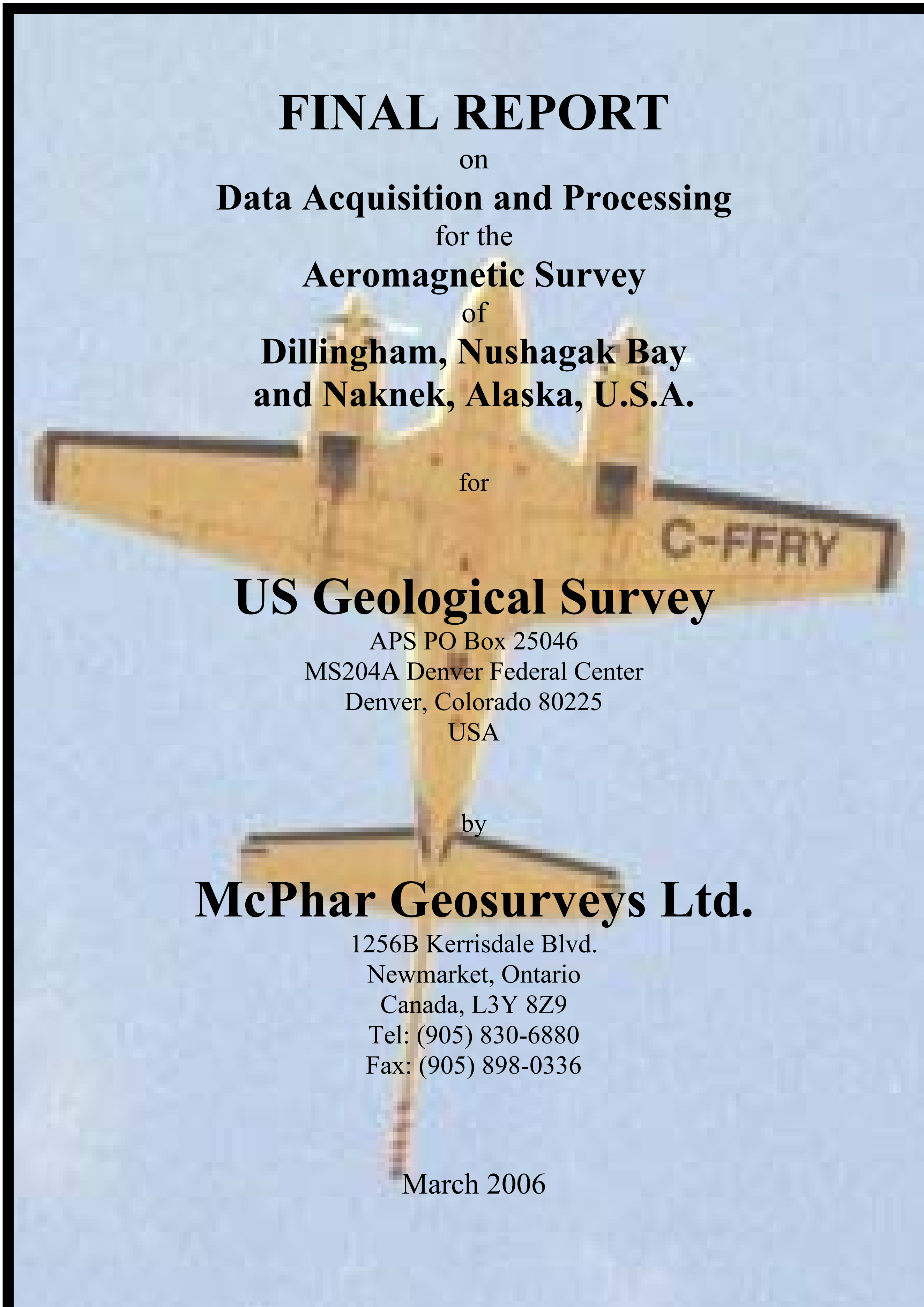

FINAL REPORT

on

Data Acquisition and Processing

for the

Aeromagnetic Survey

of

Dillingham, Nushagak Bay and Naknek, Alaska, U.S.A.

for

US Geological Survey

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SUMMARY

An airborne high-resolution magnetic survey was completed over the Dillingham and Nushagak Bay and Naknek area in southwestern Alaska. The flying was undertaken by McPhar Geosurveys Ltd. on behalf of the United States Geological Survey (USGS). First tests and calibration flights were completed by August 26th, 2005 and data acquisition was initiated on September 1st, 2005. The final data acquisition flight was completed on October 22nd, 2005. A total of 8,630 line-miles of data were acquired during the survey.

Figure 1: Example of the survey area in the Dillingham survey area, Alaska

1. INTRODUCTION

A detailed high-resolution fixed-wing magnetic survey was carried out during the period of August 21st, 2005 through October 22nd, 2005 on behalf of the United States Geological Survey, hereinafter referred to as "USGS", by McPhar Geosurveys Ltd., hereinafter referred to as "McPhar", over the Dillingham, Nushagak Bay and Naknek survey area in South-Western Alaska (*see Figure 1 on the next page*).

Mobilization of the aircraft, equipment and personnel to the survey base was completed on August 22nd, 2005. The initial flight tests and calibrations were completed on August 26th, 2005, and the first survey flight was carried out on September 1st, 2005. The last survey flight was carried out on October 22nd, 2005.

Field operations were based out of the village of Dillingham, South Western Alaska.

A 1:250,000-scale contour map and digital grid of the total magnetic field were produced, as well as a digital grid of the radar altimeter (ground clearance) data.

This report describes the data acquisition and processing procedures, parameters and delivery products for this survey.

2. SURVEY AREA

2.1 Outline of the Survey Area

The survey consisted of two blocks, Dillingham, and Nushagak Bay and Naknek. Below are the two blocks as outlined in the contract, and the actual block flown.

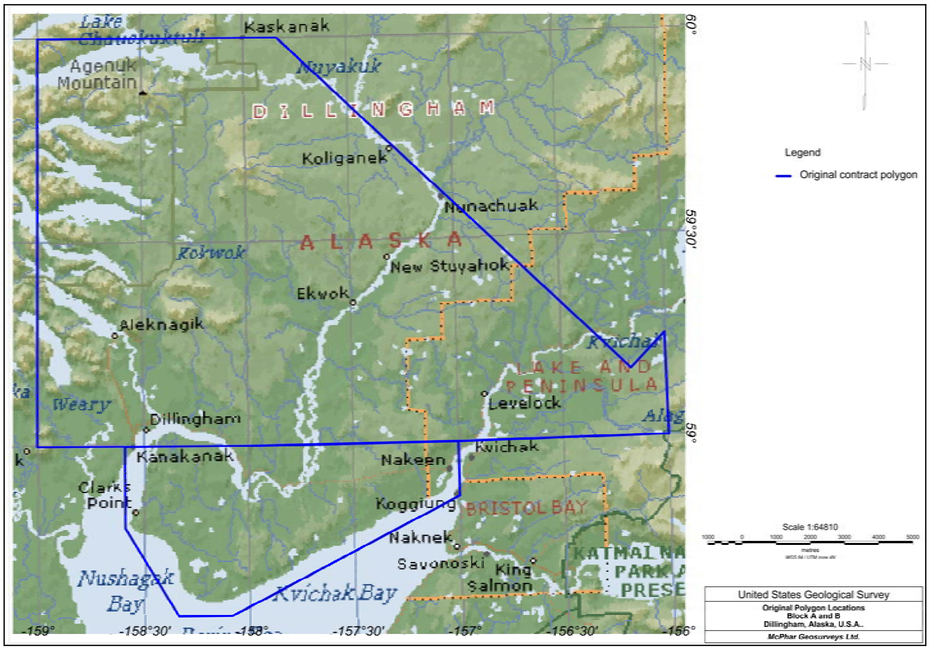

Figure 2: Location of the original Dillingham, and Nushagak bay and Naknek blocks as outlined in the contract.

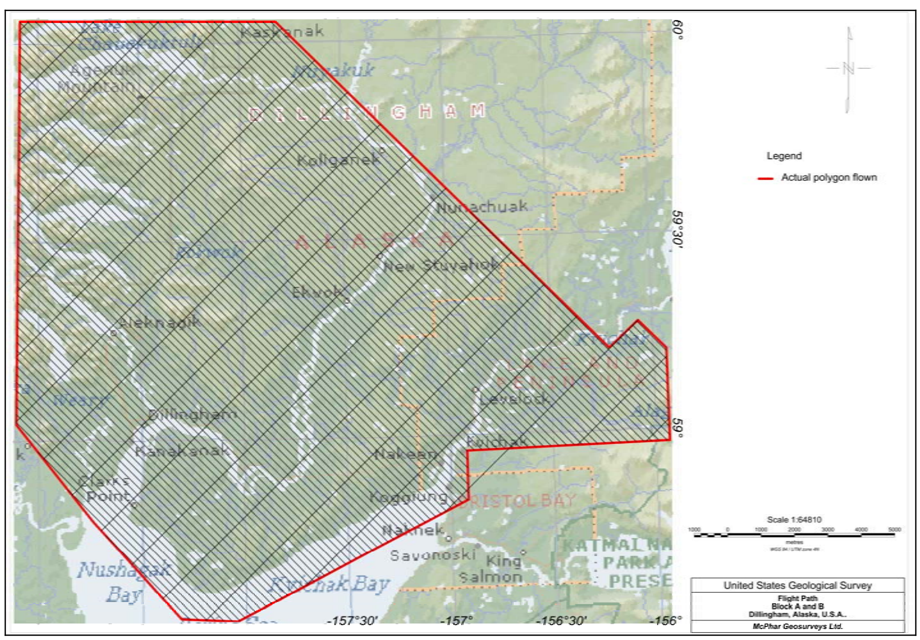

Figure 3: Actual polygon flown over the Dillingham, and Nushagak Bay and Naknek.

3. TECHNICAL SPECIFICATIONS

This section describes in detail the guidelines followed throughout the performance of the project.

3.1 Flight Specifications

Traverse Line Directions	315˚
Traverse Line Spacing	one (1) mile
Control Line Direction	55˚
Control Line Spacing	eight (8) miles
Terrain Clearance	nominally 1,000 feet
Line Miles	8, 616
Average Sampling Interval	20 feet (6 metres)

3.2 Tolerances

Reflights were carried out at McPhar's expense whenever survey lines or part survey lines were noted in the field to be beyond the contractual tolerances. All reflights covered a minimum of two control lines.

The tolerances observed were:

3.2.1 Navigation

Deviations from the pre-planned (pre-flight) paths will not exceed 10% of the designated flight line spacing. Gaps between adjacent flight lines greater than 1.5 times the designated flight line spacing for more than 2 linear miles (3.2 km) will require fill-in lines.

3.2.2 Flight Height

The maximum vertical deviations as indicated by the barometric altimeter will be +/-200 feet (61m) from the pre-planned draped flight surface except in areas where FAA regulations prevent flying at this height, and in areas of severe topography where the pilot's judgement will prevail.

3.2.3 Magnetic Diurnal

Survey data will not be acceptable when gathered during magnetic storms or short-term disturbances of magnetic activity at the magnetometer base station used, which exceeds the following:

- Monotonic changes in the magnetic field of 5 nT in any 5 minute period
- Pulsations having periods of 5 minutes or less shall not exceed 2 nT
- Pulsations having periods between 5 and 10 minutes shall not exceed 4 nT
- Pulsations having periods between 10 and 20 minutes shall not exceed 8 nT.

Survey data acquisition will be stopped altogether in the case of magnetic diurnal activity exceeding the above specifications.

3.2.4 Airborne Magnetometer Noise

The error envelope due to turbulence and the internal magnetometer noise will not exceed ±0.1 nT for more than 10% of any flight line. The magnetometer will be compensated for errors caused by the magnetic field of the aircraft such that manoeuvre noise will not exceed 3 nT for pitches or rolls of $\pm 20^{o}$ and heading changes will not cause a variation of more than 1 nT in the magnetic reading.

4. SURVEY OPERATIONS

4.1 Operations Base

Survey operations were based from Dillingham, Alaska. The magnetic base station was set up outside the Beaver Creek Bed and Breakfast, in a lightly forested area about 200 meters to the west of the main house.

McPhar's personnel at the crew residence undertook Quality Control and Preliminary Data Processing in Dillingham.

4.2 Diurnal Conditions

Magnetic diurnal conditions were varied throughout the survey. No production days were lost during the survey due to magnetic diurnal conditions being out of specifications.

4.3 Other Survey Conditions

Weather conditions during the survey were variable. Temperatures varied from a few degrees above zero Celsius on some days to as low as minus twenty degrees Celsius on others. The majority of the production days lost was due to unsafe flying conditions due to poor weather i.e. rain and/or snow, fog and poor visibility.

A total of two (2) days were lost to production for either aircraft or equipment maintenance.

In Appendix 2, the daily reports for the project, which describe in more detail the weather conditions for each day throughout the survey, may be found.

4.4 Navigation

The nominal data acquisition speed was approximately 220 kilometres per hour. Scan rates for the magnetic data acquisition was 0.1 second, 1.0 second for the radar and barometric altimeters, and 1.0 second for the GPS navigation/positioning system. Therefore, there is a magnetic value recorded about every 20 feet (6 metres) and a position fix each 65 yards (60 metres) along the flight track.

Navigation was assisted by a GPS receiver system that reports GPS co-ordinates as WGS-84 latitude & longitude and directs the pilot over the pre-programmed three-dimensional (3D) survey grid. The x-y-z position of the aircraft as reported by the GPS system was recorded together with the terrain clearance as reported by the radar altimeter and the pressure altitude observed by the barometric altimeter.

Vertical navigation along flight lines was established using the radar altimeter. The nominal terrain clearance during normal survey flying was 1,000 feet. However, due to rugged terrain in some areas, and the pilot's judgment of safe flying conditions in these areas, this terrain clearance was not possible 100% of the time.

The final vertical and horizontal survey positions were differentially corrected in real time during the flight, computed using the data from the onboard GPS receiver and three differential services: Space Base Augmentation Systems (SBAS), OmniSTAR, and DGPS beacon stations, to a precision of approximately +/- 1 m.

4.4.1 Flight Line Elevation Design

As a smooth acquisition surface was considered to be critical to the success of this program, McPhar pre-determined the flight line elevation variations and designed the acquisition altitude for each flight line in order to obtain optimum responses from the survey. The critical elements in the design of the flight surface were the safety of the data acquisition operation, the (median) performance parameters of the survey aircraft for climb/descent rates and the desire to drape as closely as possible to the specified 304 meters survey altitude. The pre-plot of this survey was, therefore, designed to encompass not only the standard XY location of each line, but also the Z component. To prepare the pre-plot, a digital topographic grid of the survey area using a sample density of points with a maximum spacing of thirty meters was used. The pre-plot was prepared using a climb gradient for the aircraft of 100 m/km. The pre-plot survey design was stored as the on-board navigation information for the pilot to fly with, using radar altimeter and, where possible, real-time differentially corrected GPS height for vertical control, and GPS positions for horizontal control. Final aircraft position was based on real time GPS in X, Y and Z and the radar altimeter.

Prior to the start of survey operations, McPhar provided a copy of the proposed 3D navigation flight plan to the USGS's supervisor for approval.

4.5 Geodetic & Mapping Parameters

The following geodetic and mapping parameters were observed throughout the data acquisition phase.

Length unit	metres
Projection	UTM zone 4N
Type	Transverse Mercator
Lat0, Lon0, SF, FE, FN	0, -159, 0.9996, 500000, 0
Datum	WGS84
Ellipsoid	WGS84
Majax, Eccen, PrimeMer	6378137, 0.08181919084,0
Local datum transform	WGS84 World

4.6 Quality Control & Field Processing

McPhar ensures Quality Control by using a team concept. The instrumentation onboard the survey aircraft permits basic quality control procedures. The team concept is continued at the Survey Base where a McPhar geophysicist undertakes a more comprehensive QC analysis of the data, and performs preliminary data processing. The data is then given a second, and more complete review, wherein all the systems onboard the aircraft are tested for compliance to the survey's specifications. Any problematic or unacceptable data is identified and flagged for re-flying by the survey crew. On a daily basis, this preliminary processed data is sent to McPhar's data processing centre, where other geophysicists commence the Final Data Processing work.

On this project, the survey data was transferred to portable magnetic media on a flight-by-flight basis, and then copied to the field data processing workstation. In-field data processing included reduction of the data to Geosoft GDB database format, post-flight compensation of the magnetometer data using McPhar's CCMAG software, and inspection of all data for adherence to contract specifications. Survey lines which showed excessive deviation after differential correction, or which were considered to be of inferior quality, for whatever reason, were reflown.

4.7 Survey Statistics and Daily Operations Reports

The aeromagnetic survey entailed a total of 35 flights; of which 19 were production flights or "re-flights". The first production flight was on September 1st, 2005 with the last production flight on October 22nd, 2005. The balance of the flights, were either test and/or calibration flights or flights that were aborted for bad weather or aircraft or equipment problems. Re-flights of data found unacceptable were carried out as processing of the data set progressed.

4.7.1 Daily Operations Reports

Daily Operations Reports commencing with Report #1 dated August 21st, 2005 and ending with, report # 63 October 22nd, 2005 may be found in Appendix 2.

These reports provide detailed information on the daily happenings during the survey.

5. Aircraft and Equipment

5.1 The Aircraft

The survey was flown using a PA-31 Piper Navajo aircraft with Canadian registration C-FFRY, which was owned and operated by Aries Aviation International of Calgary. The aircraft was modified as a geophysical survey platform, and features one high sensitivity magnetometer installed in a tail stinger. This aircraft can acquire aeromagnetic data at nominal survey airspeed of 135 knots (approx. 230 km/hour) with approximately 7 hours flight duration including the geophysical system and a crew of 2 persons onboard.

McPhar personnel at the Aries Aviation hanger in Calgary, Alberta carried out the installation of the geophysical and ancillary equipment. After the aircraft's arrival, final adjustments, calibration, and testing were completed in Dillingham, Alaska, prior to production survey flights commencing.

5.1.1 Aircraft Details

Aircraft Model:	-	PA-31 Piper Navajo
Aircraft Registration:	-	C-FFRY
Engines:	-	2 x Textron Lycoming T10-540-A
Empty Weight:	-	3,759 lbs / 1,709kg
Gross Weight:	-	6,500 lbs / 2.955 kg
Fuel Capacity:	-	350 gal/1,330 litres
Survey Speed:	-	120-160 knots/220-295 km/h
Survey duration:	-	7.5 hours
Ferry:	-	185 knots/ 340 km/h
Cruise Range:	-	1.295 nm/ 2300 km
Max. Alt:	-	26, 000 ft/ 8092 m.

The PA-31 Piper Navajo is fully described in Appendix 3.

5.2 The Survey Instrumentation

5.2.1 Survey System Overview

The instrumentation installed in the aircraft included:

- One Scintrex CS-2 high resolution cesium magnetometer
- Pico Envirotec AGIS-100 Data Acquisition System with imbedded GPS Navigation
- Computer and 3D Pilot Steering Indicator
- Pico Envirotec MMS-4 Multi-channel Cesium Magnetometer Processor
- NovAtel Performance GPS receiver
- NovAtel MiLLennium 24-channel, geodetic quality, L1/L2 GPS Navigation Receiver and antenna
- King KP-10 radar altimeter

* Billingsley Triaxial Fluxgate Magnetometer
* Dev-Tech Geo-iMAGE Lite Digital Imaging System and Sony digital camera
* Instrumentation Rack and Power Distribution System

The Base Stations and Ground Support Equipment comprised:

* Field Workstation comprising a portable Pentium PC, printer and full data processing software (CCMag Magnetic Compensation Software and Geosoft Montaj Processing Software)
* A Pico Envirotec GMAG Base Station, complete with a Cesium Magnetometer
* GEM GSM-19 Overhauser Magnetometer
  Synchronization of each of the two base stations described above with the airborne system was via GPS time.
* A complement of spare parts and test equipment were maintained at the survey base

5.2.2 Airborne Magnetometers

A Scintrex CS-2 cesium split-beam total-field magnetometer was installed in the tail stinger of the aircraft. Sampling rate was twenty (20) times per second with an in-flight sensitivity of 0.001 nT. Aerodynamic magnetometer noise was +/- 0.01 nT. The sensitivity of the magnetometer was recorded at 0.001 nT when operated at a sampling rate of 0.1 second.

The Scintrex CS-2 magnetometer is described in Appendix 3.

5.2.3 Magnetic Compensation

Compensation for the orientation and movement of the aircraft in the Earth's ambient magnetic field was undertaken using a McPhar proprietary program called "CCMAG" installed on the Field Workstation. The Larmor frequency output of the cesium magnetometer sensor installed in the tail stinger on the aircraft was processed by a high precision frequency counter in the AGIS 100/ MMS-4 data acquisition system (resolution of 0.001nT at a sampling rate of 20 times per second). A three-axis Billingsley fluxgate magnetometer monitored the attitude and motion of the aircraft in flight. The output from this fluxgate magnetometer, or attitude sensor, was then used in the "CCMAG" processing of the raw magnetic data to produce magnetic data compensated for the orientation and motion of the aircraft in the Earth's magnetic field.

The CCMAG post-flight compensation program and the Billingsley fluxgate 3-axis magnetometer are described in Appendix 3.

5.2.4 The Base Station Magnetometers

Two base station magnetometers were used during this project. Both utilized high-sensitivity cesium vapor magnetometers and were time-synchronised with the airborne system using GPS time.

The magnetometer system used at the survey base in Dillingham was comprised of a Pico-Envirotec GMAG base station data recorder and cesium magnetometer to monitor and record diurnal variations of the Earth's magnetic field. The base station magnetometer was set up in a quiet area just outside the Beaver Creek Bed and Breakfast. Every effort was made to ensure that the magnetometer sensor was placed in a location of low magnetic gradient and sited away from electric transmission lines, and moving ferrous objects, such as motor vehicles and aircraft.

The magnetometer system that was used at the remote field sites (the USGS contract required that "*One or more continuously recording ground magnetometers shall be located within 50 miles (80 km) of all survey points"*) was a GEM GSM-19 Overhauser magnetometer. This base station was operated continuously throughout the airborne data acquisition work from September 20th , 2005, until the end of the survey, at Larry Lee's residence in Koliganek. The ground and airborne system clocks were synchronised using GPS time, to an accuracy of 1 second or better. The sample rate of the base station was once per second. A continuously updated profile plot of the base station values was presented on the base station screen. Every two to three days, the digital data was transferred from the base station's data logger to the fieldwork station.

A pamphlet describing the GMAG Magnetometer and GEM GSM-19 can be found in Appendix 3.

Figure 4: Base station located in Dillingham, Alaska outside the Beaver Creek B&B – magnetometer.

Figure 5: Console and Batteries for the Dillingham base station.

Figure 6: GEM GSM-19 Magnetometer and all components.

5.2.5 Altimeters

A King KP-10 radar altimeter system was used to record the aircraft terrain clearance to an accuracy of less than 1 metre (approximately 3 ft), over a range of 40 ft to 2,500 ft.

A Setra 276 barometric altimeter/pressure transducer measured the barometric pressure, from which the elevation of the aircraft above sea level was calculated.

This barometric altimeter has an accuracy of ±0.02% and a resolution of 0.5 meters.

The altimeters were interfaced to the data acquisition system with an output repetition rate of 0.1 second, and were digitally recorded.

The Altimeters are further described in Appendix 3.

5.2.6 The GPS NAVSTAR Satellite Navigation System

A NovAtel high-performance navigation/positioning system was used on the aircraft. This system consisted of a NovAtel Millennium GPS receiver and NovAtel L1/L2 GPS Antenna.

Figure 7: Koliganek base station console at Larry Lee's residence.

A pilot steering indicator, providing steering instructions to the pilot in three dimensions, was installed on top of the cockpit dashboard. This indicator was connected to the AGIS-100 data acquisition system receiving information from the GPS system and the radar altimeter.

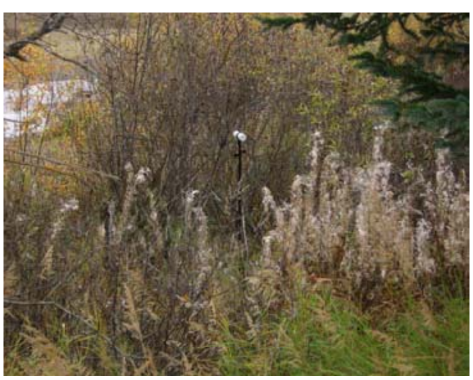

Figure 8: Base station magnetometer in Koliganek.

Survey co-ordinates were set-up prior to commencement of the survey and the information loaded into the airborne navigation system. The co-ordinate system employed in the survey design and digital recording was WGS-84 latitude and longitude. The GPS positional data was recorded at one second intervals and used with data obtained from three different differential services: Space Based Augmentation Systems (SBAS), Omni STAR, and DGPS beacon stations, to calculate real-time differentially corrected locations.

5.2.7 Data Acquisition/Recording System

A PC-based AGIS-100 data acquisition system (DAS) was used to record the geophysical and navigation data on board the aircraft. Data was simultaneously recorded on hard disk (and later copied to a flashcard) at a repetition rate of 0.1 sec for post-flight computer processing. The five main functions fulfilled by the DAS are: 1) system control and monitoring, 2) data acquisition, 3) real-time data processing, 4) navigation, and 5) data playback and analysis.

The AGIS-100 is a fully PC-compatible microcomputer. All data collection routines, checking, buffering, recording and verification are software controlled for maximum flexibility. A modular concept is used for both the software and the hardware to allow for future expandability. The sensors used with AGIS-100 may include radiometric, magnetic and electromagnetic. Data being recorded is monitored on a colour LCD display as pseudo-analog traces to verify quality and functionality of the data being recorded.

The AGIS-100 is fully described in Appendix 3.

Figure 9: Agis 100 Data Acquisition System installed in C-FFRY.

5.2.8 Field Computer Workstations

A Data Processing Field Workstation (FWS), a dedicated PC- based notebook computer for use at the technical base in the field, was used on this project. The FWS is designed for use with Geosoft OASIS/Montaj Data Processing Software. The FWS has a data re-plot capability, and may be used to produce pseudo-analogue charts from the recorded digital data within less than 12 hours after the completion of a survey flight, if this is necessary. It is also capable of processing and imaging all the geophysical and navigation data acquired during the survey, producing semi-final, preliminary-levelled maps.

The FWS was used to accomplish the following:

- **Quality Control/Digital Data Verification** - flight data quality and completeness were assured by both statistical and graphical means on a daily basis
- **Flight Path Plots** - flight path plots were generated from the GPS satellite data to verify the completeness and accuracy of each day's flying
- **Preliminary Maps -** the Geosoft software system permitted preliminary maps to be quickly and efficiently created for noise and coherency checks.

The Montaj software is designed for airborne data editing, compilation, processing and plotting.

The software reads the portable data media from the airborne system, checks for gaps, spikes or other defects and permits the data to be edited where necessary. The base station GPS/magnetometer data is checked, edited, processed and then merged with the airborne data. GPS flight path plots are created and plotted for both flight planning and flight path verification. Multi-channel stacked profiles of the recorded and edited data may be produced on a dot-matrix printer or plotter, as required. The software can also be used to carry out flight path recovery, magnetic levelling, filtering, gridding and contouring of data, imaging of gridded data and plotted to any desired map scale and map layout should the facilities be available.

5.2.9 Geo-iMAGe Lite Colour Digital Imaging System

The primary focus of this digital video imaging system is to replace the traditional 8-mm "VCR" with a digital picture recording mechanism. Any standard CD-ROM may be used to view the frame or frames of choice on a computer, using any variety of commercial imagery software, such as ER-MAPPER.

To record digital imagery of the ground over which the aircraft flew, a DevTech Geo-iMAGe-Lite Colour Digital Imaging System, comprised of the following, was provided:

- Stand alone rack mountable mini-computer system, Pentium III 1.0 GHz clock speed c/w 256 MB RAM memory, 20 GB HDD, LCD TFT screen, keyboard and mouse.
- Windows 2000 Professional Operating System and custom software to enable acquisition of .JPG video frames at a resolution of up to 800 x 600 pixel x 256 colours.
- User selectable frame acquisition rate controlled by 1 PPS signal from GPS receiver - from 1 frame to 5 frames per second.
- Sony digital colour video camera with 1/3 inch CCD video element.
- 2.8- to 4-mm focal length auto-iris lens for low-level video acquisition (47^{o} to 96^{o} viewing angle).

5.2.10 Spares

A normal compliment of spare parts, tools, back-up software, and necessary test instrumentation was kept available in the field office.

6. INSTRUMENT CHECKS AND CALIBRATIONS

6.1 Airborne Magnetometer System Tests and Calibrations

6.1.1 Manoeuvre Noise

As the magnetometer system sensor, installed in the tail stinger, is still within the magnetic effect of the aircraft structure, tests were conducted at regular intervals to determine the effects of aircraft roll, pitch, and yaw. These tests were completed at high altitude over an area of low magnetic gradient by performing +/- 10˚ rolls, +/- 5˚ pitches and +/- 5˚ yaw manoeuvres flown over periods of 4-5 seconds in the same direction as the flight and tie lines. A compensated Figure-of-Merit (FOM) for the aircraft was calculated by summing the peak-to-peak amplitudes of the twelve magnetic manoeuvres. The FOM was determined at the commencement of flight operations on August 26th, 2005. The FOM on flight #1 was determined to be 0.237nT for the tail stinger sensor. Detailed information about the FOM tests is provided in Appendix 2.

6.1.2 Magnetic Heading Effect

The magnetic heading effect was determined by flying a cloverleaf pattern oriented in the same direction as the survey lines and tie lines on several occasions. At least two passes in each direction were flown over a recognizable feature on the ground in order to obtain sufficient statistical information to estimate the heading error. The heading error was determined before the survey on August 26th, 2005. Results of the Magnetic Heading test are provided in Appendix 2.

6.1.3 Lag Tests

Lag tests were performed on August 26th, 2005 to ascertain the time difference between the recorded magnetometer readings and the output of the GPS System. Test flights were flown in two directions at survey altitude across distinct anomalies on several occasions during survey operations. Results of the Lag test are provided in Appendix 2.

6.1.4 Altimeter Calibration Checks

Checks of the radar altimeter calibration were undertaken at regular intervals during the survey. The calibration was determined by comparing the radar altitude with the Differential GPS altitude and readings from the barometric altimeter during flights at predetermined altitudes. Altimeter calibrations for the start and end of the survey August 26th, 2005 are provided in Appendix 2.

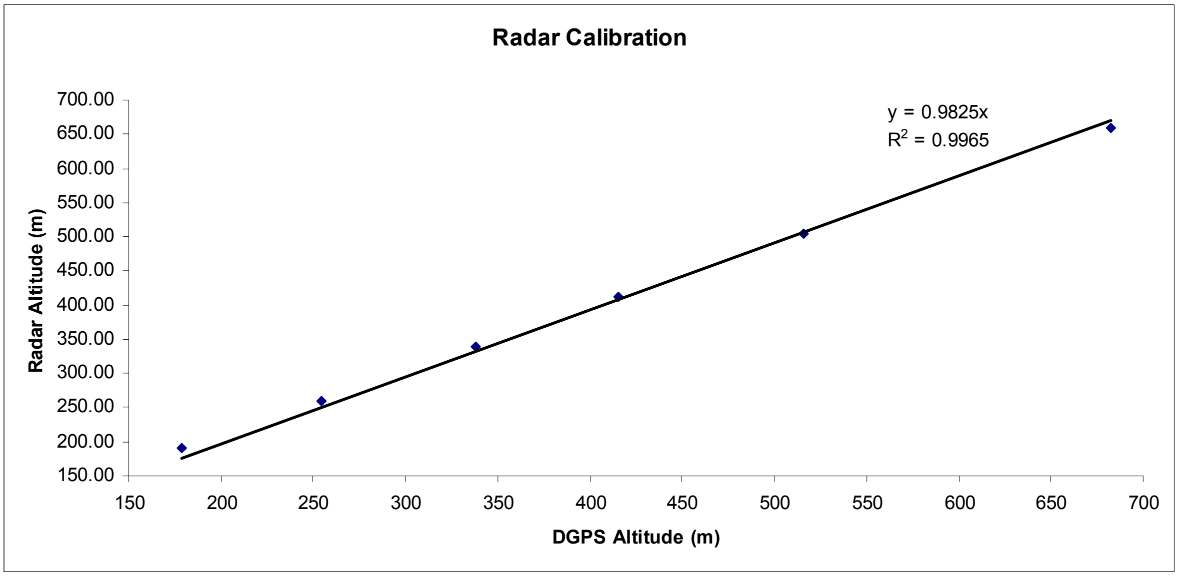

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Figure10: Results of the Radar test performed August 26th, 2005.

6.1.5 Other Daily Checks

The validity of data on all system channels were checked at the start and end of each survey flight, together with the synchronization of each of the systems (airborne and ground).

7. DATA PROCESSING

Daily quality control, initial processing and archiving of the data were done on-site at the base of operations in Dillingham, Alaska. The final data processing, map generation and report writing was undertaken at the offices of McPhar Geosurveys Ltd, in Newmarket, Ontario.

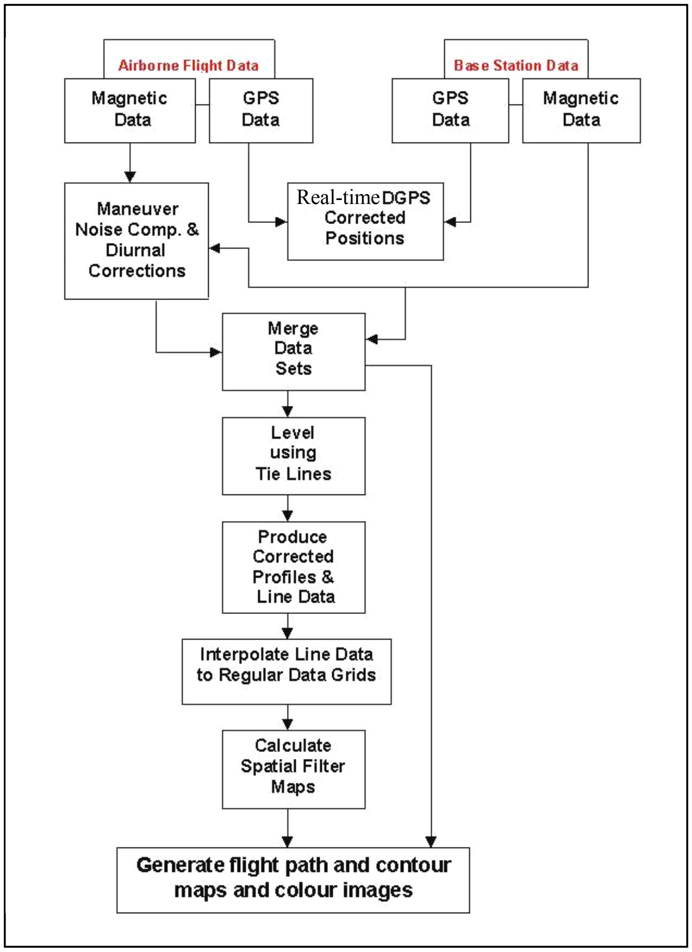

Figure 11: Data Processing Flow Chart

7.1 Flight Path Compilation

The flight path was derived from real-time differentially corrected GPS positions using the airborne and three different differential services (Space Based Augmentation Systems (SBAS), OmniSTAR, and DGPS beacon stations) GPS data. A position was calculated each 1.0 second (approx. each 60 metres along the flight path) to an accuracy of better than ±1.5 metre. These position data were merged into magnetic and ancillary data in the Geosoft GDB database.

7.2 Base Station Magnetic Data

The base station magnetometer data was edited, plotted and merged into the GDB database on a daily basis.

7.3. Corrections to the Magnetic Data

The processing of the Naknek, Nushagak, and Dillingham data involved post-flight compensation for the movement and orientation of the aircraft in the Earth's magnetic field, correcting for diurnal variations by using the digitally recorded ground base station magnetic values, and finally network adjustment using the flight-line and tie-line information to level the survey data set. This corrected data set was used to generate the initial grids and served as a base for all further processing and analysis.

7.3.1 Additional corrections applied to profile data

After applying the above mentioned initial corrections to the profile data there were still some line- direction-related noise present on the calculated grids. To remove this noise, microleveling was applied. Its main purpose is to remove from the data remaining line-direction-related noise. The microleveling technique consists of applying directional and high pass filters to the resulting grid, which leaves signal with noise-only in the line direction. In order to differentiate between the two of them, the grid is extracted to the profile database, and an amplitude limit and a filter length are determined, so that the final error channel reflects only noise present on the grid without removing or changing geological signal. This error channel is then subtracted from the initial data channel in order to get the final microleveled channel. The resulting grid is then free of line directed-noise.

This method was applied to the Total Magnetic Field, Horizontal Gradient and Digital Elevation Model Channels. Those channels were then subjected to further gridding and spatial filtering.

7.3.2 Gridding

The corrected magnetic line data from each grid was interpolated between survey lines using a random point gridding method to yield x-y grid values for a standard grid cell size of 1/5th of the line spacing. Generally the Minimum Curvature algorithm (MINC) is used to interpolate values onto a regular spaced grid.

8. DELIVERABLE PRODUCTS

8.1 Maps

Two copies of the magnetic field contour map are presented at 1:250,000 scale with UTM registration plus screened flight path, in black and white, on mylar.

8.2 Digital Archives

Files:	raw and final processed profile data, final magnetic, and radar altitude grids
Format:	The ASCII format is used for profiles, and ASCII *Geosoft exchange format* (.gxf) is used for grids. A full format description is included in the appendix.
Media:	CD-ROM.
Copies:	two

8.3 Report

Two (2) copies of a survey report were delivered, complete with final map as page size map. This report provides information about the acquisition, processing and presentation of the survey data.

Respectfully submitted,

McPhar Geosurveys Ltd.

Robert Hearst, M.Sc., P.Geoph. (NAPEG)
General Manager - Operations

9. ONSITE PERSONNEL

The following personnel were onsite crew on the project in Alaska, based out of Dillingham:

		Days Onsite
Data Processor/QC Geophysicist:	Dallas Antill	7
	Rebecca Bodger	63
Technician/Operator:	Daniel McKinnon	63
Pilot:	Rory Clayton	32
	Hakon Askerhaug	31
AME:	Andre Leblanc	32
	Bob Passon	31

9.1 Diary of Personnel Movements

August 22	Crew arrives in Dillingham
September 20	Second base station in Koliganek is set up.
October 23	De-mobilization of aircraft, equipment and personnel from Dillingham Alaska

The crew onsite at the end of the project were:

Hakon Askerhaug	Norwegian/Canadian	Pilot
Bob Passon	Canadian	AME
Daniel Mckinnon	Canadian	Field Technician/Operator
Rebecca Bodger	Canadian	Field QC

9.2 Data Processing Personnel

The following personnel were involved in the Final Data Processing at McPhar's office in Newmarket:

Robert Hearst
Tomas Grand
Tonia Bojkova
Christina Clark
Rebecca Bodger

APPENDICES

APPENDIX 1 **Statement of Qualifications**

APPENDIX 2 **System Tests and Reports**

- Altimeter Test
- Lag Test
- Heading Correction Tests
- FOM
- Magnetic Base Station Forms
- Daily Reports
- Flight Logs

APPENDIX 3 **Equipment Description**

- Piper PA-31 Navajo Aircraft
- Scintrex CS-2 High Resolution Cesium Magnetometer
- Pico-Envirotec AGIS Airborne Data Acquisition System
- Billingsley Triaxial Fluxgate Magnetometer
- MMs-4 Multi-channel Cesium Magnetometer Processor
- Terra TRA3000/TRI-30 Radar Altimeter
- NovAtel MiLLenniumGPS System
- NovAtel L1/L2 GPS Antenna
- Pico-Envirotec GMAG Base Station Cesium Magnetometer
- GEM GSM-19 Overhauser Magnetometer Base Station
- Geo-iMAGe Lite Colour Digital Imaging System
- CCMag Magnetic Compensation Software
- Geosoft Montaj Processing Software
- FWS Field Workstations

APPENDIX 4 **McPhar Personnel Resumes**

- Robert Hearst
- Tomas Grand
- Tonia Bojkova
- Christina Clark
- Daniel McKinnon
- Dallas Antill
- Rebecca Bodger

APPENDIX 5 **Digital Data Specifications**

APPENDIX 6 **Page Size Maps**