-74.01.19.90	565 125	5 908 952
2	53.21.10.35	-74.00.12.22	566 335	5 911 989
3	53.20.36.24	-73.57.54.85	568 890	5 910 971
4	53.21.32.30	-73.57.15.95	569 584	5 912 714
5	53.20.35.79	-73.53.28.76	573 811	5 911 031
6	53.21.10.29	-73.53.04.77	574 238	5 912 104
7	53.20.19.23	-73.49.40.15	578 047	5 910 587
8	53.19.44.75	-73.50.04.18	577 620	5 909 514
9	53.19.22.31	-73.48.34.42	579 292	5 908 848
10	53.16.48.70	-73.50.21.44	577 389	5 904 069

Table 3: La Grande Sud, Block Co-ordinates (NAD83 UTM zone 18)				
Vertex	Latitude	Longitude	X (UTM)	Y (UTM)
1	53.35.59.97	-76.10.13.65	422 545	5 939 655
2	53.33.23.87	-76.09.13.41	423 574	5 934 813
3	53.32.18.46	-76.17.09.86	414 771	5 932 942
4	53.30.43.87	-76.16.33.11	415 395	5 930 007
5	53.29.33.91	-76.24.58.25	406 048	5 928 021
6	53.28.30.10	-76.24.33.29	406 469	5 926 040
7	53.26.26.47	-76.39.14.31	390 139	5 922 569
8	53.31.40.50	-76.41.19.19	388 065	5 932 326
9	53.35.59.97	-76.10.13.65	422 545	5 939 655

Table 4: Plex, Block Co-ordinates (NAD83 UTM zone 18)				
Vertex	Latitude	Longitude	X (UTM)	Y (UTM)
1	53.33.32	-75.28.15	468 821	5 934 553
2	53.33.32	-75.27.01	470 169	5 934 553
3	53.34.02	-75.27.02	470 169	5 935 469
4	53.34.03	-75.24.01	473 493	5 935 469
5	53.33.33	-75.24.01	473 493	5 934 553
6	53.33.34	-75.21.30	476 260	5 934 553
7	53.33.00	-75.21.30	476 260	5 933 512
8	53.33.00	-75.21.04	476 745	5 933 512
9	53.32.31	-75.21.03	476 745	5 932 632
10	53.32.32	-75.17.28	4 80 716	5 932 632
11	53.32.02	-75.17.27	4 80 716	5 931 699
12	53.32.02	-75.15.29	4 82 890	5 931 699
13	53.31.03	-75.15.29	482 890	5 929 861
14	53.31.03	-75.16.00	482 325	5 929 861
15	53.30.33	-75.15.59	482 325	5 928 945
16	53.30.33	-75.16.59	481 229	5 928 945
17	53.30.04	-75.16.59	481 229	5 928 048
18	53.30.04	-75.15.59	482 325	5 928 048
19	53.29.02	-75.15.59	482 325	5 926 145
20	53.29.03	-75.11.01	487 822	5 926 145
21	53.28.31	-75.11.01	487 822	5 925 158
22	53.28.31	-75.09.31	489 475	5 925 158
23	53.28.00	-75.09.31	489 475	5 924 206
24	53.28.00	-75.07.56	491 218	5 924 206
25	53.28.31	-75.07.56	491 218	5 925 158
26	53.28.31	-75.03.24	496 238	5 925 158
27	53.28.05	-75.03.24	496 238	5 924 342
28	53.28.05	-74.59.57	500 064	5 924 342
29	53.26.16	-74.59.57	500 064	5 920 980
30	53.26.15	-74.59.49	500 199	5 920 939
31	53.26.15	-74.58.45	501 393	5 920 939
32	53.26.03	-74.58.45	501 393	5 920 573
33	53.25.51	-74.57.36	502 652	5 920 189
34	53.25.51	-74.56.30	503 868	5 920 189
35	53.25.39	-74.56.30	503 868	5 919 817
36	53.25.33	-74.55.58	504 468	5 919 633
37	53.23.25	-74.55.58	504 468	5 915 689
38	53.23.25	-74.56.35	503 793	5 915 689
39	53.23.37	-74.56.35	503 793	5 916 052
40	53.23.49	-74.57.47	502 455	5 916 439
41	53.23.49	-74.58.57	501 168	5 916 439
42	53.24.01	-74.58.57	501 168	5 916 810
43	53.24.14	-75.00.08	499 859	5 917 189

44	53.24.14	-75.01.15	498 618	5 917 189
45	53.24.25	-75.01.15	498 618	5 917 547
46	53.24.38	-75.02.28	497 262	5 917 939
47	53.24.38	-75.03.37	495 993	5 917 939
48	53.24.50	-75.03.37	495 993	5 918 305
49	53.25.02	-75.04.49	494 666	5 918 689
50	53.25.02	-75.05.59	493 368	5 918 689
51	53.25.14	-75.05.59	493 368	5 919 063
52	53.25.26	-75.07.10	492 069	5 919 439
53	53.25.26	-75.08.17	490 818	5 919 439
54	53.25.38	-75.08.17	490 818	5 919 800
55	53.25.50	-75.09.30	489 473	5 920 189
56	53.25.50	-75.10.40	488 193	5 920 189
57	53.26.02	-75.10.40	488 193	5 920 558
58	53.26.14	-75.11.51	486 876	5 920 939
59	53.26.14	-75.13.02	485 568	5 920 939
60	53.26.26	-75.13.02	485 568	5 921 316
61	53.26.38	-75.14.12	484 280	5 921 689
62	53.26.38	-75.15.20	483 018	5 921 689
63	53.26.50	-75.15.21	483 018	5 922 053
64	53.27.02	-75.16.33	481 683	5 922 439
65	53.27.02	-75.17.43	480 393	5 922 439
66	53.27.14	-75.17.43	480 393	5 922 811
67	53.27.26	-75.18.54	479 087	5 923 189
68	53.27.26	-75.20.01	477 843	5 923 189
69	53.27.38	-75.20.01	477 843	5 923 548
70	53.27.50	-75.21.15	476 491	5 923 939
71	53.27.50	-75.22.24	475 218	5 923 939
72	53.28.02	-75.22.24	475 218	5 924 306
73	53.28.14	-75.23.36	473 894	5 924 689
74	53.28.14	-75.24.46	472 593	5 924 689
75	53.28.26	-75.24.47	472 593	5 925 064
76	53.28.38	-75.25.57	471 298	5 925 439
77	53.28.37	-75.27.05	470 043	5 925 439
78	53.28.49	-75.27.05	470 043	5 925 801
79	53.29.01	-75.28.18	468 701	5 926 189
80	53.29.01	-75.28.42	468 259	5 926 189
81	53.28.48	-75.29.44	467 118	5 925 791
82	53.28.37	-75.29.44	467 118	5 925 439
83	53.28.37	-75.30.39	466 106	5 925 439
84	53.28.24	-75.31.37	465 018	5 925 060
85	53.28.12	-75.31.37	465 018	5 924 689
86	53.28.12	-75.32.35	463 953	5 924 689
87	53.27.59	-75.33.35	462 843	5 924 302
88	53.27.47	-75.33.35	462 843	5 923 939
89	53.27.47	-75.34.31	461 800	5 923 939
90	53.27.34	-75.35.33	460 668	5 923 544
91	53.27.22	-75.35.32	460 668	5 923 189
92	53.27.22	-75.36.28	459 647	5 923 189

93	53.27.09	-75.37.30	458 493	5 922 787
94	53.26.58	-75.37.30	458 493	5 922 439
95	53.26.57	-75.38.24	457 494	5 922 439
96	53.26.44	-75.39.28	456 318	5 922 029
97	53.26.33	-75.39.28	456 318	5 921 689
98	53.26.32	-75.40.20	455 341	5 921 689
99	53.26.19	-75.41.21	454 218	5 921 297
100	53.26.08	-75.41.21	454 218	5 920 939
101	53.26.07	-75.42.17	453 188	5 920 939
102	53.25.54	-75.43.19	452 043	5 920 540
103	53.25.43	-75.43.18	452 043	5 920 189
104	53.25.42	-75.44.13	451 035	5 920 189
105	53.25.39	-75.44.27	450 768	5 920 096
106	53.28.09	-75.44.30	450 768	5 924 705
107	53.28.21	-75.43.29	451 893	5 925 073
108	53.28.33	-75.43.29	451 893	5 925 439
109	53.28.33	-75.42.29	453 011	5 925 439
110	53.28.46	-75.41.24	454 218	5 925 833
111	53.28.58	-75.41.24	454 218	5 926 189
112	53.28.58	-75.40.25	455 305	5 926 189
113	53.29.11	-75.39.22	456 468	5 926 569
114	53.29.23	-75.39.22	456 468	5 926 939
115	53.29.23	-75.38.21	457 599	5 926 939
116	53.29.36	-75.37.16	458 793	5 927 329
117	53.29.48	-75.37.16	458 793	5 927 689
118	53.29.48	-75.36.17	459 893	5 927 689
119	53.30.00	-75.35.14	461 043	5 928 065
120	53.30.12	-75.35.14	461 043	5 928 439
121	53.30.13	-75.34.12	462 187	5 928 439
122	53.30.26	-75.33.08	463 368	5 928 825
123	53.30.37	-75.33.09	463 368	5 929 189
124	53.30.38	-75.32.08	464 480	5 929 189
125	53.30.51	-75.31.03	465 693	5 929 585
126	53.31.02	-75.31.03	465 693	5 929 939
127	53.31.02	-75.30.04	466 774	5 929 939
128	53.31.15	-75.29.01	467 943	5 930 321
129	53.31.27	-75.29.01	467 943	5 930 689
130	53.31.27	-75.28.12	468 835	5 930 689

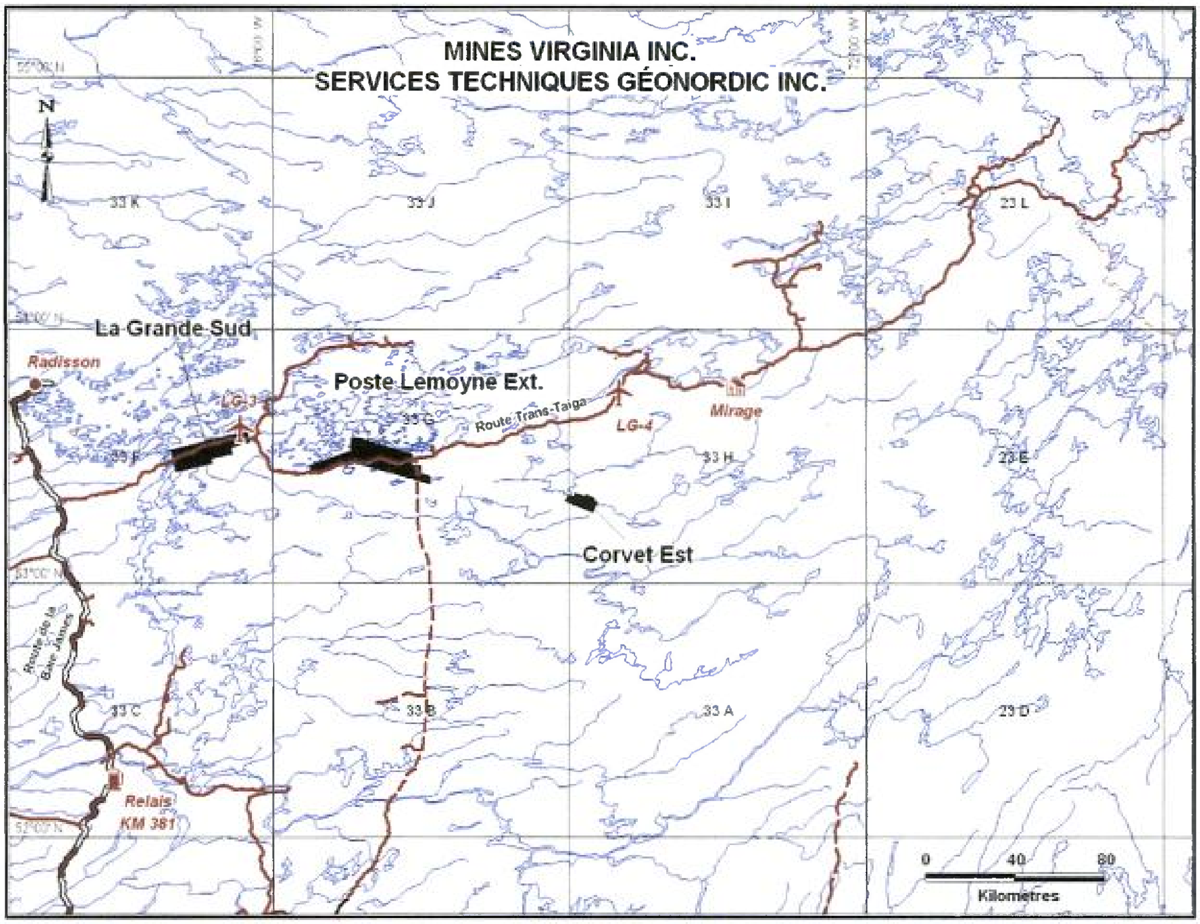


Figure 1: Property Locations

2.0 SURVEY SPECIFICATIONS

Airborne survey and noise specifications were as follows:

a) Number of line-km flown, traverse spacing and direction
   - Table 1 presents the number of line-km flown and traverse/tie-line spacing and directions.

b) Nominal terrain clearances
   - helicopter nominal terrain clearances: 35 metres
   - magnetometer nominal terrain clearances: 35 metres

   Figure 5 presents the mean terrain clearance flown over each block.

c) magnetic diurnal variation
   - A maximum tolerance of 3.0 nT (peak to peak) deviation from a long chord equivalent to a period of 30 seconds at the magnetometer base station was respected during all the survey period.

d) magnetometer noise envelope
- in-flight noise envelope did not exceed 0.5 nT, for straight and level flight.
- base station noise envelope did not exceed 0.2 nT.

e) Re-flights and turns
- line-spacing did not vary by more than 25 % from the nominal spacing over a distance of more than 1 km. The minimum length of any survey line was 3 km.
- all reflights of line segments intersected at least two control lines.

3.0 HELICOPTER, EQUIPMENT AND PERSONNEL

3.1 Helicopter

Helicopter:	Astar 350-BA+ (figure 2)	
	Mean Survey Speed:	37.5 m/sec
	Typical distance between data:	3.8 metres
	Nominal Ground Clearance:	35 metres

Type	Astar 350-BA+
Powerplant	Turbomeca Arriel 1 B series turbine
Power	641 shp
Number of main rotor blades	3
Average cruising speed	135 km/hr
Maximum gross weight	Internal: 4630 lbs
	External: 4960 lbs
Aircraft empty eight	2850 lbs
Maximum range	410 miles
Fuel consumption	170 L/hr

Figure 2: Astar 350-BA+ helicopter

3.2 Equipment

Magnetometer: Geometrics Cesium split-beam total field magnetic sensor installed at the end of a stinger fixed to the helicopter, with a sensitivity of 0.01 nT, a sampling rate of 10 Hz and a resolution better than 0.025 nT per measurement. The sensor tolerates gradients up to 10 000 nT/m, and operates in a range from 20 000 nT to 100 000 nT. A 0.5 nT noise envelope was not exceeded over 500 metres line-length without a reflight.

Magnetometer Base Station: A GEM GSM-19 Overhauser magnetometer base station (figure 3) was mounted in a magnetically quiet area. The base station measured the total intensity of the earth's magnetic field in units of 0.01 nT at intervals of 1 second, within a noise envelope of 0.10 nT. The Magnetic Field Mean Value obtained at the base station was 57 252 nT

Co-ordinates of the base station were:
Lat.: 53.4710256° Long.: -75.1686682°

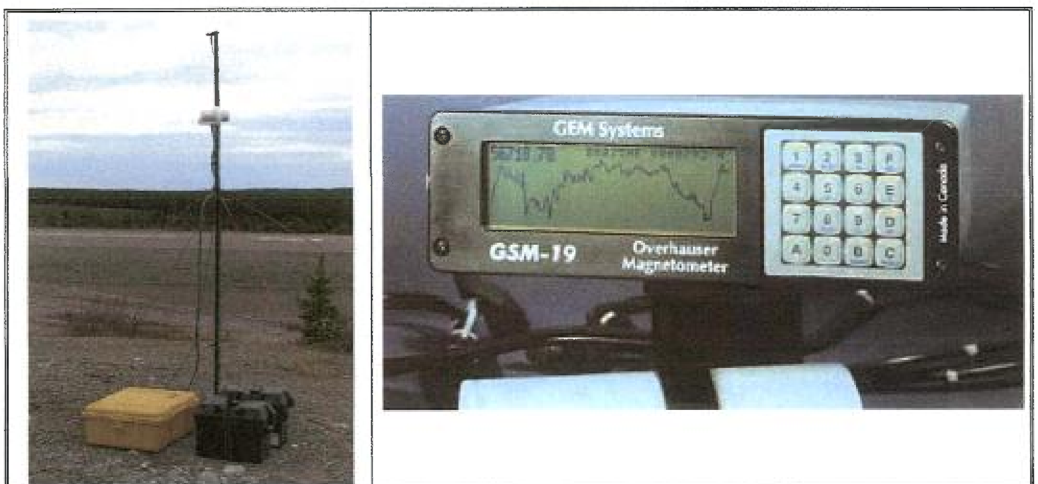


Figure 3: Base station magnetometer and console

Magnetic Compensator and Data Acquisition System (figure 4):

The magnetic field generated by the aircraft was compensated using a RMS DAARC500 Automatic Aeromagnetic Digital Compensator system. The DAARC500 is an instrument used to compensate or correct in real time for the magnetic interference caused by the aircraft itself and aircraft manoeuvring in the Earth's magnetic field, when using inboard-mounted high sensitivity magnetometers. The compensation accounts for the effects of permanent magnetism, induced magnetism, Eddy currents and also heading errors caused by the sensor themselves. It provides a frequency bandwidth of DC to 0.9 Hz, frequencies of most interest to the geophysicist. Other bandwidths are optionally available. Signals from magnetometers are digitized faithfully without aliasing or phase distortion.

The DAARC500 is based on many years of research and development on automatic aeromagnetic compensation by the National Aeronautical Establishment (NAE), a division of the National Research Council of Canada. Following the transfer of technology, RMS Instruments continued with the development resulting in an instrument which is extremely reliable, capable of accepting the Larmor frequencies of up to four high sensitivity magnetometers, and is based on a sophisticated compensation algorithm which is extremely robust.

The DAARC500 incorporate a sophisticated and flexible data acquisition system. Geophysical instruments and sensors may be directly connected to the DAARC500, via 8 Outputs and Inputs high speed RS232 digital ports, 16 analogic Inputs ports and an Ethernet port. Incoming data are real time processed. All acquired data are synchronized through a GPS receiver pulse-per-second (PPS).

Figure 4: Magnetic compensator and Data Acquisition System

Differential GPS and Navigation System:

The following table describes the airborne differential GPS system, which provided both real-time navigation and flight-path recovery.

Equipment	Helicopter
GPS Manufacturer	Novatel
Model	DL-V3 Dual-freq L1/L2
Serial Number	NBV07400024
Frequency	1 hertz
Number of Channels	12
Sampling Interval	2 Hz
Differential System	OmniStar Real Time
Navigation System	AGNAV (LiNAV)

Post-flight differential corrections of the raw GPS data were done using the PPP Web application from GSC.

Radar Altimeter

A frequency-modulated radio altimeter was used for measuring accurately distances between helicopter and ground. The following table presents its technical characteristics.

Equipment	Helicopter
Manufacturer:	Free Flight
Model	TRA 3000
Minimum range	0 to 800 metres
Accuracy:	5 %
Sensitivity:	10 mV/m
Digital resolution:	0.1 metre
Sampling rate:	5 Hz

Ancillary Equipment: Computer workstation, complement of spare parts and test equipment

3.3 Personnel

The general management of the project was monitored offsite by Mr. Mouhamed Moussaoui, **GDS**'s President. Mr. José Martinez was responsible for the field data quality control to ensure that the work was carried out according to contractual specifications. Final data evaluation and processing were performed at the Laval **GDS**'s office by Mrs François Caty and Mouhamed Moussaoui. Survey crew and office personnel are listed in table 5.

Table 5: Field and Office Crew	
Position	**Name**
Project Manager	Mr. Mouhamed Moussaoui, Ing.
Data quality control	Mr. José Martinez
Field Operator	Mr. Pierre Filion
Pilot	Mr. Phillippe
Final Processing	Mrs François Caty and M. Moussaoui
Survey Report	Mr. Camille St-Hilaire, P.Geo

4.0 SURVEY SCHEDULE

The survey was flown over two adjacent blocks with flight line bearing selected to run perpendicular to the average trend of the local geological structures.

Survey steps were:

Mobilization:	October 22nd, 2011
Survey:	October 24th to November 22nd, 2011
Demobilization:	November 23rd, 2011
Number of Flights:	40 production flight

Preliminary results were delivered to **STG** on December 5th, 2011 while final maps and data were sent late in December 2011.

5.0 DATA ACQUISITION

The following test and quality control were performed before and during survey production.

FOM Magnetometer Tests:

Effects of helicopter manoeuvres (roll, pitch and yaw) are determined by a FOM test (Figure of Merit). The test is performed over a magnetically quiet zone, at high altitude. It consists of flying $\pm 10^{\circ}$ rolls, $\pm 5^{\circ}$ pitches and $\pm 5^{\circ}$ yaws peak to peak along North, South, East and West headings over periods of 4-5 seconds. The compensation Figure of Merit (FOM) for the helicopter is calculated by summing up the peak-to-peak amplitudes of these 12 magnetic signatures. Test results are presented in appendix A, which shows that the FOM was lower than 1 nT

Quality Control

After data acquisition, profiles were examined as a preliminary assessment of the noise level on the recorded data. Altimeter deviations from the prescribed flying altitudes were also closely examined as well as the magnetic diurnal activity, as recorded on the base station.

All digital data were verified for validity and continuity. Data from helicopter and base station were transferred to a PC's hard disk. Basic statistics were generated for each parameter recorded. These included minimum, maximum, mean values, standard deviation, and any null values were located. Editing of all recorded parameters for spikes or datum shifts was done, followed by final data verification via an interactive graphic screen with on-screen editing and interpolation routines.

Quality of GPS navigation was controlled by recovering the helicopter flight path.

Checking all data for adherence to specifications was carried out before crew and aircraft demobilization.

6.0 DATA COMPILATION AND PROCESSING

6.1 Base maps

The base map of the survey area was plotted from topographic maps of the Department of Natural Resources Canada at a scale of 1:50 000.

Projection description

Datum:	Nad83 (Compatible WGS84)
Projection:	UTM Zone 18N
False Easting:	500 000
False Northing:	0
Scale Factor:	0.9996

6.2 Processing of Base Station data

Recorded magnetic diurnal data from the magnetometer base station were reformatted and loaded into the OASIS database. After initial verification of the integrity of the data from statistical analysis, the appropriate portion of the data was selected to correspond to the exact start and end time of the flight. Data were then checked and corrected for spikes using a fourth difference editing routine. Following this, interactive editing of the data was done, via a graphic editing tool, to remove events caused by man-made disturbances. A small low pass noise filter (30 seconds) was then applied. The final processing step consisted of subtracting result from the airborne magnetic data as a pre-levelling step. The average of the Total Field Magnetic Intensity measured at the Base Station was 57 252 nT.

6.3 Processing of the Positioning Data (GPS)

The raw GPS data were recovered and corrected from spikes. The resulting corrected latitudes and longitudes were then converted to the local map projection and datum (Nad83). A point-to-point speed calculation was then done from the final X, Y coordinates and reviewed as part of the quality control. The flight data were then cut back to the proper survey line limits and a preliminary plot of the flight path was done and compared to the planned flight path to verify the navigation. The positioning data were then exported to the other processing files.

6.4 Processing of the Altimeter data

The altimeter data, which includes radar altimeter and the GPS elevation values were checked and corrected for spikes using a fourth difference editing routine. A small low pass filter of 2 seconds was then applied to the data. Following this, a digital terrain trace was computed by subtracting the radar altimeter values from the corrected GPS elevation values. All resulting parameters were then checked, in profile form, for integrity and consistency, using a graphic viewing editor.

6.5 Processing of Magnetic data

The airborne magnetic data were reformatted and loaded into the OASIS database. After initial verification of the data by statistical analysis, positions were adjusted for system lag. The data were then checked and corrected for any spikes using a fourth difference editing routine and inspected on the screen using a graphic profile display. Interactive editing, if necessary, was done at this stage. Following this, the long wavelength component of the diurnal was subtracted from the data as a pre-levelling step.

A first levelling process is applied using tie-lines intersections and preliminary grids of the total field and first vertical derivative were created and verified for obvious problems, such as errors in positioning or bad diurnal. Appropriate corrections were then applied to the data, as required.

An altitude correction was applied to the total field magnetic intensity by using the vertical gradient. This correction was done by downward or upward continuation of the field around the flight surface. Histograms of the ground clearance are shown on figure 5.

The levelling process was then undertaken. This consisted of calculating the positions of the control points (intersections of traverses and tie lines), calculating the elevation and magnetic differences at the control points and applying a series of levelling corrections to reduce the misclosures to zero. A new grid of the values was then created and checked for residual errors. Any gross errors detected were corrected in the profile database and the levelling process repeated.

A micro-levelling was applied in order to removes minor imperfections visible on shadow images. This produced grids of exceptional aesthetic quality with no degradation of the high frequency content of the data.

And finally, the International Geomagnetic Reference Field (IGRF) was then calculated and removed using the following models:

Plex: Model 2010, Z: 340 m, Date: 2011/11/01
La Grande Sud: Model 2010, Z: 242 m, Date: 2011/11/17
Corvet Est: Model 2010, Z: 408 m, Date: 2011/11/15

6.6 Total Magnetic field and First Vertical Derivative Grids

The total field magnetic grids were calculated from the final reprocessed profiles by a minimum curvature algorithm. The accuracy standard for gridding was that the grid values fit the profile data to within 0.01 nT for 99.99% of the profile data points. According to traverse line spacing, grids have a grid cell size of 18.75 m (Blocks Plex and La Grande Sud) and 12.5 m (Block Corvet Est).

Minimum curvature gridding provides the smoothest possible grid surface that also honours the profile line data. However, sometimes this can cause narrow linear anomalies cutting across flight lines to appear as a series of isolated spots.

The first vertical derivative of the total magnetic field was computed to enhance small and weak near-surface anomalies and as an aid to delineate geologic contacts having contrasting susceptibilities. The calculation was done in the frequency domain, using Win-Trans FFT algorithms.

7.0 FINAL PRODUCTS

7.1 Maps:

GDS made the base map from information present on published topographic maps. Each map was produce at a scale of 1:20 000 displaying base-map features, flight path and UTM co-ordinates. Three paper copies of the following final maps were delivered to **STG**:

(a) Shaded Residual Total Magnetic Field (colour interval)
(b) Shaded Magnetic First Vertical Derivative (colour interval)

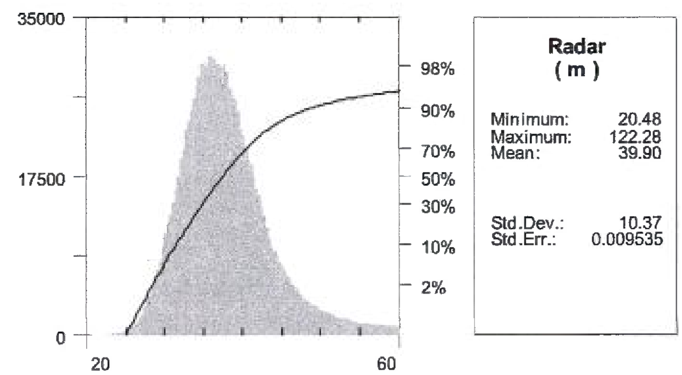
7.2 Final digital archive of line data:

GDS produced copies of a CD-ROM containing digital archives and maps (PDF and Geotiff formats). Digital archives, described in Appendix B, contain Geosoft databases of all survey data. Databases are referenced to the standard UTM co-ordinates for the area.

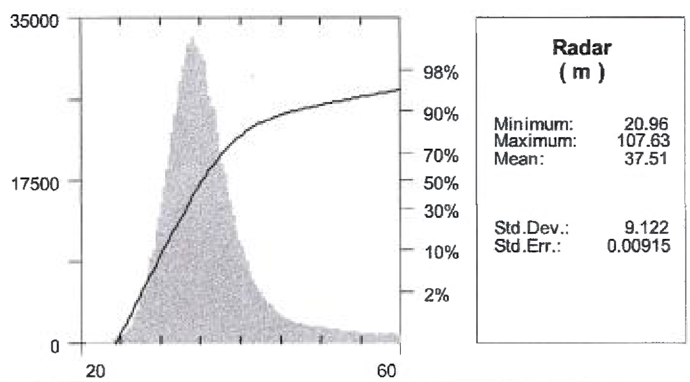
GDS store a copy of the digital archive for one year after production of final products. On request by **STG**, **GDS** will supply raw data from the survey with survey products. Otherwise, **GDS** will store raw data with copy of the digital archive.

7.3 Miscellaneous

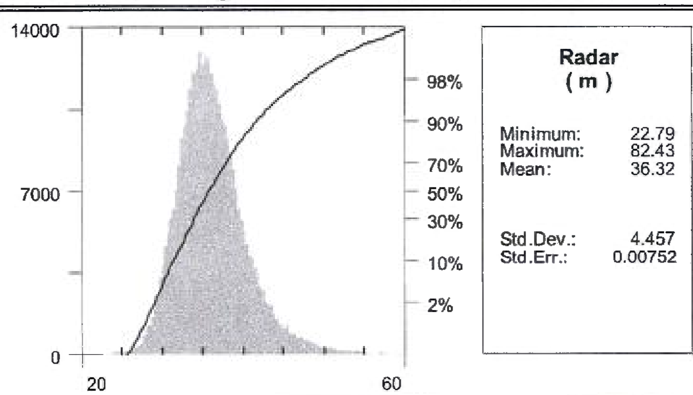
Three paper copies of this technical report, with the corresponding digital PDF file, have been produced and delivered to **STG**.



Plex, Histogram of the Helicopter Ground Clearance



La Grande Sud, Histogram of the Helicopter Ground Clearance



Corvet Est, Histogram of the Helicopter Ground Clearance

Figure 5: Ground Clearance Histograms

8.0 CONCLUSION

Flown from October 24^{th} to November 22^{nd}, 2011, the helicopter borne aeromagnetic survey was completed inside the estimated time frame.

All airborne and ground-based records were of excellent quality. Magnetic data acquisition was done in good diurnal conditions.

Noise levels observed on the Total Magnetic Field were well within accepted limits, determined from the fourth difference of the lagged, edited airborne magnetic data.

GPS results proved to be of high quality. The flight path was surveyed accurately and speed checks showed no abnormal jumps in data.

It is hoped that information presented in this report, and on the accompanying products, will be useful both in planning subsequent exploration efforts and in the interpretation of related exploration data.

Respectfully Submitted,

Camille St-Hilaire, M.Sc.A.
P.Geo. no. 339

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APPENDIX A

TESTING AND CALIBRATION

Geo Data Solutions GDS Inc.

FOM Test

Location:	Magatami	**Date:**	23-Nov-11
Pilot:	Philippe	**Aircraft:**	C-FMQM
Operator:	Pierre Filion	**Configuration:**	Stinger
Compiled by:	José M. Martínez	**Altitude:**	3000ft

Sensor3 - Tail Stinger

North (360°)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	71516 to 71527.3	0.742	0.037	20.054
ROLL	71537.1 to 71547.9	4.582	0.071	64.535
YAW	71563.1 to 71574.9	2.889	0.100	28.890
	TOTAL	**8.213**	**0.208**	**39.486**

East (90°)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	71697.7 to 71711.4	1.647	0.068	24.221
ROLL	71722.7 to 71735.7	7.819	0.071	110.127
YAW	71747.3 to 71758.3	2.889	0.100	28.890
	TOTAL	**12.355**	**0.239**	**51.695**

South (180°)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	71802.4 to 71813.6	1.647	0.068	24.221
ROLL	71826.9 to 71837.7	7.819	0.071	110.127
YAW	71854.7 to 71866.7	2.889	0.050	57.780
	TOTAL	**12.355**	**0.189**	**65.370**

West (270°)	Fid range	Uncompensated mag (nT)	Compensated mag (nT)	Improv. Ratio
PITCH	71926.5 to 71935.5	1.280	0.057	22.456
ROLL	71951.5 to 71963.3	8.190	0.058	141.207
YAW	71982.4 to 71994.6	1.447	0.085	17.024
	TOTAL	**10.917**	**0.200**	**54.585**

Uncomp. mag (nT)	**Comp. Mag (nT)**	**Improv. Ratio**
43.840	0.836	**52.440**

ALTIMETER CALIBRATION

Location: Saint-Hubert
Pilot: Pilippe
Operator: Pierre Fillion

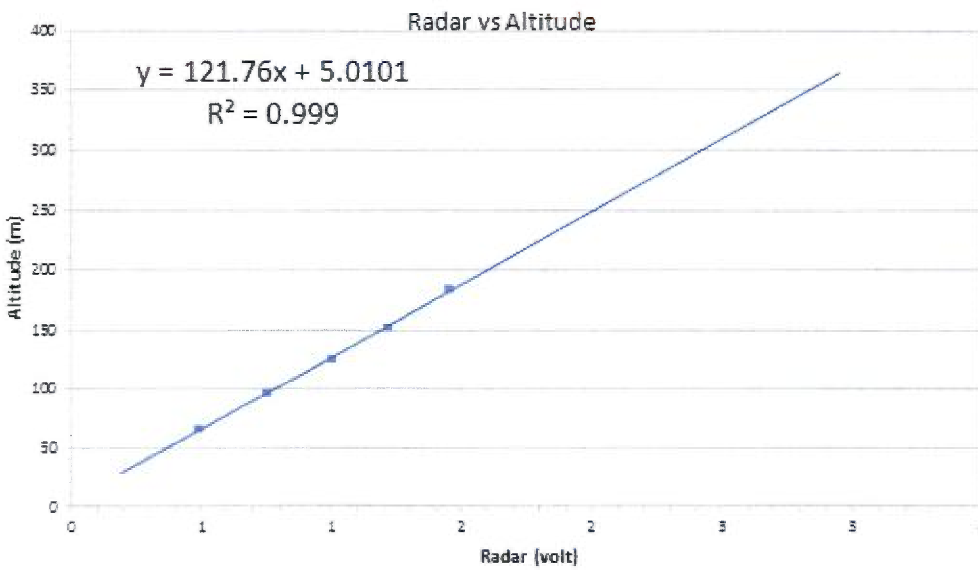
Date: 23/11/11
Aircraft: C-FMQM
Compiled by: José M. Martínez

Antenna Height (m): 2.0

Terrain clearance (ft)	Radar raw (volt)	Zgps (m)	Topo (m)	Altitude (m)
100	0.49	91.69	23.57	66.12
150	0.75	122.71	25.34	95.37
200	1.00	152.43	24.67	125.76
300	1.22	178.59	24.21	152.38
400	1.45	209.81	24.57	183.24

Test Radar	
64.67	-1.45
96.33	+0.96
126.77	+1.01
153.55	+1.17
181.56	-1.68
Error Sum	+0.00

radar(m)= 121.76 x (volt) + 5.01



APPENDIX B

PROFILE DATABASE ARCHIVE AND CHANNEL DEFINITIONS

Magnetic Line archive channel description		
Channel	**Unit**	**Description**
Date	yyyy/mm/dd	Flight date
Flt		Flight number
line		Line number
UTC	second	UTC Time in second after midnight
lon	dd.mm.ss.s	Longitude NAD83
lat	dd.mm.ss.s	Latitude NAD83
x	meters	Easting UTM, NAD83 Zone 18
y	meters	Northing UTM, NAD83 Zone 18
z	meters	GPS elevation – Final orthometric MSL
radar	meters	Corrected Radar altimeter
drape	meters	Drape surface used for processing
drapefield	meters	Drape surface used for height navigation
ddrape	meters	Actual deviation from the flight surface (z-drape)
DTMC	meters	Digital Terrain Model (levelled)
basea	nanoteslas	Filtered main base mag
mfluxX	nanoteslas	Fluxgate X component
mfluxY	nanoteslas	Fluxgate Y component
mfluxZ	nanoteslas	Fluxgate Z component
MBu	nanoteslas	Raw uncompensated mag
MBul	nanoteslas	Lagged uncompensated mag
Mbc	nanoteslas	Raw compensated mag
Mbclc	nanoteslas	Compensated mag (edited, lagged and de-spiked)
drift_LF	nanoteslas	Low-Frequency diurnal correction
magbc	nanoteslas	Magnetic field, diurnally corrected (TMI)
coralt	nanoteslas	Altitude correction
magalt	nanoteslas	Magnetic field, corrected by altitude
corlvl	nanoteslas	Cumulative tie line mag levelling adjustment
maglvl	nanoteslas	Levelled mag
cormicro	nanoteslas	Microleveling correction
magmicro	nanoteslas	Microleveled mag
Igrf	nanoteslas	International geo-referenced field (model 2010)
magres	nanoteslas	Mag IGRF removed (residual)

Gridding cell sizes: Plex: 18.75 m La Grande Sud: 18.75 m Corvet Est: 12.5 m

MagRes_Final_*** . GRD: grid of the Residual total magnetic field
Fvd_Final_*** . GRD: grid of the first vertical derivative

DATA BASES
DataBase_***.GDB: Data base

*** Name of the block (Plex, Lagrande Sud or Corvet Est)