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Ontario Airborne Geophysical Surveys
Magnetic Gradiometer Data
Sturgeon River Area

ONTARIO GEOLOGICAL SURVEY

Geophysical Data Set 1088

2020

Ontario

ONTARIO GEOLOGICAL SURVEY

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Ontario Airborne Geophysical Surveys
Magnetic Gradiometer Data
Sturgeon River Area

by

Ontario Geological Survey

2020

Users of OGS products should be aware that Indigenous communities may have Aboriginal or treaty rights or other interests that overlap with areas of mineral potential and exploration.

Ontario Geological Survey
Ministry of Energy, Northern Development and Mines
Willet Green Miller Centre, 933 Ramsey Lake Road
Sudbury, Ontario, Canada P3E 6B5

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CREDITS

List of accountabilities and responsibilities.

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- Edna Mueller-Markham, Vice President, Paterson, Grant & Watson Limited (PGW), Toronto, Ontario, Geophysicist under contract to ENDM – responsible for the airborne geophysical survey project management, quality assurance (QA) and quality control (QC)
- Carlo Castrechino, Acting Manager, Publication Services Unit, GeoServices Section, Ontario Geological Survey, ENDM – managed the project-related hard-copy products
- Desmond Rainsford, Senior Geoscience Leader - geophysics, Earth Resources and Geoscience Mapping Section, Ontario Geological Survey – responsible for final quality assurance (QA), quality control (QC) of published digital products
- Sander Geophysics Limited (SGL), Ottawa, Ontario – data acquisition and data compilation

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Ontario Geological Survey 2020. Ontario airborne geophysical surveys, magnetic gradiometer data, grid and profile data (ASCII and Geosoft® formats), and vector data, Sturgeon River Area; Ontario Geological Survey, Geophysical Data Set 1088.

NOTE

1. Introduction

The airborne survey contract was awarded through a Request for Proposal and Contractor Selection process. The system and contractor selected for the survey area were judged on many criteria, including the following.

- applicability of the proposed system to the local geology and potential deposit types
- aircraft capabilities and safety plan
- experience with similar surveys
- QA/QC plan
- capacity to acquire the data and prepare final products in the allotted time
- price-performance

2. Survey Location and Specifications

2.1. SURVEY GENERAL GEOLOGY AND LOCATION

The survey, which occupies an approximately rectangular area of about 9 231 km^2, is located 25 km north of the City of Greater Sudbury.

The survey area is predominantly underlain by Proterozoic age Huronian Supergroup rocks (coloured brown and dark purple in Figure 1) belonging to the Lorrain, Cobalt, Bruce and Gowganda formations. These are flat-lying sedimentary rocks comprising sandstones, siltstones, conglomerates and argillites. Proterozoic, Nipissing mafic sills are exposed throughout the area occupied by the Huronian sedimentary rocks (coloured light purple in Figure 1).

Archean age granodiorite, granite and foliated tonalites (coloured in shades of orange-pink in Figure 1) dominate the western and southwestern parts of the survey area. These rocks underlie the Huronian sedimentary rocks described above and, in some cases, appear as inliers exposed within "windows" of the younger Huronian geology. Archean greenstone rocks, which occur as scattered small patches, have been mapped mostly in the western and extreme eastern part of the survey area. These greenstone patches comprise mostly mafic metavolcanic, metasedimentary and felsic to intermediate metavolcanic rocks and are represented in Figure 1 as green, grey and dark yellow colours.

A part of the Sudbury Igneous Complex (SIC) occurs at the south-central margin of the survey area. The SIC comprises granophyre, norite-gabbro and quartz-norite rocks (dark red colour in Figure 1). West-northwest–striking, Sudbury swarm magnetic dikes are scattered throughout the area and north-northwest to northwest-trending Matachewan swarm magnetic mafic dikes are observed in the western half of the survey area.

Numerous occurrences of gold and copper mineralization have been recorded within the survey area. The greatest numbers of gold occurrences tend to be within the greenstone slivers, although there are also many gold showings in the Huronian sedimentary rocks. Copper occurrences have mostly been noted in Huronian rocks. Other occurrences including uranium, cobalt, nickel, silver and rare metals have been documented in the region.

Further details about the regional geology can be found in Geology of Ontario (Thurston et al. 1991), chapter 14.

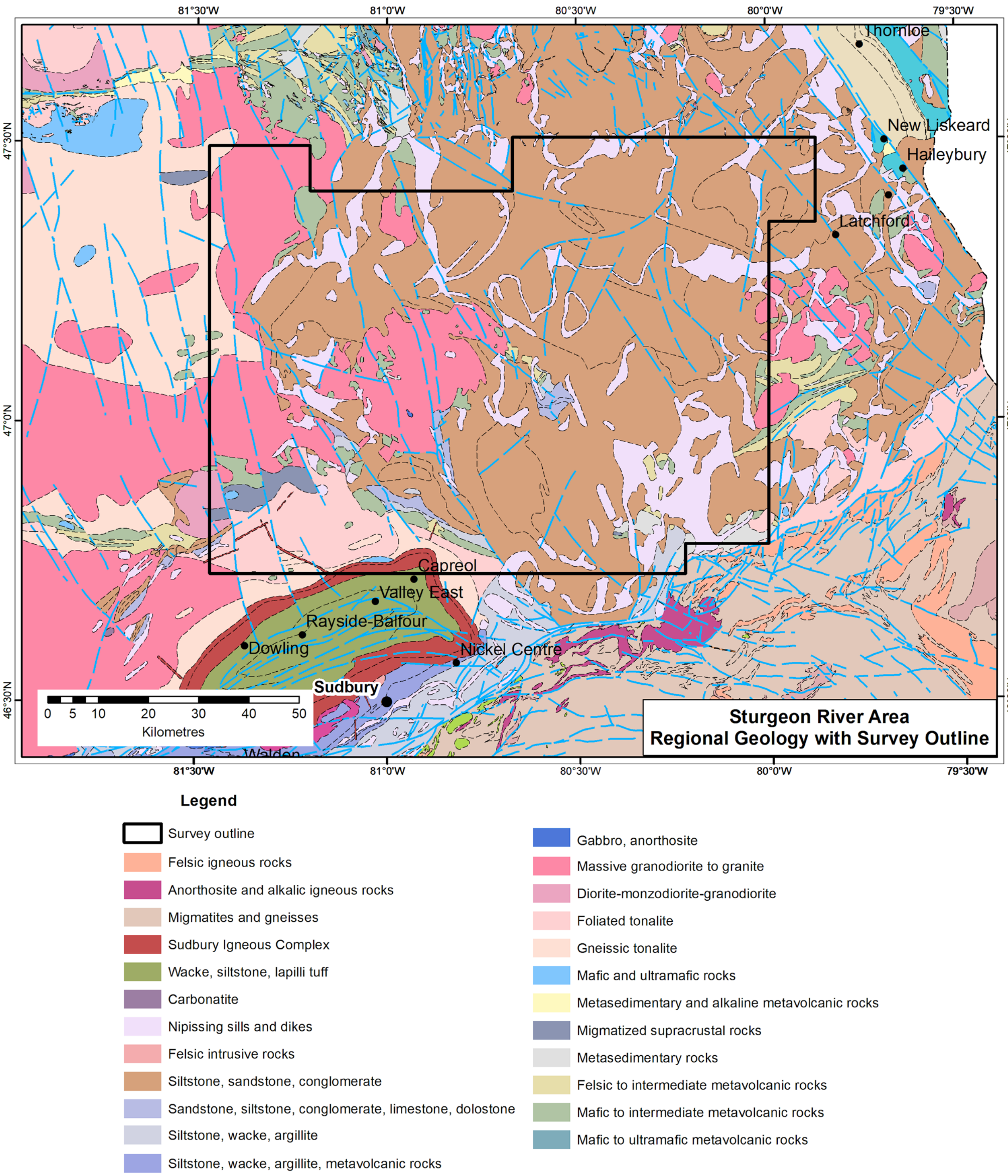

Figure 1. The bedrock geology of the Sturgeon River survey area (*from* Ontario Geological Survey 2011); survey boundary shown in black.

2.2. SURVEY SPECIFICATIONS

The Sturgeon River survey area specifications and tolerances are as follows:

1. Line spacing and direction for the magnetic gradiometer survey
   - the nominal flight-line spacing is 200 m
   - flight-line direction 0°
   - maximum deviation from the nominal flight-line location could not exceed 50 m over a distance greater than 2000 m
   - minimum separation between 2 adjacent lines could be no smaller than 150 m or larger than 250 m
   - for each survey flight, adjacent lines must be flown separately and in opposite directions. A racetrack-flying pattern is not permitted
2. Control-line spacing and direction
   - the nominal control-line spacing is 2000 m, perpendicular to the traverse-line direction
   - control-line direction 90°
   - maximum deviation from the nominal control-line location could not exceed 50 m over a distance greater than 2000 m
3. Terrain clearance of the magnetometers
   - nominal terrain clearance is 100 m and will be consistent with safety of aircraft and crew
   - altitude tolerance limited to ±15 m, except in areas of severe topography
   - altitude tolerance limited to ±10 m at flight-line–control-line intersections, except in areas of severe topography
4. Aircraft speed
   - nominal aircraft speed is 70 m/s
   - aircraft speed tolerance limited to ±10.0 m/sec, except in areas of severe topography
5. Magnetic diurnal variation
   - could not exceed a maximum deviation of 3.0 nT peak-to-peak over a long chord equivalent to 1 minute
6. Magnetometer noise envelope
   - in-flight noise envelope, calculated using a non-normalized 4th difference, shall not exceed 0.1 nT, for straight and level flight
   - heading error not to exceed 2.0 nT
   - base station noise envelope, calculated using a non-normalized 4^{th} difference, shall not exceed 0.1 nT
7. Reflights and turns
   - all reflights of flight-line segments intersected at least 2 control lines
   - all turns at the end of flight lines or control lines took place beyond the survey or block boundaries

3. Aircraft, Equipment and Personnel

3.1. AIRCRAFT: C-GSGV

Operator:	Sander Geophysics Limited
Registration:	C-GSGV
Type:	Cessna® 208B Grand Caravan®
Mean Survey Speed:	70 m/s

3.1.1. EQUIPMENT

3.1.1.1. MAGNETOMETER: GEOMETRICS® G-822A

The magnetometers are non-oriented (strap-down) optically pumped cesium split-beam sensors with a sensitivity of 0.005 nT, a range of 20 000 to 100 000 nT and noise of less than 0.0005 nT. The primary airborne sensor was mounted in a fibreglass stinger extending from the tail of the aircraft (designated as sensor #3). The system included 2 additional sensors, housed in each wingtip pod (designated as sensor #1 on the port side, and sensor #2 on the starboard side). Total magnetic field measurements were recorded at 160 Hz in the aircraft, and then later down-sampled to 10 Hz in the processing.

3.1.1.2. DIGITAL ACQUISITION: SANDER GEOPHYSICS DATA ACQUISITION SYSTEM (SGDAS)

The SGDAS is the latest version of airborne navigation and data acquisition computers developed by SGL. It is the data gathering core for all the different types of survey data. The computer incorporates a magnetometer coupler, an altimeter analog to digital converter and a NovAtel® GPS multi-frequency receiver (*see* "GPS Receivers" for details), which automatically provides the UTC time base for the recorded data. The system acquires the different data streams from the sensors and receives and processes GPS signals from the GPS antenna. Navigation information from the navigation side of the computer guides the pilots along the pre-planned flight path in all 3 dimensions. Profiles of the incoming data are displayed in real-time to the pilots for continuous monitoring. The data are recorded in database format on redundant solid-state data storage modules.

3.1.1.3. RADAR ALTIMETER: BENDIX/KING® KRA-10A

The Bendix/King® KRA-10A altimeter has a resolution of 0.5 m, an accuracy of 5%, a range of 6 to 760 m, and a 10 Hz data rate. This system was used as a primary system and actively employed for survey guidance and data processing.

3.1.1.4. LASER ALTIMETER: SGLAS-P–RIEGL® LD90-31K-HIP LASER RANGEFINDER

The Riegl® laser altimeter uses a single optical laser beam to measure distance to the ground. It is effective over water and is eye safe. This profilometer has a range of 1500 m, a resolution of 0.01 m with an accuracy of 5 cm and a 3.3 Hz data rate.

3.1.1.5. DIGITAL IMAGING SYSTEM: SGDIS–DATATOYS™ E580 BULLET CAMERA

The Digital Imaging System is mounted in the floor of the aircraft and oriented to look vertically below while in flight. The system automatically records the position, time (fiducials), line and flight number on the video. The data are stored by flight line in *.avi* format, viewable by any commercial media player.

3.1.1.6. GPS RECEIVER: NOVATEL® OEMV®-3 RECEIVER BOARD

The NovAtel® OEMV®-3, multi-frequency GNSS (Global Navigation Satellite System) receiver is configurable up to 72 channels with the tracking of GPS (L1, L2, L5), GLONASS (L1, L2), SBAS, and L-band satellites and signals. It provides averaged position and raw range information of all satellites in view. The GNSS positional data are recorded at 10 Hz.

3.2. AIRCRAFT: C-GSGL

Operator:	Sander Geophysics Limited
Registration:	C-GSGL
Type:	Cessna® 208B Grand Caravan®
Mean Survey Speed:	70 m/s

3.2.1. EQUIPMENT

3.2.1.1. MAGNETOMETER: GEOMETRICS® G-822A

The magnetometers are non-oriented (strap-down) optically pumped cesium split-beam sensors with a sensitivity of 0.005 nT, a range of 20 000 to 100 000 nT and noise of less than 0.0005 nT. The primary airborne sensor was mounted in a fibreglass stinger extending from the tail of the aircraft (designated as sensor #3). The system included 2 additional sensors, housed in each wingtip pod (designated as sensor #1 on the port side, and sensor #2 on the starboard side). Total magnetic field measurements were recorded at 160 Hz in the aircraft, then later down sampled to 10 Hz in the processing.

3.2.1.2. DIGITAL ACQUISITION: SANDER GEOPHYSICS DATA ACQUISITION SYSTEM (SGDAS)

The SGDAS is the latest version of airborne navigation and data acquisition computers developed by SGL. It is the data gathering core for all the different types of survey data. The computer incorporates a magnetometer coupler, an altimeter analog to digital converter and a NovAtel® GPS multi-frequency receiver (*see* “GPS Receivers” for details), which automatically provides the UTC time base for the recorded data. The system acquires the different data streams from the sensors and receives and processes GPS signals from the GPS antenna. Navigation information from the navigation side of the computer guides the pilots along the pre-planned flight path in all 3 dimensions. Profiles of the incoming data are displayed in real-time to the pilots for continuous monitoring. The data are recorded in database format on redundant solid-state data storage modules.

3.2.1.3. RADAR ALTIMETER: BENDIX/KING® KRA-10A

The Bendix/King® KRA-10A altimeter has a resolution of 0.5 m, an accuracy of 5%, a range of 6 to 760 m, and a 10 Hz data rate. This system is employed as a backup system and not actively employed for survey guidance or data processing.

3.2.1.4. DIGITAL RADAR ALTIMETER: THOMSON-CSF ERT 530A

The Thomson-CSF ERT 530A uses radio wave echoing to determine the height above ground. It will generally “see through” foliage. The Thomson-CSF ERT 530A radar altimeter has a resolution of 0.5 m, an accuracy of 1%, a range of 1 to 2440 m and a 10 Hz data rate.

3.2.1.5. LASER ALTIMETER: SGLAS-P–RIEGL® LD90-31K-HIP LASER RANGEFINDER

The RIEGL® laser altimeter uses a single optical laser beam to measure distance to the ground. It is effective over water and is eye safe. This profilometer has a range of 1500 m, a resolution of 0.01 m with an accuracy of 5 cm and a 3.3 Hz data rate.

3.2.1.6. DIGITAL IMAGING SYSTEM: SGDIS–DATATOYS™ E580 BULLET CAMERA

The Digital Imaging System is mounted in the floor of the aircraft and oriented to look vertically below while in flight. The system automatically records the position, time (fiducials), line and flight number on the video. The data are stored by flight line in *.avi* format, viewable by any commercial media player.

3.2.1.7. GPS RECEIVER: NOVATEL® OEMV®-3 RECEIVER BOARD

The NovAtel® OEMV®-3, multi-frequency GNSS (Global Navigation Satellite System) receiver is configurable up to 72 channels with the tracking of GPS (L1, L2, L5), GLONASS (L1, L2), SBAS, and L-band satellites and signals. It provides averaged position and raw range information of all satellites in view. The GNSS positional data are recorded at 10 Hz.

3.3. AIRCRAFT: C-GSGW

Operator:	Sander Geophysics Limited
Registration:	C-GSGW
Type:	Cessna® 208B Grand Caravan®
Mean Survey Speed:	70 m/s

3.3.1. EQUIPMENT

3.3.1.1. MAGNETOMETER: GEOMETRICS® G-822A

The magnetometers are non-oriented (strap-down) optically pumped cesium split-beam sensors with a sensitivity of 0.005 nT, a range of 20 000 to 100 000 nT and noise of less than 0.0005 nT. The primary airborne sensor was mounted in a fibreglass stinger extending from the tail of the aircraft (designated as sensor #3). The system included 2 additional sensors, housed in each wingtip pod (designated as sensor #1 on the port side, and sensor #2 on the starboard side). Total magnetic field measurements were recorded at 160 Hz in the aircraft, then later down sampled to 10 Hz in the processing.

3.3.1.2. DIGITAL ACQUISITION: SANDER GEOPHYSICS DATA ACQUISITION SYSTEM (SGDAS)

The SGDAS is the latest version of airborne navigation and data acquisition computers developed by SGL. It is the data gathering core for all the different types of survey data. The computer incorporates a magnetometer coupler, an altimeter analog to digital converter and a NovAtel® GPS multi-frequency receiver (*see* “GPS Receivers” for details), which automatically provides the UTC time base for the recorded data. The system acquires the different data streams from the sensors and receives and processes GPS signals from the GPS antenna. Navigation information from the navigation side of the computer guides the pilots along the pre-planned flight path in all 3 dimensions. Profiles of the incoming data are displayed in real-time to the pilots for continuous monitoring. The data are recorded in database format on redundant solid-state data storage modules.

3.3.1.3. RADAR ALTIMETER: GRA™ 55 - GARMIN

The GRA™ 55 - Garmin altimeter has a resolution of 0.5 m, an accuracy of 2%, a range of 30 to 760 m, and a 10 Hz data rate. This system is employed as a backup system and not actively employed for survey guidance or data processing.

3.3.1.4. DIGITAL RADAR ALTIMETER: THOMSON-CSF ERT 530A

The Thomson-CSF ERT 530A uses radio wave echoing to determine the height above ground. It will generally "see through" foliage. The Thomson-CSF ERT 530A radar altimeter has a resolution of 0.5 m, an accuracy of 1%, a range of 1 to 2440 m and a 10 Hz data rate.

3.3.1.5. LASER ALTIMETER: SGLAS-P–RIEGL® LD90-31K-HIP LASER RANGEFINDER

The Riegl® laser altimeter uses a single optical laser beam to measure distance to the ground. It is effective over water and is eye safe. This profilometer has a range of 1500 m, a resolution of 0.01 m with an accuracy of 5 cm and a 3.3 Hz data rate.

3.3.1.6. DIGITAL IMAGING SYSTEM: SGDIS–DATATOYS™ E580 BULLET CAMERA

The Digital Imaging System is mounted in the floor of the aircraft and oriented to look vertically below while in flight. The system automatically records the position, time (fiducials), line and flight number on the video. The data are stored by flight line in *.avi* format, viewable by any commercial media player.

3.3.1.7. GPS RECEIVER: NOVATEL® OEMV®-3 RECEIVER BOARD

The NovAtel® OEMV®-3, multi-frequency GNSS (Global Navigation Satellite System) receiver is configurable up to 72 channels with the tracking of GPS (L1, L2, L5), GLONASS (L1, L2), SBAS, and L-band satellites and signals. It provides averaged position and raw range information of all satellites in view. The GNSS positional data are recorded at 10 Hz.

3.4. BASE STATION EQUIPMENT

3.4.1. MAGNETOMETER: GEOMETRICS® G-822A

The magnetometer is a non-oriented (strap-down) optically pumped cesium split-beam sensor with a sensitivity of 0.005 nT, a range of 20 000 to 100 000 nT and noise of less than 0.0005 nT. Total magnetic field measurements were recorded at 11 Hz, then later down sampled to 10 Hz in the processing.

3.4.2. GPS RECEIVER: NOVATEL® OEM®-4 RECEIVER BOARD

The NovAtel® dual frequency NovAtel® OEM®-4 measures all GPS channels, for up to 12 satellites. The GNSS positional data are recorded at 10 Hz.

3.5. PERSONNEL

Pilots:	Randall Forwell George Sakgaev Martin Stirajs Andrew Fleider Jean Deschenes Shaun Rodriguez Steven Hyde Aymeric Douerin Sarah Newland Kris Lawson
Field Crew Chief:	Krista Kaski Derek Kouhi Aamna Sirohey
Field Data Analysts:	Lindsay Upiter Andrea Reman Malcolm MacDougall
Field Technician:	Zachary Seguin-Forest
Aircraft Maintenance Engineer:	Simon Worswick Branden Lachapelle Mike Devenny
Project Manager:	Kevin Charles

4. Data Acquisition

4.1. ACQUISITION SUMMARY

Sander Geophysics Limited (SGL) was selected by the Ministry of Energy, Northern Development and Mines (ENDM) to perform the Sturgeon River area horizontal magnetic gradient survey.

The principal geophysical sensors were 3 high-sensitivity, optically pumped cesium split-beam magnetometers. Ancillary equipment included a GPS navigation system with GPS base station, a digital imaging system, temperature and pressure sensors, radar altimeters and 2 base station magnetometers.

A pre-planned drape surface was prepared for the survey to guide the aircraft over the topography in a consistent manner, as close to the minimum clearance as possible. The drape surface was prepared with digital elevation model (DEM) data obtained from the Shuttle Radar Topography Mission (http://srtm.usgs.gov/) for the area in question. The DEM included an extension beyond the survey boundary to allow the aircraft to achieve the drape clearance before coming on line.

The drape surface created used a climb and descent rate of 400 ft/nm at 214 m above mean sea level (msl) and 375 ft/nm at an altitude of 783 m msl. Interpolation or extrapolation was used to calculate climb and descent rates for the smooth surface for all locations. The temperature component used for the calculation was based on published weather history. The gentle drape surface created was below the maximum climbing and descending capabilities of the survey aircraft and guided the aircraft to a target height of 100 m above the terrain.

Sander Geophysics Limited utilized 3 of its aircraft—registrations C-GSGV, C-GSGL and C-GSGW—for this survey and based its operations out of Sudbury, Ontario.

The survey was flown as a single block with the traverse lines oriented north–south and the control lines situated perpendicular to the traverse lines. The traverse-line spacing was 200 m, whereas the control-line spacing was 2000 m. Total survey coverage was 51 101 line-kilometres.

The first aircraft, C-GSGV, mobilized to Sudbury, Ontario on November 1, 2019. This was followed by a few days of equipment setup and safety briefings prior to the first data acquisition on November 8, 2019. The second aircraft, C-GSGL, mobilized to Sudbury on November 30, 2019, and commenced survey flying the following day. The third aircraft, C-GSGW, mobilized to Sudbury on December 5, 2019 and commenced survey flying on December 10, 2019.

The 2 ground reference stations used were dual reference stations. One half consisted of a data acquisition computer with a cesium magnetometer interface and frequency counter to process the signal from the magnetometer sensor and from the GPS receiver. The other half contains only a GPS receiver. These 2 halves operate independently of each other. The time base (UTC) of both the ground and airborne systems was automatically provided by the GPS receiver, ensuring proper merging of both data sets. All data are displayed on an LCD flat panel monitor. The magnetic data, sampled at 11 Hz and the GPS data, sampled at 10 Hz, were recorded on solid state data storage modules. The entire reference data acquisition system was set for automatic, unattended recording. The noise level of the reference station magnetometer was less than 0.1 nT.

One reference station was set up on the grounds of the Rustic Craft warehouse, a private business located near the Sudbury Airport. The co-ordinates of REF1 were 46°36′22.7518″N, 80°49′27.9781″W with respect to WGS84 at an elevation of 267.69 m above the geoid. A second reference station was set up at a private residence on Deschene Road, near the town of Val Therese north of Sudbury. REF2 was located at 46°39′53.8027″N, 80°59′09.9884″W at an elevation of 258.61 m above the geoid.

General Statistics:

Survey dates:	November 8, 2019 to February 4, 2020
Total kilometres flown:	51 100.7 km
Total flying hours:	295.0 hours
Number of production days:	34 days
Number of production flights:	61 flights

4.2. PRESURVEY TESTS AND CALIBRATIONS

The following tests and calibrations were performed prior to the commencement of the survey:

- magnetometer lag test
- radar and laser altimeter test
- magnetometer Figure of Merit test
- magnetometer heading test and GPS navigation test
- altimeter land/water comparison

The compensation flights were performed at high altitude (roughly 10 000 feet) in the Ottawa area. The heading tests and GPS tests were flown over the Geological Survey of Canada (GSC) Morewood test range near Ottawa. The lag tests were flown over a railway bridge that crosses the Ottawa River near the township of Pontiac. The altimeter calibrations were carried out over the Gatineau Airport runway. The altimeter land/water comparisons were flown across the Ottawa River near Clarence–Rockland. Details of these tests and their results are provided in Appendix A.

4.3. SURVEY TESTS AND CALIBRATIONS

The following tests and calibrations were performed during the survey:

- magnetometer Figure of Merit test
- stationary aircraft GPS position test

All tests were performed in the Sudbury area. Details of these tests and their results are provided in Appendix A.

4.4. POSTSURVEY TESTS AND CALIBRATIONS

The following tests and calibrations were performed following survey completion.

- magnetometer Figure of Merit test
- magnetometer lag test
- radar altimeter test
- heading and absolute accuracy test

The compensation flights were performed at high altitude (roughly 10 000 feet) in the Ottawa area. The lag tests were flown over a railway bridge that crosses the Ottawa River near the township of Pontiac. Details of these tests and their results are provided in Appendix A.

4.5. FIELD PROCESSING PROCEDURES

All digital data were verified for validity and continuity. The data from the aircraft and base station were transferred to the personal computer's hard disk. Two additional data copies were written to external hard disks. Basic statistics were generated for each parameter recorded. These included the minimum, maximum and mean values, the standard deviation and any null values located. Editing of all recorded parameters for spikes or datum shifts was done, followed by final data verification, via an interactive graphics screen with on-screen editing and interpolation routines.

A NovAtel® OEMV®-3, multi-frequency GNSS (Global Navigation Satellite System) receiver was used to ferry to the survey site and to survey along each line. Co-ordinates for the survey blocks were supplied by ENDM and were used to establish the survey boundaries and the flight lines. Any other aircraft operating in the area were notified about the location of the survey blocks and flying height for safety reasons.

A video camera recorded the ground image in *.avi* format along the flight path. The field data processor reviewed the flight path after each survey flight for continuity and quality. Issues regarding the video are listed in Appendix C.

Checking all data for adherence to specifications was carried out in the office by an experienced SGL data processor.

5. Data Compilation and Processing

5.1. PERSONNEL

The following personnel were involved in the compilation of data and creation of the final products:

Project Manager:	Kevin Charles
Processing Manager:	Martin Bates
Data Analysts:	Krista Kaski Malcolm MacDougall Derek Kouhi
Cartography:	Yves Collins

5.2. BASE MAPS

Base maps of the survey area were supplied by the Ontario Ministry of Energy, Northern Development and Mines.

5.2.1. PROJECT DESCRIPTION

Datum:	North American Datum 1983 (NAD83) Canadian Spatial Reference System (CSRS)
Ellipsoid:	Geodetic Reference System 1980 (GRS 80)
Projection:	UTM 17N
Central Meridian:	81°W
False Northing:	0 m
False Easting:	500 000 m
Scale Factor:	0.9996

5.3. PROCESSING OF THE POSITIONAL AND ALTITUDE DATA

5.3.1. PREPROCESSING OF THE POSITIONAL DATA (GPS)

The positional data processing flowchart is presented Figure 2.

Accurate locations of the GPS antenna were determined through Precise Point Positioning (PPP). Positions were recalculated using the algorithm developed by Natural Resources Canada (NRCAN) (http://webapp.geod.nrcan.gc.ca/geod/tools-outils/ppp.php) adapted to run under SGL's suite of software. Precise satellite orbit and clock data files were obtained from the International GPS Service. This technique provides a final receiver location with an accuracy of better than 5 cm. All survey lines were processed using this method.

Positional data (x, y, z) were recorded and all data processing was performed in the WGS84 datum. The delivered data were provided in x, y locations in UTM projection zone UTM 17N, with respect to the NAD83 CSRS datum. Tables 1, 2 and 3 provide the ellipsoid and datum conversion parameters.

Table 1. Ellipsoid parameters for World Geodetic System 1984 (WGS84).

Ellipsoid	WGS84
Semi-major axis	6378137.0
1/flattening	298.257223563

Table 2. Ellipsoid parameters for NAD83 Canadian Spatial Reference System.

Ellipsoid	GRS 80
Semi-major axis	6378137.0
1/flattening	298.257222101

Table 3. Datum conversion parameters from WGS84 to NAD83 Canadian Spatial Reference System.

x shift (m)	0.9910
y shift (m)	−1.9072
z shift (m)	−0.5129
x rotation (rad)	1.2581 ×E−7
y rotation (rad)	3.5990 ×E−7
z rotation (rad)	5.6070 ×E−7

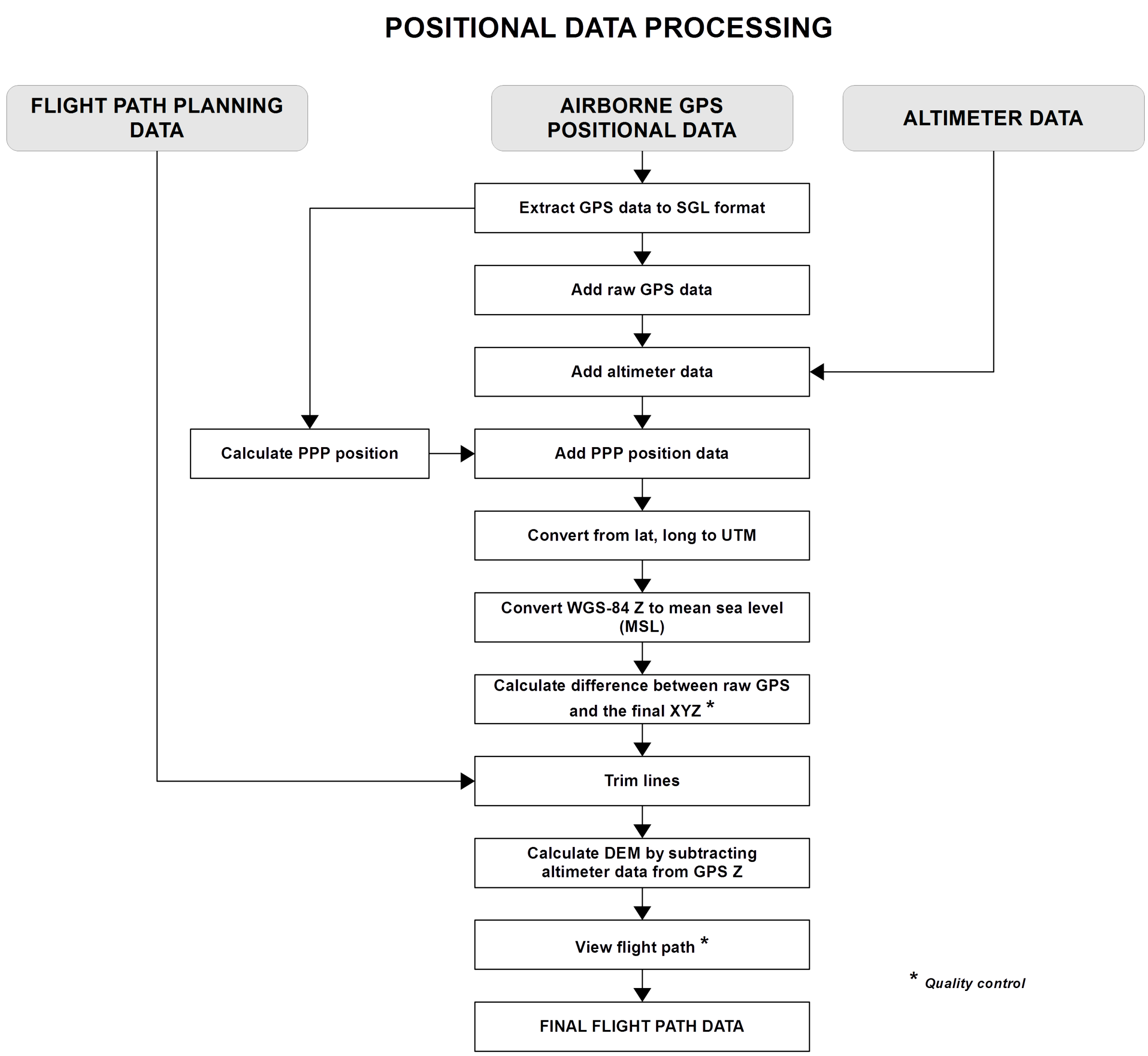

Figure 2. Positional data flowchart ("Precise Point Positioning").

Elevation data were recorded relative to the GRS 80 ellipsoid and transformed to mean sea level (msl) using the CGVD2013 model.

5.3.2. Processing of the Positional Data

The terrain clearance measured by the radar altimeters were recorded at 10 Hz.

The laser altimeter recorded terrain clearance at 3.3 Hz. The laser data show the effects of the dense tree cover; variable penetration of the canopy results in a high frequency variation of recorded altitude.

The radar data penetrate the canopy less as it records the first return within the footprint of its signal. The radar altimeter data were filtered to remove high-frequency noise using a 67-point low-pass filter. The final data were plotted and inspected for quality.

Two versions of digital elevation model (DEM) were derived. The first DEM was derived by subtracting the radar altimeter data from the GPS altitude with respect to mean sea level. As there was no Thomson-CSF radar installed in C-GSGV, the Bendix/King radar data was used, combined with the Thomson-CSF radar from the other 2 aircraft. In some cases, where the Bendix/King radar was less accurate than the Thomson-CSF radar, the Bendix/King radar was adjusted by applying a long wavelength correction derived by comparing the DEM calculated by subtracting the Bendix/King radar from the GPS altitude to the equivalent DEM generated from the laser data or to the SRTM. The second DEM was derived by subtracting the laser data from the GPS altitude with respect to mean sea level. Short sections of poor laser data, resulting from locally weak reflectivity, were replaced using Thomson-CSF or Bendix/King radar data. Microlevelling and flattening adjustments were selectively employed to the DEM over large lakes (e.g., Lake Wanapitei) to remove some residual line-parallel artifacts probably due to variable reflectivity of the water surface depending on prevailing conditions.

5.4. PROCESSING OF THE MAGNETIC DATA

5.4.1. Processing of Base Station Data

Ground magnetometer data were inspected for cultural interference and edited where necessary. All reference station magnetometer data were filtered, REF1 using a 301-point low-pass filter and REF2 using a 369-point low-pass filter, to remove any high-frequency signal, but retain the low-frequency diurnal variations. The mean residual value of the ground stations was subtracted to remove any bias from the local anomalous field. For base station REF1, the mean was 55 307.6 nT and, for base station REF2, the mean was 55 124.6 nT.

5.4.2. Processing of Airborne Magnetic Data

Figure 4 summarizes the steps involved in processing the magnetic data collected during the survey.

The tail boom–mounted sensor #3 was used to make the standard magnetic anomaly field grid of data. The airborne magnetometer data were recorded at 160 Hz, and down-sampled to 10 Hz for processing. All magnetic data were plotted and checked for any spikes or noise. A dynamic lag correction to account for the offset in the direction of flight of the tail sensor and 2 wingtip sensors from the GPS antenna were applied to each data point. The actual correction, applied to each data point, depends on the instantaneous velocity of the aircraft, and varies between 0.04 s and 0.06 s. The aircraft speed dependent dynamic lag was calculated using SGL's Dynlag software.

Diurnal variations in the airborne magnetometer data were removed by subtracting the corrected reference station data. REF1 was used for flights 1001, 1002, 1020, 1022, 1026, 2015, 3007, 3009, 3011, 3012, 3017, and 3018. REF2 was used for all other remaining flights.

Intersections between control and traverse lines were determined by a program that extracts the magnetic, altitude, and X and Y values of the traverse and control lines at each intersection point. Each control line was then adjusted by a constant value to minimize the intersection differences that were calculated using the following equation:

$$\sum |i - a| \text{ summed over all traverse lines}$$

where,

i = individual intersection difference

a = average intersection difference for that traverse line

Adjusted control lines were further corrected locally to minimize the difference between individual corrections and the average correction for the control line that results from residual diurnal variations along the line. Traverse-line levelling was then carried out by a program that interpolates and extrapolates levelling values for each point based on the 2 closest levelling values. After traverse lines have been levelled, the control lines were matched to them. This ensures that all intersections tie perfectly and permits the use of all data in the final products. At this point, the total magnetic intensity (TMI) field has been derived.

The levelling procedure was verified through inspection of magnetic intensity contour maps, inspection of vertical derivative grids, plotting profiles of corrections along lines, and examining levelling statistics to check for steep correction gradients. Microlevelling was applied with a cut-off value of ±0.5 nT, with some smaller subsets of the block microlevelled with a cut-off value of ±2 nT (Figure 3).

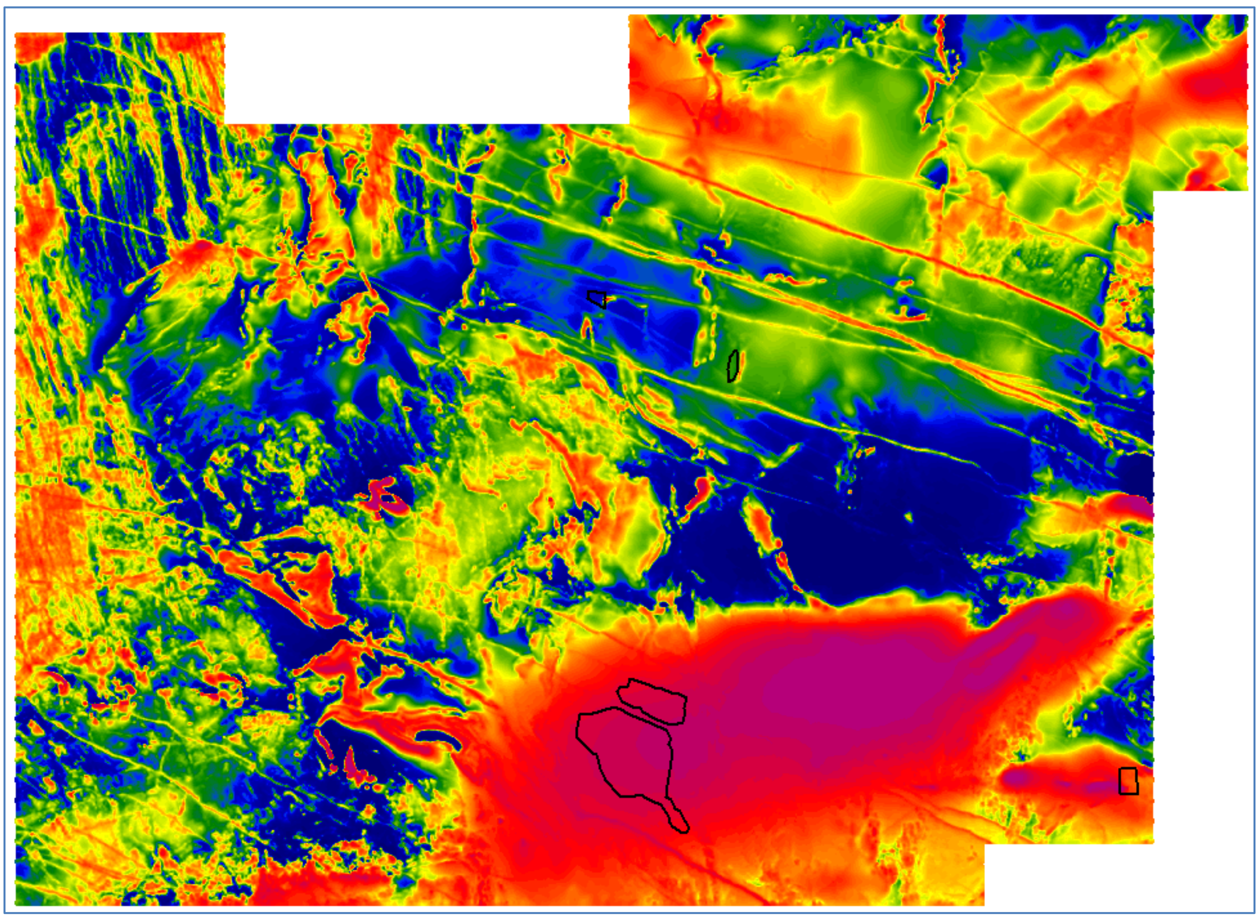

Figure 3. Grid of levelled anomalous magnetic field of the Sturgeon River Area with outlines of subsets that were microlevelled with a cut-off value of ±2 nT overlain.

The International Geomagnetic Reference Field (IGRF) was then calculated from the 2015 model year extrapolated to 2020.0 (January 1, 2020) at the mean survey elevation of 451.484 m above the WGS84 ellipsoid and removed from the corrected values to generate the residual magnetic anomaly field.

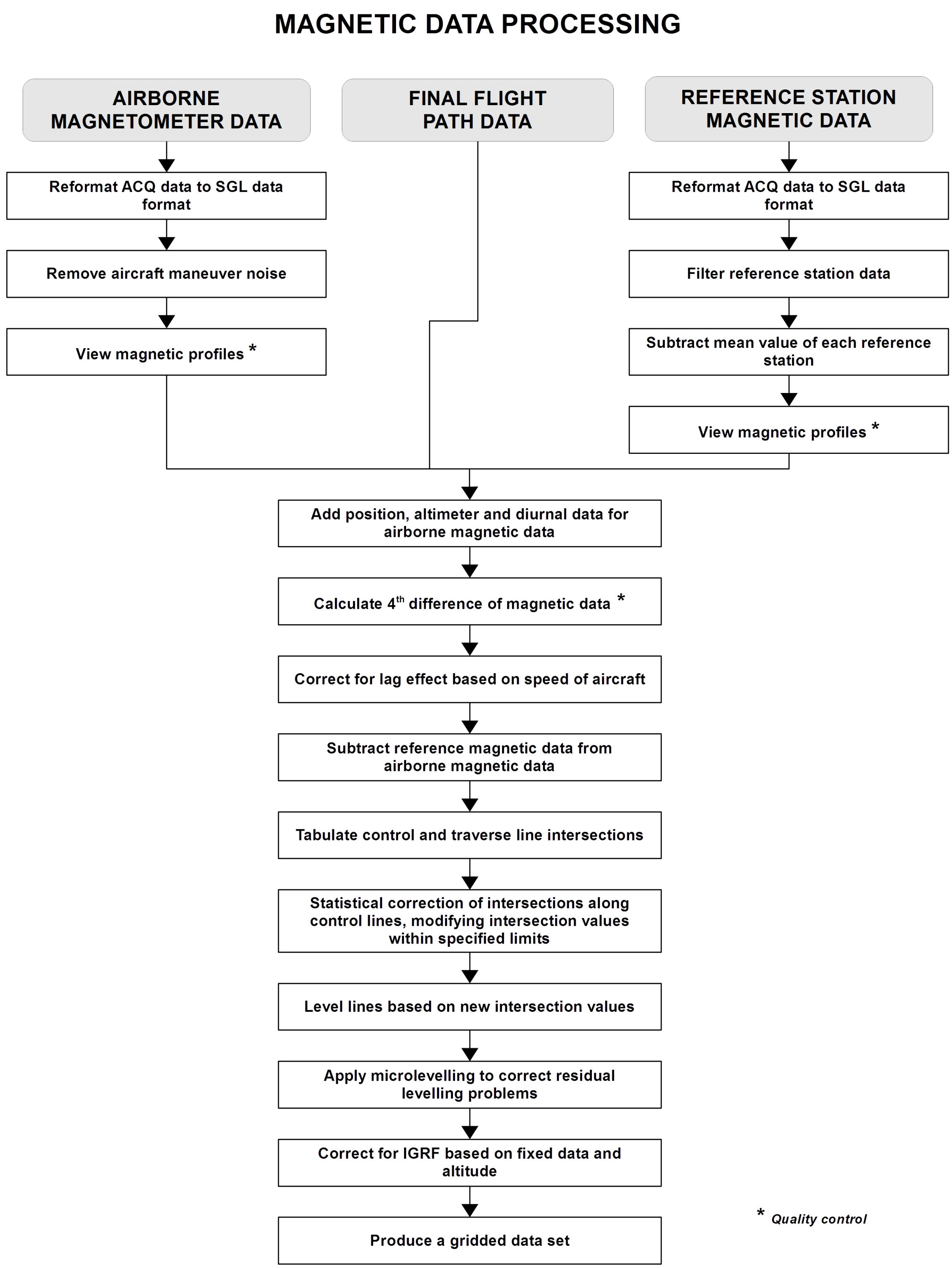

Figure 4. Magnetometer data processing flowchart.

5.4.3. Processing of Measured Magnetic Gradients

The measured lateral and longitudinal gradients provide an improved rendition of the shorter wavelengths in magnetic field than the total magnetic field measured by the tail sensor #3 alone. This is because the direction and amplitude of the field's total horizontal gradient can be determined using the 2 measured gradients, providing information regarding the behaviour of the magnetic field in between traverse lines.

Initially, the magnetic gradients were derived with respect to the aircraft frame. The across-aircraft gradient data were derived from the difference in total magnetic intensity recorded at the wingtip sensors #1 and #2 divided by the separation across the wings, which is 19.2 m for C-GSGW and C-GSGV, and 19.0 m for C-GSGL. The along-aircraft gradient is derived from all sensors, being the difference in total magnetic intensity between the mean value of the wingtip sensors #1 and #2 and the tail sensor #3 divided by the longitudinal separation along the aircraft body, which is 11.0 m for C-GSGL and C-GSGV, and 10.9 m for C-GSGW.

The across and along the aircraft gradients and the azimuth of the aircraft, available from the aircraft avionics, are combined to calculate the horizontal and longitudinal gradients with respect to the survey lines, so that positive gradients are eastward and northward, respectively. After correcting for orientation, there remains an inherent directional bias in the horizontal gradients because of the different sensors employed on the aircraft. An algorithm based on comparing the average value of a line compared to the global average was used to apply a zeroth order shift to the lateral and longitudinal gradient for every traverse line.

Lateral and longitudinal gradients were then "levelled" to gradients derived from the tail sensor total magnetic intensity (TMI). This was done by taking the difference between the measured and derived gradients, applying a moving 117-point filter, and adding back the filtered difference.

The 2 horizontal gradients, lateral gradient and longitudinal gradient, can be utilized to create a first vertical derivative using the Hilbert transform relationship (Nabighian 1984). Once the Hilbert transform had been applied to the lateral and longitudinal gradients, the outputs were summed to create a first vertical derivative grid. The first vertical derivation was then integrated to create a gradient-enhanced TMI.

However, the integrated gradient-enhanced TMI does not contain the long wavelength signal that is well sampled and retained in the single-sensor TMI data. To account for this, the long wavelength magnetic anomaly must be recovered. This was achieved by analysis of the power spectrum of the integrated data. The wavelength at which the power drops off was determined to be at 2.0 km, so a low-pass second-order Butterworth filter was applied to the single-sensor TMI data using this value as the cut off to isolate the missing long wave content of the integrated data. The long wavelength data were then added to the integrated data to create the gradient-enhanced TMI grid.

The International Geomagnetic Reference Field (IGRF) was then calculated from the 2015 model year extrapolated to 2020.0 (January 1, 2020) at the mean survey elevation of 451.484 m above the WGS84 ellipsoid and removed from the corrected values to generate the enhanced residual magnetic anomaly field.

The gradient-enhanced residual magnetic anomaly was then subjected to the GSC levelling procedure (*see* section 5.4.4. "Geological Survey of Canada Data Levelling").

All grids generated during this procedure were created using a minimum curvature algorithm and a cell size of 40 m.

5.4.4. Geological Survey of Canada Data Levelling

In 1989, as part of the requirements for the contract with the Ontario Geological Survey to compile and level all existing Geological Survey of Canada aeromagnetic data (flown prior to 1989) in Ontario, Paterson, Grant and Watson Limited developed a robust method to level the magnetic data of various base levels to a common datum provided by the GSC as 812.8 m grids. The essential theoretical aspects of the levelling methodology were fully discussed by Gupta et al. (1989) and Reford et al. (1990). The method was later applied to the remainder of the GSC data across Canada and the high-resolution airborne magnetic and electromagnetic surveys flown by the OGS (Ontario Geological Survey 2003a). It has since been applied to all newly acquired OGS aeromagnetic surveys.

a) Terminology

- Master grid: refers to the 200 m Ontario magnetic grid compiled and levelled to the 812.8 m magnetic datum from the GSC
- GSC levelling: the process of levelling profile data to a master grid, first applied to GSC data
- Intrasurvey levelling or microlevelling: refers to the removal of residual line noise described earlier in this chapter; the wavelengths of the noise removed are usually shorter than tie-line spacing
- Intersurvey levelling or GSC levelling: refers to the level adjustments applied to a block of data; the adjustments are the long wavelength (in the order of tens of kilometres) differences with respect to a common datum, in this case, the 200 m Ontario master grid, which was derived from all pre-1989 GSC magnetic data and adjusted, in turn, by the 812.8 m GSC Canada-wide grid

b) The GSC Levelling Methodology

The GSC levelling methodology is described below, as applied to the Sturgeon River area survey flown for the OGS. This procedure was applied to the gradient-enhanced residual magnetic field.

Several data processing procedures are assumed to be applied to the survey data prior to levelling, such as microlevelling, IGRF calculation and removal. The final levelled data are gridded at 1/5 of the line spacing. If a survey was flown as several distinct blocks with different flight directions, then each block is treated as an independent survey.

The steps in the GSC levelling process were as follows:

1. Create an upward continuation of the survey grid to 305 m.

   Almost all recent surveys (1990 and later) to be compiled were flown at a nominal terrain clearance of 100 m or less. The first step in the levelling method was to upward continue the survey grid to 305 m, the nominal terrain clearance of the Ontario master grid (Figure 5).

   The grid cell size for the survey grids was set at 100 m. Since the wavelengths of level corrections will be greater than 10 to 15 km, working with 100 m or even 200 m grids at this stage will not affect the integrity of the levelling method. Only at the very end, when the level corrections were imported into the databases, will the level correction grids be regridded to 1/10 of line spacing.

2. Create a difference grid between the survey grid and the Ontario master grid.

   The difference between the upward-continued survey grid and the Ontario master grid, regridded at 100 m, was computed (Figure 6). The short wavelengths represent the higher resolution of the survey grid. The long wavelengths represent the level difference between the 2 grids.

3. Rotate difference grid so that flight-line direction is parallel with grid column or row, if necessary.

4. Apply the first pass of a nonlinear filter (Naudy and Dreyer 1968) of wavelength on the order of roughly half the length of the shortest dimension of the grid along the flight-line direction. Reapply the same nonlinear filter across the tie-line direction.

5. Apply the second pass of a nonlinear filter with approximately 1/2 the filter cut-off from the previous step along the flight-line direction. Reapply the same nonlinear filter across the tie-line direction.

6. Rotate the filtered grid back to its original (true) orientation (Figure 7).

7. Apply a low-pass filter to the nonlinear filtered grid. Streaks may remain in the nonlinear filtered grid, mostly caused by edge effects. They must be removed by a frequency-domain, low-pass filter with a wavelength cut-off sufficient to remove these streaks (Figure 8).

8. Regrid to 1/10 line spacing and import level corrections into database.

9. Subtract the level correction channel from the unlevelled channel to obtain the level corrected channel.

10. Make final grid using the gridding algorithm of choice with grid cell size at 1/10 of line spacing.

c) Survey Specific Parameters

The following GSC levelling parameters were used in the Sturgeon River survey:

- Upward continuation distance: 205 m
- First pass nonlinear filter length: 40 000 m
- Second pass nonlinear filter length: 20 000 m
- Low-pass filter cut-off wavelength: 45 000 m

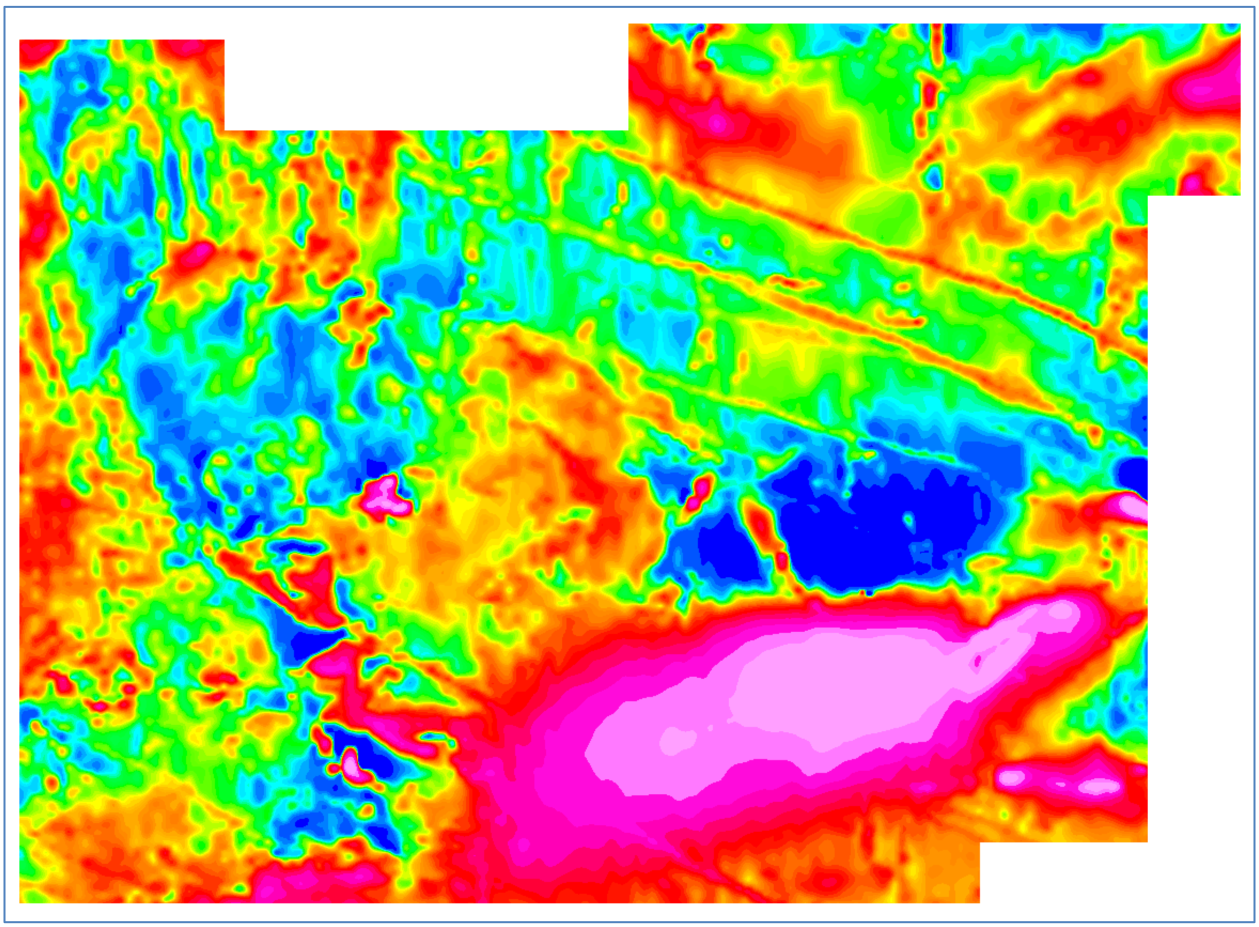

Figure 5. Ontario master aeromagnetic grid (Ontario Geological Survey 2003b). The outline for the sample data set to be levelled, using the Sturgeon River survey area as the example, is shown.

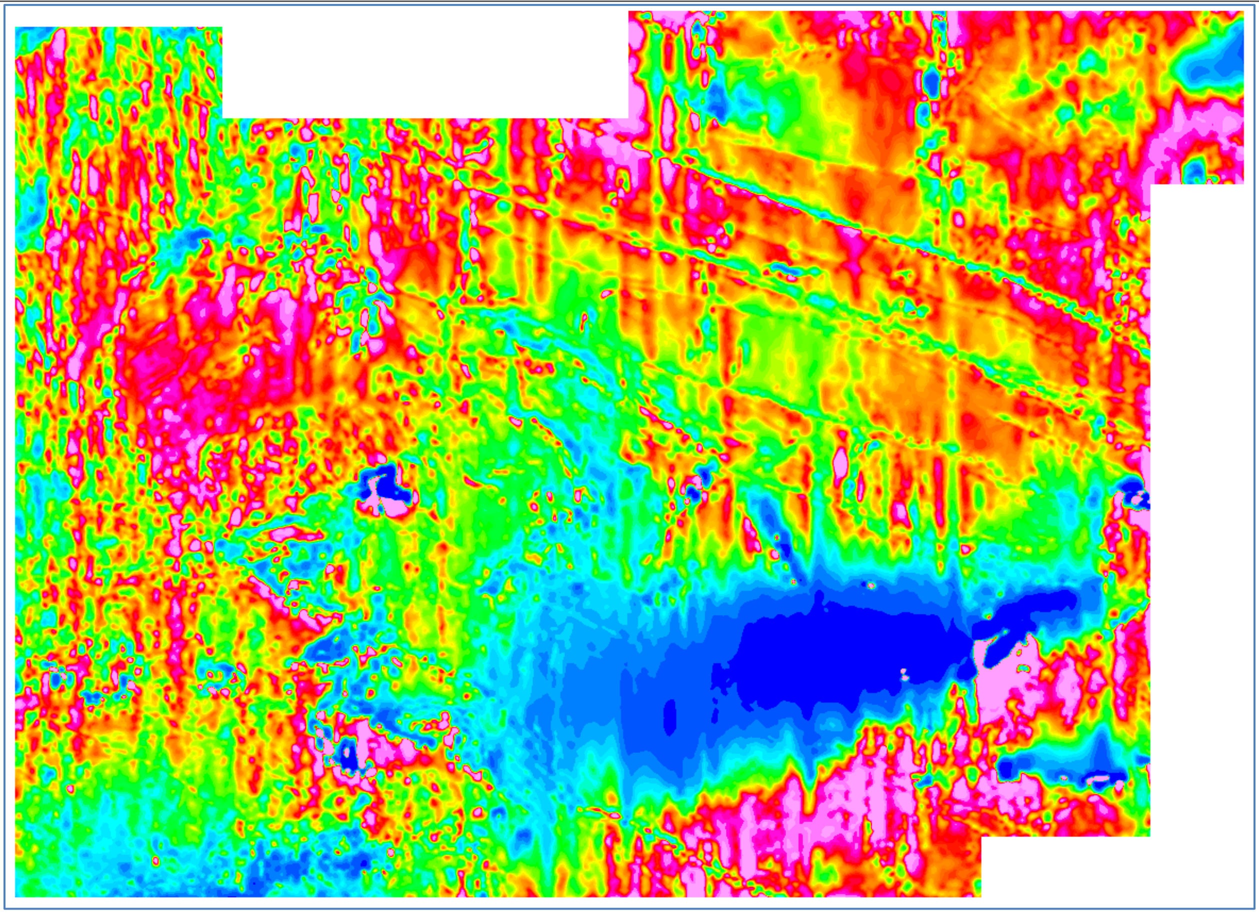

Figure 6. Difference grid (difference between survey grid and master grid), using the Sturgeon River survey as the example.

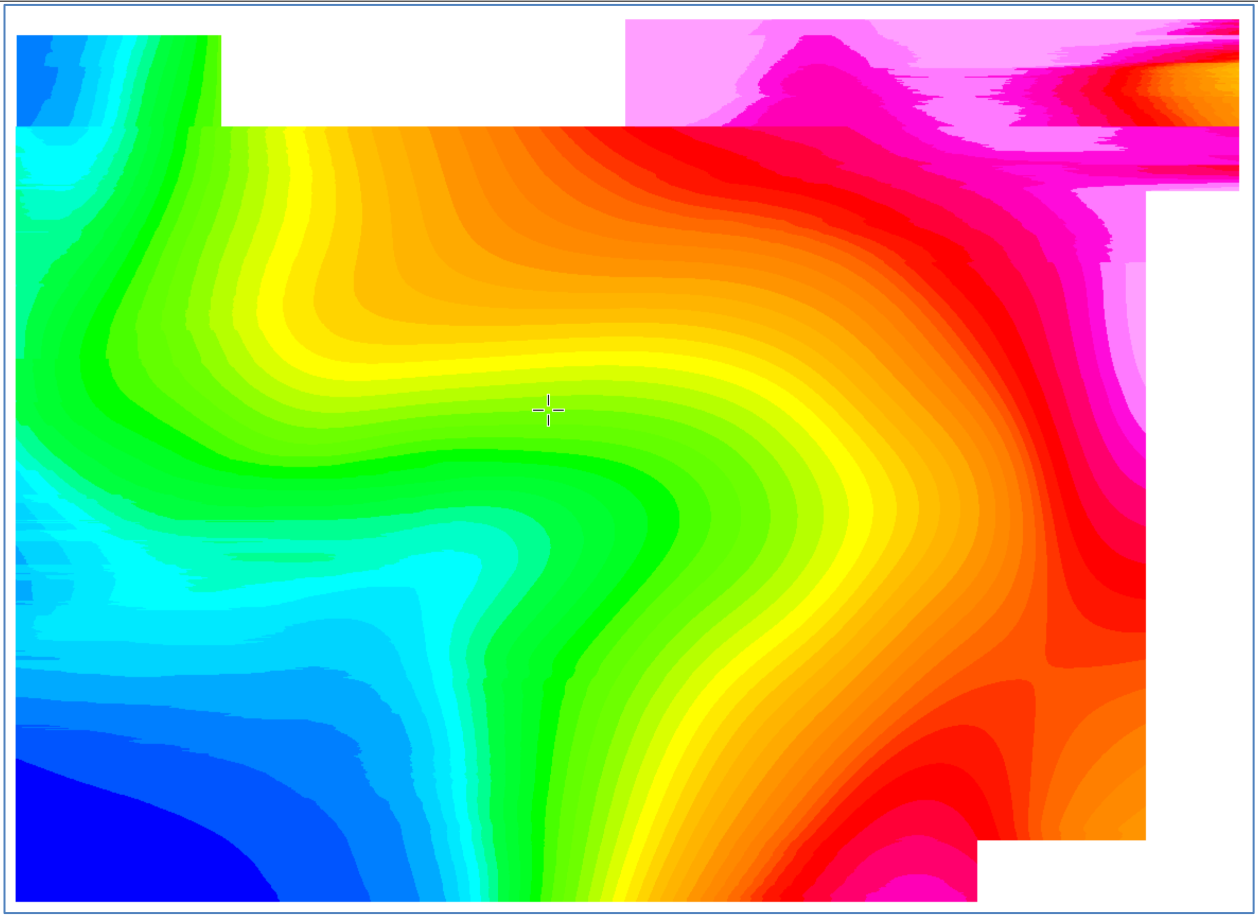

Figure 7. Difference grid after application of nonlinear filtering and rotation, using the Sturgeon River survey as the example.

Figure 8. Level correction grid, using the Sturgeon River survey as the example.

5.4.5. Final Magnetic Field and Second Vertical Derivative Grids

After GSC levelling was applied to the gradient-enhanced residual magnetic field data, they were used to create derivative grids. The magnetic grids were calculated from the final reprocessed profiles using a bidirectional minimum curvature algorithm (Briggs 1974). The accuracy standard for gridding is that the grid values fit the profile data to within 0.001 nT for 99.99% of the profile data points, for 100 iterations (or 0.00001 nT/m for the horizontal gradient data). The average gridding error is well below 0.1 nT.

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. This effect is minimized in the gradient-enhanced GSC levelled magnetic grid, and as a result it was used for the map products. These grids are rendered with a cell size of 20 m (1/10 of the line spacing).

The final GSC levelled gradient-enhanced grid values were then used as input to create the second vertical derivative grids.

5.4.6. Calculation of the Keating Coefficients

Possible kimberlite targets were identified from the GSC levelled gradient enhanced residual magnetic intensity data, based on the identification of roughly circular anomalies. This procedure was automated by using a known pattern recognition technique (Keating 1995, 2001), which consists of computing, over a moving window, a first-order regression between a vertical cylinder model anomaly and the gridded magnetic data. Only the results where the absolute value of the correlation coefficient is above a threshold of 75% were retained. On the magnetic maps, the results are depicted as circular symbols, scaled to reflect the correlation value. The most favourable targets are those that exhibit a cluster of high-amplitude solutions. Correlation coefficients with a negative value correspond to reversely magnetized sources.

The cylinder model parameters are as follows.

- Cylinder Radius 100 m
- Cylinder length: infinite
- Overburden thickness: 3.6 m
- Magnetic inclination: 72.1°
- Magnetic declination: 10.7°W
- Window size: 1000 m x 1000 m
- Susceptibility: 0.005

An example of the model's magnetic response is shown in Figure 9.

It is important to be aware that other magnetic sources may correlate well with the vertical cylinder model, whereas some kimberlite pipes of irregular geometry may not. The user should study the magnetic anomaly that corresponds with the Keating symbols, to determine whether it does resemble a kimberlite pipe signature, reflects some other type of source or even noise in the data, e.g., boudinage (beading) effect of the minimum curvature gridding. All available geological information should be incorporated in kimberlite pipe target selection.

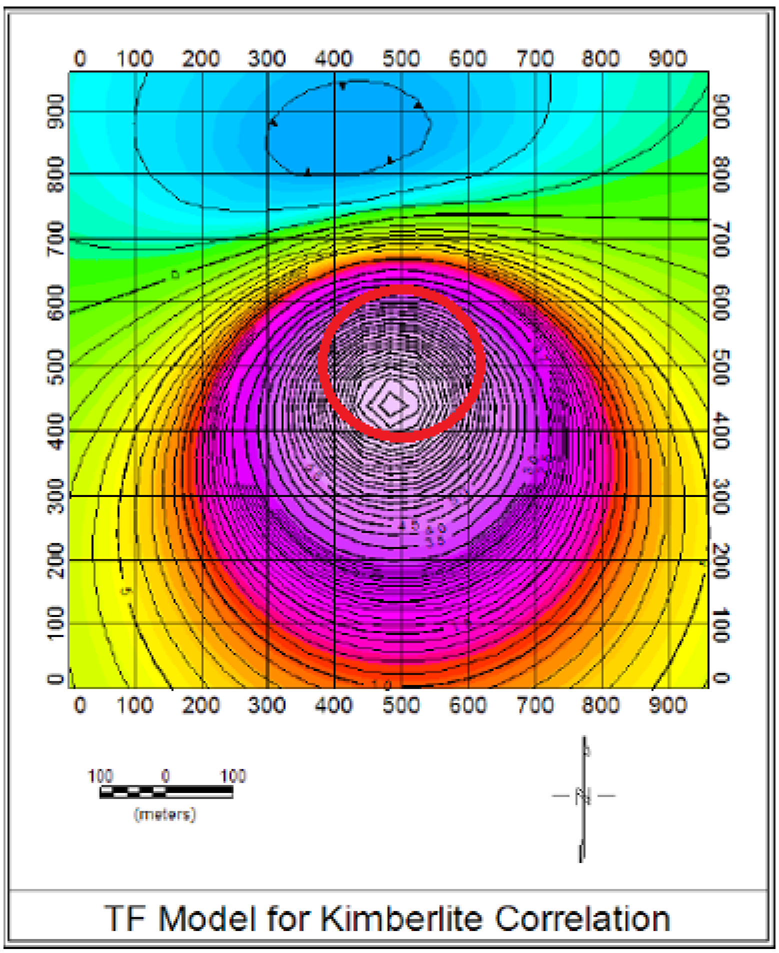

Figure 9. Vertical cylinder anomaly model used for Keating correlation.

6. Final Products

The following products were delivered to the ENDM.

1. Profile Databases

A database, in both Geosoft® *.gdb* and ASCII *.xyz* format, was provided for the magnetic line data archive.

A database, in both Geosoft® *.gdb* and comma-separated values *.csv* format, was provided for the Keating coefficient archive.

2. Gridded Data

Grids, in both Geosoft® *.grd* and Grid Exchange *.gxf* formats, gridded from co-ordinates in UTM Zone 17N, NAD83 CSRS, of the following data:

- digital elevation model from laser altimeter
- total magnetic field from the tail sensor
- "GSC levelled" gradient-enhanced residual magnetic field
- second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field
- measured lateral horizontal gradient
- measured longitudinal horizontal gradient
- first vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field
- second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field
- calculated total horizontal gradient of the "GSC levelled" gradient-enhanced reduced-to-pole residual magnetic field
- analytic signal derived from "GSC levelled" gradient-enhanced residual magnetic field

3. Project Report

Provided in portable document format (*.pdf*).

4. Flight Videos

The digitally recorded video from each survey flight are provided in a compressed binary format on a hard drive.

5. Maps

Digital 1:50 000 scale maps (NAD83 CSRS UTM Zone 17N) in Geosoft® *.map* format, with a topographic layer, of the following:

- colour-filled contours of gradient-enhanced "GSC levelled" residual magnetic field and flight lines (Figure 10) (with the following tile names and layout, where "m830xx" indicates OGS Map 830xx)
- shaded colour of the second vertical derivative of the gradient-enhanced "GSC levelled" residual magnetic field with Keating coefficients (Figure 11) (with the following tile names and layout, where "m830xx" indicates OGS Map 830xx)

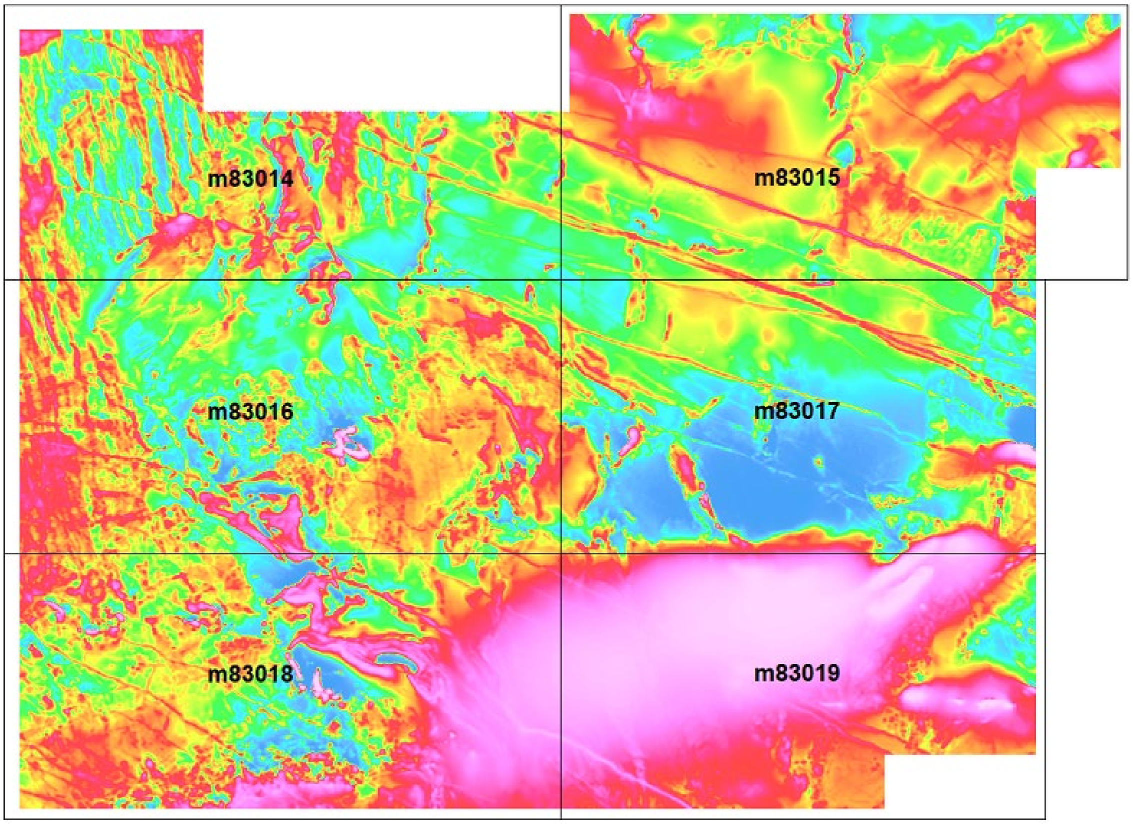

Figure 10. Gradient-enhanced "GSC levelled" residual magnetic field.

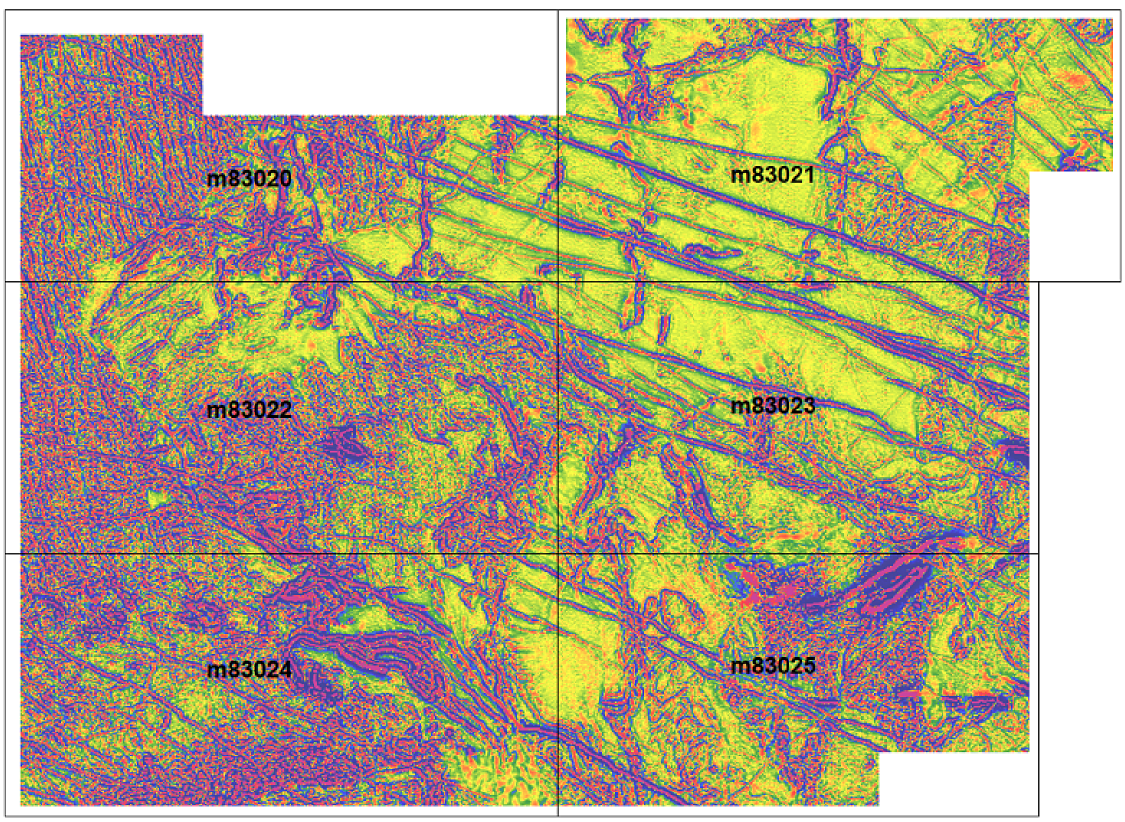

Figure 11. Second vertical derivative of the gradient-enhanced "GSC levelled" residual magnetic field.

7. Quality Assurance and Quality Control

Quality assurance and quality control (QA/QC) were undertaken by the survey contractor Sander Geophysics Limited and Paterson, Grant and Watson Limited, as well as by ENDM. Stringent QA/QC is emphasized throughout the project so that the optimal geological signal is measured, archived and presented.

7.1. SURVEY CONTRACTOR

Important checks are required during the data acquisition stage to ensure that the data quality is kept within the survey specifications. The following lists, in detail, the standard data quality checks that were performed by SGL during the course of the survey.

7.1.1. TESTS AND CALIBRATIONS

The full results of the tests and calibrations described below are provided in Appendix A.

1. Magnetometer Lag Test (Appendix A: Figures 12 to 29)

To verify the magnetic system latency, the survey aircraft conducted lag tests. These tests involve flying multiple passes over a known magnetic feature and comparing the position of the observed magnetic peaks with the known position of the target.

Both prior to commencement and after completion of the survey, aircraft C-GSGL, C-GSGW and C-GSGV flew this test over a railway bridge near Ottawa.

The calculated system latencies from these tests were determined to be consistent between the pre- and post-survey values and were consistent with previous tests performed by each aircraft.

2. Radar and Laser Altimeter Test (Appendix A: Figures 30 to 35)

The radar altimeter calibration and verification were performed by acquiring altitude data from several passes of increasing altitude over the Gatineau Airport runway. The radar altimeter of the aircraft was confirmed to have a linear relationship with and within acceptable range of the GPS height.

3. Magnetometer Figure of Merit Test (Appendix A: Figures 36 to 55; Table 4)

Compensation calibrations determine the magnetic influence of aircraft and its manoeuvres. During the compensation calibration flight, the aircraft performs sets of 3 pitches (±5°), rolls (±10°) and yaws (±5°), while flying in the 4 flight-line directions at high altitude over a magnetically “quiet” area. The coefficients calculated from the calibration are applied to the acquired magnetometer data to measure the effectiveness of the compensation system in mitigating the magnetic interference.

The total compensated signal noise resulting from the 12 manoeuvres, referred to as the Figure of Merit (FOM), is calculated from the maximum peak-to-peak value resulting from each manoeuvre. A new compensation calibration must be performed after any aircraft or system modifications that may affect the aircraft’s magnetic field interference.

In all calibrations performed by the aircraft, the resultant FOMs for the tail and wingtip sensors were below the specified threshold of 1.5 nT.

4. Magnetometer Heading Test (Appendix A: Figure 56; Tables 5 to 22)

To verify system accuracy and acceptable heading error, a heading test was performed over the GSC magnetic observatory at Morewood, Ontario, prior to commencement of the survey. The aircraft performed 2 passes in NW, NE, SW and SE directions directly over the observatory and the aircraft measured total field was compared against the observatory data.

For the calibration performed, the calculated heading errors were minimal, and the absolute accuracies were within the contract threshold of 10 nT.

5. Altimeter Land/Water Comparison (Appendix A: Figure 57 to 60)

To compare the effect of flying radar and laser altimeters over both land and water, a test line was flown across the Ottawa River near Clarence-Rockland. The test line was flown from north to south. Terrain channels were calculated using each altimeter and then plotted on top of each other

6. GPS Static Test (Appendix A: Figure 61 to 63)

A GPS static test was performed to evaluate the accuracy of the GPS receiver for each aircraft. These tests were performed with the aircraft parked and not moving on the airport ramp in Sudbury, Ontario.

7.1.2. Daily Quality Control

1. Navigation Data

- The differentially corrected GPS flight track was recovered and matched against the theoretical flight path to ensure that any deviations are within the specifications (i.e., deviations not greater than 50 m from the nominal line spacing over a 2 km distance).
- All altimeter data were checked for consistency and deviations in terrain clearance were monitored closely. The survey was flown in a smooth drape fashion maintaining a nominal terrain clearance of 100 m, whenever possible. A digital elevation trace, calculated from the radar altimeter and the GPS elevation values, was also generated to further control the quality of the altimeter data.
- The synchronicity of the GPS time and the acquired time of the geophysical data was checked by matching the recorded time fields.
- A final check on the navigation data was done by computing the point-to-point speed from the corrected UTM X and Y values. The computed values should be free of erratic behaviour showing a nominal ground speed of 70 m/s with point-to-point variations not exceeding ±10 m/s.

2. Magnetic Data

- The diurnal variation was examined for any deviations that exceed the specified 3 nT peak-to-peak over a 60 second chord. Further quality control on the diurnal variation was to examine the data for any man-made disturbances. When noted, these artefacts were graphically removed by a polynomial interpolation so that they are not introduced into the final data when the diurnal values are subtracted from the recorded airborne data.
- The integrity of the airborne magnetometer data was checked through statistical analysis and graphically viewed in profile form to ensure that there were no gaps and that the noise specifications were met.
- A fourth difference algorithm was applied to the raw data to help locate and correct any small steps and/or spikes in the data.
- Any effects of filtering applied to the data were examined by displaying, in profile form, the final processed results against the original raw data, via a graphic screen. This was done to ensure that any noise filtering applied has not compromised the resolution of the geological signal.
- Ongoing gridding and imaging of the data were also done to control the overall quality of the magnetic data.

7.1.3. Near-Final Field Products

Near-final products of the profile and gridded magnetic data were made available to the QA/QC Geophysicist during visits to the survey site, for review and approval, prior to demobilization.

7.1.4. Quality Control in the Office

1. Review of preliminary processed data

The general results of the preliminary processing were reviewed in the profile database by producing a multichannel stacked display of the data (raw and processed) for every line, using a graphic viewing tool. The magnetic and altimeter data were checked for spikes and residual noise.

2. Review of the final processed data

The results of the field levelling of the magnetics were reviewed, using imaging and shadowing techniques. Any residual errors noted were corrected and the final microlevelling re-applied to the profile data.

3. Creation of first and second vertical derivative

The first and second vertical derivatives were created from the final gridded values of the residual field magnetic data and checked for any residual errors using imaging and shadowing techniques.

7.1.5. Interim Products

Archive files containing the raw and interim processed profile data and the gridded data were provided to the QA/QC Geophysicist for review and approval.

7.1.6. Creation of 1:50 000 Maps

After approval of the interim data, the 1:50 000 maps were created and verified for registration, labelling, dropping weights, general surround information, etc. The corresponding digital files were provided to the QA/QC Data Manager for review and approval.

7.2. QA/QC GEOPHYSICIST

The QA/QC Geophysicist received data on a regular basis throughout the data acquisition, focussing initially on the data acquisition procedures, base station monitoring and instrument calibration. As data were collected, they were reviewed for adherence to the survey specifications and completeness. Any problems encountered during data acquisition were discussed and resolved.

The QA/QC checks included the following.

1. Navigation Data

- appropriate location of the GPS base station
- flight-line and control-line separations are maintained, and deviations along lines are minimized
- verify synchronicity of GPS navigation and flight video
- all boundary control lines are properly located
- terrain clearance specifications are maintained
- aircraft speed remained within the satisfactory range
- area flown covers the entire specified survey area
- real-time corrected GPS data does not suffer from satellite induced shifts or dropouts
- GPS height and radar/laser altimeter data are able to produce an image-quality Digital Elevation Model
- GPS and geophysical data acquisition systems are properly synchronized
- GPS data are adequately sampled.

2. Magnetic Data
   - appropriate location of the magnetic base station, and adequate sampling of the diurnal variations
   - heading error and lag tests are satisfactory
   - magnetometer noise levels are within specifications
   - magnetic diurnal variations remain within specifications
   - spikes and/or drop-outs are minimal to non-existent in the raw data
   - filtering of the profile data is minimal to non-existent
   - preliminary levelling produces image-quality grids of total magnetic field and higher order products (e.g., second vertical derivative).

The QA/QC Geophysicist reviewed interim and final digital and map products throughout the data compilation phase, to ensure that noise was minimized and that the products adhered to the QA/QC specifications. This typically resulted in several iterations before all digital products were considered satisfactory. Considerable effort was devoted to specifying the data formats and verifying that the data adhered to these formats.

7.3. MINISTRY OF ENERGY, NORTHERN DEVELOPMENT AND MINES

ENDM prepared all of the base map and map surround information required for the hard-copy maps. This ensured consistency and completeness for all of the geophysical map products. The base map was constructed from digital files of the 1:50 000 NTS map sheet series.

ENDM worked with the QA/QC Geophysicist to ensure that the digital files adhered to the specified ASCII and binary file formats, that the file names and channel names were consistent, and that all required data were delivered on schedule. The map products were carefully reviewed in digital and hard-copy form to ensure legibility and completeness.

ENDM and the QA/QC geophysicist provided the magnetic profile and gridded data guidelines for SGL as part of the GSC levelling process.

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Appendix A. Test and Calibration Results

MAGNETOMETER LAG TEST

The lag in the magnetic data is a function of a speed-dependent dynamic lag resulting from the physical offset of the magnetometer and the GPS antenna. A dynamic lag correction to account for the offset in the direction of flight of the tail sensor and 2 wingtip sensors from the GPS antenna were applied to each data point. For the wingtip sensors #1 and #2 the offset is 1 m, whereas for the tail sensor #3 the offset is 12 m. So, for example, at a speed of 70 m/s, the total lag for the wingtip sensors would be 0.01 s and 0.17 s for the tail sensor.

Lag tests were performed by all aircraft before deployment and after the survey as follows: C-GSGV on October 29, 2019 and February 6, 2020; C-GSGW on November 20, 2019 and February 12, 2020; and C-GSGL on November 23, 2019 and January 30, 2020. The tests were flown close to Ottawa over a railway bridge that crosses the Ottawa River near the township of Pontiac.

Results of the lag tests performed for this survey are provided below. The lag on the geophysical instruments is calculated using a computer program written by SGL. This program uses a statistical comparison of high-pass filtered data from the same line flown in opposite directions.

The program was developed by SGL because we found that it is not possible to determine the lag in an airborne system to an accuracy of better than about one second using a visible ground feature, which causes a distinct anomaly. It is difficult to find the exact centre of the magnetic anomaly, and to locate the precise time on the video flight path record. This method calculates the lag between the GPS data and the magnetometer data, rather than the lag between the magnetometer data and the flight path video. It is important to calculate the lag using the GPS positional data, which is actually used in the compilation process.

The known lag for the airborne magnetometer acquisition system is applied to the airborne magnetic data. The lag test is considered successful if the peaks of the lag corrected magnetic anomaly acquired on passes in opposite directions are not offset by more than one data point as based on data rate and survey speed (0.1 s × 70 m/s = 7.0 m) plus an allowance for the expected final GPS accuracy of ±0.5 m for each data peak, so that the peaks will be within 6.0 m to 8.0 m along the direction of flight.

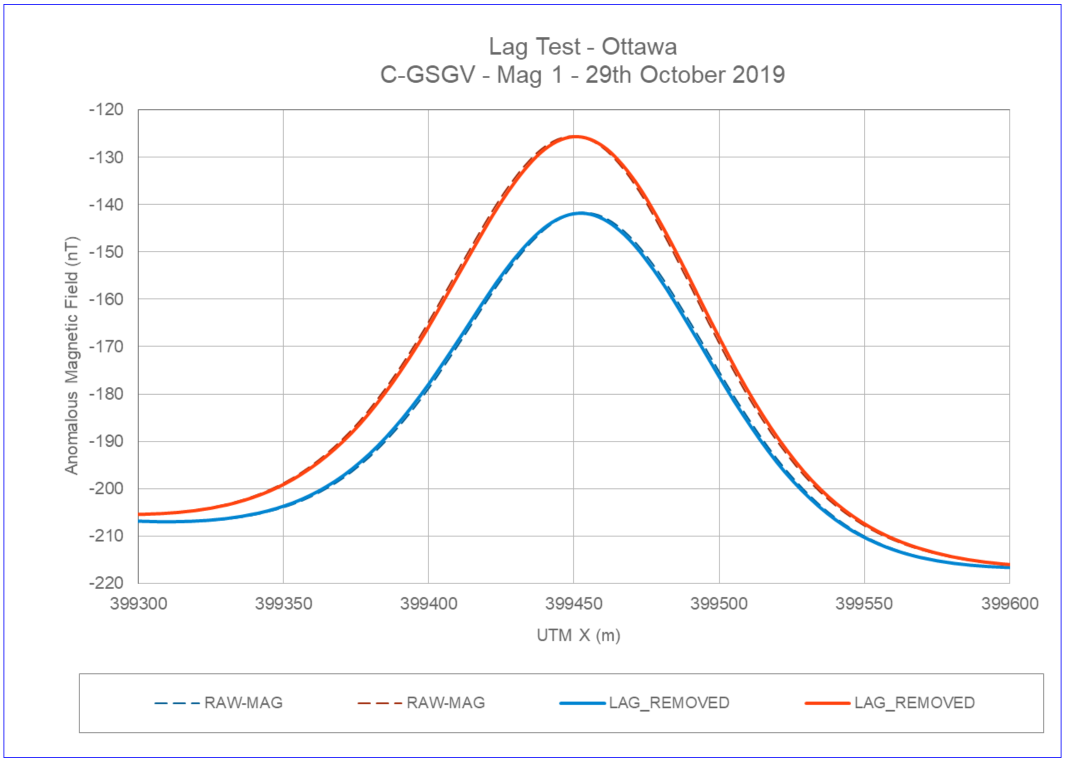

Figure 12. Lag test, Ottawa, C-GSGV, Mag1, October 29, 2019.

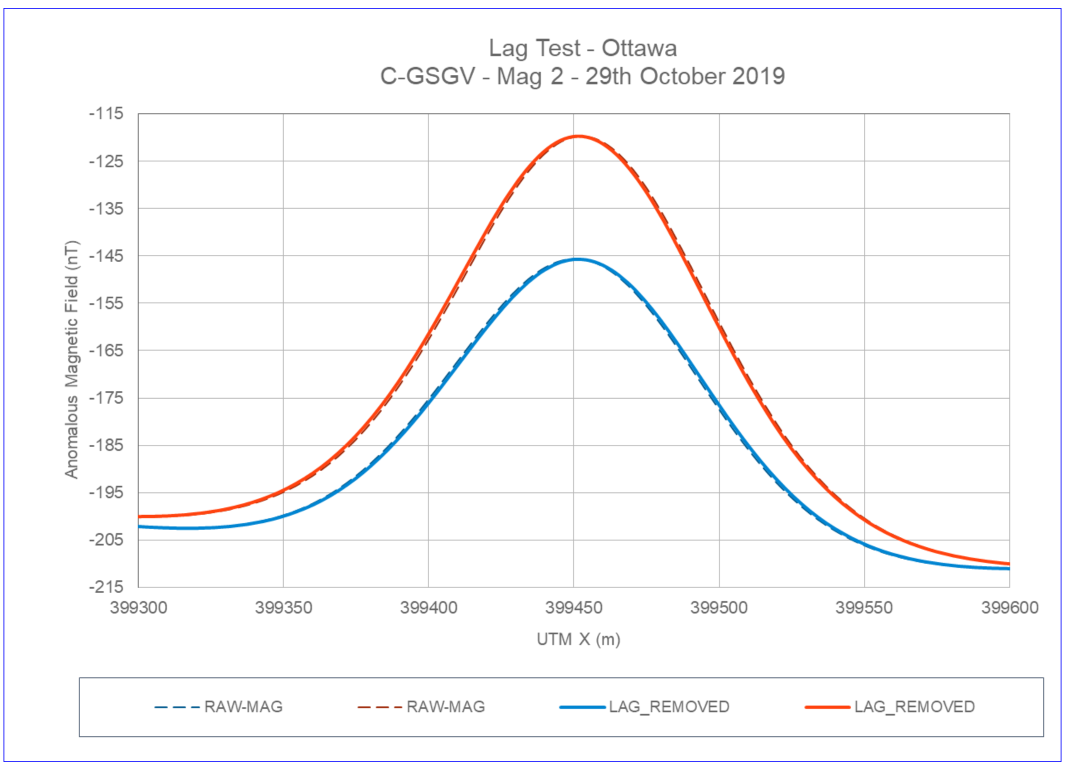

Figure 13. Lag test, Ottawa, C-GSGV, Mag2, October 29, 2019.

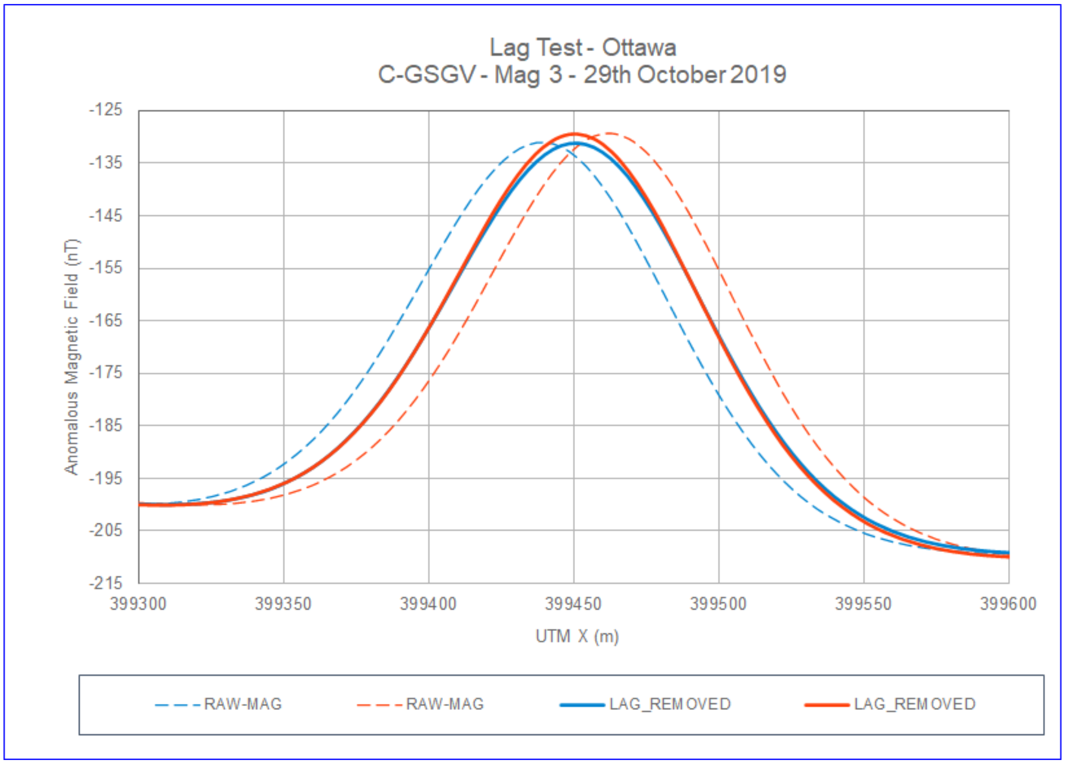

Figure 14. Lag test, Ottawa, C-GSGV, Mag3, October 29, 2019.

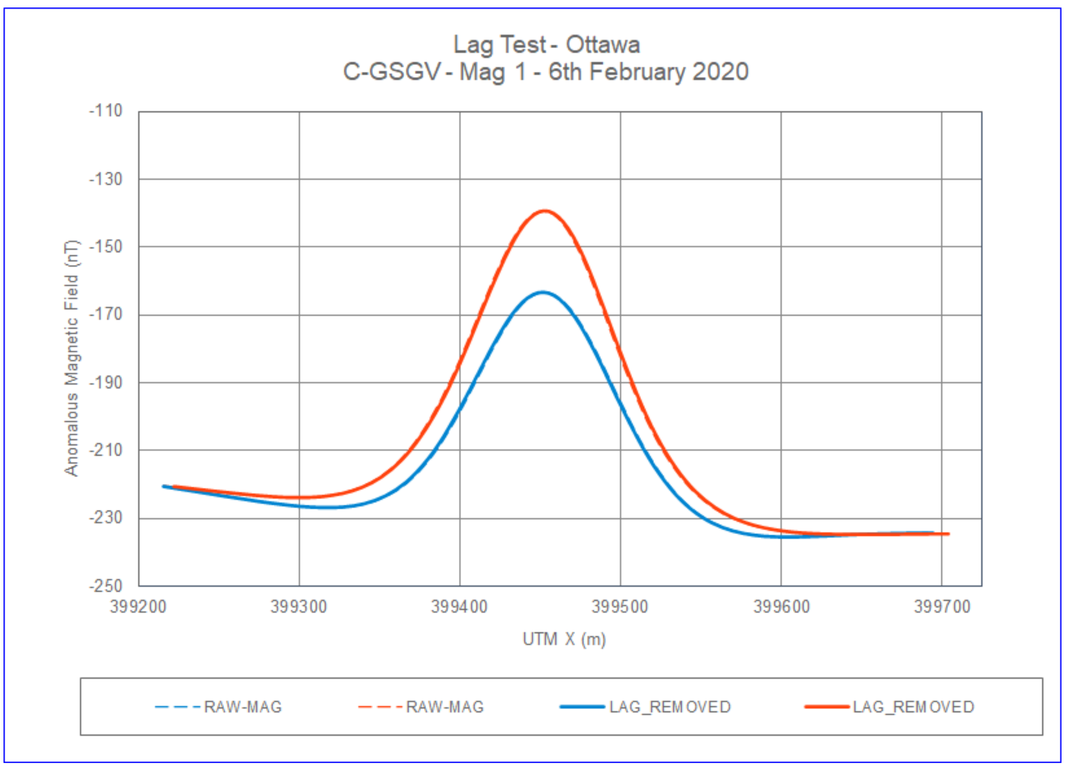

Figure 15. Lag test, Ottawa, C-GSGV, Mag1, February 6, 2020.

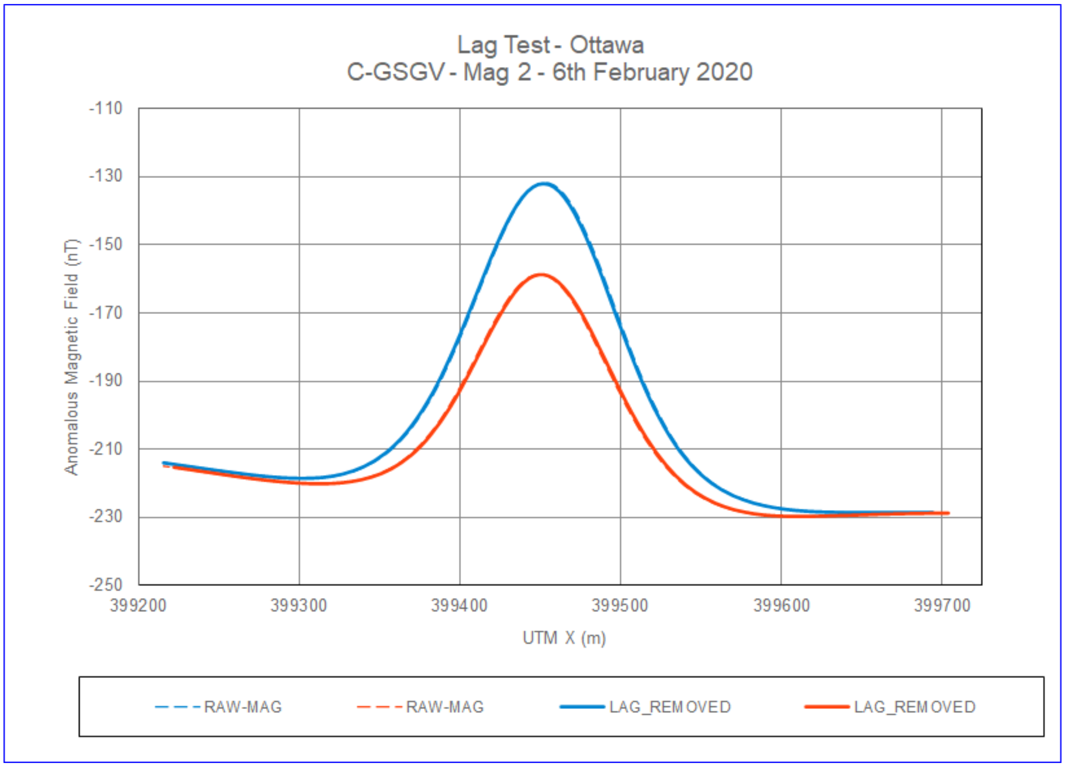

Figure 16. Lag test, Ottawa, C-GSGV, Mag2, February 6, 2020.

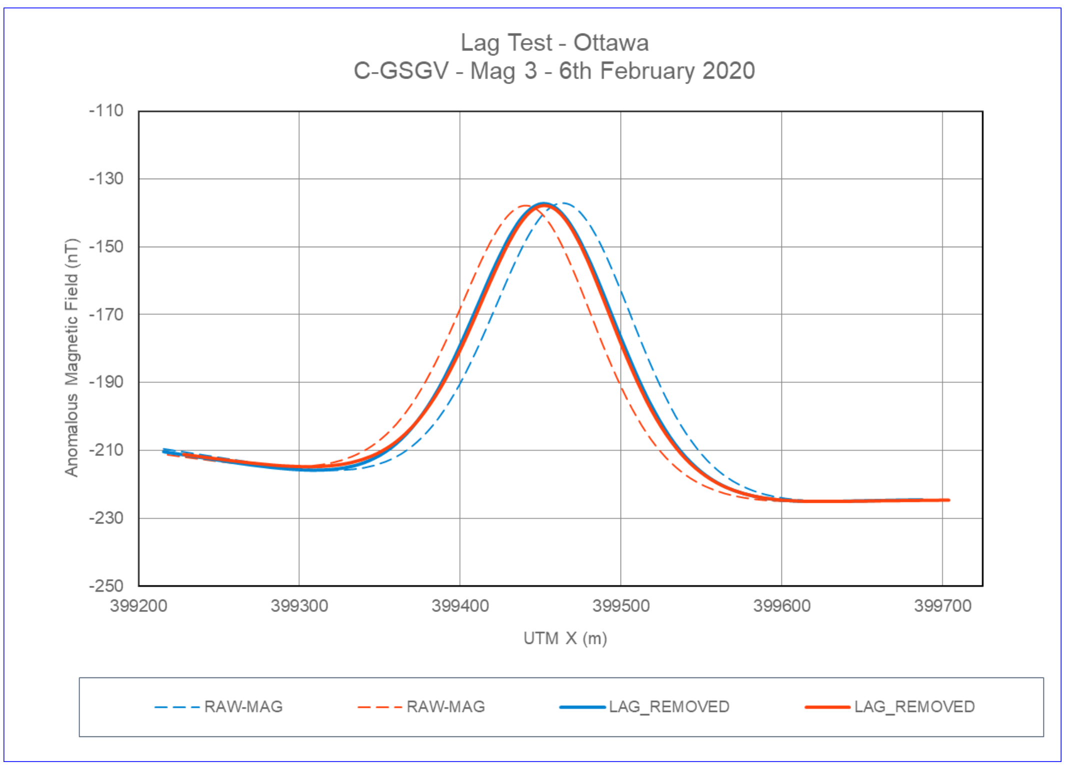

Figure 17. Lag test, Ottawa, C-GSGV, Mag3, February 6, 2020.

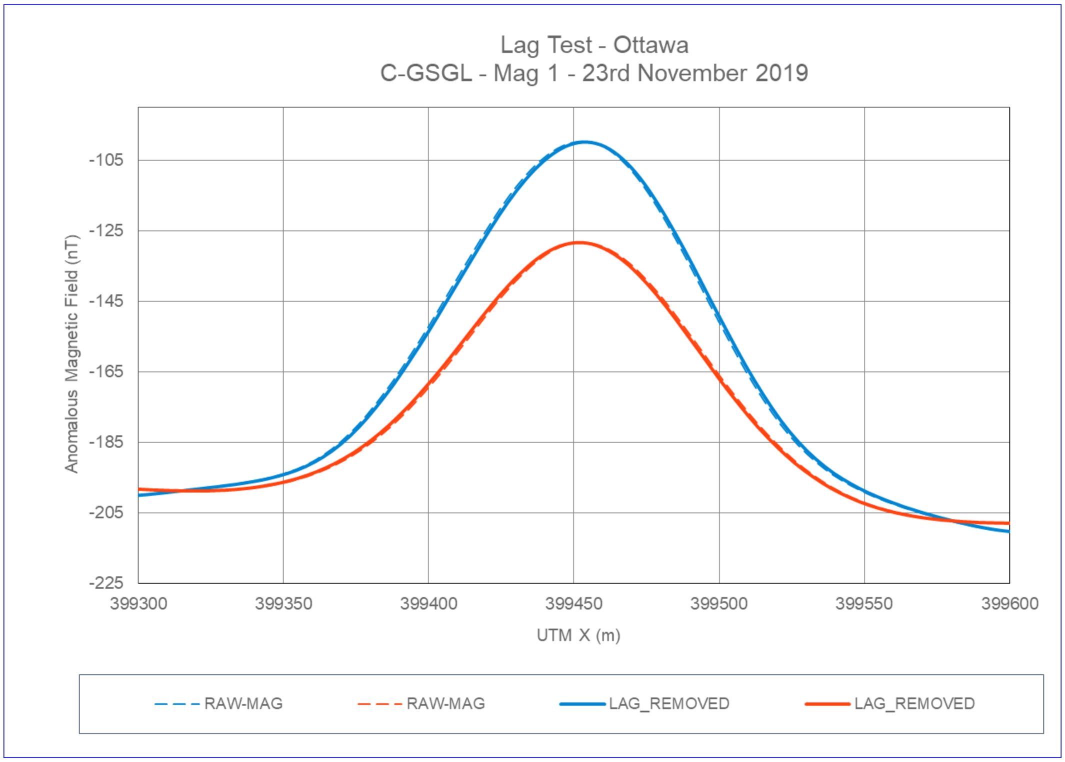

Figure 18. Lag test, Ottawa, C-GSGL, Mag1, November 23, 2019.

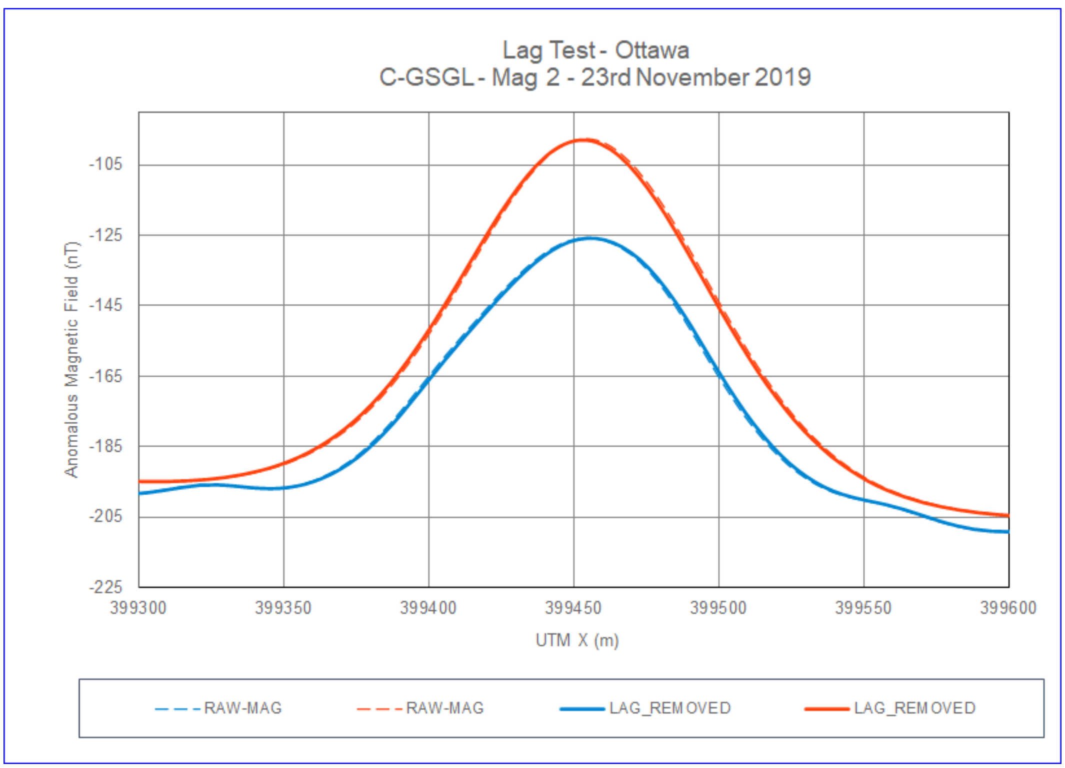

Figure 19. Lag test, Ottawa, C-GSGL, Mag2, November 23, 2019.

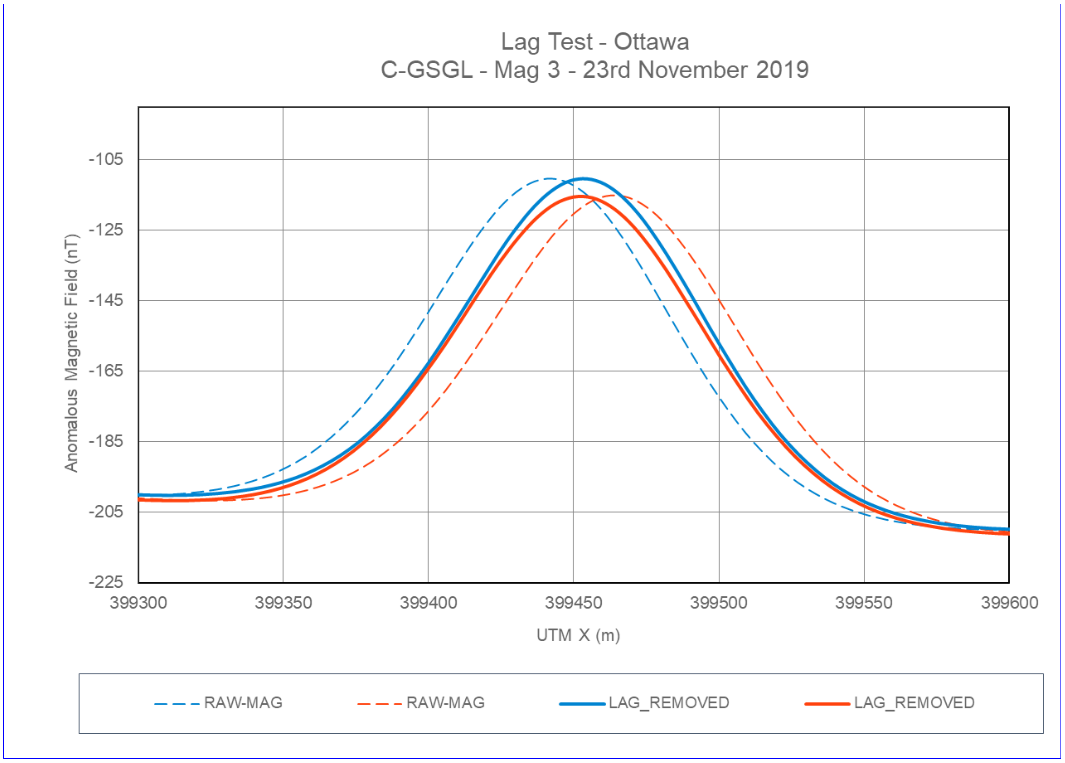

Figure 20. Lag test, Ottawa, C-GSGL, Mag3, November 23, 2019.

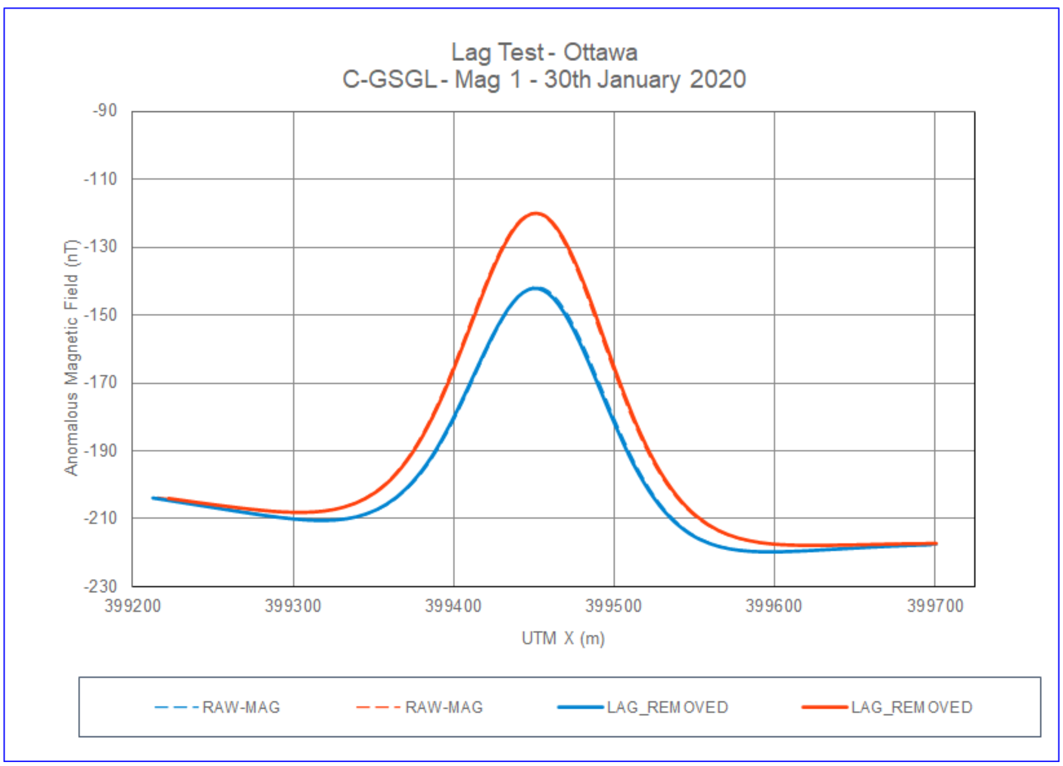

Figure 21. Lag test, Ottawa, C-GSGL, Mag1, January 30, 2020.

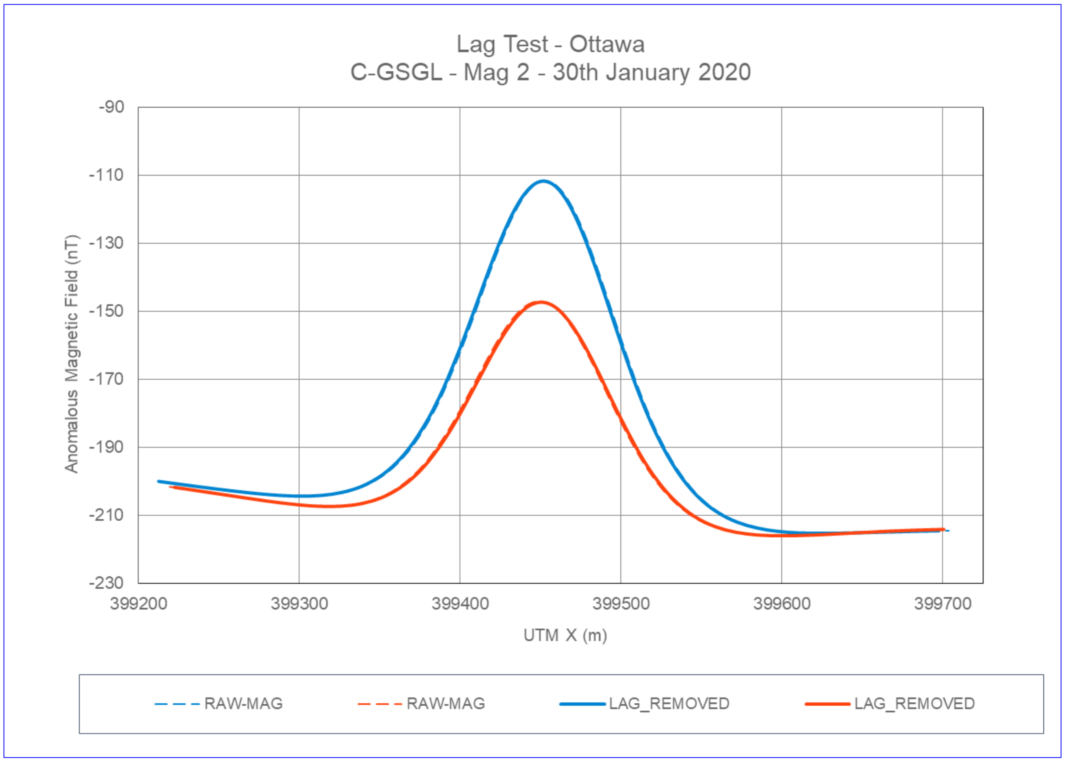

Figure 22. Lag test, Ottawa, C-GSGL, Mag2, January 30, 2020.

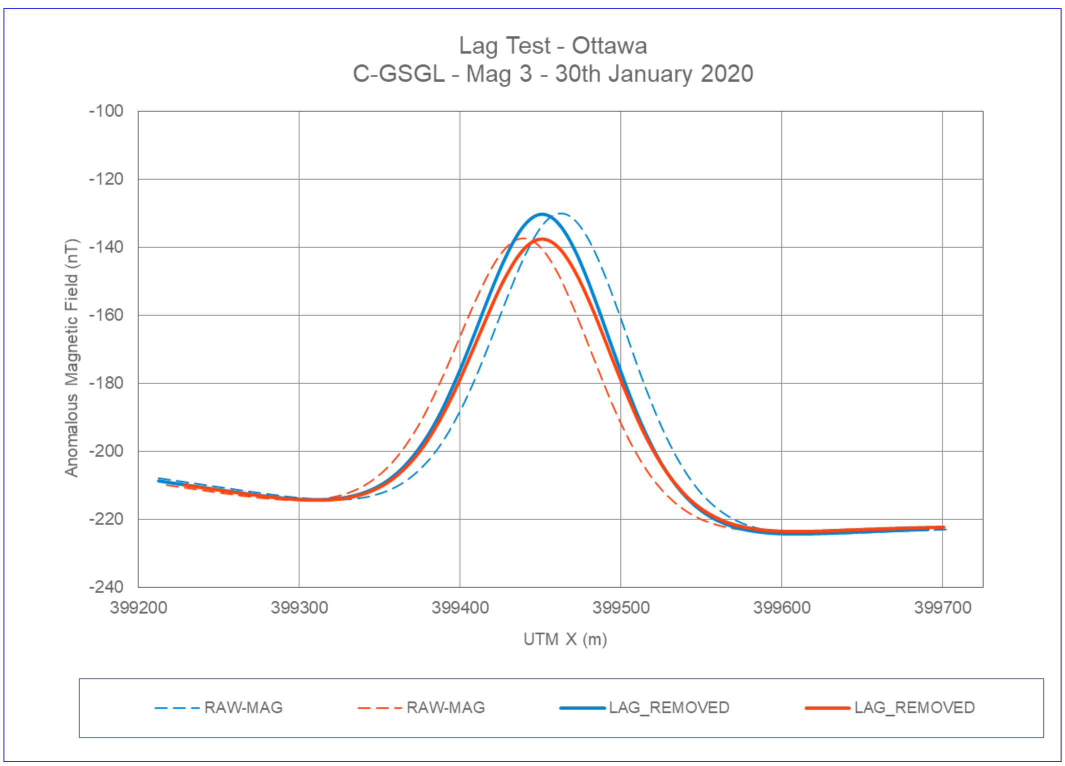

Figure 23. Lag test, Ottawa, C-GSGL, Mag3, January 30, 2020.

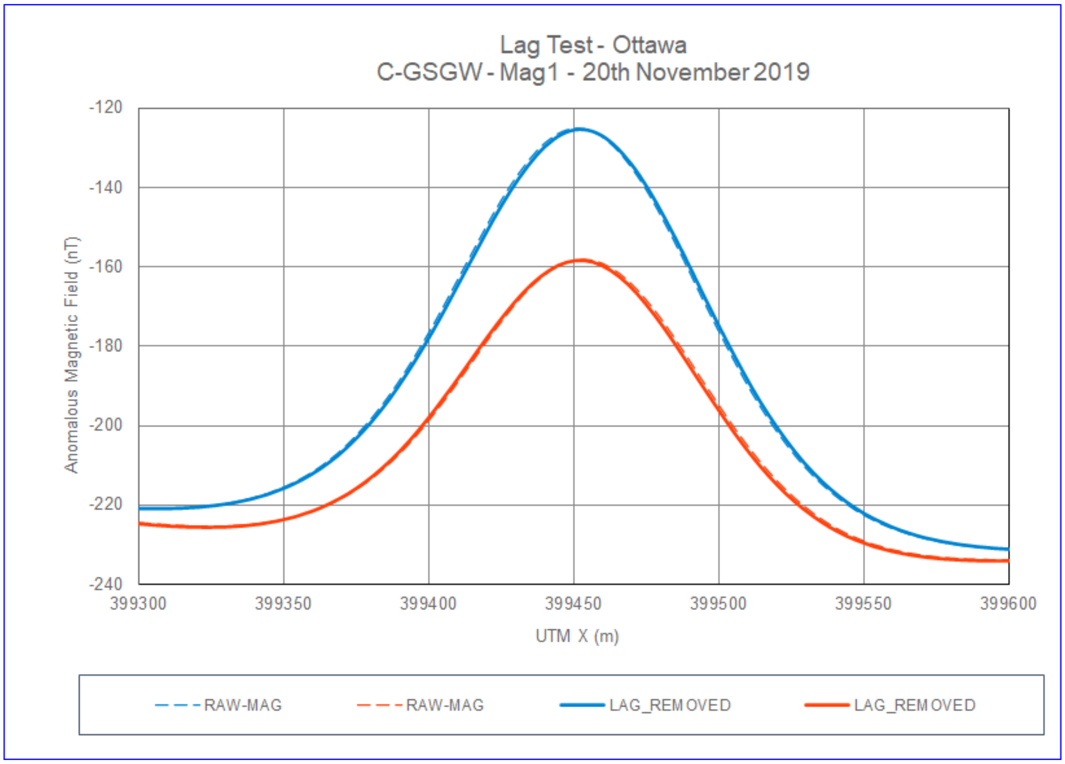

Figure 24. Lag test, Ottawa, C-GSGW, Mag1, November 20, 2019.

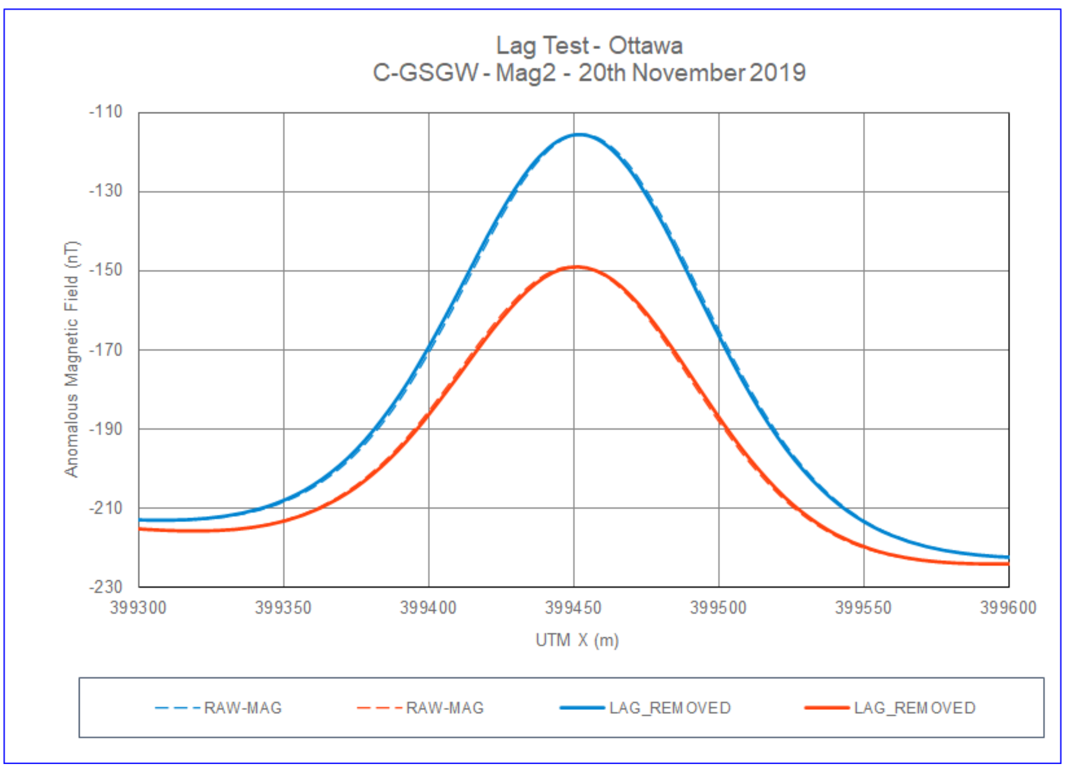

Figure 25. Lag test, Ottawa, C-GSGW, Mag2, November 20, 2019.

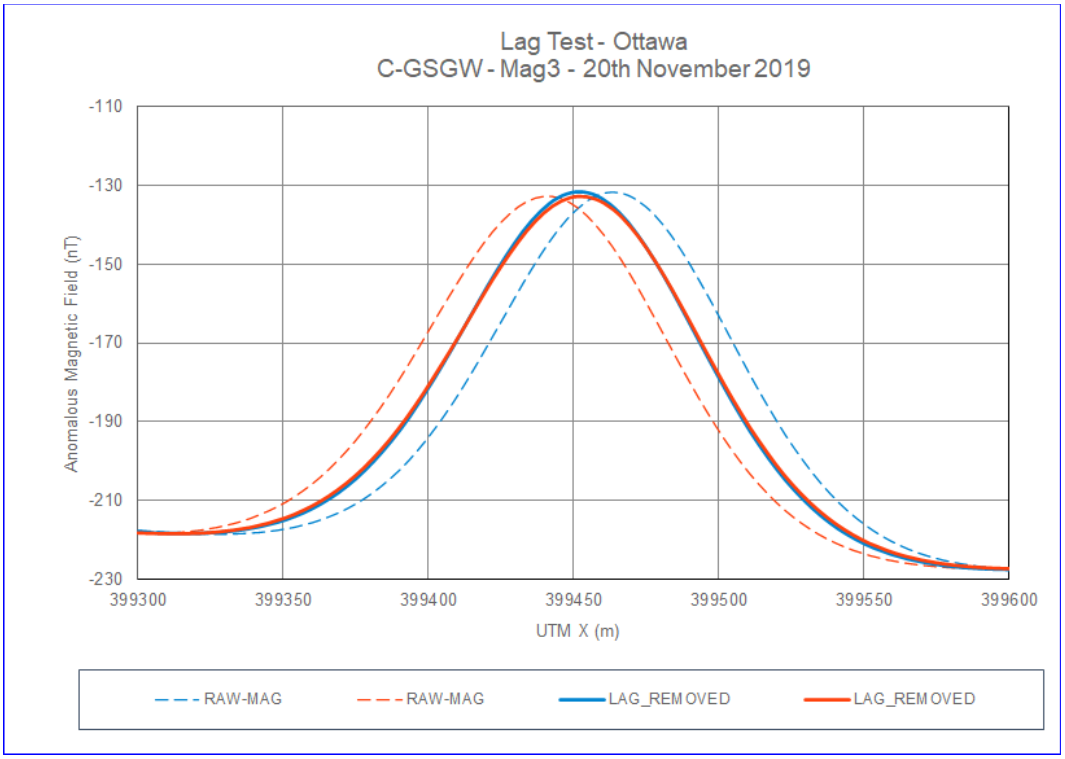

Figure 26. Lag test, Ottawa, C-GSGW, Mag3, November 20, 2019.

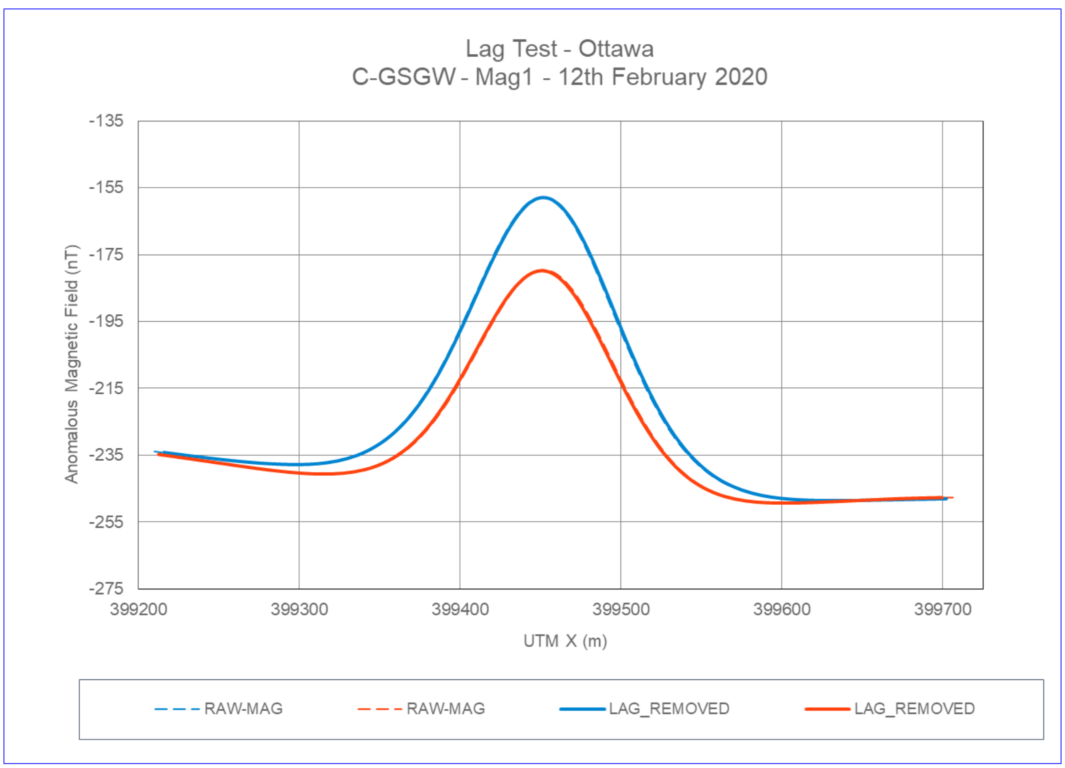

Figure 27. Lag test, Ottawa, C-GSGW, Mag1, February 12, 2020.

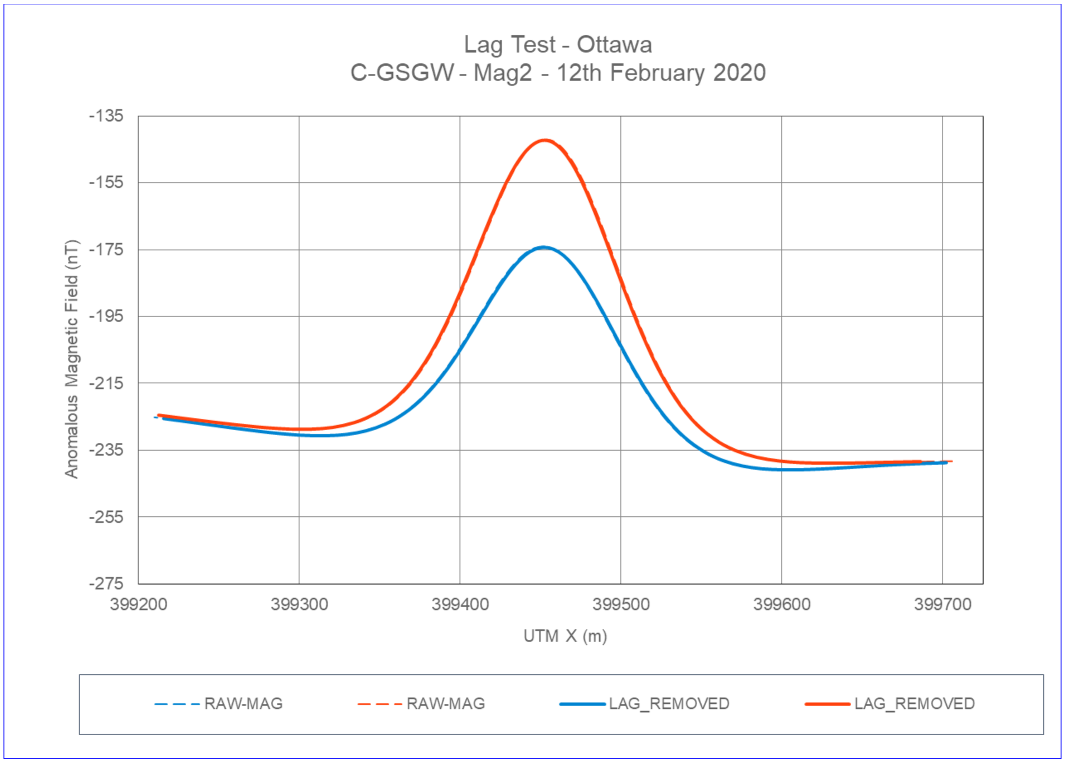

Figure 28. Lag test, Ottawa, C-GSGW, Mag2, February 12, 2020.

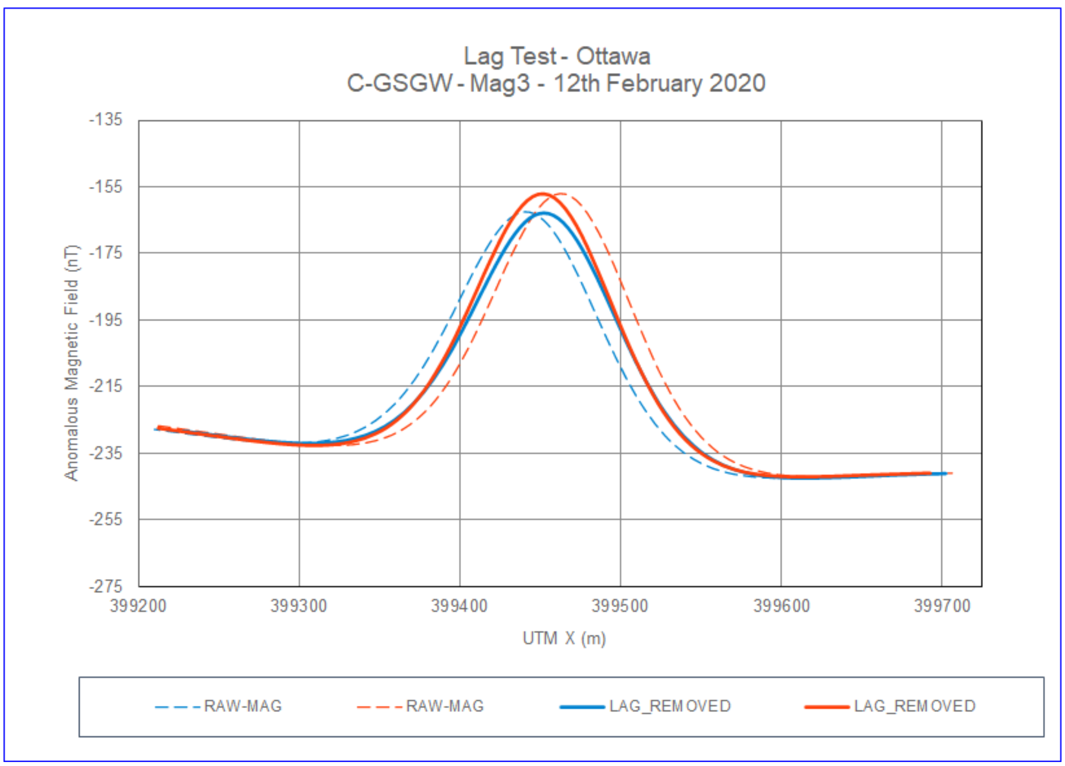

Figure 29. Lag test, Ottawa, C-GSGW, Mag3, February 12, 2020.

Radar and Laser Altimeter Test

Altimeter calibration test flights were performed by all aircraft over the Gatineau Airport runway before deployment and after the survey. The radar tests were flown for C-GSGV on October 29, 2019 and February 6, 2020. The radar tests for C-GSGL were flown on November 28, 2019 and January 31, 2020. The radar tests were flown for C-GSGW on November 20, 2019 and February 12, 2020.

Results of the altimeter tests performed for this survey are provided below. For this test, the survey aircraft flies at pre-established altitudes over an airport runway or a very flat area, so that the corresponding readings of the altimeters can be checked. The aircraft is flown over the runway, once, in either direction at the following heights above ground level: 50 m, 150 m, 250 m, 350 m and 450 m.

Four types of altimeter are tested: Thomson-CSF ERT 530A radar (“TRT” installed in survey aircraft C-GSGL and C-GSGW), Bendix/King® KRA-10A radar (“King” installed in survey aircraft C-GSGV and C-GSGL), GRA™ 55 - Garmin radar (GRA 55 installed in survey aircraft C-GSGW), and Riegl® LD90-31K-HiP (“laser” in all 3 survey aircraft). Calibration coefficients as derived from the altimeter test are applied to all the observed altimeter data. The altimeter test is considered successful if the adjusted data for all passes over the test range fall within accepted accuracy limitations of the altimeter plus an allowance for 0.5 m error in final GPS altitude.

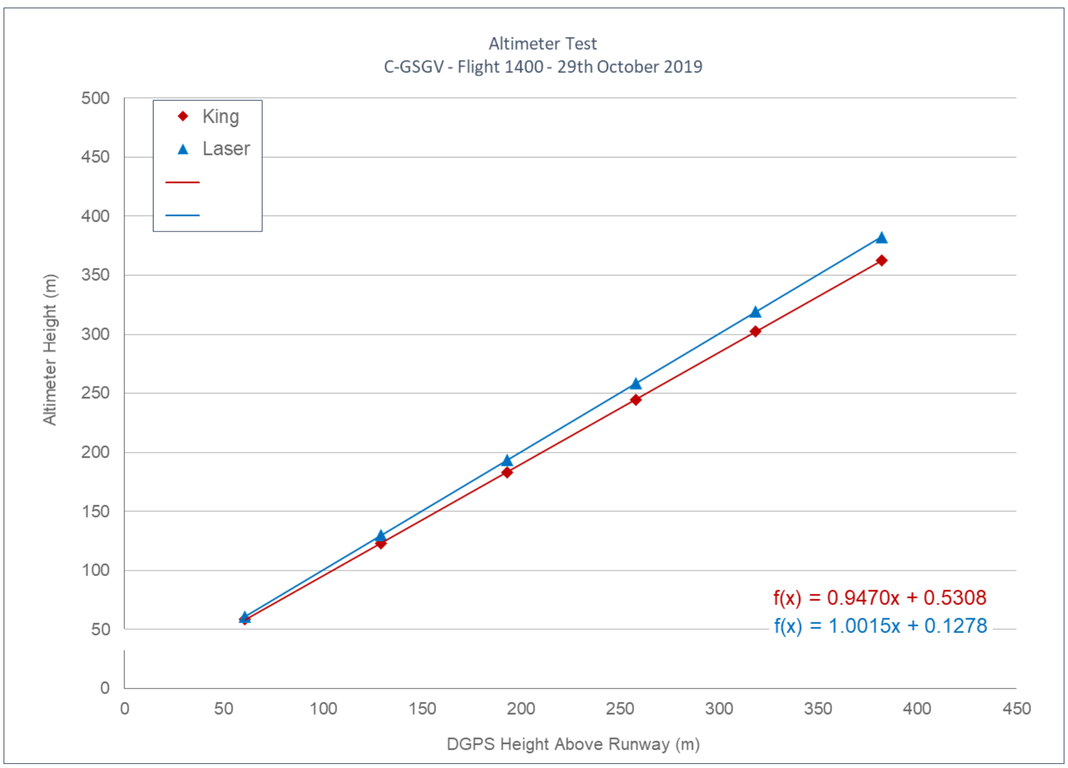

Figure 30. Altimeter test, C-GSGV, flight 1400, October 29, 2019.

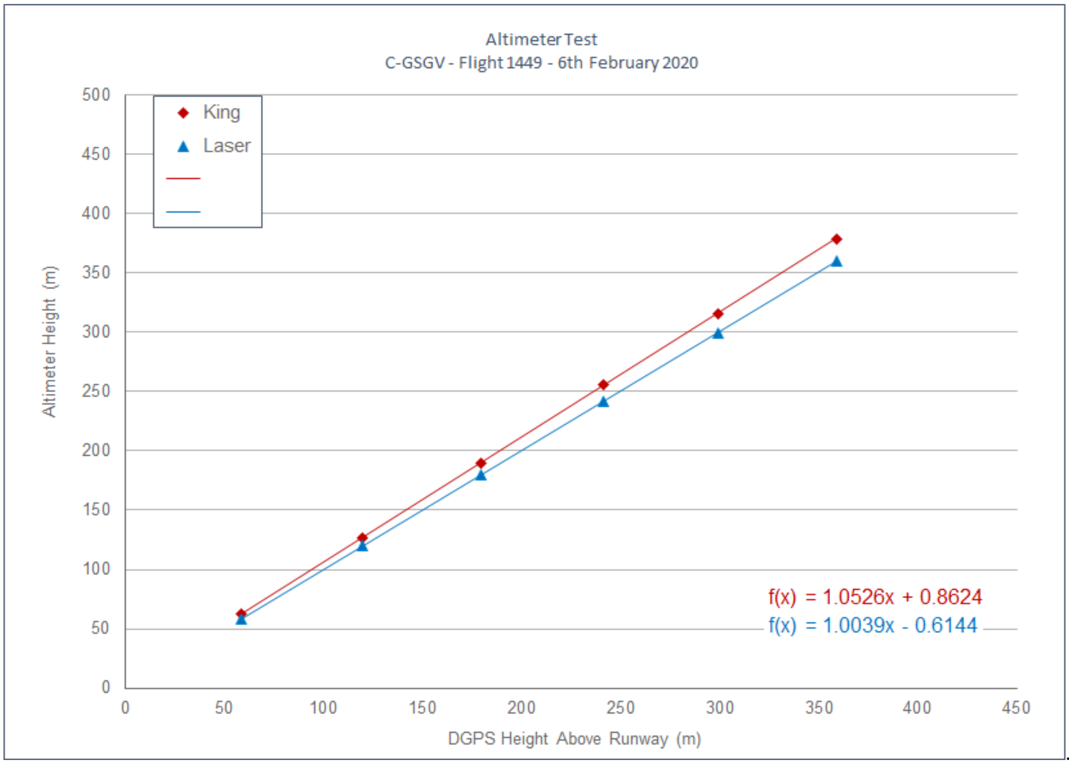

Figure 31. Altimeter test, C-GSGV, flight 1449, February 6, 2020.

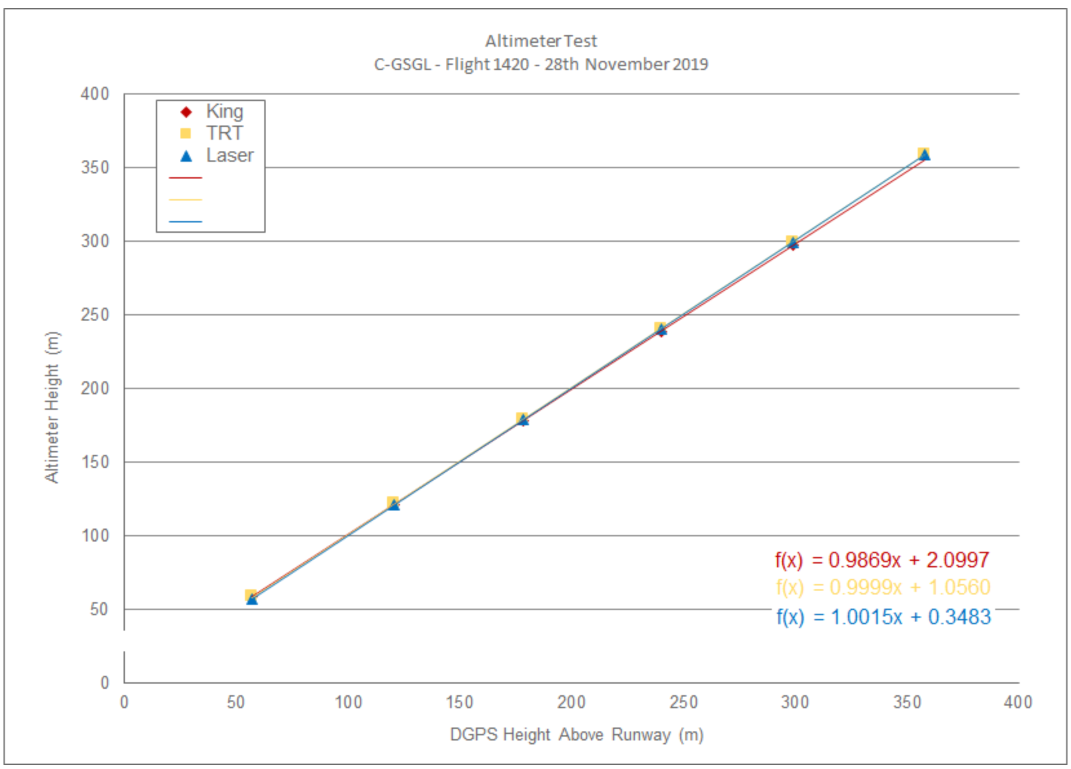

Figure 32. Altimeter test, C-GSGL, flight 1420, November 28, 2019.

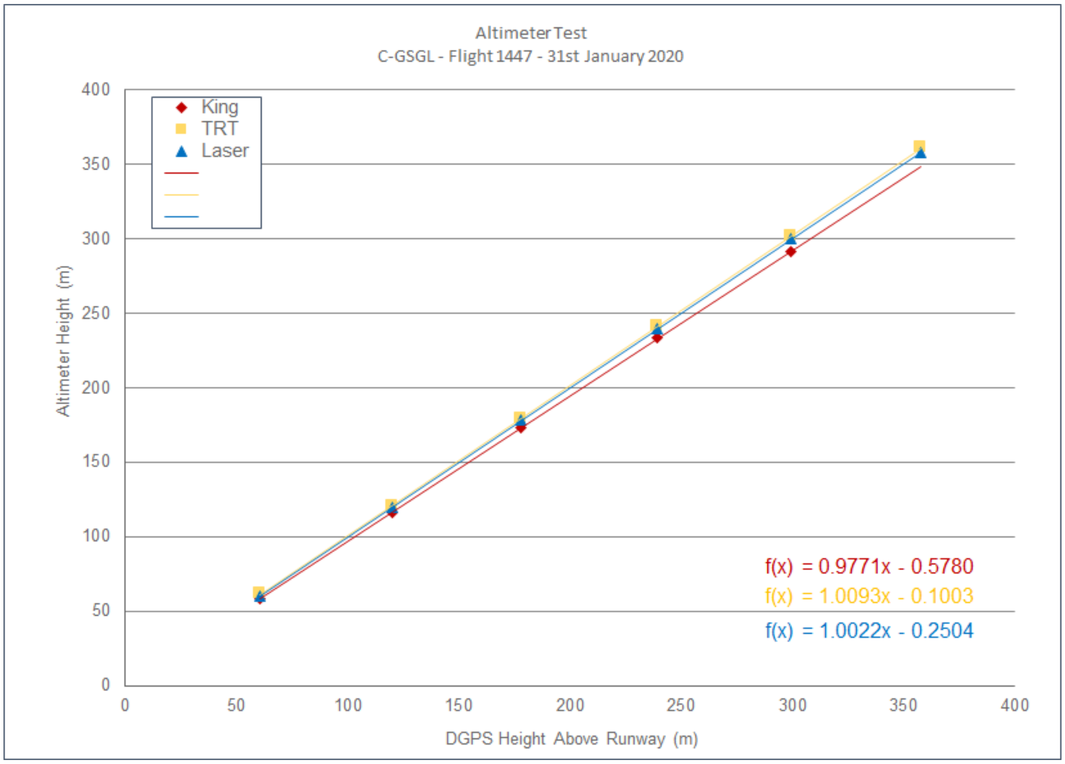

Figure 33. Altimeter test, C-GSGL, flight 1447, January 31, 2020.

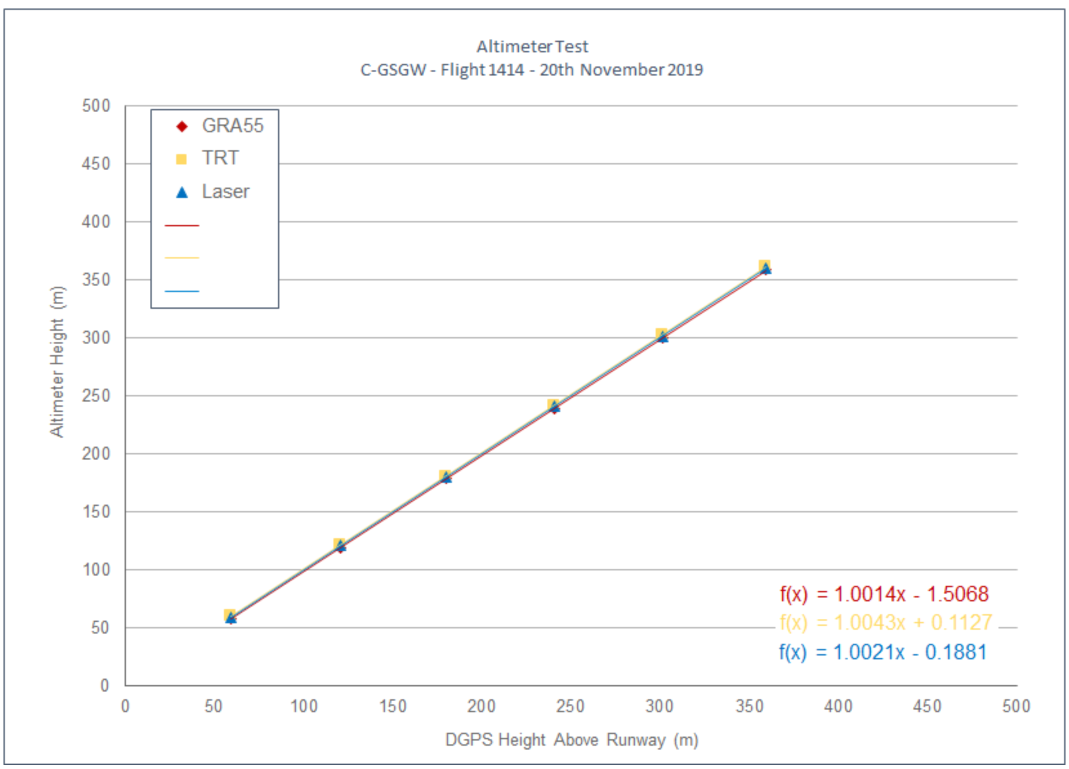

Figure 34. Altimeter test, C-GSGW, flight 1414, November 20, 2019.

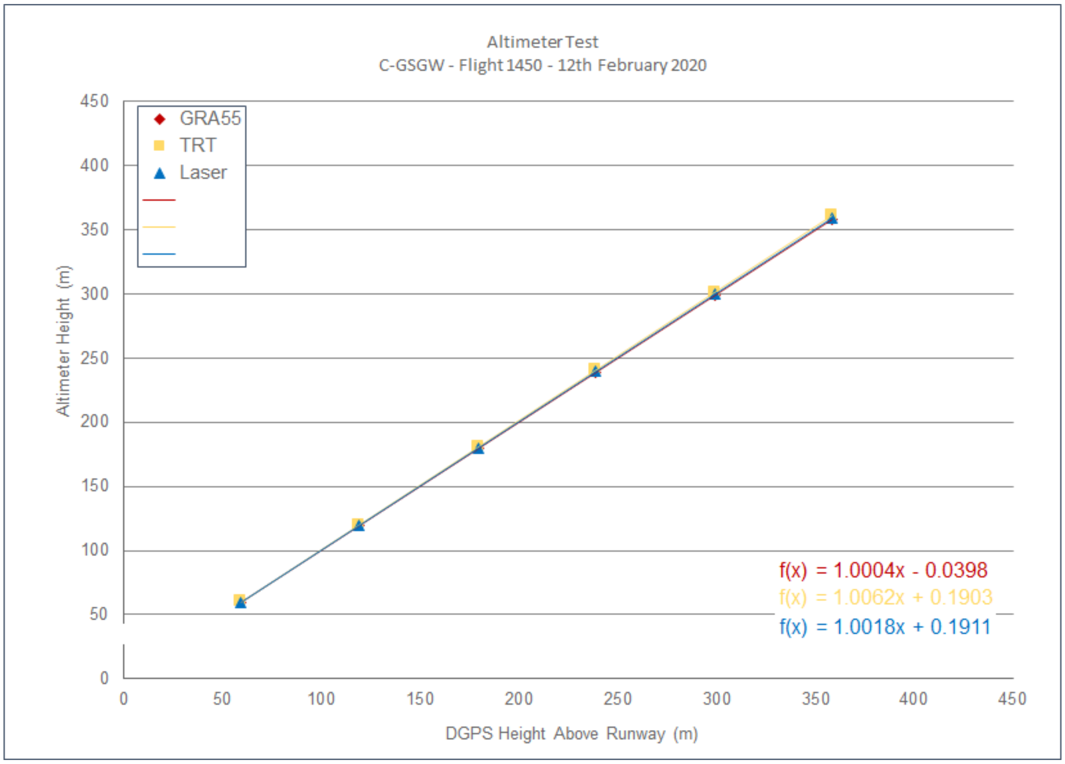

Figure 35. Altimeter test, C-GSGW, flight 1450, February 12, 2020.

MAGNETOMETER FIGURE OF MERIT TEST

The compensation calibration determines the magnetic influence of aircraft manoeuvres and the effectiveness of the compensation. The aircraft flies a square pattern in the 4 survey directions at a high altitude over a magnetically quiet area and performs 3 pitches, 3 rolls and 3 yaws. The total compensated signal resulting from the 12 manoeuvres is referred to as the Figure of Merit ("FOM").

The magnetic compensation tests were flown prior to and after data acquisition near Ottawa. If a magnetometer was replaced during the survey, the compensation test for the new sensor was performed in Sudbury during the survey. This was necessary for the #3 sensor of survey aircraft C-GSGV and for the #2 sensor of survey aircraft C-GSGW. Compensation tests are deemed acceptable if the FOM is less than 1.5 nT. Compensation calibration flights were performed by both aircraft before and after the survey at high altitude (roughly 10 000 feet) in the Ottawa area. Separate compensation calibration coefficients are obtained for each magnetometer: #1 on the port wingtip, #2 on the starboard wingtip and #3 in the tail. Test results are illustrated below and summarized in Table 4.

Table 4. Figures of Merit ("FOM") for the 3 survey aircraft.

Aircraft	Date	Location	Magnetometer	FOM (nT)
C-GSGV	October 29, 2019	Ottawa	Port #1	0.54
			Starboard #2	0.66
			Tail #3	0.40
	January 13, 2020	Sudbury	Port #1	-
			Starboard #2	-
			Tail #3	0.59
	February 6, 2020	Ottawa	Port #1	0.54
			Starboard #2	0.66
			Tail #3	0.49
C-GSGL	November 26, 2019	Ottawa	Port #1	0.53
			Starboard #2	0.52
			Tail #3	0.48
	January 30, 2020	Ottawa	Port #1	0.50
			Starboard #2	0.55
			Tail #3	0.47
C-GSGW	November 19, 2019	Ottawa	Port #1	0.52
			Starboard #2	0.60
			Tail #3	0.44
	January 8, 2020	Sudbury	Port #1	-
			Starboard #2	0.41
			Tail #3	-
	February 12, 2020	Ottawa	Port #1	0.51
			Starboard #2	0.59
			Tail #3	0.39

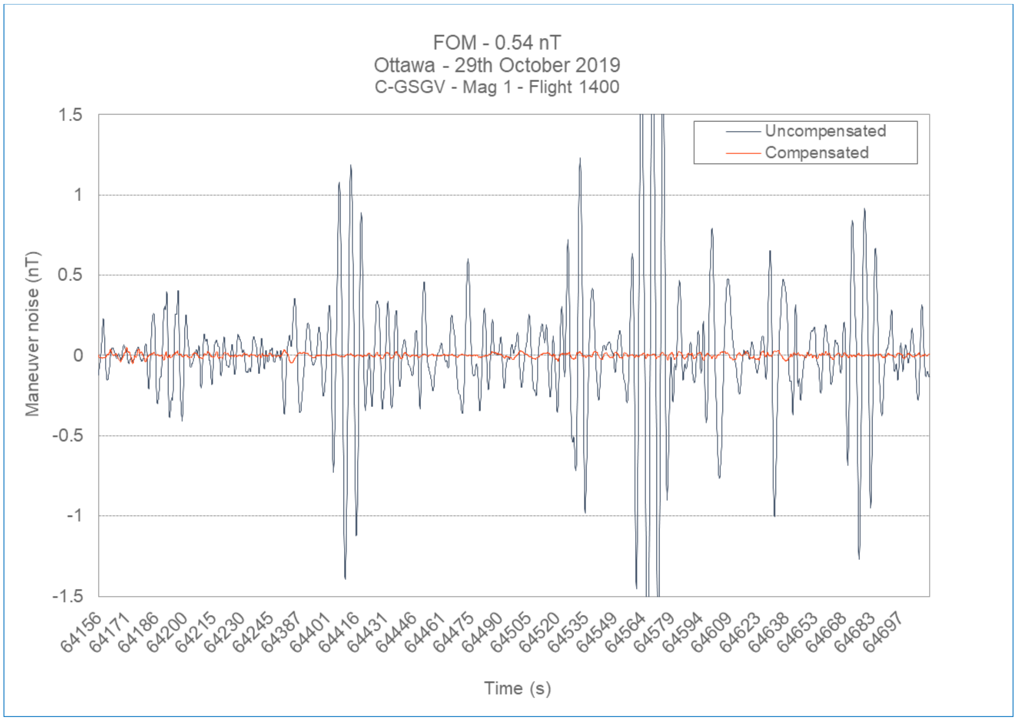

Figure 36. Figure of Merit (FOM) = 0.54 nT, Ottawa, October 29, 2019, C-GSGV, Mag1, flight 1400.

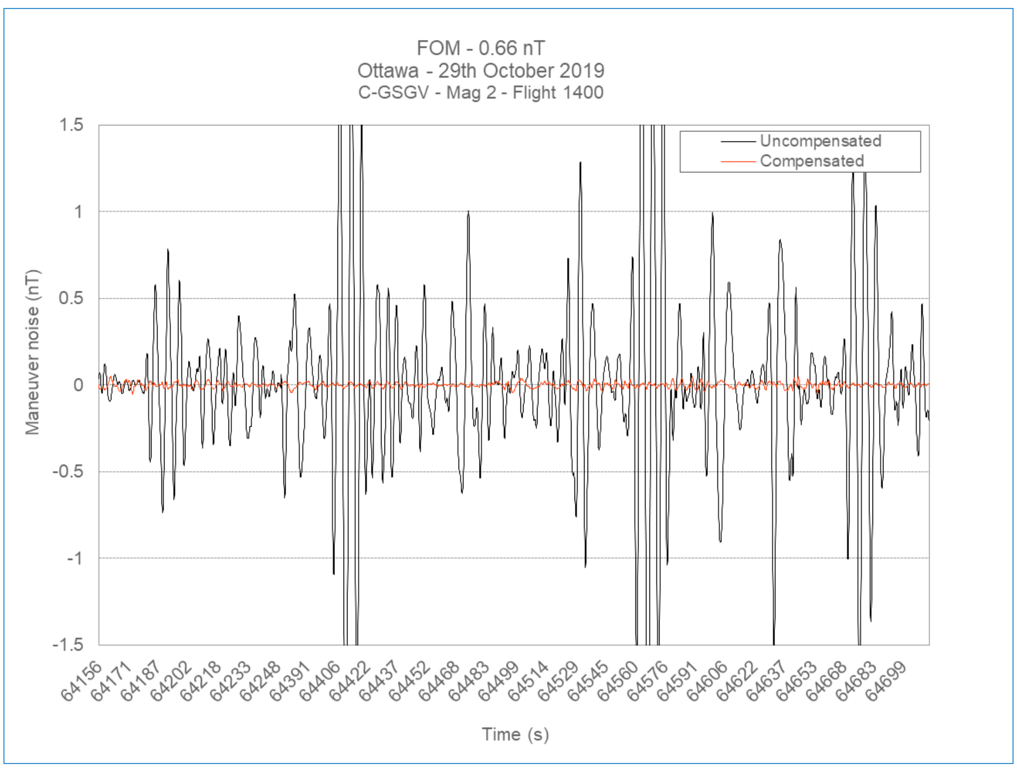

Figure 37. Figure of Merit (FOM) = 0.66 nT, Ottawa, October 29, 2019, C-GSGV, Mag2, flight 1400.

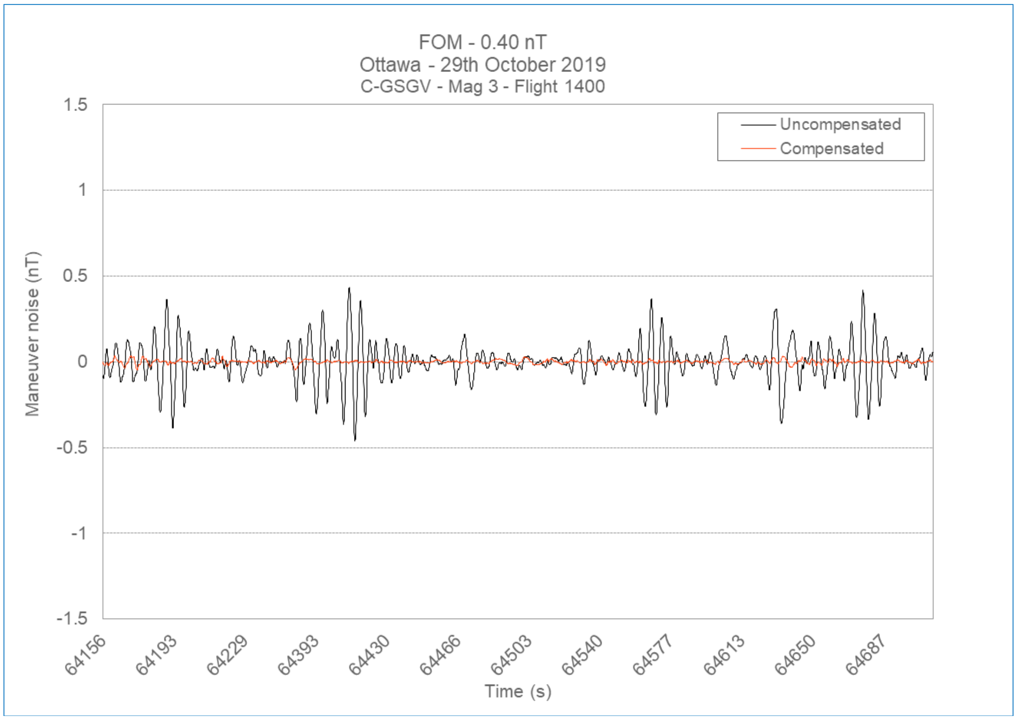

Figure 38. Figure of Merit (FOM) = 0.40 nT, Ottawa, November 26, 2019, C-GSGV, Mag3, flight 1400.

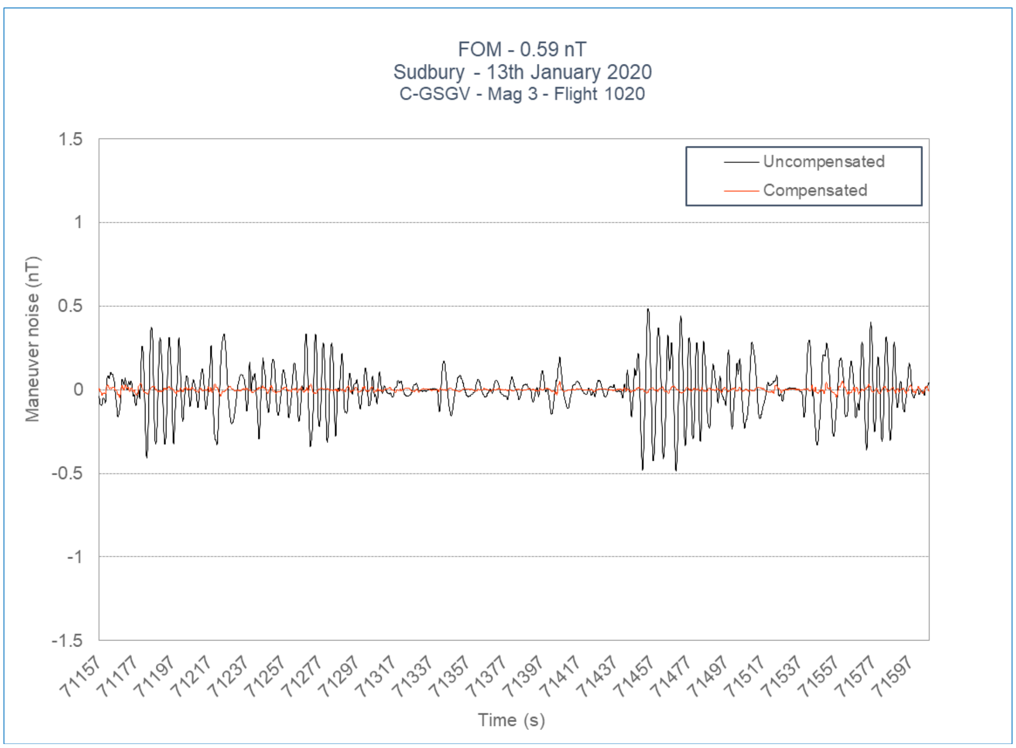

Figure 39. Figure of Merit (FOM) = 0.59 nT, Sudbury, January 13, 2020, C-GSGV, Mag3, flight 1020.

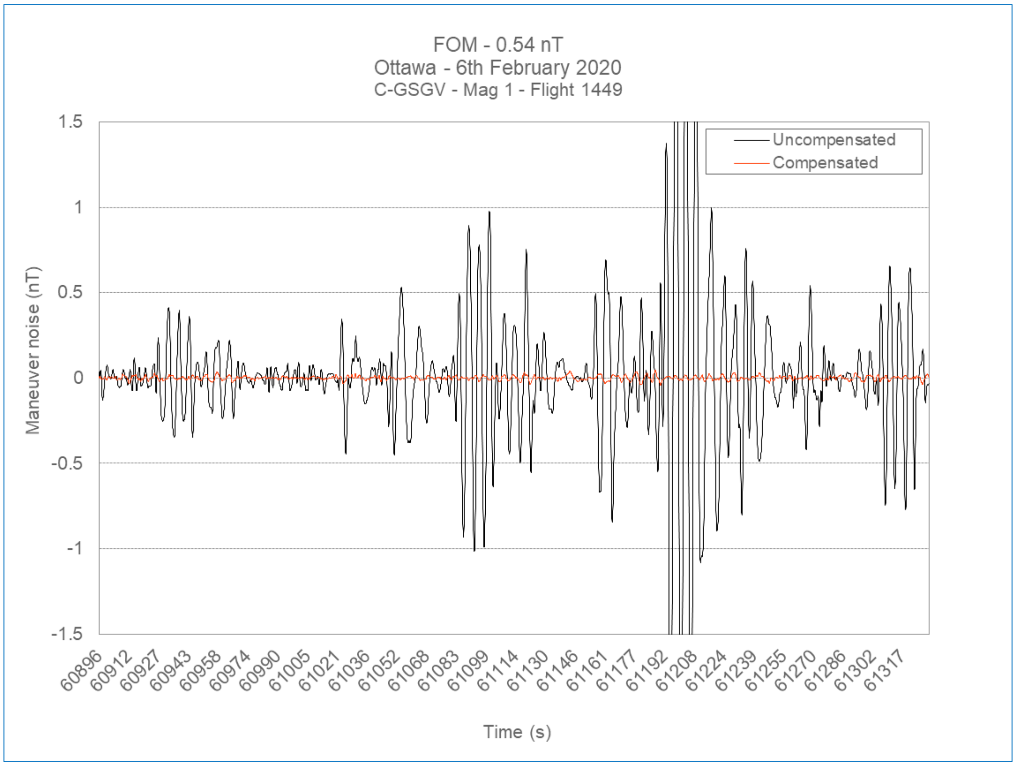

Figure 40. Figure of Merit (FOM) = 0.54 nT, Ottawa, February 6, 2020, C-GSGV, Mag1, flight 1449.

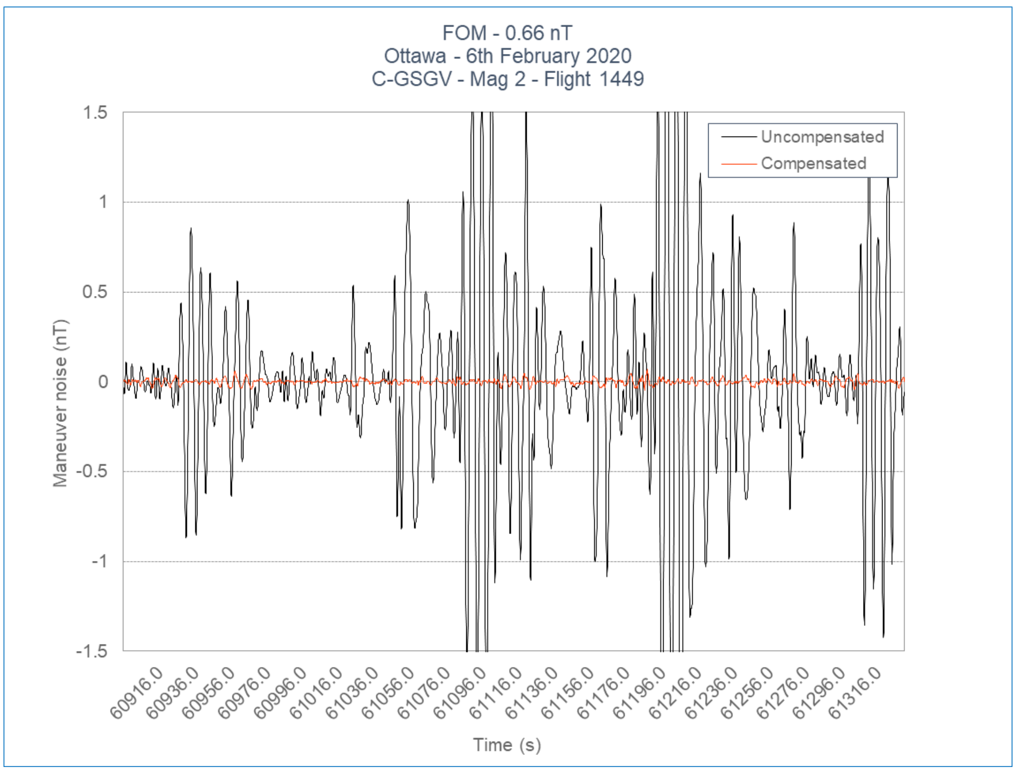

Figure 41. Figure of Merit (FOM) = 0.66 nT, Ottawa, February 6, 2020, C-GSGV, Mag2, flight 1449.

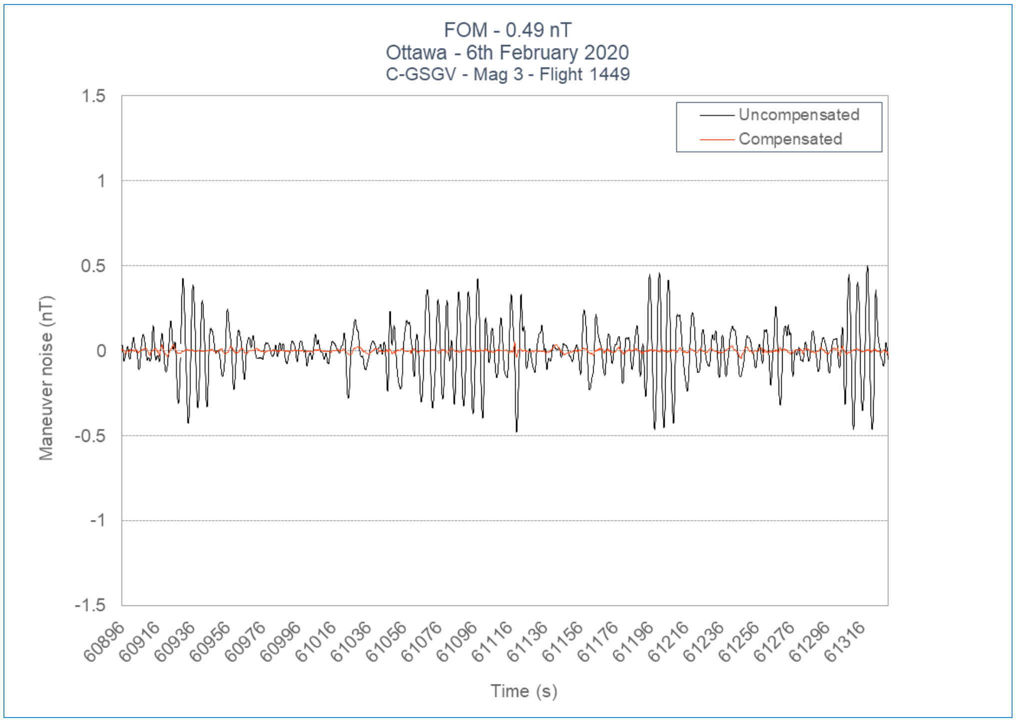

Figure 42. Figure of Merit (FOM) = 0.49 nT, Ottawa, February 6, 2020, C-GSGV, Mag3, flight 1449.

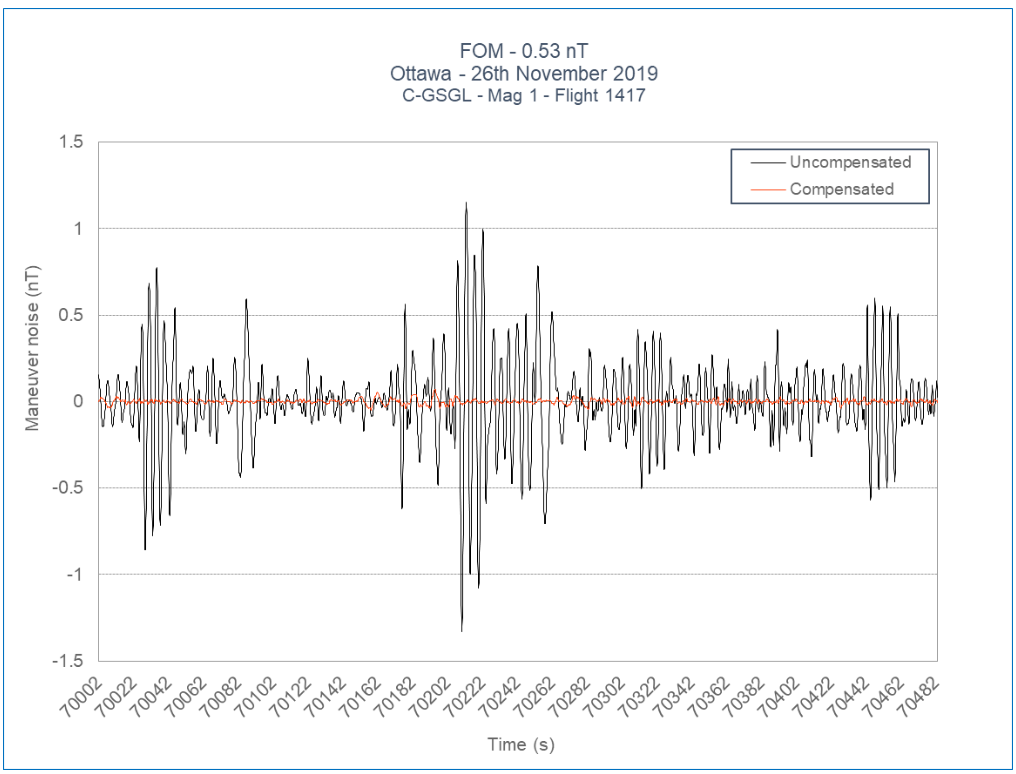

Figure 43. Figure of Merit (FOM) = 0.53 nT, Ottawa, November 26, 2019, C-GSGL, Mag1, flight 1417.

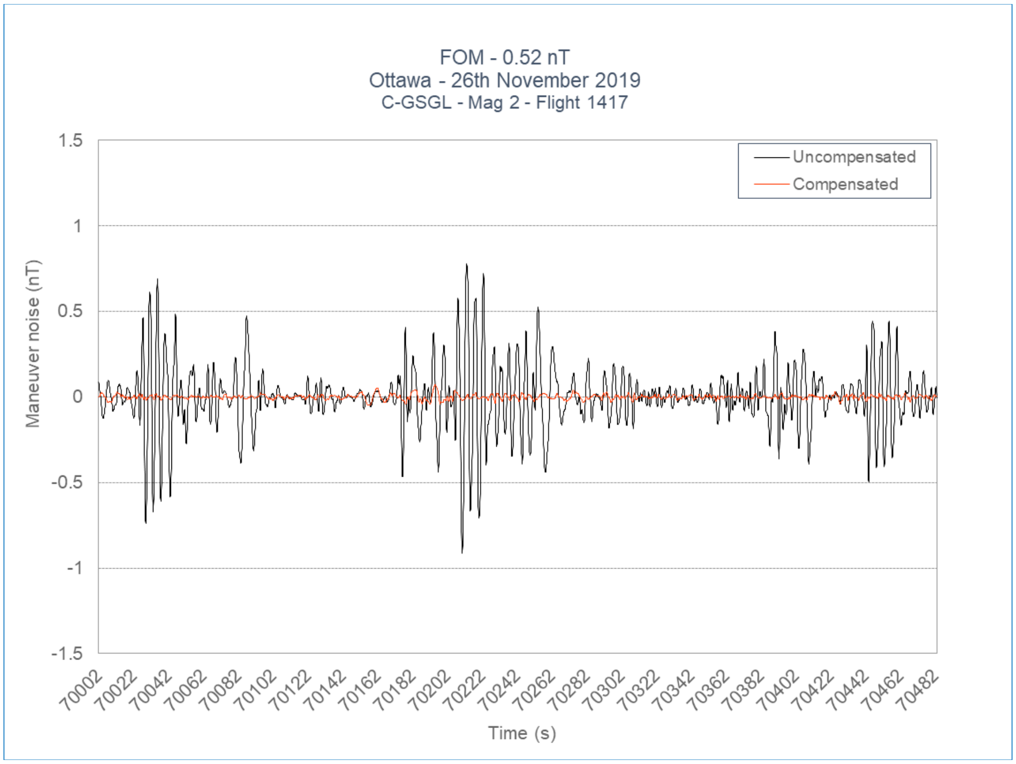

Figure 44. Figure of Merit (FOM) = 0.52 nT, Ottawa, November 26, 2019, C-GSGL, Mag2, flight 1417.

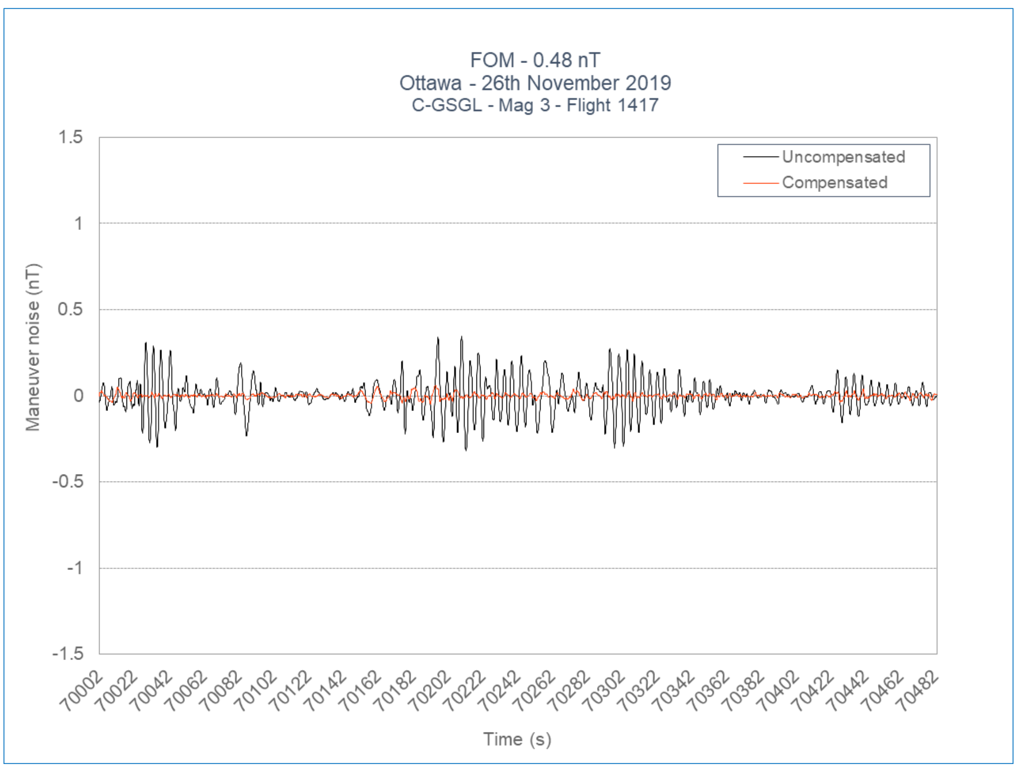

Figure 45. Figure of Merit (FOM) = 0.48 nT, Ottawa, November 26, 2019, C-GSGL, Mag3, flight 1417.

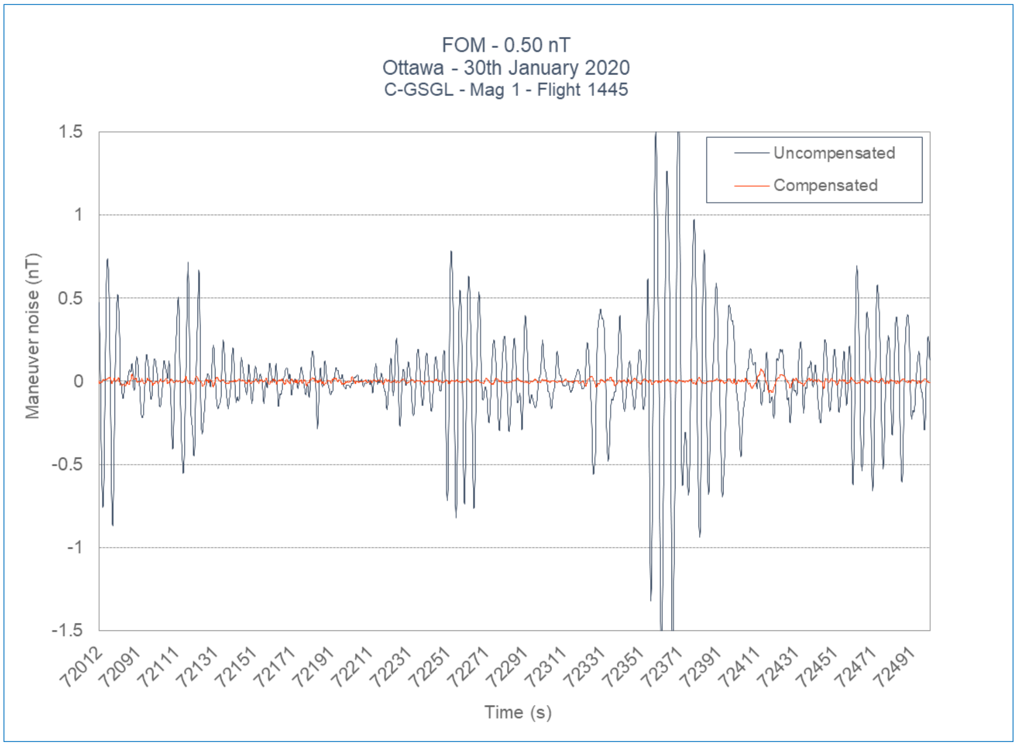

Figure 46. Figure of Merit (FOM) = 0.50 nT, Ottawa, January 30, 2020, C-GSGL, Mag1, flight 1445.

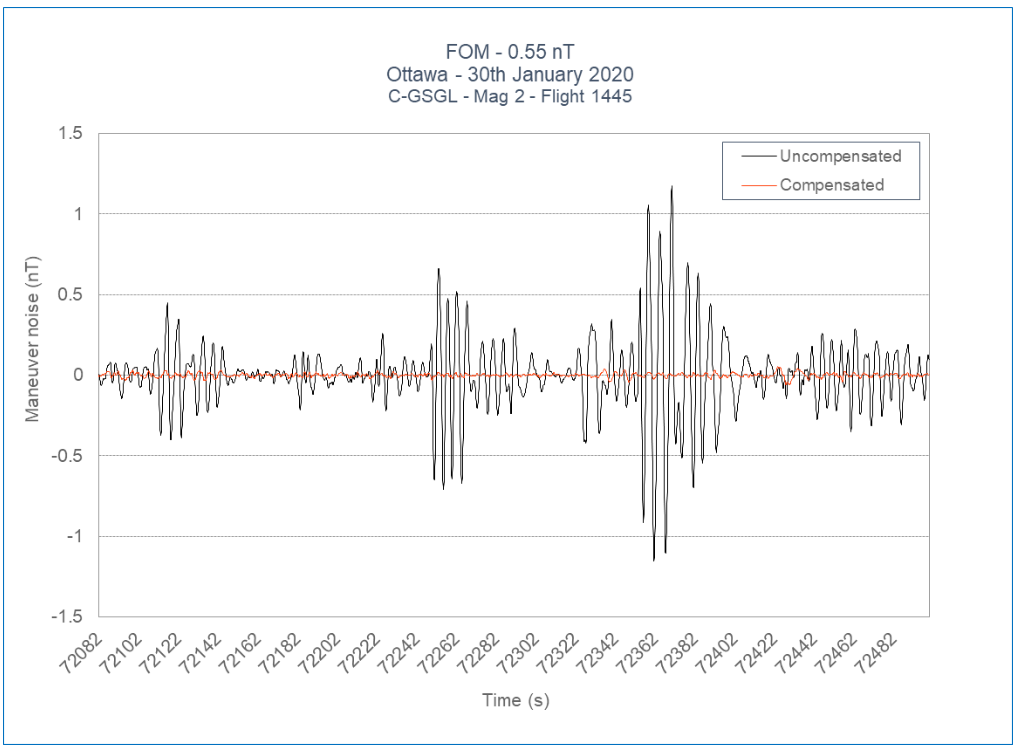

Figure 47. Figure of Merit (FOM) = 0.55 nT, Ottawa, January 30, 2020, C-GSGL, Mag2, flight 1445.

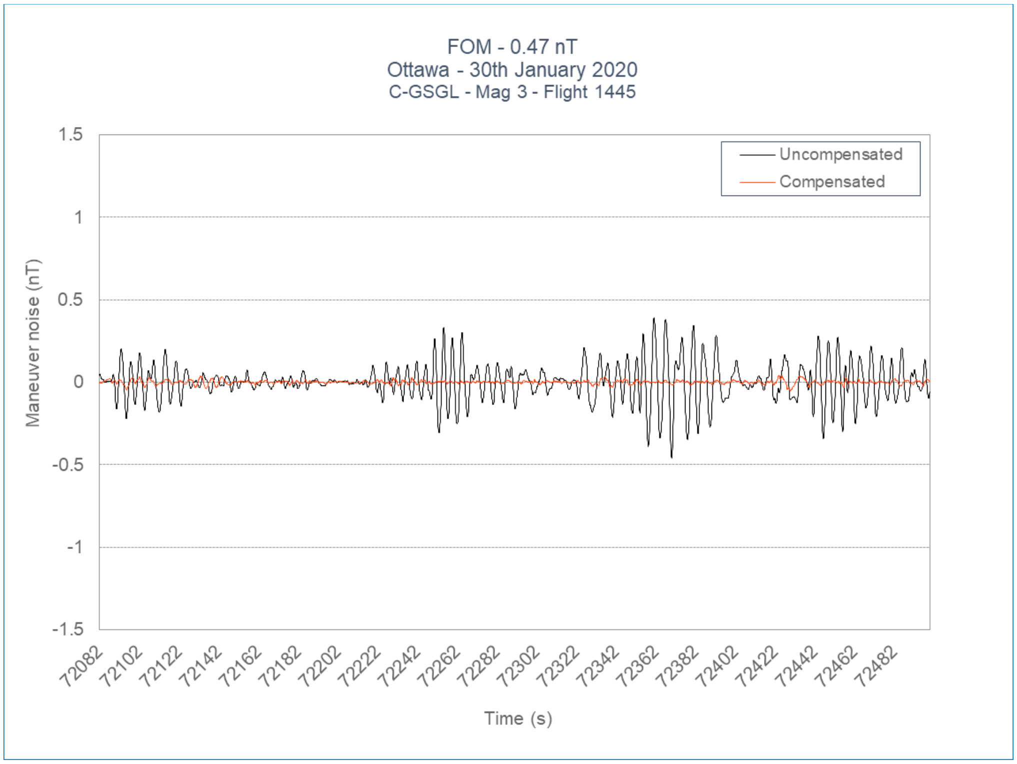

Figure 48. Figure of Merit (FOM) = 0.47 nT, Ottawa, January 30, 2020, C-GSGL, Mag3, flight 1445.

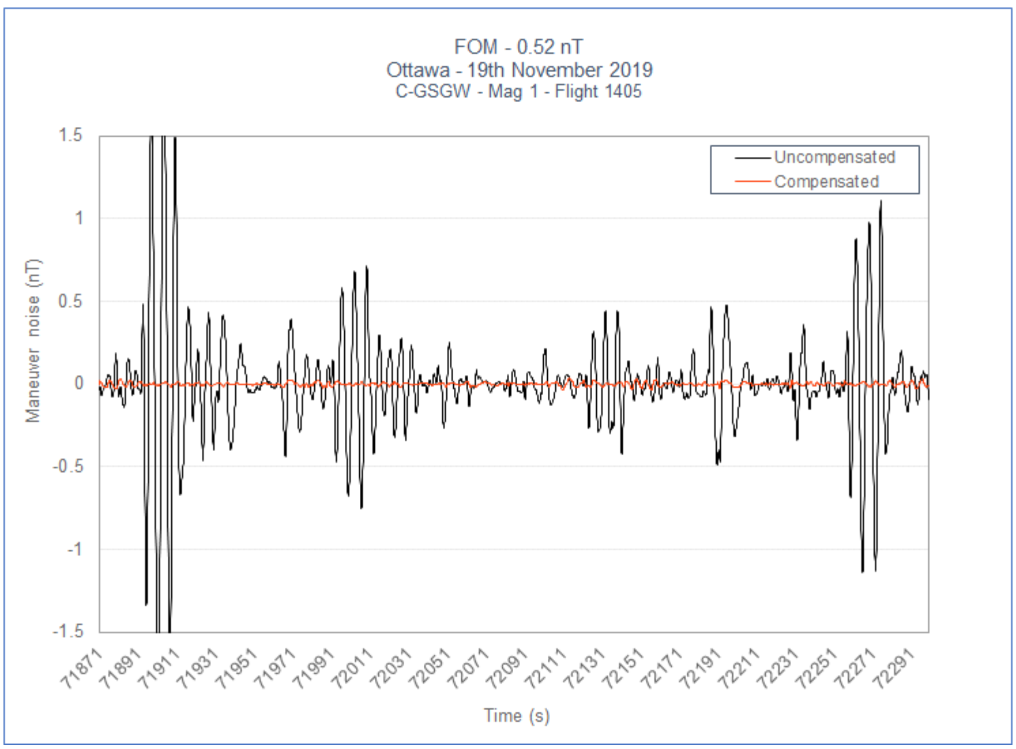

Figure 49. Figure of Merit (FOM) = 0.52 nT, Ottawa, November 19, 2019, C-GSGW, Mag1, flight 1405.

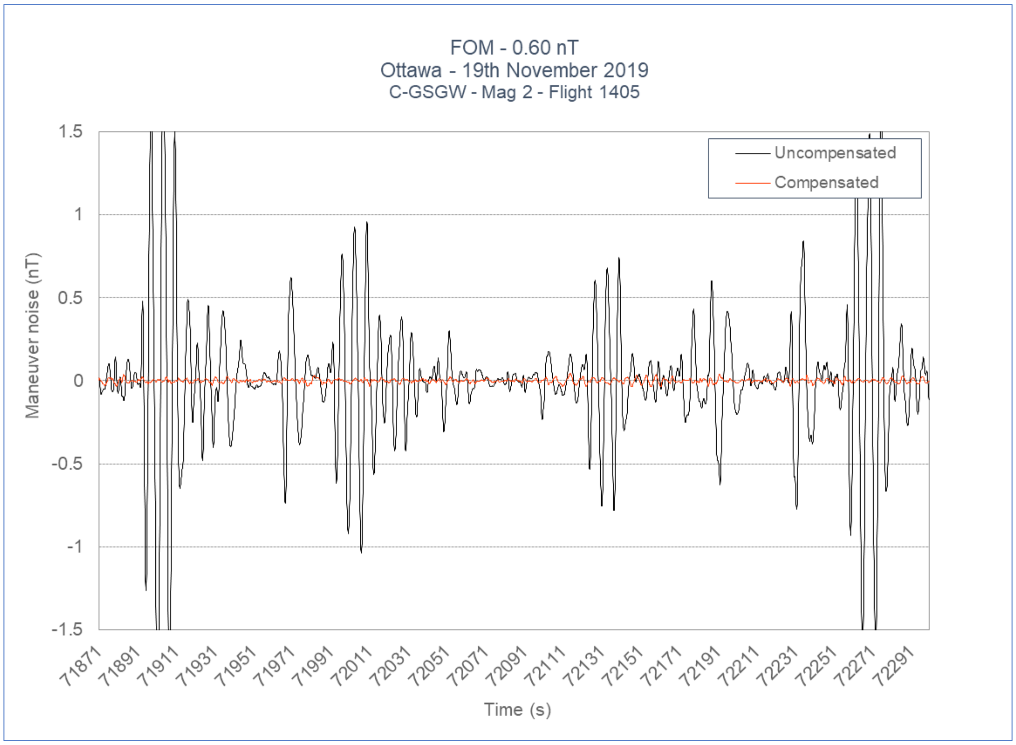

Figure 50. Figure of Merit (FOM) = 0.60 nT, Ottawa, November 19, 2019, C-GSGW, Mag2, flight 1405.

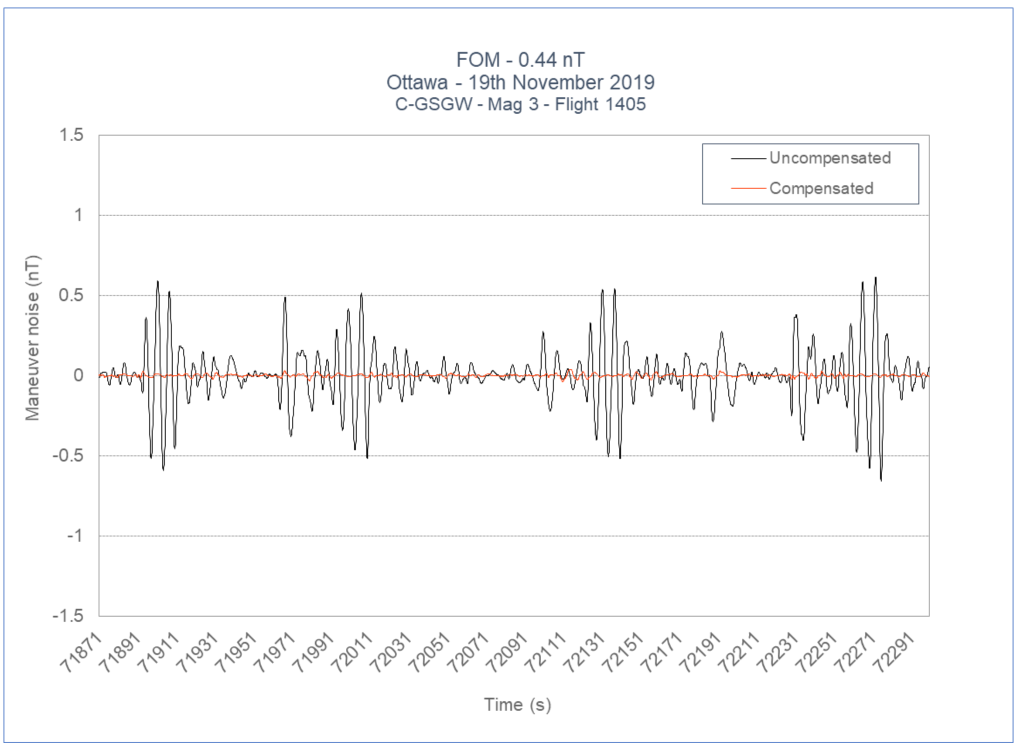

Figure 51. Figure of Merit (FOM) = 0.44 nT, Ottawa, November 19, 2019, C-GSGW, Mag3, flight 1405.

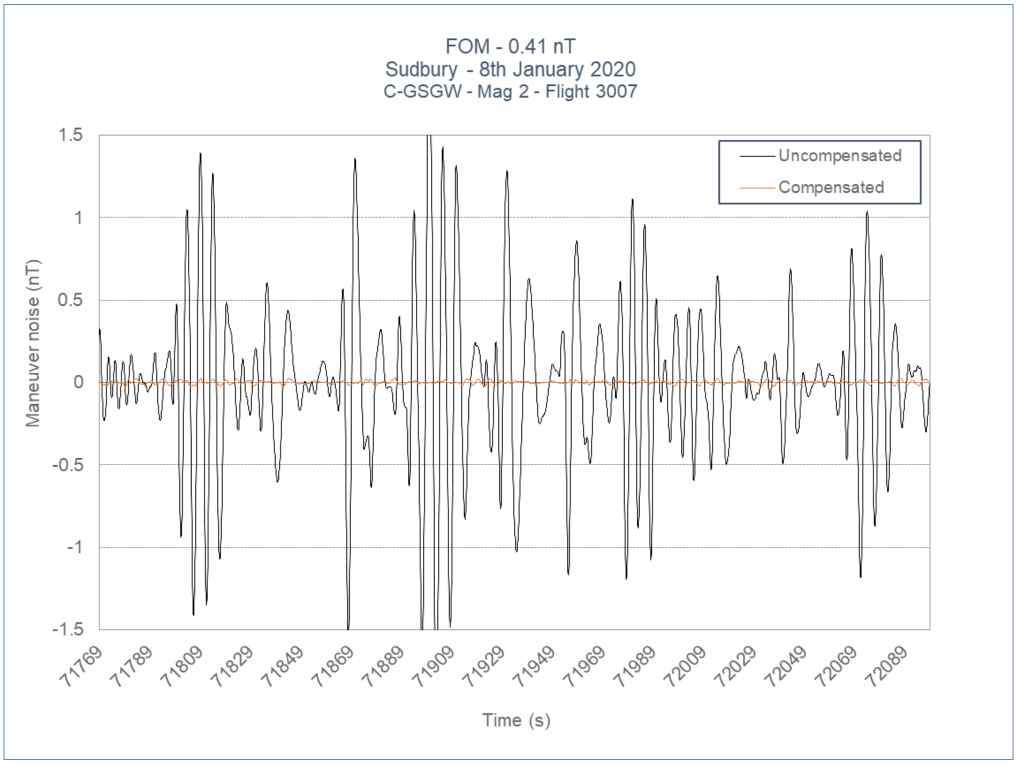

Figure 52. Figure of Merit (FOM) = 0.41 nT, Sudbury, January 8, 2020, C-GSGW, Mag2, flight 3007.

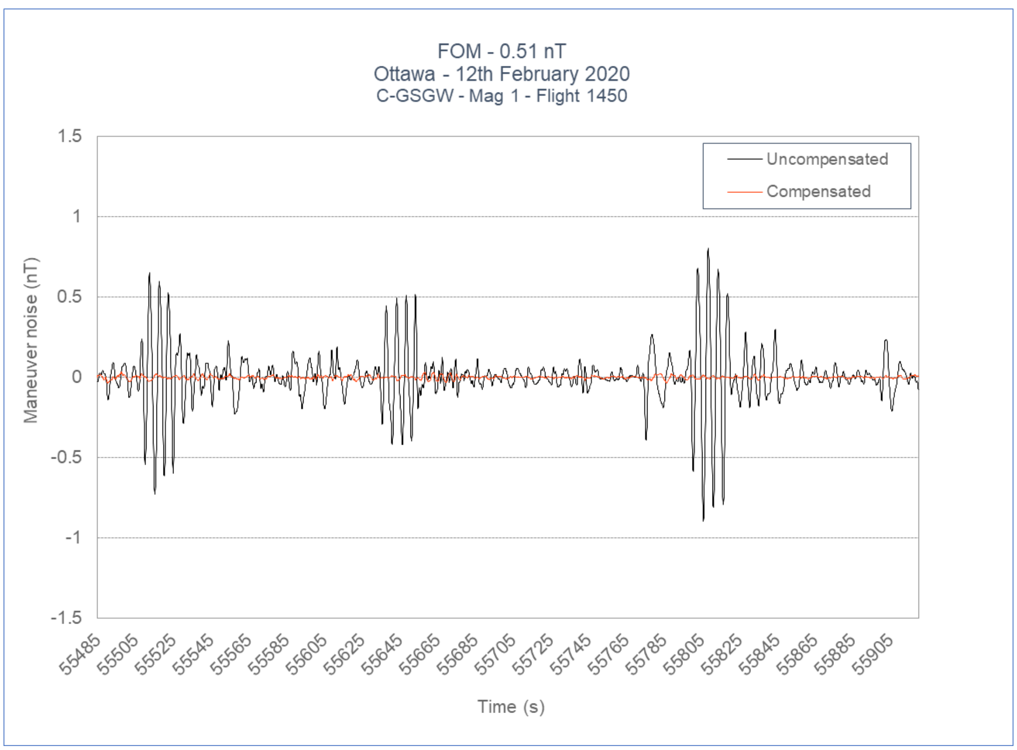

Figure 53. Figure of Merit (FOM) = 0.51 nT, Ottawa, February 12, 2020, C-GSGW, Mag1, flight 1450.

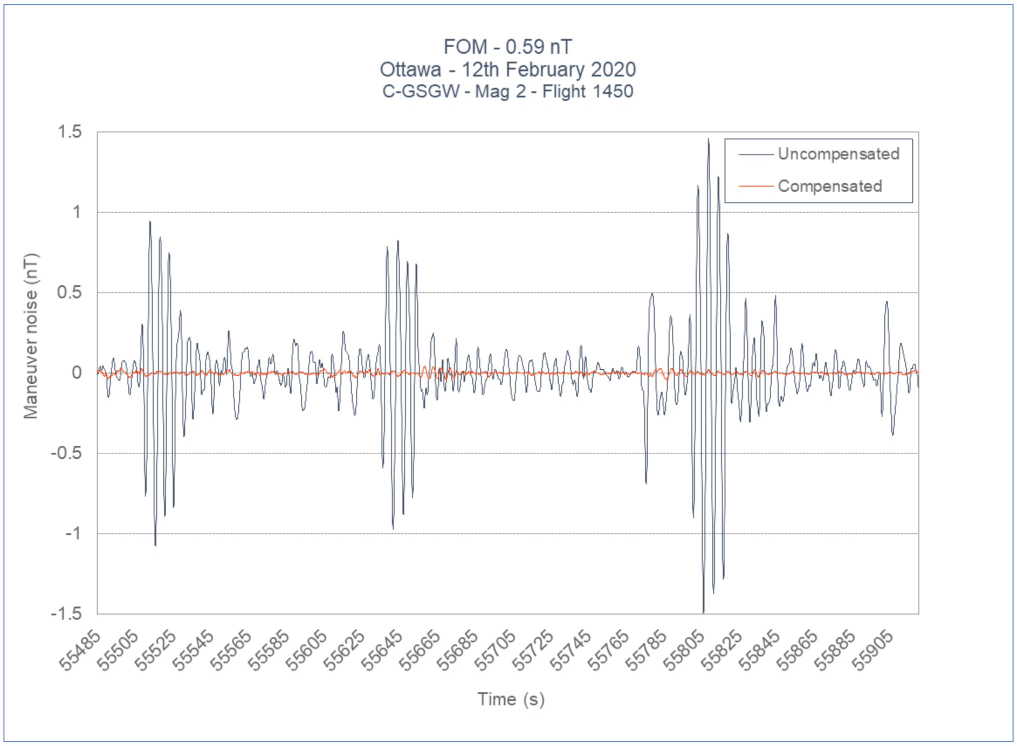

Figure 54. Figure of Merit (FOM) = 0.59 nT, Ottawa, February 12, 2020, C-GSGW, Mag2, flight 1450.

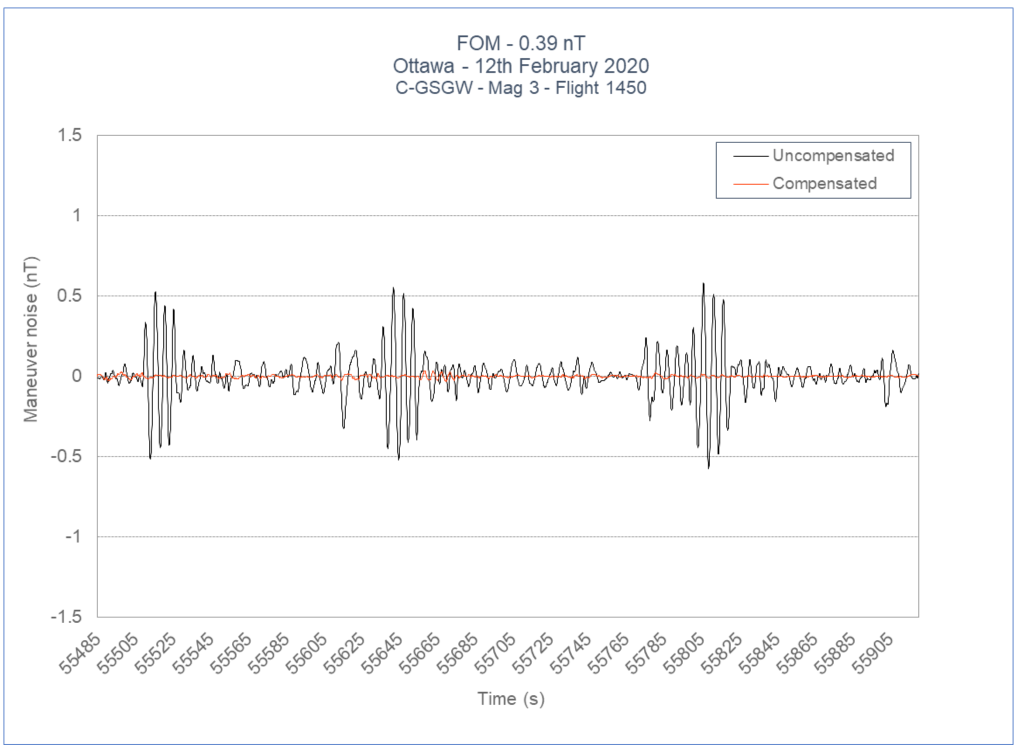

Figure 55. Figure of Merit (FOM) = 0.39 nT, Ottawa, February 12, 2020, C-GSGW, Mag3, flight 1450.

MAGNETOMETER HEADING TEST AND GPS NAVIGATION TEST

The heading tests for each of the 3 magnetometers (port #1, starboard #2 and tail #3) for each of the 3 survey aircraft were carried out at the Morewood test site west of Ottawa, established by the Geological Survey of Canada, by flying in a “cloverleaf” pattern over a predetermined location with a known value at 1500 feet above the ground. This pattern allows the airplane to fly 2 passes in 4 directions (NW, SE, NE, SW) while crossing over a single intersection point. For each pass (at the intersection point), magnetic data are recorded for both the airplane and on the ground at the geomagnetic observatory located at Blackburn just east of Ottawa. These data are then used to determine the error values for each magnetometer and the heading error effects. Tests were flown before deployment as follows: C-GSGV on October 24, 2019, C-GSGL on November 26, 2019, and C-GSGW on November 20, 2019. After the survey, these tests were flown as follows: C-GSGV on February 6, 2020, C-GSGL on January 31, 2020, and C-GSGW on February 12, 2020. This test also serves to verify the functioning of the GPS Navigation System. Results are provided below.

Figure 56. Flight path of the heading tests flown over the Geological Survey of Canada (GSC) Morewood calibration point, superimposed on an image from Google Earth™ mapping service.

Table 5. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGV Port, October 24, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGV)	DATE:	October 24, 2019
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75423-C1931 Port		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., H hours+(M+1)mins (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) / 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	19:13:56	53, 415.39	54, 063.5	54, 063.5	54, 063.5	53, 423.4	-7.96
SE	19:02:33	53, 398.07	54, 046.8	54, 046.8	54, 046.8	53, 406.7	-8.58
NE	19:19:50	53, 411.26	54, 059.9	54, 059.9	54, 059.9	53, 419.8	-8.58
SW	19:08:10	53, 400.90	54, 049.1	54, 049.1	54, 049.1	53, 409.0	-8.11
NW	19:40:16	53, 409.70	54, 058.4	54, 058.4	54, 058.1	53, 418.3	-8.61
SE	19:28:10	53, 410.31	54, 059.4	54, 059.4	54, 059.4	53, 419.3	-9.02
NE	19:46:29	53, 415.31	54, 064.4	54, 064.4	54, 064.4	53, 424.3	-8.96
SW	19:34:00	53, 408.57	54, 058.5	54, 058.5	54, 058.5	53, 418.4	-8.82

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = −66.64 nT

Average North-South Heading Error (T6 North – T6 South) = 0.51 nT
Average East-West Heading Error (T6 East – T6 West) = −0.31 nT

Number of Passes for Average = 8 passes, Average = −8.58 nT

Table 6. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGV Starboard, October 24, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGV)	DATE:	October 24, 2019
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	HEIGHT FLOWN (AGL):	1500 feet
MAGNETOMETER TYPE:	Geometrics G-822A	SAMPLING RATE:	10 / second
MAGNETOMETER SERIAL NUMBER:	75287-C872 Starboard	DATA ACQUISITION SYSTEM:	SGDAS
COMPILED BY:	Jenrené Martel		GSC 11/2015

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours + Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., H hours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4 =T2+S(T3−T2) / 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	19:13:56	53, 420.81	54, 063.5	54, 063.5	54, 063.5	-2.54	0.77
SE	19:02:33	53, 403.04	54, 046.8	54, 046.8	54, 046.8	-3.61	-0.30
NE	19:19:50	53, 416.66	54, 059.9	54, 059.9	54, 059.9	-3.18	0.13
SW	19:08:10	53, 406.14	54, 049.1	54, 049.1	54, 049.1	-2.87	0.44
NW	19:40:16	53, 415. 16	54 058.4	54, 058.4	54, 058.1	-3.15	0.16
SE	19:28:10	53, 415.30	54, 059.4	54, 059.4	54, 059.4	-4.03	-0.72
NE	19:46:29	53, 420.73	54, 064.4	54, 064.4	54, 064.4	-3.54	-0.23
SW	19:34:00	53, 414.81	54 058.5	54, 058.5	54, 058.5	-3.58	-0.27

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = −26.50 nT

Average North-South Heading Error (T6 North – T6 South) = 0.97 nT
Average East-West Heading Error (T6 East – T6 West) = -0.13 nT

Number of Passes for Average = 8 passes   Average = −3.31 nT

Table 7. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGV Tail, October 24, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGV)	DATE:	October 24, 2019
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75296-C948 Tail		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	19:13:56	53, 422.12	54, 063.5	54, 063.5	54, 063.5	53, 423.4	-1.23
SE	19:02:33	53, 405.20	54, 046.8	54, 046.8	54, 046.8	53, 406.7	-1.45
NE	19:19:50	53, 418.84	54, 059.9	54, 059.9	54, 059.9	53, 419.8	-1.00
SW	19:08:10	53, 407.31	54, 049.1	54, 049.1	54, 049.1	53, 409.0	-1.70
NW	19:40:16	53, 416.47	54, 058.4	54, 058.4	54, 058.4	53, 418.3	-1.84
SE	19:28:10	53, 417.33	54, 059.4	54, 059.4	54, 059.4	53, 419.3	-2.00
NE	19:46:29	53, 423.00	54. 064.4	54, 064.4	54, 064.4	53, 424.3	-1.27
SW	19:34:00	53, 415.83	54, 058.5	54, 058.5	54, 058.5	53, 418.4	-2.56

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = -13.05 nT

Average North-South Heading Error (T6 North – T6 South) = 0.19 nT
Average East-West Heading Error (T6 East – T6 West) = 0.99 nT

Number of Passes for Average = 8 passes Average = -1.63 nT

Table 8. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGV Port, February 6, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGV)	DATE:	February 6, 2020
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY): Ltd.	Sander Geophysics	SAMPLING RATE:	10 / second
		DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER TYPE:	Geometrics G-822A		GSC 11/2015
MAGNETOMETER SERIAL NUMBER:	75423-C1931 Port		
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	18:39:24	53,389.55	54,038.5	54,038.5	54038.5	53398.4	-8.82
SE	18:31:33	53,389.34	54,039.0	54,039.0	54039.0	53398.9	-9.56
NE	18:43:25	53,389.64	54,038.7	54,038.7	54038.7	53398.6	-9.00
SW	18:35:24	53,389.24	54,038.4	54,038.4	54038.4	53398.3	-9.09
NW	18:55:16	53,390.88	54,039.9	54,039.9	54039.9	53399.8	-8.93
SE	18:47:24	53,389.60	54,039.2	54,039.2	54039.2	53399.1	-9.49
NE	18:59:14	53,390.44	54,039.6	54,039.6	54039.6	53399.5	-9.10
SW	18:51:12	53,390.23	54,039.5	54,039.5	54039.5	53399.4	-9.18

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = −73.17 nT

Average North-South Heading Error (T6 North – T6 South) = 0.65 nT
Average East-West Heading Error (T6 East – T6 West) = 0.09 nT

Number of Passes for Average = 8 passes   Average = −9.15 nT

Table 9. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGV Starboard, February 6, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION: Grand Caravan® (C-GSGV)	Cessna® 208B	DATE:	February 6, 2020
ORGANIZATION (COMPANY): Geophysics Ltd.	Sander	HEIGHT FLOWN (AGL):	1500 feet
MAGNETOMETER TYPE: 822A	Geometrics G-	SAMPLING RATE:	10 / second
MAGNETOMETER SERIAL NUMBER: Starboard	75287-C872	DATA ACQUISITION SYSTEM:	SGDAS GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	18:39:24	53,395.72	54,038.5	54,038.5	54038.5	53398.4	-2.65
SE	18:31:33	53,395.37	54,039.0	54,039.0	54039.0	53398.9	-3.53
NE	18:35:24	53,395.40	54,038.7	54,038.7	54038.7	53398.6	-3.24
SW	18:43:25	53,395.42	54,038.4	54,038.4	54038.4	53398.3	-2.91
NW	18:55:16	53,397.12	54,039.9	54,039.9	54039.9	53399.8	-2.69
SE	18:47:24	53,395.63	54,039.2	54,039.2	54039.2	53399.1	-3.46
NE	18:51:12	53,396.45	54,039.6	54,039.6	54039.6	53399.5	-3.09
SW	18:59:14	53,396.28	54,039.5	54,039.5	54039.5	53399.4	-3.13

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = -24.70 nT

Average North-South Heading Error (T6 North – T6 South) = 0.83 nT
Average East-West Heading Error (T6 East – T6 West) = −0.14 nT

Number of Passes for Average = 8 passes   Average = -3.09 nT

Table 10. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGV Tail, February 6, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGV)	DATE:	February 6, 2020
ORGANIZATION (COMPANY): Ltd.	Sander Geophysics	HEIGHT FLOWN (AGL):	1500 feet
MAGNETOMETER TYPE:	Geometrics G-822A	SAMPLING RATE:	10 / second
MAGNETOMETER SERIAL NUMBER:	75130-C059 Tail	DATA ACQUISITION SYSTEM:	SGDAS
COMPILED BY:	Jenrené Martel		GSC 11/2015

Direction of flight across the intersection point	**Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time**	**Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)**	**Observatory Diurnal Reading at Previous Minute, i.e., Hours + Minutes (T2) from Printout**	**Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout**	**Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60**	**Calculated Observatory Value T5 = T4 − C***	**Error Value T6=T1−T5**
NW	18:39:24	53,399.81	54,038.5	54,038.5	54038.5	53398.4	1.44
SE	18:31:33	53,399.57	54,039.0	54,039.0	54039.0	53398.9	0.67
NE	18:43:25	53,399.62	54,038.7	54,038.7	54038.7	53398.6	0.98
SW	18:35:24	53,399.64	54,038.4	54,038.4	54038.4	53398.3	1.31
NW	18:55:16	53,401.19	54,039.9	54,039.9	54039.9	53399.8	1.38
SE	18:47:24	53,399.78	54,039.2	54,039.2	54039.2	53399.1	0.69
NE	18:59:14	53,400.46	54,039.6	54,039.6	54039.6	53399.5	0.92
SW	18:51:12	53,400.64	54,039.5	54,039.5	54039.5	53399.4	1.23

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 8.62 nT

Average North-South Heading Error (T6 North – T6 South) = 0.73 nT
Average East-West Heading Error (T6 East – T6 West) = -0.32 nT

Number of Passes for Average = 8 passes Average = 1.08 nT

Table 11. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGL Port, November 26, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION: Caravan® (C-GSGL)	Cessna® 208B Grand	DATE:	November 26, 2019
ORGANIZATION (COMPANY): Ltd.	Sander Geophysics	HEIGHT FLOWN (AGL):	1500 feet
MAGNETOMETER TYPE:	Geometrics G-822A	SAMPLING RATE:	10 / second
MAGNETOMETER SERIAL NUMBER:	75421-C1961 Port	DATA ACQUISITION SYSTEM:	SGDAS
COMPILED BY:	Jenrené Martel		GSC 11/2015

Direction of flight across the intersection point	**Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time**	**Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)**	**Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout**	**Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout**	**Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60**	**Calculated Observatory Value T5 = T4 − C***	**Error Value T6=T1−T5**
NW	18:01:51	53419.5	54056.1	54056.1	54056.1	53416.0	3.48
SE	17:58:21	53418.5	54055.3	54055.3	54055.3	53415.2	3.25
NE	18:16:13	53421.8	54058.4	54058.4	54058.4	53418.3	3.45
SW	18:12:39	53422.8	54058.9	54058.9	54058.9	53418.8	3.97
NW	18:08:37	53419.8	54056.2	54056.2	54056.2	53416.1	3.72
SE	18:05:16	53418.7	54055.6	54055.6	54055.6	53415.5	3.14
NE	18:23:00	53423.1	54059.5	54059.5	54059.5	53419.4	3.75
SW	18:19:34	53422.9	54059.5	54059.5	54059.5	53419.4	3.52

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 28.28 nT

Average North-South Heading Error (T6 North – T6 South) = 0.41 nT
Average East-West Heading Error (T6 East – T6 West) = -0.15 nT

Number of Passes for Average = 8 passes   Average = 3.53 nT

Table 12. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGL Starboard, November 26, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGL)	DATE:	November 26, 2019
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75100-C1014 Starboard		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	**Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time**	**Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)**	**Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout**	**Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout**	**Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60**	**Calculated Observatory Value T5 = T4 − C***	**Error Value T6=T1−T5**
NW	18:01:51	53422.0	54056.1	54056.1	54056.1	53416.0	6.04
SE	17:58:21	53421.0	54055.3	54055.3	54055.3	53415.2	5.79
NE	18:16:13	53424.4	54058.4	54058.4	54058.4	53418.3	6.10
SW	18:12:39	53425.0	54058.9	54058.9	54058.9	53418.8	6.22
NW	18:08:37	53422.1	54056.2	54056.2	54056.2	53416.1	6.03
SE	18:05:16	53421.2	54055.6	54055.6	54055.6	53415.5	5.61
NE	18:23:00	53425.9	54059.5	54059.5	54059.5	53419.4	6.50
SW	18:19:34	53425.2	54059.5	54059.5	54059.5	53419.4	5.76

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 48.05 nT

Average North-South Heading Error (T6 North – T6 South) = 0.33 nT
Average East-West Heading Error (T6 East – T6 West) = 0.31 nT

Number of Passes for Average = 8 passes   Average = 6.01 nT

Table 13. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGL Tail, November 26, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION: Cessna® 208B Grand Caravan® (C-GSGL)		DATE:	November 26, 2019
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	7536-C1557 Tail		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	**Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time**	**Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)**	**Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout**	**Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout**	**Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60**	**Calculated Observatory Value T5 = T4 − C***	**Error Value T6=T1−T5**
NW	18:01:51	53414.5	54056.1	54056.1	54056.1	53416.0	-1.53
SE	17:58:21	53413.4	54055.3	54055.3	54055.3	53415.2	-1.80
NE	18:16:13	53416.7	54058.4	54058.4	54058.4	53418.3	-1.64
SW	18:12:39	53417.5	54058.9	54058.9	54058.9	53418.8	-1.27
NW	18:08:37	53414.7	54056.2	54056.2	54056.2	53416.1	-1.40
SE	18:05:16	53413.6	54055.6	54055.6	54055.6	53415.5	-1.93
NE	18:23:00	53418.1	54059.5	54059.5	54059.5	53419.4	-1.31
SW	18:19:34	53417.7	54059.5	54059.5	54059.5	53419.4	-1.74

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = -12.62 nT

Average North-South Heading Error (T6 North – T6 South) = 0.40 nT
Average East-West Heading Error (T6 East – T6 West) = 0.03 nT

Number of Passes for Average = 8 passes   Average = -1.58 nT

Table 14. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGL Port, January 31, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGL)	DATE:	January 31, 2020
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	HEIGHT FLOWN (AGL):	1500 feet
MAGNETOMETER TYPE:	Geometrics G-822A	SAMPLING RATE:	10 / second
MAGNETOMETER SERIAL NUMBER:	75421-C1961 Port	DATA ACQUISITION SYSTEM:	SGDAS
COMPILED BY:	Jenrené Martel		GSC 11/2015

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) / 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	16:11:34	53,390.42	54,026.4	54,026.4	54026.4	53386.3	4.08
SE	16:03:36	53,389.12	54,025.8	54,025.8	54025.8	53385.7	3.44
NE	16:07:33	53,390.27	54,026.9	54,026.9	54026.9	53386.8	3.52
SW	16:15:39	53,391.57	54,027.3	54,027.3	54027.3	53387.2	4.33
NW	16:29:30	53,391.93	54,027.8	54,027.8	54027.8	53387.7	4.26
SE	16:19:43	53,391.09	54,027.5	54,027.5	54027.5	53387.4	3.73
NE	16:25:33	53,391.08	54,027.5	54,027.5	54027.5	53387.4	3.70
SW	16:33:32	53,392.08	54,027.9	54,027.9	54027.9	53387.8	4.32

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 31.38 nT

Average North-South Heading Error (T6 North – T6 South) = 0.58 nT
Average East-West Heading Error (T6 East – T6 West) = -0.72 nT

Number of Passes for Average = 8 passes   Average = 3.92 nT

Table 15. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGL Starboard, January 31, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGL)	DATE:	January 31, 2020
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75100-C1014 Starboard		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours + Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	16:11:34	53,392.90	54,026.4	54,026.4	54026.4	53386.3	6.56
SE	16:03:36	53,391.81	54,025.8	54,025.8	54025.8	53385.7	6.13
NE	16:07:33	53,393.20	54,026.9	54,026.9	54026.9	53386.8	6.45
SW	16:15:39	53,393.83	54,027.3	54,027.3	54027.3	53387.2	6.59
NW	16:29:30	53,394.39	54,027.8	54,027.8	54027.8	53387.7	6.72
SE	16:19:43	53,393.80	54,027.5	54,027.5	54027.5	53387.4	6.44
NE	16:25:33	53,393.99	54,027.5	54,027.5	54027.5	53387.4	6.61
SW	16:33:32	53,394.30	54,027.9	54,027.9	54027.9	53387.8	6.54

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 52.04 nT

Average North-South Heading Error (T6 North – T6 South) = 0.35 nT
Average East-West Heading Error (T6 East – T6 West) = −0.04 nT

Number of Passes for Average = 8 passes   Average = 6.50 nT

Table 16. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGL Tail, January 31, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION: Caravan®	Cessna® 208B Grand (C-GSGL)	DATE:	January 31, 2020
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	7536-C1557 Tail		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	16:11:34	53,385.58	54,026.4	54,026.4	54026.4	53386.3	-0.76
SE	16:03:36	53,383.90	54,025.8	54,025.8	54025.8	53385.7	-1.78
NE	16:07:33	53,385.60	54,026.9	54,026.9	54026.9	53386.8	-1.15
SW	16:15:39	53,386.08	54,027.3	54,027.3	54027.3	53387.2	-1.16
NW	16:29:30	53,387.11	54,027.8	54,027.8	54027.8	53387.7	-0.56
SE	16:19:43	53,385.91	54,027.5	54,027.5	54027.5	53387.4	-1.45
NE	16:25:33	53,386.35	54,027.5	54,027.5	54027.5	53387.4	-1.03
SW	16:33:32	53,386.56	54,027.9	54,027.9	54027.9	53387.8	-1.20

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = -9.09 nT

Average North-South Heading Error (T6 North – T6 South) = 0.95 nT
Average East-West Heading Error (T6 East– T6 West) = 0.09 nT

Number of Passes for Average = 8 passes   Average = -1.14 nT

Table 17. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGW Port, November 20, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGW)	DATE:	November 20, 2019
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75285-C5082 Port		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours + Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec $T4=T2+\frac{S(T3-T2)}{60}$	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	16:33:00	53394.7	54039.6	54039.6	54039.6	53399.5	-4.8
SE	16:22:34	53394.8	54039.9	54039.9	54039.9	53399.8	-5.0
NE	16:27:52	53394.7	54039.8	54039.8	54039.8	53399.7	-4.9
SW	16:38:18	53395.0	54039.9	54039.9	54039.9	53399.8	-4.8
NW	16:55:21	53396.4	54041.4	54041.4	54041.4	53401.3	-4.9
SE	16:43:56	53395.5	54040.9	54040.9	54040.9	53400.8	-5.4
NE	16:49:39	53396.1	54041.0	54041.0	54041.0	53400.9	-4.8
SW	17:00:08	53398.3	54043.1	54043.1	54043.1	53403.0	-4.7

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = −39.22 nT

Average North-South Heading Error (T6 North – T6 South) = 0.32 nT
Average East-West Heading Error (T6 East – T6 West) = −0.16 nT

Number of Passes for Average = 8 passes   Average = −4.90 nT

Table 18. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGW Starboard, November 20, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGW)	DATE: HEIGHT FLOWN (AGL):	November 20, 2019 1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER: Starboard	75304-C1015		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	16:33:00	53404.0	54039.6	54039.6	54039.6	53399.5	4.5
SE	16:22:34	53403.9	54039.9	54039.9	54039.9	53399.8	4.1
NE	16:27:52	53404.1	54039.8	54039.8	54039.8	53399.7	4.4
SW	16:38:18	53404.0	54039.9	54039.9	54039.9	53399.8	4.2
NW	16:55:21	53405.7	54041.4	54041.4	54041.4	53401.3	4.4
SE	16:43:56	53404.5	54040.9	54040.9	54040.9	53400.8	3.7
NE	16:49:39	53405.5	54041.0	54041.0	54041.0	53400.9	4.6
SW	17:00:08	53407.3	54043.1	54043.1	54043.1	53403.0	4.4

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 34.29 nT

Average North-South Heading Error (T6 North – T6 South) = 0.58 nT
Average East-West Heading Error (T6 East – T6 West) = 0.21 nT

Number of Passes for Average = 8 passes Average = 4.29 nT

Table 19. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGW Tail, November 20, 2019.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGW)	DATE:	November 20, 2019
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75188-C876 Tail		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours+Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec $T4=T2+\frac{S(T3-T2)}{60}$	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	16:22:34	53400.6	54039.6	54039.6	54039.6	53399.5	1.1
SE	16:33:00	53400.9	54039.9	54039.9	54039.9	53399.8	1.1
NE	16:27:52	53400.7	54039.8	54039.8	54039.8	53399.7	1.1
SW	16:38:18	53400.5	54039.9	54039.9	54039.9	53399.8	0.7
NW	16:43:56	53401.3	54041.4	54041.4	54041.4	53401.3	-0.1
SE	16:55:21	53402.6	54040.9	54040.9	54040.9	53400.8	1.7
NE	16:49:39	53402.2	54041.0	54041.0	54041.0	53400.9	1.2
SW	17:00:08	53403.9	54043.1	54043.1	54043.1	53403.0	0.9

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 7.77 nT

Average North-South Heading Error (T6 North – T6 South) = -0.85 nT
Average East-West Heading Error (T6 East – T6 West) = 0.37 nT

Number of Passes for Average = 8 passes   Average = 0.97 nT

Table 20. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGW Port, February 12, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGW)	DATE:	February 12, 2020
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75285-C5082 Port		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours + Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	17:39:25	53,381.25	54,027.0	54,027.0	54027.0	53386.9	-5.69
SE	17:30:35	53,379.29	54,025.9	54,025.9	54025.9	53385.8	-6.46
NE	17:34:56	53,378.94	54,025.0	54,025.0	54025.0	53384.9	-5.92
SW	17:43:38	53,380.89	54,027.1	54,027.1	54027.1	53387.0	-6.14
NW	17:57:01	53,383.81	54,029.9	54,029.9	54029.9	53389.8	-5.99
SE	17:48:20	53,381.20	54,027.9	54,027.9	54027.9	53387.8	-6.56
NE	17:52:56	53,381.80	54,028.0	54,028.0	54028.0	53387.9	-6.08
SW	18:00:49	53,383.93	54,030.3	54,030.3	54030.3	53390.2	-6.31

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = −49.15 nT

Average North-South Heading Error (T6 North – T6 South) = 0.67 nT
Average East-West Heading Error (T6 East – T6 West) = 0.22 nT

Number of Passes for Average = 8 passes   Average = −6.14 nT

Table 21. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGW Starboard, February 12, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGW)	DATE:	February 12, 2020
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75424-C1963 Starboard		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours + Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	17:39:25	53,390.49	54,027.0	54,027.0	54027.0	53386.9	3.55
SE	17:30:35	53,388.58	54,025.9	54,025.9	54025.9	53385.8	2.83
NE	17:34:56	53,388.24	54,025.0	54,025.0	54025.0	53384.9	3.38
SW	17:43:38	53,390.00	54,027.1	54,027.1	54027.1	53387.0	2.97
NW	17:57:01	53,393.02	54,029.9	54,029.9	54029.9	53389.8	3.22
SE	17:48:20	53,390.55	54,027.9	54,027.9	54027.9	53387.8	2.79
NE	17:52:56	53,391.05	54,028.0	54,028.0	54028.0	53387.9	3.17
SW	18:00:49	53,392.91	54,030.3	54,030.3	54030.3	53390.2	2.67

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 24.58 nT

Average North-South Heading Error (T6 North – T6 South) = 0.57 nT
Average East-West Heading Error (T6 East – T6 West) = 0.45 nT

Number of Passes for Average = 8 passes   Average = 3.07 nT

Table 22. Aeromagnetic survey system calibration test, Cessna® 208B Grand Caravan® C-GSGW Tail, February 12, 2020.

AEROMAGNETIC SURVEY SYSTEM CALIBRATION TEST RANGES AT MOREWOOD, ONTARIO

AIRCRAFT TYPE AND REGISTRATION:	Cessna® 208B Grand Caravan® (C-GSGW)	DATE:	February 12, 2020
		HEIGHT FLOWN (AGL):	1500 feet
ORGANIZATION (COMPANY):	Sander Geophysics Ltd.	SAMPLING RATE:	10 / second
MAGNETOMETER TYPE:	Geometrics G-822A	DATA ACQUISITION SYSTEM:	SGDAS
MAGNETOMETER SERIAL NUMBER:	75188-C876 Tail		GSC 11/2015
COMPILED BY:	Jenrené Martel		

Direction of flight across the intersection point	Time that Survey Aircraft was over the intersection point (HH/MM/SS) Greenwich Mean Time	Total Field Value (nT) Recorded in Survey Aircraft over the intersection point (T1)	Observatory Diurnal Reading at Previous Minute, i.e., Hours + Minutes (T2) from Printout	Observatory Diurnal Reading at Subsequent Minute, i.e., Hhours+(M+1)mins. (T3) from Printout	Interpolated Observatory Diurnal Reading at Time Hhours+Mmins+Ssec T4=T2+S(T3−T2) ----- 60	Calculated Observatory Value T5 = T4 − C*	Error Value T6=T1−T5
NW	17:39:25	53,388.31	54,027.0	54,027.0	54027.0	53386.9	1.37
SE	17:30:35	53,386.39	54,025.9	54,025.9	54025.9	53385.8	0.64
NE	17:34:56	53,385.84	54,025.0	54,025.0	54025.0	53384.9	0.98
SW	17:43:38	53,387.71	54,027.1	54,027.1	54027.1	53387.0	0.68
NW	17:57:01	53,390.88	54,029.9	54,029.9	54029.9	53389.8	1.08
SE	17:48:20	53,388.32	54,027.9	54,027.9	54027.9	53387.8	0.56
NE	17:52:56	53,388.74	54,028.0	54,028.0	54028.0	53387.9	0.86
SW	18:00:49	53,390.69	54,030.3	54,030.3	54030.3	53390.2	0.45

**C is the difference in the total field between the Blackburn, Meanook and Baker Observatories (O) and the value (B) at the test site intersection point above the designated height.*

Ottawa(O)/Morewood(B), Ontario: 1500 feet, C = (O − B) = 640.1 nT

Total = 6.62 nT

Average North-South Heading Error (T6 North – T6 South) = 0.62 nT
Average East-West Heading Error (T6 East – T6 West) = 0.35 nT

Number of Passes for Average = 8 passes   Average = 0.83 nT

Altimeter Land/Water Comparison

To compare the effect of flying radar and laser altimeters over both land and water, a test line was flown across the Ottawa River near Clarence–Rockland. The test line was flown from north to south. Terrain channels were calculated using each altimeter and then plotted on top of each other. These tests were performed by all aircraft before deployment as follows: C-GSGV on October 29, C-GSGW on November 20, and C-GSGL on November 28, 2019.

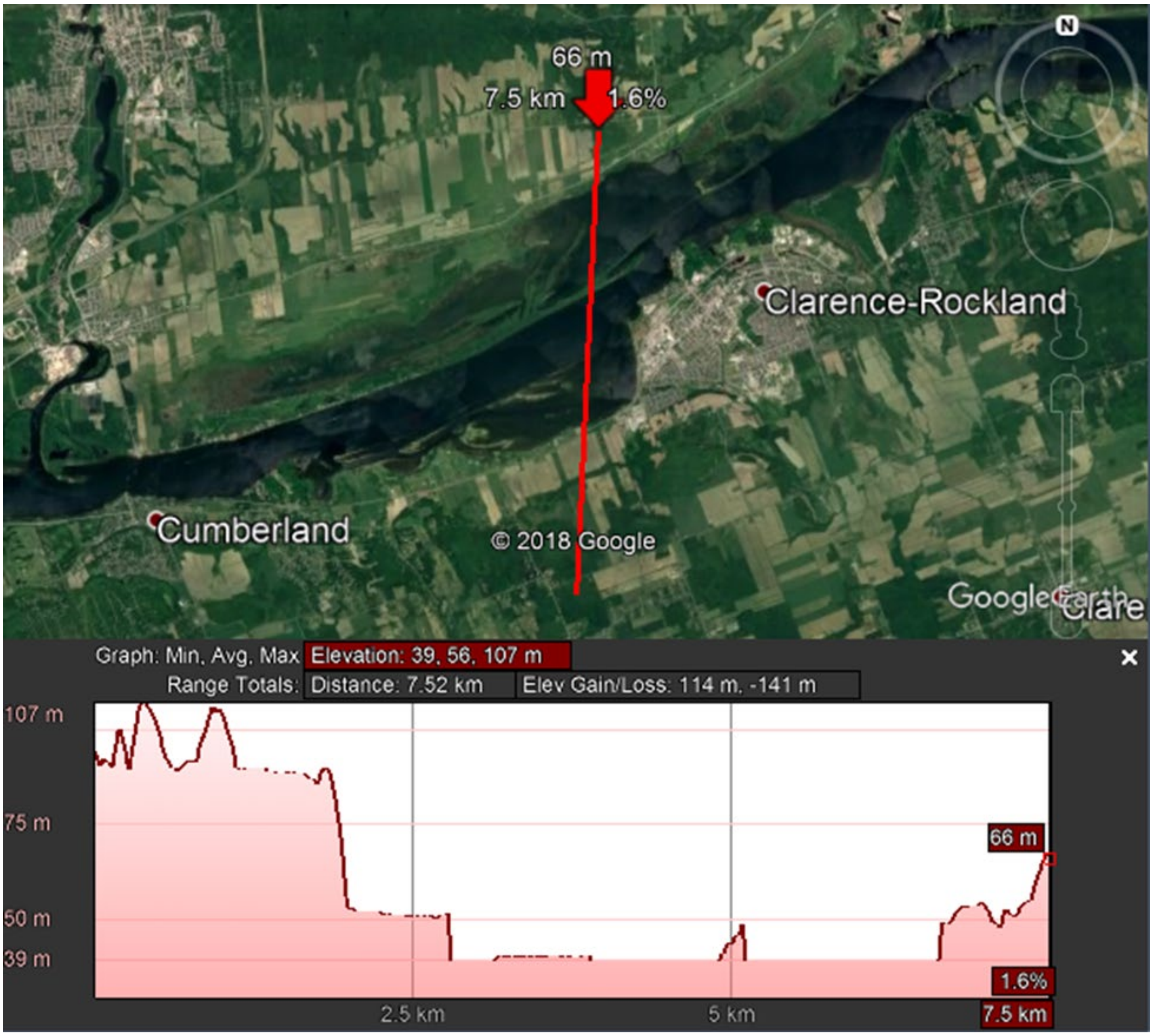

Figure 57. Land/water test line location map.

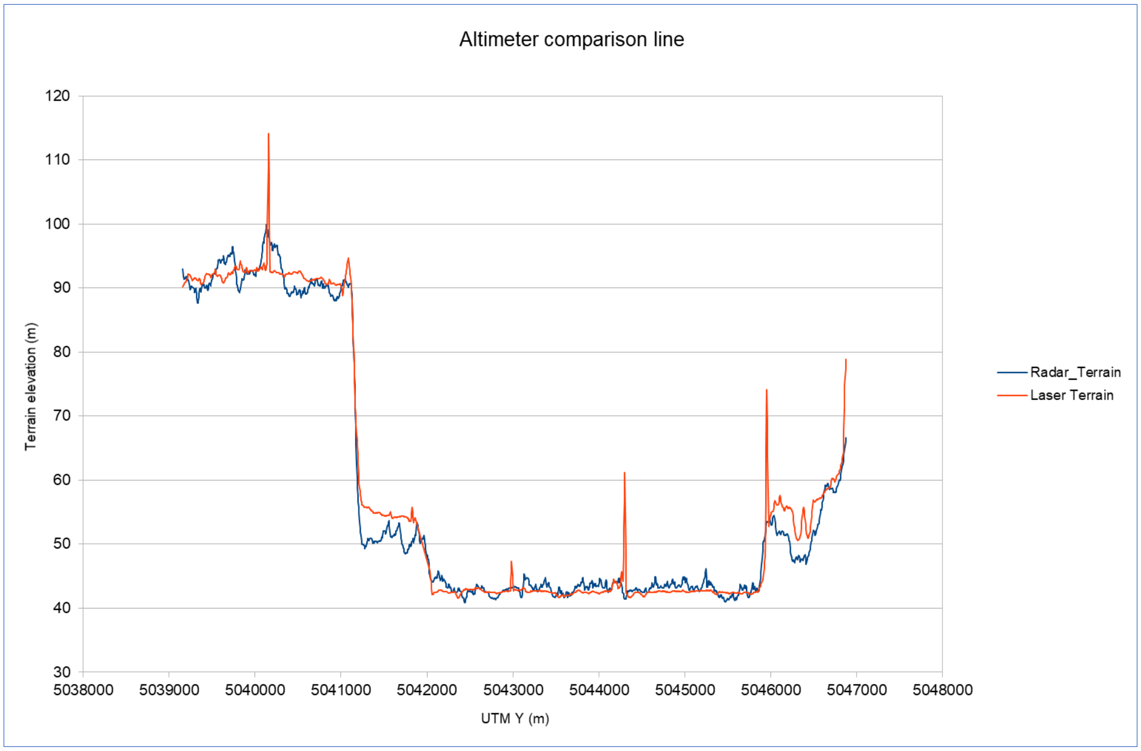

Figure 58. Altimeter test line profiles for C-GSGV flown October 29, 2019.

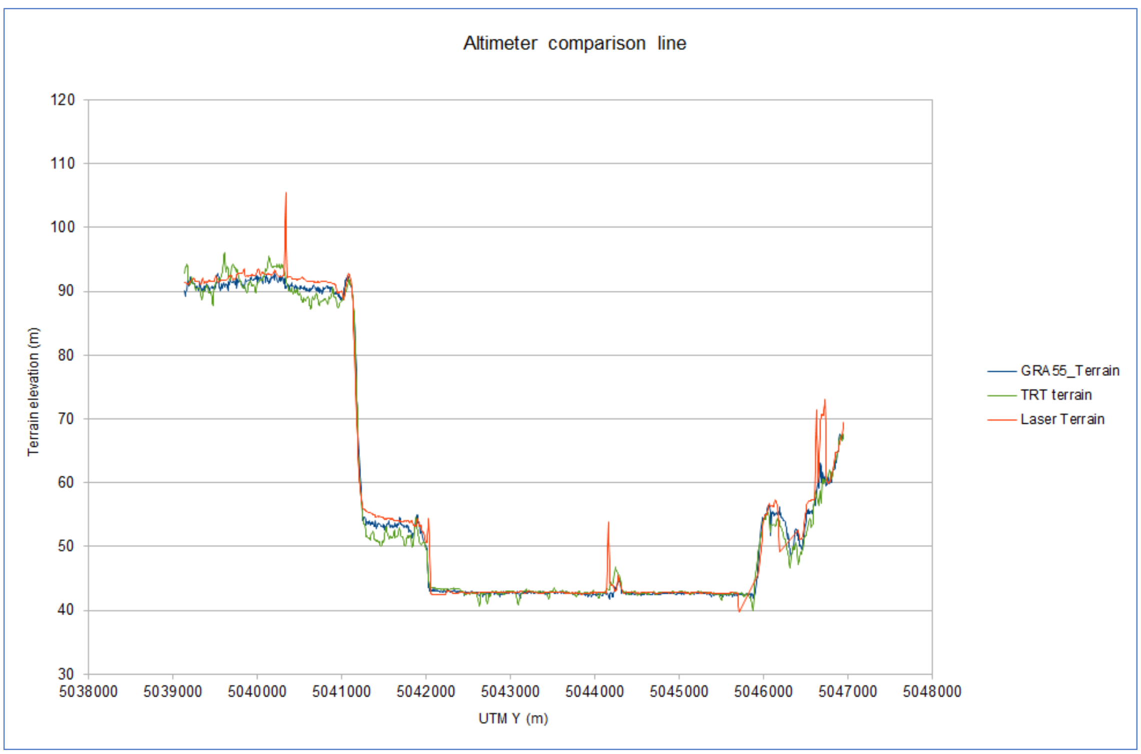

Figure 59. Altimeter test line profiles for C-GSGW flown November 20, 2019.

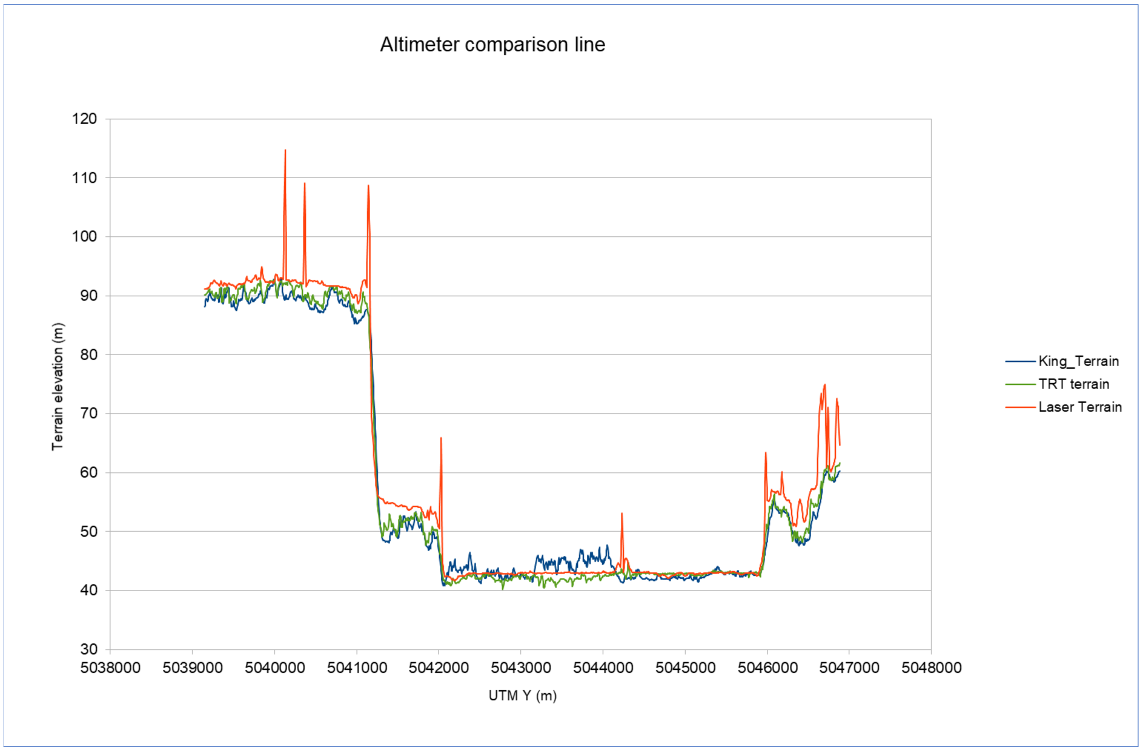

Figure 60. Altimeter test line profiles for C-GSGL flown November 28, 2019.

STATIONARY AIRCRAFT GPS POSITION TEST

A GPS static test was performed to evaluate the accuracy of the GPS receiver for each aircraft. These tests were performed in Sudbury, Ontario. While the planes were parked on the airport ramp, positional data was collected over a period of approximately 10 minutes. The accuracy of the GPS positional data is evaluated by plotting the error in metres (calculated as the difference between each positional measurement and the average) for UTM X vs. UTM Y. This test was complete for C-GSGV on November 5, 2019, for C-GSGL on December 5, 2019, and for C-GSGW on December 12, 2019.

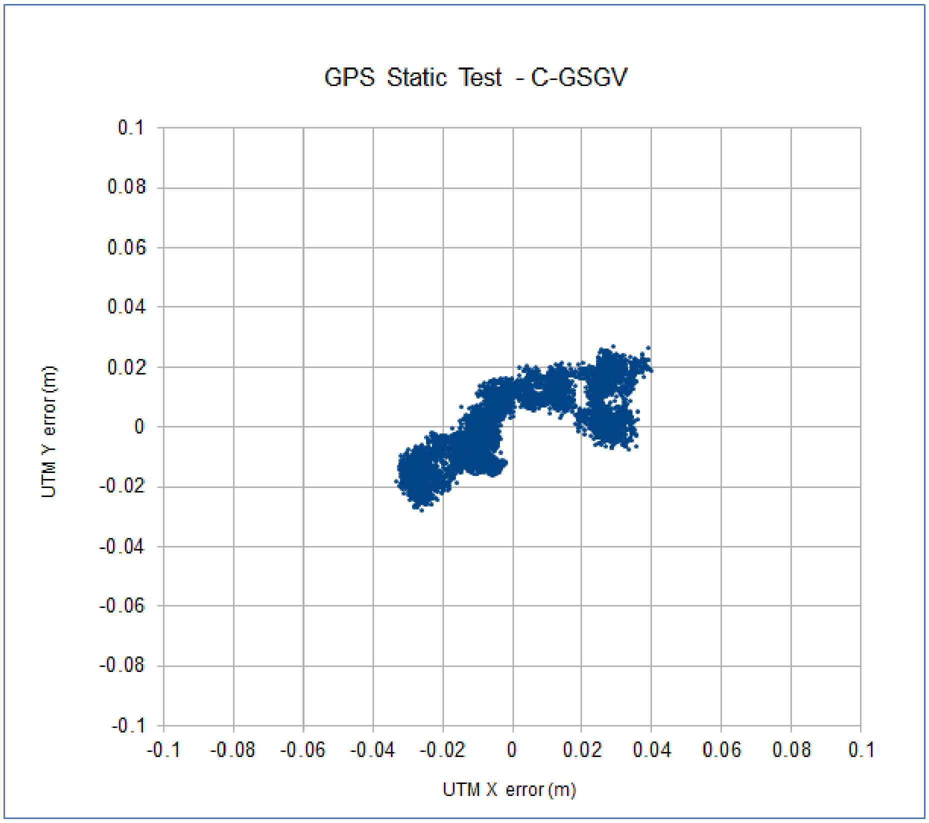

Figure 61. GPS Static test for C-GSGV carried out on November 5, 2019.

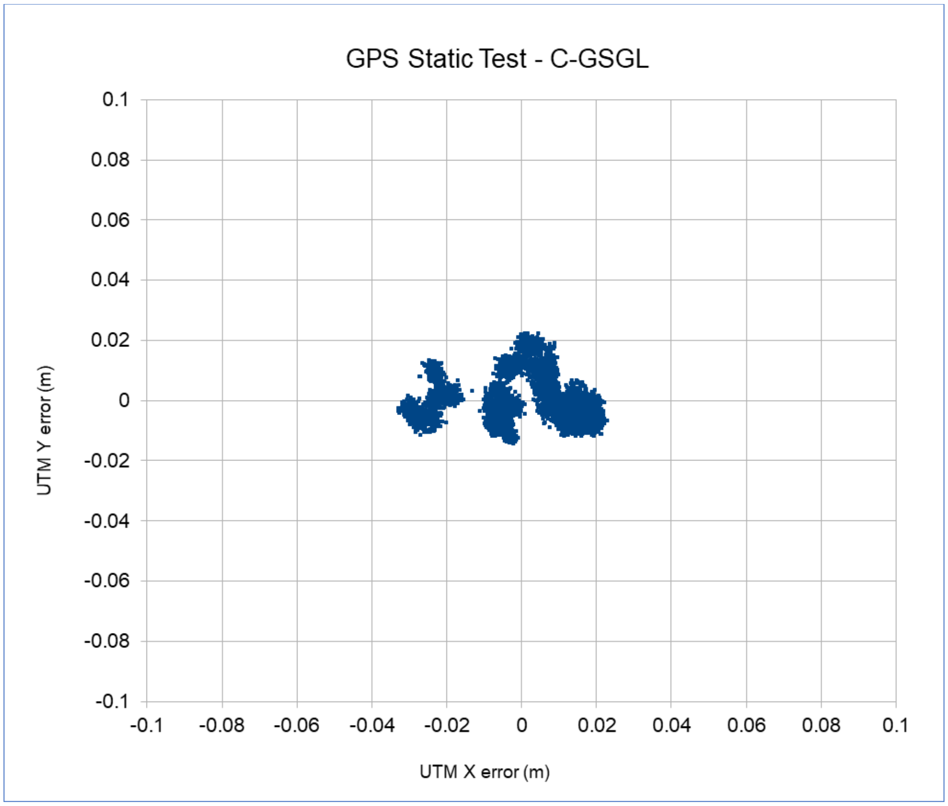

Figure 62. GPS Static test for C-GSGL carried out on November 5, 2019.

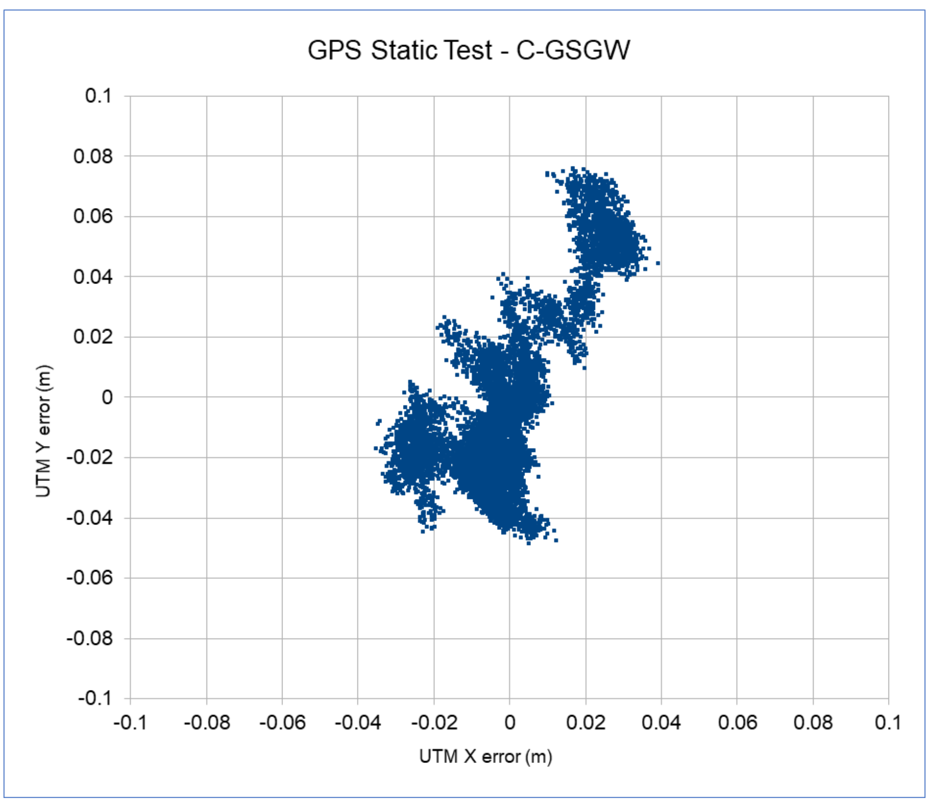

Figure 63. GPS Static test for C-GSGW carried out on December 12, 2019.

Appendix B. Archive Definitions

Geophysical Data Set 1088 is derived from surveys using a magnetic gradiometry system mounted on fixed-wing platforms and carried out by SGL.

ARCHIVE LAYOUT

The files for the Sturgeon River area geophysical survey are archived on one DVD.

Type of Data	Magnetic Gradiometer
Format	Grid and Profile Data (DVD)
ASCII	Geophysical Data Set (GDS) 1088
Geosoft® Binary	Geophysical Data Set (GDS) 1088

The content of the ASCII and Geosoft® binary file types are identical. They are provided in both forms to suit the user's available software. The survey data are divided as follows.

Geophysical Data Set 1088 (DVD)

a) ASCII (*.gxf*) grids
- digital elevation model
- total magnetic field
- "GSC levelled" gradient-enhanced residual magnetic field
- second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field
- measured lateral (across line) horizontal magnetic gradient
- measured longitudinal (along line) horizontal magnetic gradient
- total horizontal magnetic gradient of the gradient-enhanced, pole reduced "GSC levelled" residual magnetic field
- analytic signal of the gradient-enhanced, "GSC levelled" residual magnetic field

b) Vector (*.dxf*) files
- flight path
- magnetic contours
- Keating coefficients

c) GeoTIFF seamless map images
- "GSC levelled" gradient-enhanced residual magnetic field with planimetric base
- shaded second vertical derivative of the "GSC levelled" gradient-enhanced residual magnetic field with planimetric base

d) ASCII (*.xyz*) data
- profile database of magnetic data (10 Hz sampling) in ASCII XYZ format
- database of Keating coefficients in ASCII CSV (comma-separated values) format

e) Geosoft® binary (*.grd*) grids
- digital elevation model
- total magnetic field
- "GSC levelled" gradient-enhanced total magnetic field
- second vertical derivative of the "GSC levelled" gradient-enhanced total magnetic field
- measured lateral (across line) horizontal magnetic gradient
- measured longitudinal (along line) horizontal magnetic gradient
- total horizontal magnetic gradient of the gradient-enhanced, pole reduced "GSC levelled" residual magnetic field
- analytic signal of the gradient-enhanced, "GSC levelled" residual magnetic field

f) Geosoft® (*.gdb*) binary data
- profile database of magnetic data (10 Hz sampling) in Geosoft® GDB format
- Keating coefficients in Geosoft® GDB format

g) Geosoft® (*.map*) map files
- colour-filled contours of gradient-enhanced "GSC levelled" residual magnetic field grid with contours, flight lines and base
- shaded colour of the second vertical derivative of the gradient-enhanced "GSC levelled" residual magnetic field grid with Keating coefficients, flight lines and base

h) Survey report in portable document (*.pdf*) format

CO-ORDINATE SYSTEMS

The profile data are provided in 2 co-ordinate systems:

- Universal Transverse Mercator (UTM) projection, Zone 17N, NAD83 CSRS datum, Canada local datum
- latitude/longitude co-ordinates, NAD83 CSRS, Canada local datum

The gridded data are provided in Universal Transverse Mercator (UTM) projection, Zone 17N, NAD83 CSRS datum, Canada local datum.

LINE NUMBERING

The line numbering convention for survey data provided in GDS 1088a and GDS 1088b are as follows.

- Traverse-line numbers are 6 digits and control lines are 5 digits with the last 2 digits indicating part or revision number. An example for clarification is presented in the following paragraph.

  Line 1001.00 is the first traverse line of the survey followed by line 1002.00; should line 1001.00 be in 2 parts, the first is 1001.00 and the second is 1001.10. Should line 1001.00 have been reflown, it will be in the database as line 1001.01. The same convention is used for the control lines.

- The control lines flown perpendicular to the traverse lines range from 101.00 to 190.00.
- In the Geosoft® Oasis montaj™ binary database, traverse lines are designated with a leading character "L" and control lines are designated with a leading character "T".

DATA FILES

The survey data files are provided as follows.

SRMAG.gdb	Geosoft® Oasis montaj™ uncompressed binary database file of the magnetic data, sampled at 10 Hz
SRMAG.xyz	ASCII file of the magnetic data, sampled at 10 Hz
SRKC.gdb	Geosoft® Oasis montaj™ uncompressed binary database file of the Keating coefficients
SRKC.csv	Comma-separated values file of the Keating coefficients

The contents of SRMAG.xyz/.gdb (both file types contain the same set of data channels) are summarized as follows.

Table 23. Contents of aeromagnetic data files SRMAG.xyz/.gdb.

Channel Name	Description	Units
gps_x_raw	Raw GPS X (NAD83 CSRS datum, UTM zone 17N)	metres
gps_y_raw	Raw GPS Y (NAD83 CSRS datum, UTM zone 17N)	metres
gps_z_raw	Raw GPS Z (CGVD2013)	metres
gps_base_x	GPS base station X (NAD83 CSRS datum, longitude)	decimal-degrees
gps_base_y	GPS base station Y (NAD83 CSRS datum, latitude)	decimal-degrees
gps_base_z	GPS base station Z (CGVD2013)	metres
gps_x_final	Differentially corrected GPS X (NAD83 CSRS datum, longitude)	decimal-degrees
gps_y_final	Differentially corrected GPS Y (NAD83 CSRS datum, latitude)	decimal-degrees
gps_z_final	Differentially corrected GPS Z (CGVD2013)	metres
x_nad83	Easting in UTM coordinates (NAD83 CSRS datum, UTM zone 17N)	metres
y_nad83	Northing in UTM coordinates (NAD83 CSRS datum, UTM zone 17N)	metres
lon_nad83	Raw longitude (NAD83 CSRS datum)	decimal-degrees
lat_nad83	Raw latitude (NAD83 CSRS datum)	decimal-degrees
radar_raw	Raw radar altimeter (metres above terrain)	metres
radar_final	Corrected radar altimeter (metres above terrain)	metres
radar_dem	Radar based digital elevation model with respect to mean sea level (CGVD2013)	metres
laser_raw	Raw laser altimeter (metres above terrain)	metres
laser_final	Corrected laser altimeter (metres above terrain)	metres
laser_dem	Laser based digital elevation model with respect to mean seal level (CGVD2013)	metres
fiducial	Fiducial	-
flight	Flight number	-
line_number	Full flight-line number (flight-line and part numbers)	-

Channel Name	Description	Units
line	Flight-line number	-
line_part	Flight-line part number	-
time_utc	UTC time	seconds
time_local	Local time	seconds
date	Local date	YYYY/MM/DD
height_mag	Magnetometer height (metres above terrain)	metres
mag_base_raw	Raw magnetic base station data	nanoteslas
mag_base_final	Corrected magnetic base station data	nanoteslas
fluxgate_x	X-component field of the compensation fluxgate magnetometer	nanoteslas
fluxgate_y	Y-component field of the compensation fluxgate magnetometer	nanoteslas
fluxgate_z	Z-component field of the compensation fluxgate magnetometer	nanoteslas
mag_raw_left	Raw magnetic field from port sensor	nanoteslas
mag_comp_left	Compensated magnetic field from port sensor	nanoteslas
mag_lag_left	Compensated, edited and lag corrected magnetic field from port sensor	nanoteslas
mag_raw_right	Raw magnetic field from starboard sensor	nanoteslas
mag_comp_right	Compensated magnetic field from starboard sensor	nanoteslas
mag_lag_right	Compensated, edited and lag corrected magnetic field from starboard sensor	nanoteslas
mag_raw_tail	Raw magnetic field from tail sensor	nanoteslas
mag_comp_tail	Compensated magnetic field from tail sensor	nanoteslas
mag_lag_tail	Compensated, edited and lag corrected magnetic field from tail sensor	nanoteslas
mag_diurn_tail	Diurnally corrected magnetic field from tail sensor	nanoteslas
mag_lev_tail	Levelled magnetic field from tail sensor	nanoteslas
mag_mlev_tail	Microlevelled magnetic field from tail sensor	nanoteslas
igrf	Local IGRF field	nanoteslas
mag_igrf_tail	Final microlevelled, IGRF corrected magnetic field from tail sensor	nanoteslas
mag_gsclev_tail	GSC montajlevelled magnetic field from tail sensor	nanoteslas
mag_grad_lat_raw	Raw lateral horizontal magnetic gradient (from wingtip sensors)	nanoteslas/metre
mag_grad_lat_cor	Levelling correction for lateral horizontal magnetic gradient (from wingtip sensors)	nanoteslas/metre
mag_grad_lat_final	Levelled lateral horizontal magnetic gradient (from wingtip sensors)	nanoteslas/metre
mag_grad_long_raw	Raw longitudinal horizontal magnetic gradient	nanoteslas/metre
mag_grad_long_cor	Levelling correction for longitudinal horizontal magnetic gradient	nanoteslas/metre
mag_grad_long_final	Levelled longitudinal horizontal magnetic gradient	nanoteslas/metre
pitch	Aircraft pitch	degrees
roll	Aircraft roll	degrees
yaw	Aircraft yaw	degrees
azimuth	Aircraft azimuth	degrees

The contents of SRKC.csv/.gdb (both file types contain the same set of data channels) are summarized as follows.

Table 24. Contents of Keating coefficient files SRKC.csv/.gdb.

Channel Name	Description	Units
x_nad83	easting in UTM coordinates using NAD83 CSRS datum	metres
y_nad83	northing in UTM coordinates using NAD83 CSRS datum	metres
lon_nad83	longitude using NAD83 CSRS datum	decimal-degrees
lat_nad83	latitude using NAD83 CSRS datum	decimal-degrees
corr_coeff	correlation coefficient	percent
amplitude	peak-to-peak anomaly amplitude within window	nanoteslas
norm_error	standard error normalized to amplitude	percent
pos_coeff	positive correlation coefficient	percent
neg_coeff	negative correlation coefficient	percent

GRID FILES

All grids are NAD83 CSRS UTM Zone 17N, in .gxf and .grd format and are summarized as follows.

Grid Name	Grid Cell Size (m)	Description
SRLASDEM83	40	Laser based digital elevation model with respect to mean sea level (CGVD2013)
SRMAG83	40	Total magnetic field
SRGMAGGSC83	20	“GSC levelled” gradient enhanced residual magnetic field
SRG1VDMAGGSC83	20	First vertical derivative of the “GSC levelled” gradient enhanced residual magnetic field
SRG2VDMAGGSC83	20	Second vertical derivative of the “GSC levelled” gradient enhanced residual magnetic field
SRLAG83	40	Measured lateral (across line) horizontal magnetic gradient
SRLOG83	40	Measured longitudinal (along line) horizontal magnetic gradient
SRHGRAD83	40	Calculated total horizontal magnetic gradient of the “GSC levelled”, gradient enhanced, pole reduced, residual magnetic field
SRANSIG83	40	Analytic signal derived from the “GSC levelled” gradient enhanced residual magnetic field

*Notes: *.gxf - Geosoft® uncompressed ASCII grid exchange format; *.grd - Geosoft® Oasis montaj™ uncompressed binary grid file*

GEOREFERENCED IMAGE FILES

Geographically referenced colour images, incorporating a base map, are provided in GeoTIFF format for use in GIS applications.

- SRGMAGGSC83.TIF — “GSC levelled” gradient-enhanced residual magnetic field grid + planimetric base
- SRG2VDMAGGSC83.TIF — shaded second vertical derivative of the “GSC levelled” gradient-enhanced residual magnetic field grid + planimetric base

VECTOR FILES

Vector line work from the maps is provided in DXF (v.12) ASCII format using the following naming convention:

- SRPATH83.DXF — flight path
- SRKC83.DXF — Keating coefficients
- SRMAG83.DXF — magnetic contours

The layers within the DXF files correspond to the various object types found therein and have intuitive names.

Appendix C. Digital Video Inventory Notes

Table 25. Digital video inventory notes.

Flight Line	Flight	Data Start Time	Data End Time	Note
1200.00	1006	47851.06	47985.45	File improperly closed at end of flight, original and repaired file provided
1520.00	2002	74457.50	75687.30	File improperly closed at end of flight, original and repaired file provided
1800.00	2005	61802.70	63006.60	Recording error, original and repaired file provided
2250.00	2011	63012.40	64224.70	File improperly closed at end of flight, original and repaired file provided
2470.00	2014	68820.30	69980.80	Recording error, original and repaired file provided