

FUGRO AIRBORNE SURVEYS INC.

**NON-EXCLUSIVE
HIGH SENSITIVITY AEROMAGNETIC SURVEY
FORT SIMPSON AREA, NWT
Project Ref. 01C08-18**

Blocks North and South

FINAL TECHNICAL REPORT

November 2002



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1.0 INTRODUCTION

From August 20th to November 23rd, 2001 and from February 16th to June 7th, 2002, FUGRO Airborne Surveys Quebec Inc. (FASQ) had flown a non-exclusive high-resolution aeromagnetic survey on two blocks located in the Fort-Simpson area, Northwest Territories.

The blocks shown on figure 1 were flown with traverse lines spaced 400 and 800 metres. The spacing between traverse lines never varied by more than 50% from the nominal spacings over a distance of more than 2 km. Control line was 1200 and 2400 metres spaced and presented the same absolute horizontal deviation tolerance. Table 1 presents the specifications of the survey block and table 2 outlines the survey areas. The nominal survey height was 100 metres above the surface of the ground. The topographic relief in the survey area presented no significant challenge in meeting altitude specifications.

The base of operation was located in the small town of Fort Simpson. The field quality control and data processing was performed at the field office, which was located at the Nahanni Hotel.

The primary goal of this project was to provide high quality digitally recorded and processed geophysical data in order to assist geological mapping and to indicate structures potentially favourable to petroleum and mineralisation.

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



Table 1: Survey Blocks

| BLOCK | TIE-LINE SPACING (m.) | TIE-LINE DIRECTION | TRaverse SPACING (m.) | TRaverse DIRECTION |
|-------|-----------------------|--------------------|-----------------------|--------------------|
| North | 2400 | 0° | 800 | 90° |
| South | 1200 | 0° | 400 | 90° |

Table 2: Survey Areas

| Block North | | | |
|--------------|---------------|-----------|-----------|
| Latitude (°) | Longitude (°) | X (Nad27) | Y (Nad27) |
| -124.000000 | 61.000000 | 445913.5 | 6762995.9 |
| -124.000000 | 62.000000 | 447622.1 | 6874382.0 |
| -126.000000 | 64.000000 | 353298.8 | 7100271.1 |
| -122.000000 | 64.000000 | 548912.6 | 7097201.7 |
| -122.000000 | 62.000000 | 552377.9 | 6874382.0 |
| -120.000000 | 62.000000 | 657098.0 | 6877611.0 |
| -120.000000 | 61.000000 | 662224.6 | 6766298.9 |
| Block South | | | |
| Latitude (°) | Longitude (°) | X (Nad27) | Y (Nad27) |
| -122.000000 | 61.000000 | 554086.5 | 6762995.9 |
| -120.000000 | 61.000000 | 662224.6 | 6766298.9 |
| -120.000000 | 61.166667 | 661373.6 | 6784850.1 |
| -119.083333 | 61.166667 | 710645.9 | 6787458.6 |
| -119.083333 | 59.820556 | 719568.5 | 6637711.5 |
| -118.345556 | 59.820556 | 760886.8 | 6640388.1 |
| -118.345556 | 59.997778 | 759498.7 | 6660092.6 |
| -118.000000 | 59.997778 | 778740.8 | 6661499.9 |
| -118.000000 | 59.500000 | 782922.4 | 6606168.7 |
| -120.000000 | 59.500000 | 665820.5 | 6599353.8 |
| -120.000000 | 60.000000 | 667301.3 | 6654999.1 |
| -122.000000 | 60.000000 | 555778.4 | 6631626.2 |

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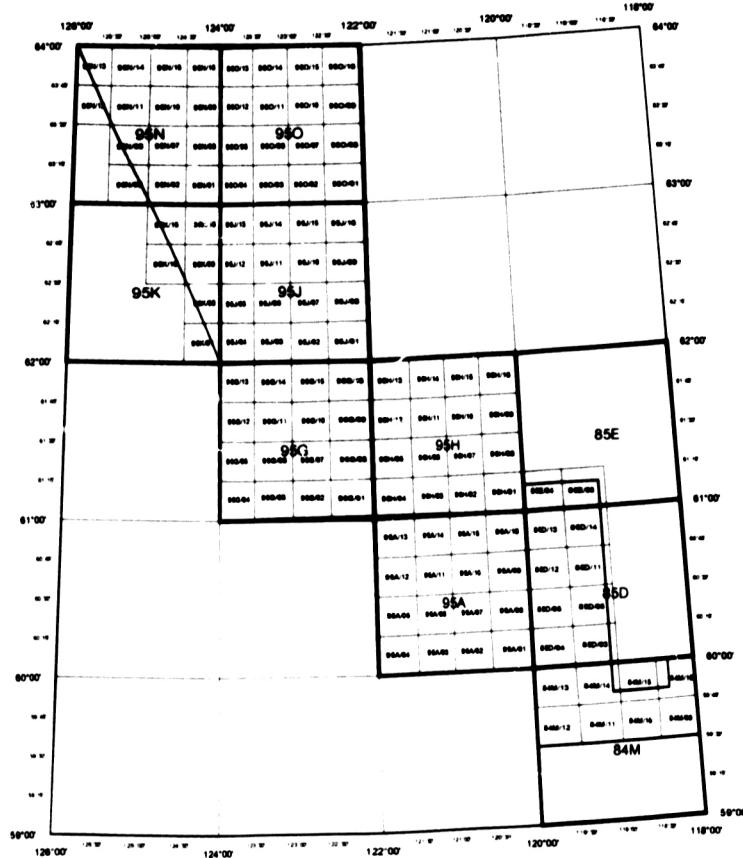


Figure 1: Survey Areas

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2.0 SURVEY OPERATIONS

The base of operation was located in the small town of Fort Simpson. The field quality control and data processing was performed at the field office, which was located at the Nahanni Hotel.

Due to the bad winter weather in the area, the survey was flown in two phases (2001 and 2002). Table 3 shows that four different aircraft were mobilized and Table 4 presents the overall production of each aircraft.

Preliminary data were available on a regular basis while the survey was in progress. The final processed database, on CD-ROM, was delivered early in October 2002.

Table 3: Aircraft Used

| Phase | Aircraft Registration | Type | Schedule | |
|-------|-----------------------|-----------------------|-------------|--------------|
| | | | From | To |
| 2001 | C-FXCI | Piper Navajo PA31-350 | August 20 | September 13 |
| | C-FYAU | Cessna 404 StationAir | August 20 | November 16 |
| | C-FZLK | Cessna 208B | August 20 | November 23 |
| 2002 | C-GHRM | Cheyenne II PA-31 | February 23 | April 28 |
| | C-FZLK | Cessna 208B | February 16 | June 7 |



Table 4: Overall Survey Progress

| Fort Simpson | | | | | | | |
|----------------------|------------------|-------------|-------------|-------------|------------|-------------|-----------------|
| | Lost Time (Days) | | | | Tests | Mobi-Demob. | Production Days |
| | Weather | Diurnal | Instruments | Aircraft | | | |
| C-FYAU (2001) | 34 | 10 | 1.5 | 25.5 | 0.5 | 1 | 11.5 |
| C-FZLK (2001) | 28.5 | 11 | 1 | 8.5 | | | 18.5 |
| C-FXCI (2001) | 1.5 | 3 | | 10 | 1 | | 9 |
| C-GKRM (2002) | 14 | 16.5 | | 3 | 0.5 | | 20.5 |
| C-FZLK (2002) | 17.5 | 28.5 | 2.5 | 6 | 3.5 | 2 | 51.5 |
| TOTAL (days) | 95.5 | 69 | 5 | 53 | 5.5 | 3 | 111 |
| TOTAL (%) | 27.9 | 20.2 | 1.5 | 15.5 | 1.6 | 0.9 | 32.4 |

3.0 CALIBRATION AND TESTS

3.1 Figure of Merit

Aircraft movements induce spurious magnetic fields, which are removed from the magnetic data by the compensator (section 5.2.2). The efficiency of this removal can be evaluated by conducting a test called a Figure of Merit (F.O.M.). The aircraft flies a series of three manoeuvres of $\pm 10^\circ$ rolls, $\pm 5^\circ$ pitches and $\pm 5^\circ$ yaws in each of the traverse and control line directions (N-S, S-N, E-W and W-E for this survey) in a magnetically quiet zone (low gradient) at high altitude. The peak-to-peak amplitudes of the responses obtained on the magnetometer compensated channel are determined for each of the three manoeuvre types and for each of the four directions. The twelve values are then

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summed giving a total called the Figure of Merit. This F.O.M. must be less than 2.0 nT or corrective action must be taken to minimise these spurious magnetic fields on the survey aircraft. The F.O.M. is determined at the beginning of the survey and repeated monthly or if a major change in aircraft or magnetometer equipment has occurred. The F.O.M. tests performed during the survey are presented in appendix A and summarised in Table 5.

Table 5: F.O.M. Tests

| Aircraft | Date | Results (nT) | Note |
|----------|-----------------------------------|--------------|---------|
| C-FXCI | August 20 th , 2001 | 0.814 | On Site |
| C-GHRM | February 25 th , 2002 | 1.676 | On site |
| C-FYAU | August 21 st , 2001 | 0.458 | On site |
| | September 19 th , 2001 | 1.183 | On site |
| | October 15 th , 2001 | 1.300 | On site |
| C-FZLK | February 17 th , 2002 | 0.920 | On site |
| | March 28 th , 2002 | 1.179 | On site |
| | April 27 th , 2002 | 1.130 | On site |
| | May 6 th , 2002 | 0.747 | On site |

2.2 Heading Tests

Before survey production starts, a Heading Test is performed at the survey altitude in two directions (roughly N-S and E-W). The Heading errors are determined for both orientations. The maximum value to be tolerated in each of the two headings is 2 nT, and 10 nT for the total field magnetic absolute value. The Heading Tests performed during the survey are presented in appendix A and summarised in Table 6.

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Table 6: Heading Text

| Table 6: Heading Tests | | | |
|------------------------|----------------------------------|--------------|---------|
| Alarms | Date | Results (mT) | Note |
| C-FXCI | August 28 th , 2001 | 1.01 | On Site |
| C-GHRM | February 25 th , 2002 | 1.96 | On site |
| C-FYAU | August 22 nd , 2001 | 0.74 | On site |
| C-FZLK | May 12 th , 2002 | 1.98 | On site |

3.3 Lag Test

In order to ascertain the lag between the navigational data (i.e. X-Y co-ordinates) and the total magnetic field, radar and barometric altimeter data, a lag test is performed before the survey begins. For the magnetic data, this was done by flying in two opposite directions over a body creating a sharp magnetic anomaly (antenna). For barometer and radar altimeter, data from the altimeter tests and from the actual survey (over flat ground or water surfaces) were used for lag determination. Results are presented in Appendix A and summarised in table 7.

Table 7: Results of the Log Test

| Table 7: Results of the Lag Tests | | |
|-----------------------------------|----------------------------------|-------------------|
| Aircraft | Date | Lag Mag. (second) |
| C-FXCI | August 8 th , 2001 | 0.80 |
| C-GHRM | February 25 th , 2002 | 0.62 |
| C-FYAU | August 21 st , 2001 | 0.75 |
| C-FZLK | April 27 th , 2002 | 0.58 |
| | May 5 th , 2002 | 0.66 |

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3.4 Altimeter Tests

For each aircraft, the barometer and radar altimeter calibration was performed on site. Results are presented and graphed in Appendix A.

| Table 8: Altimeter Tests | |
|--------------------------|----------------------------------|
| Aircraft | Date |
| C-FXCI | August 21 st , 2001 |
| C-GHRM | February 25 th , 2002 |
| C-FYAU | August 21 st , 2001 |
| C-FZLK | March 9 th , 2002 |

4.0 PERSONNEL

Mr. Mouhamed Moussaoui, Operation Manager for FASQ, carried out co-ordination and general management of the project. Mr. Roger Poirier and Ms. Sarah Forté were responsible for the field quality control. Mr. Camille St-Hilaire was responsible for the final data processing, which was carried out at FASQ's office in Montreal. The survey crew and office personnel are presented in table 9.

FUGRO AIRBORNE SURVEYS**Table 9: Field and Office Crew**

| Position | Name | |
|--|--|---|
| Project Manager | Mr. Mouhamed Mouassou, P.Eng. | |
| Field Geophysicist & data processing | Mr. Saleh Elmoussou Mr. Pierrick Chasseriau Mr. Roger Poirier | Mr. Jeremy Weber Mr. Deru Cao Ms. Sarah Forté |
| Field Operator & Electronic Technician | Mr. Sylvain St-Onge Mr. Pierre Filion Mr. Iaroslav Gorokhovski Mr. Edmarques costa Mr. Antonio Fonseca Mr. Charles Matteau Mr. Hector Cuellar | Mr. Kenneth Bernier Mr. Patrick Chapados Mr. Trvais Reed Mr. Dominique Béland Mr. Olivier Ayotte Mr. Enrique Aparacio Mr. Kent Gorling |
| Pilot | Mr. Micheal Waller Mr. Les Maike Mr. Ed Heisler Mr. Enrique Silva Mr. Steve Katsikaris Mr. Mark Tapp Mr. Brian McEvoy Mr. Kari Mattinen Mr. Dave Jacques | Mr. Hugues Thériault Mr. Chris Rye Mr. Eric Picaud Mr. Duane Colbers Mr. Brock Gorrell Mr. Kirk Bromfield Mr. Sam El-Tawill Mr. Paul Collieran Mr. Neil Fieldsend |
| Aircraft mechanic | Mr. Shawn Erikson Mr. Tom Gresham Mr. Stathi Tasangaris Mr. Mike Kilback | Mr. Leo Favaron Mr. Rob Vincent Mr. Jeff Rob |
| Office Data Verification | Ms. My Phuong Vo Mr. Gérard Tessier | Ms. Isabelle D'Amours Mr. Saleh El Moussou |
| Survey Report | Mr. Camille St-Hilaire | |

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5.0 SURVEY EQUIPMENT

5.1 Aircraft

The survey was completed using four aircraft. The characteristics of each aircraft are given below.

5.1.1 C-FXCI

| | |
|---------------------------|---------------------|
| Type: | Piper Navajo 310 |
| Registration: | C-FXCI |
| Range (km): | 1500 |
| Survey speed (knots): | 145 |
| Sea Level Climb Gradient: | Greater than 10.8 % |
| Aviation Fuel: | AVGAS |
| Fuel consumption (L/hr): | 110 |
| Oil Consumption: | Negligible |

5.1.2 C-FYAU

| | |
|----------------------------------|------------------------------|
| Type: | Cessna 404 Titan |
| Registration: | C-FYAU |
| Engines: | 2 Turbocharged fuel-injected |
| Range (km): | 2500 |
| Survey speed (knots): | 135 (250 km/hr) |
| Sea Level Rate-of-Climb (m/sec): | 8.0 |
| Aviation Fuel: | AVGAS |
| Fuel consumption (L/hr): | 120 |
| Oil Consumption: | Negligible |

**5.1.3 C-FZLK**

| | |
|---------------------------|---------------------------|
| Type: | Cessna 208B Grand Caravan |
| Registration: | C-FZLK |
| Range (km): | 1750 |
| Survey speed (knots): | 135 |
| Sea Level Climb Gradient: | 11% |
| Aviation Fuel: | Jet A |
| Fuel consumption (L/hr): | 175 |
| Oil Consumption: | Negligible |

5.1.4 C-GHRM

| | |
|----------------------------------|------------------|
| Type: | Piper PA-31T2 |
| Registration: | C-GHRM |
| Range (km): | 5 hrs; 1300 n.m. |
| Survey speed (knots): | 133 (245 km/hr) |
| Sea Level Rate-of-Climb (m/sec): | 9 |
| Aviation Fuel: | Jet A/B |
| Fuel consumption (L/hr): | 230 |
| Oil Consumption: | Negligible |

5.2 Instruments

Table 10 shows the instruments present in each aircraft and the following sections present their technical specifications.

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Table 10: Instruments in each aircraft

| Aircraft | Airborne Mag. | Compassometer | Multifunction | GPS | Navigation | Camera | Meter Alt. | Baro. Alt. |
|----------|-----------------|---------------|---------------|----------------|-------------------|-------------------|-------------|------------|
| C-FXCI | Geometric G822A | Picodas | PDAS 1000 | Trimble 4000SE | Picodas PNAV-2001 | Panasonic AG-2400 | King Kra-10 | Rosemount |
| C-GHRM | Scintrex CS-2 | Picodas | PDAS 1000 | Trimble 4000SE | Picodas PNAV-2001 | Panasonic AG-2400 | King Kra-10 | Rosemount |
| C-FYAU | Scintrex CS-2 | RMS AADC-II | Geodas | Sercel NR103 | Geodas | Sanyo VCC-3972 | TRT AHV-8 | Rosemount |
| C-FZLK | Scintrex CS-2 | RMS AADC-II | Geodas | Sercel NR103 | Geodas | Sanyo VCC-3972 | TRT AHV-8 | Rosemount |

5.2.1 Airborne Magnetometer

A Scintrex CS-2 or a Geometric G822A cesium vapour high sensitivity magnetometer was mounted within the "tail stinger" of each aircraft (figure 2). The following table describes the technical characteristics of the airborne magnetometer:

| | |
|------------------------|----------------------------------|
| Manufacturer | Scintrex CS-2 or Geometric G822A |
| Type and Model | Optically pumped cesium vapour |
| Ambient Range (nT) | 10 000 - 100 000 |
| Sensitivity (nT) | ± 0.001 |
| Absolute Accuracy (nT) | ± 5 |
| Noise Envelope (nT) | 0.01 |
| Sampling Rate (Hz) | 10 |
| Sampling Interval | 9 m at typical survey speed |
| Heading Effect | < 2 nT |



5.2.2 Compensator

A RMS Automatic Aeromagnetic Digital Compensator (AADC-II) or a Picodas Compensator was used to correct the magnetic response from the aircraft for the changes in flight attitude (i.e. Pitch, Roll and Yaw). The system includes a tri-axial fluxgate magnetometer installed in the stinger to monitor the aircraft's orientation within the earth's magnetic field and the compensator digitally corrects the input magnetic signal from the airborne magnetometer. The technical specifications of the compensator are given in the following table:

| Manufacturer | RMS or Picodas |
|-------------------|---------------------|
| Resolution | 0.001 nT |
| Absolute Accuracy | ± 10 nT |
| Noise Level | 0.015 nT |
| Range | 20,000 - 100,000 nT |
| Sampling | 10/second |
| Standard F.O.M. | <2.0 nT |

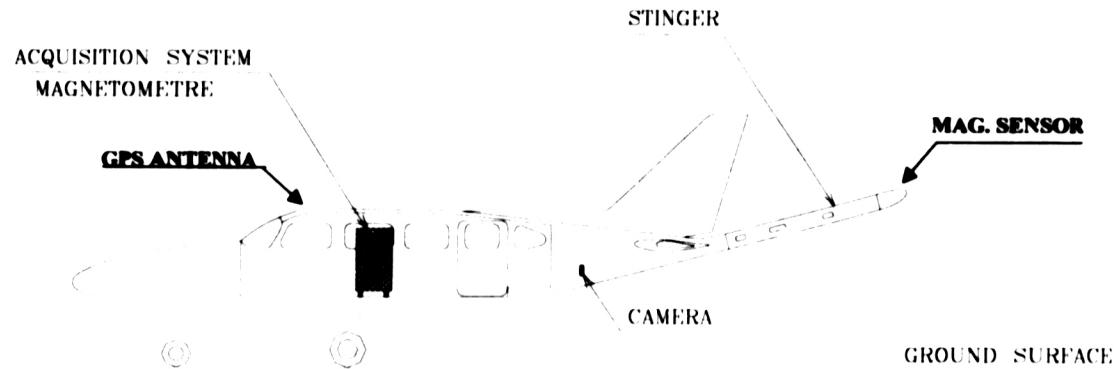


Figure 2: Magnetometer System Configuration

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5.2.3 Base stations

5.2.3.1 Base station magnetometers

For each survey phase, one Gem System Overhauser magnetic base station was deployed on this project. The base station was located at the Fort Simpson airport, at magnetic noise-free location, away from magnetic objects, vehicles and DC electrical power lines.

The following table presents the technical specifications of the GEM base station magnetometer:

| | |
|--------------------------|------------------|
| Manufacturer | GEM Systems |
| Type | Overhauser |
| Model | GSM-19 |
| Dynamic Range (nT) | 10 000 – 100 000 |
| Sensitivity (nT) | ± 0.001 |
| Sampling Rate per second | 3 |

The synchronization with the GPS time was made manually, using base or aircraft GPS units as reference.

5.2.3.2 GPS base station

A Trimble 4000 SE GPS base station, located at the base of operation, was used during the survey in order to provide data for post flight differential correction of the airborne GPS positional data. The GPS antenna was located on the office rooftop. Data processing showed that there were eight to nine satellites visible at any one time at the GPS base station.

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4.2.4 Digital acquisition System

Two different Digital Data Acquisition were installed in the aircraft:

- Picodas PDAS 1000 (C-FXCI and C-GHRM)
- Geodas (C-FYAU and C-FZLK)

These systems present a sampling rate of 10 readings/second and can be programmed to accept a wide variety of input types. Analogs were plotted on a GR33A chart recorder. The data acquisition system was synchronized to GPS time through a 1-second GPS pulse. Since the GPS position and UTC are related to the GPS pulse (while data acquisition timing is controlled by the 100-Hz system clock) a precise correlation was maintained.

The DGR-33A can plot multiple types of analog and digital signals in programmable, multi-channel strip-chart format complete with alphanumeric annotation of information such as signal identification, operating parameters, header messages, fiducial numbers and time. The advantage of an onboard chart recorder is that it is a valid record of the actual recorded data. The horizontal scale was 2 cm per 1 km of ground distance (1:50 000). The vertical scales for the total field magnetometer were 5 nT/cm (fine) and 50 nT/cm (coarse). The vertical scales for the radar and barometric altimeters, and for the Z-GPS traces, were 100 feet/cm.

5.2.5 Positioning Cameras, Navigation and Flight Path Systems

5.2.5.1 Video System

Two different types of video system were installed in the aircraft.

- Panasonic AG-2400
- Sanyo VCC-3979

5610 Chemin Bois Franc St-Laurent, Montreal, QC H4S 1A9, Canada Telephone: +514 330-2999 Telex: +514 330-2977

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The lateral field of view of each system was slightly larger than the terrain clearance. The system recorded both video and data. The data, which was displayed alphanumerically in the bottom portion of each frame, included:

- GPS time in hh:mm:ss format
- The date (year month day)
- Flight and line numbers
- Latitude and longitude co-ordinates in decimal degrees.

Data and video were available for review immediately after each flight with no further processing.

5.2.5.2 Global Positioning System (GPS)

Global Positioning System consists (at present) of a constellation of 24 active satellites orbiting the earth. The orbital period for each satellite is approximately 12 hours with an altitude of approximately 20,000 km. Each satellite contains a very accurate cesium clock that is synchronized to a common clock by the ground control stations (operated by the U.S. Air Force).

Each satellite transmits individually coded radio signals that are received by the user's GPS receiver. Along with timing information, each satellite transmits ephemerides (astronomical almanac or table) information that enables the receiver to compute the satellite's precise spatial position. The receiver decodes the timing signals from the satellites in view (4 satellites or more for a 3-dimensional fix) and, knowing their respective locations from the ephemerides information, the GPS system computes a latitude, longitude and altitude for the user. These position solutions are continuous and are updated once per second.

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Two different airborne differential GPS Systems were used on the aircraft.

- Trimble 4000-SE
- Sercel NR103

Each system presents an accuracy of ± 5 metres and positions were real-time differentially corrected with the Omni-Star system. The GPS systems were used in conjunction with a PNAV-2001 Navigation System or a Geodas Navigation System. The main features were:

- Real-time graphical and numerical display of flight path with survey-area and grid-line overlay
- Distance-from-line and distance-to-go indicators
- Operation in survey-grid or waypoint navigation mode
- Recording of raw range-data for all satellites from both the aircraft-borne and base-station GPS receivers, for post-flight refinement of GPS position

5.2.5.3 Altimeters

Two altimeters were used to record each aircraft terrain clearance or altitude: radar and barometric altimeters. The outputs from the altimeters are a linear function of altitude. The radar is pre-calibrated by the manufacturer and is checked after installation using an internal calibration procedure and also by performing calibration test flights. The altimeter calibration test flights performed for each aircraft are presented in Appendix A.

a) Radar Altimeter

The following table describes the radar altimeter that were installed in the aircraft:

| | |
|--------------|-----------------|
| Manufacturer | King or TRT |
| Model | KRA-10 or AHV-8 |

5810, Chemin Bois-Franc, St-Laurent, Montreal, QC H4S 1A8 Canada Telephone +514 339-2999 Telex +514 339-2997

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| | |
|--------------------------------|-----------|
| Range (ft) | 0 to 2500 |
| Accuracy | 1 % |
| Sampling Interval (sec) | 0.2 |

b) Barometric Altimeter

The following table describes the barometric altimeter that was installed in each aircraft:

| | |
|---------------------|-------------|
| Manufacturer | Rosemount |
| Model | PN 1241 |
| Range (ft) | 0 to 25 000 |
| Accuracy | 2 % |
| Resolution | 1 mV/ft |

5.2.6 Field Data Plotting and Verification System

5.2.6.1 Hardware

The field processing systems consisted of:

- A Pentium-PC with a high-resolution 17" screen
- A Iomega Zip drive
- A 56K modem
- A Canon BJC-80 printer
- A Brother 560 fax/printer/copier

5.2.6.2 Software

The computer was equipped with custom and commercial software capable of providing preliminary compilation to confirm the validity of data collected on each flight. The software package included the Geosoft Oasis Montaj software.

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6.0 DATA PROCESSING

6.1 Field Quality Control Procedures

Before each survey flight, all instruments were powered on for at least 30 minutes to ensure electronic stability.

6.1.1 Positioning

The GPS receivers, real-time differentially corrected through the Omni-Star systems, in conjunction with the navigation systems, provided in-flight navigation control. GPS data were post-processed daily using the Nortech software.

After each flight, data, including GPS, were transferred to the field computer system and merged into the database. Navigational data were plotted in XY plan format. Errors were noted and re-flights called where necessary.

GPS data from the real-time and post-processed sources were compared with each other and with barometer data. This comparison resulted in the selection of real-time and/or post-processed GPS. A thorough verification of X, Y, Z velocities was then made and jump (offset or level shift) corrected on-site, producing the final flight path in the field. Jumps were generally inferior to 5 metres. Most of the re-flights due to poor GPS quality occurred during short 2-D windows that were later avoided.

Lag corrections of TFM, barometer and radar were applied in the field. The quality of the GPS and the effectiveness of the lag correction were verified through preliminary grids. Once GPS

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and lag were confirmed, the final flight path was determined by cutting the line segments at the appropriate control lines.

6.1.2 Maintenance of speed and sampling

Despite the gentle to moderate terrain, the speed of the aircraft sometimes varied significantly due to prevalent strong winds during the survey. On the survey, the pilot maintained a slow economic cruising speed for the aircraft. This reduced fuel consumption and the time required for repositioning between survey lines. Lowering the speed also increased the sampling density.

6.1.3 Maintenance of flight altitude

Due to a relatively smooth topography, the flight altitude was determined by radar and visual estimation. The nominal survey altitude was 100 metres, except in the case of rugged topography where the pilot's judgement prevailed. The aim was to maintain the altitude difference at the intersections of traverse/control lines below 30 metres.

6.1.4 Diurnal monitoring

Diurnal magnetic variations were monitored and recorded using the Fort Simpson base station. Base station time and aircraft acquisition time were synchronized. For each base station, the record of variation was examined for intervals where the variation has exceeded 3.0 nT (peak to peak) from a long chord equivalent to fly the average distance between control lines. This specification was verified in the field prior to demobilisation. Any line or section of line not meeting the specifications were noted for reflight.

FUGRO AIRBORNE SURVEYS

6.1.5 Magnetic data

Compensation of the observed magnetic data for heading and aircraft effects was accomplished in real time by software controlled digital processing of the raw. Both the raw and compensated data were recorded so that post-flight processing could be performed, if required.

All magnetic data recorded in flight was checked for noise by an inspection of the fourth difference trace. The fourth difference is defined as:

$$4D_I = X_{I+2} - 4X_{I+1} + 6X_I - 4X_{I-1} + X_{I-2}$$

Where X_I is the I^{th} total field sample. In this form, the fourth difference has units of nT. High frequency noise should be such that the fourth differences divided by 16 are generally less than ± 0.1 nT. The fourth difference was displayed on analog at scales of 0.05 nT/cm.

A combination of non-linear and low-pass filters (less than 0.8 second) were applied to the data, and a noise channel calculated. The close inspection of the filtered mag., the 4th difference and noise channel allowed the correction of remaining spikes.

C-FYAU had very few spikes, due to heater activity or turbulence, corrected at the field office.

To ensure the completeness and veracity of the magnetic data, grids and preliminary magnetic contours were produced, without control line levelling, in the field.



6.2 Office Data Processing

Essentially the office processing system presents the same capabilities of the field system, plus additional presentation and colour plotting facilities. With the increased capacity, personnel and time available, editing and compilation procedures were carried out to detect and correct any remaining isolated errors, to refine the positioning, carry out levelling and gridding through to final contours. Processing was monitored closely by the Project Leader.

6.2.1 Positioning

All GPS post-processing and jump (offset or level shift) corrections made in the field were verified.

6.2.2 Compilation of magnetic data

A diurnal correction was applied prior to control line levelling. The diurnal correction channel (diurcorr) was obtained as follows. The average Fort Simpson value was updated and removed from the readings (diurcorr = Average - diurnal1) and a 200 seconds low-pass filter applied.

Also prior to levelling, flight path trimming was verified and finalised. The efficiency of the mag filtering and de-spiking (magraw to magrawed) made on-site was verified.

Intersection levelling was performed in three iterative cycles. Each cycle included (1) computation of intersections from raw controls and corrected lines; (2) misties correction model for controls; (3) computation of intersections from corrected controls and raw traverses; (4) misties correction model for traverses. Each cycle used increasingly precise (or with higher frequencies) misties correction models and greater care in removing erratic intersections (high

FUGRO AIRBORNE SURVEYS

gradient) through visual inspection.

The first cycle used polynomial (Oasis TREND) model for the controls and a 300 seconds triangular filter for the traverses. The second cycle used a triangular filter of 150 seconds for the controls. The third and last cycle used the radar intersection errors as a guide to determine intersection removal or edition and to introduce higher frequency content in the correction models.

6.2.3 Digital Elevation Model and Barometric Altimeter

The first step to obtain the DEM was to bring the Z-GPS values from different sources and aircraft to the MSL reference. The channel **zrawed** was obtained via a selection from the sources **zraw_omn** (real-time DGPS) and/or **zraw_nor** (post-processed DGPS) and corrected from remaining GPS XYZ position jumps (offsets or level shifts). The final ZGPS (z) was obtained by bringing **zrawed** closer to the MSL reference, using **zraw_omn** as reference.

Radar post-processing consisted simply in the application of a non-linear filter of 1 second (5 samples) on **raltraw** to obtain the final **ralt**.

The final DEM was obtained from the raw DEM (**z-ralt**) first through intersection levelling in 2 iterative cycles similar to the TFM levelling process, and second through micro levelling.

Final correction of the raw barometer channel (**baltraw**) was made using a special Z-GPS channel (**zbmodel = z + lvlcor**), where **lvlcor** consisted in a TREND3 model of (**demtlcorr + demmincor**), i.e. the low frequency DEM levelling correction. The final baro channel **balt** was obtained as follows:

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- Manual correction of DC level shifts and poorer data
- Application of a 1 second non-linear filter to remove short spikes.
- Low frequency correction obtained as follows: raw correction = zbm0del - edited baltraw, application of a 130 seconds low-pass filter.

6.2.4 Gridding algorithms for magnetic and elevation

All final grids were prepared with a grid-cell size of 100 and 200 metres. Gridding was carried out using the minimum curvature technique, which honours all traverse line data while producing a surface for which the total curvature is minimised.

FUGRO AIRBORNE SURVEYS



7.0 SURVEY PRODUCTS

No printed map was required on this non-exclusive project but the ASCII DXF digital files of the flight path and Total Field Magnetic Intensity contours were delivered with the following digital files on CD-ROM:

- Digital archive of line data
- Grid of the Total field magnetic data for the entire survey
- Grid of the Digital Elevation Model derived from the corrected GPS altitude and radar altitude data

8.0 PROBLEMS ENCOUNTERED

This survey was completed outside the estimated time frame. Factors, which contributed to downtime, are (table 4):

| | |
|-----------------------------------|-------------------|
| Weather: | 95.5 days (27.9%) |
| Diurnal: | 69.0 days (20.2%) |
| Instruments failures: | 5.0 days (1.5%) |
| Aircraft maintenance and repairs: | 53.0 days (15.5%) |

If we compare those results to the amount of production days (111.0 days or 32.4%), we understand that the major problems were the bad weather (fog, rain snow and blizzard, extreme cold temperatures) and diurnal.

FUGRO AIRBORNE SURVEYS



9.0 CONCLUSION

Started in August 2001 and ended in June 2002, the survey was by far not completed inside the estimated time frame. Bad weather and magnetic diurnal activity (creating reflights) are the major factors that contributed to the delay.

The noise levels for the measured Total Magnetic Field were well within the accepted limits, as shown by the fourth difference of the lagged, edited airborne magnetic data.

The flight path was surveyed accurately and the speed checks showed no abnormal jumps in the data. The aircraft were able to remain within the ± 30 metre elevation differences at the traverse/control line intersections.

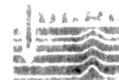
The calculation of the digital elevation model from the Z-GPS values, provided by the Real Time OMNI Star system, showed that the elevation errors were located in the 5-7 meter range.

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

Respectfully Submitted,

**Camille St-Hilaire, M.Sc.A.
Senior Geophysicist**

FUGRO AIRBORNE SURVEYS



APPENDIX A
HEADING, FOM, LAG AND ALTIMETER TESTS

FUGRO AIRBORNE SURVEYS



AIRCRAFT
Piper Navajo PA31-350
Registration C-FXCI

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FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
HEADING TEST – AUGUST 28th, 2001
Aircraft: C-FXCI

MAGR = raw (uncompensated) mag , MAGC = compensated mag

* values have been diurnally and lag corrected.

Mean magnetometer base value : 59189 nT.

| Line | Heading | Fiducial heading point | GPS altitude (m) | MAGR (nT) | MAGC * (nT) | Heading corrected MAGC (nT) |
|------|---------|------------------------|------------------|-----------|-------------|-----------------------------|
| 200 | South | 55.2 | 291.0 | 59078.65 | 59076.14 | 59078.71 |
| 210 | South | 340.7 | 270.1 | 59078.18 | 59077.15 | 59079.72 |
| 400 | West | 551.7 | 278.3 | 59078.16 | 59077.89 | 59079.40 |
| 410 | West | 804.2 | 273.6 | 59072.73 | 59077.50 | 59079.01 |
| 100 | North | 197.6 | 288.5 | 59085.18 | 59081.48 | 59078.96 |
| 110 | North | 446.7 | 281.6 | 59082.30 | 59081.98 | 59079.46 |
| 300 | East | 671.0 | 296.1 | 59080.98 | 59080.93 | 59079.38 |
| 310 | East | 915.3 | 279.5 | 59079.86 | 59080.59 | 59079.04 |

RESULTS : Max-Min = 59079.72 - 59078.71 = 1.01 < 2.00 nT

FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
F.O.M. TEST 1 – August 20th, 2001
AIRCRAFT: C-FXCI

- MAG1 = RAW MAG , CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 3 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE MAX PEAK TO PEAK MANEUVERS.

| NORTH (360⁰) | FID | MAG1 | CMA1 |
|--------------------------------|-------------|--------------|--------------|
| PITCH | 269.7-271.9 | 4.803 | 0.055 |
| ROLL | 292.9-294.2 | 0.605 | 0.037 |
| YAW | 314.3-315.3 | 0.724 | 0.054 |
| TOTAL | | 6.132 | 0.146 |

| SOUTH (180⁰) | FID | MAG1 | CMA1 |
|--------------------------------|-------------|--------------|--------------|
| PITCH | 56.4-58.1 | 1.234 | 0.115 |
| ROLL | 148.3-149.3 | 0.688 | 0.143 |
| YAW | 163.0-164.8 | 0.751 | 0.164 |
| TOTAL | | 2.673 | 0.422 |

| WEST (270⁰) | FID | MAG1 | CMA1 |
|-------------------------------|-------------|--------------|--------------|
| PITCH | 450.3-452.3 | 3.791 | 0.028 |
| ROLL | 469.2-470.0 | 0.977 | 0.01 |
| YAW | 493.9-495.0 | 0.636 | 0.044 |
| TOTAL | | 5.404 | 0.082 |

| EAST (90⁰) | FID | MAG1 | CMA1 |
|------------------------------|-------------|--------------|--------------|
| PITCH | 623.8-625.8 | 2.945 | 0.072 |
| ROLL | 639.9-640.9 | 0.317 | 0.015 |
| YAW | 665.6-666.9 | 0.712 | 0.077 |
| TOTAL | | 3.983 | 0.164 |

| TOTAL VALUES | MAG1 | CMA1 |
|-------------------------|---------------|--------------|
| | 18.142 | 0.814 |

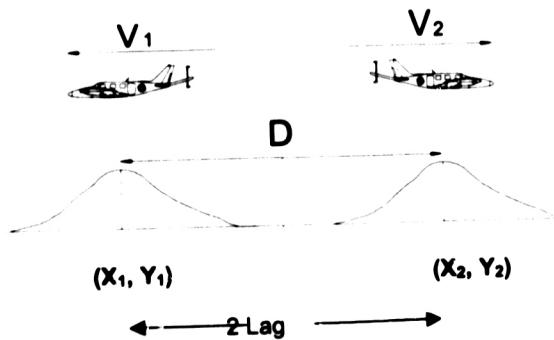
FUGRO AIRBORNE SURVEYS



FORT-SIMPSON NWT
LAG TEST

Project: 734
Location: Fort Simpson
Client: Non-Ex
Date: 21/08/2001
Target: antenna

Pilot: Kirk Broomfield
Operator: Dominique Belland
Compiled by: Pierrick Chasseriau
Aircraft : C-FXCI



| Pass | Fiducial | X (meters) | Y (meters) | Speed (m/sec) | Magnetic Field |
|---------|----------|---------------|---------------|------------------|-------------------|
| L1114 N | 3757.4 | 588096.0 | 6853551.0 | 76.9 | 59236.93 |
| L6666S | 3826.3 | 588126.3 | 6853680.5 | 89.0 | 59243.50 |

$$\begin{aligned} \text{MEAN SPEED} &= (V_1 + V_2) / 2 \\ \text{DISTANCE} &= \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2} \\ \text{LAG} &= \text{DISTANCE} / (2 * \text{MEAN SPEED}) \end{aligned}$$

$$\begin{aligned} \text{MEAN SPEED} &= 83 \text{ m/s.} \\ \text{DISTANCE} &= 133 \text{ m.} \\ \text{LAG} &= 0.80 \text{ sec.} \end{aligned}$$

FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
ALTIMETER TEST - AUGUST 21st, 2001
AIRCRAFT: C-FXCI

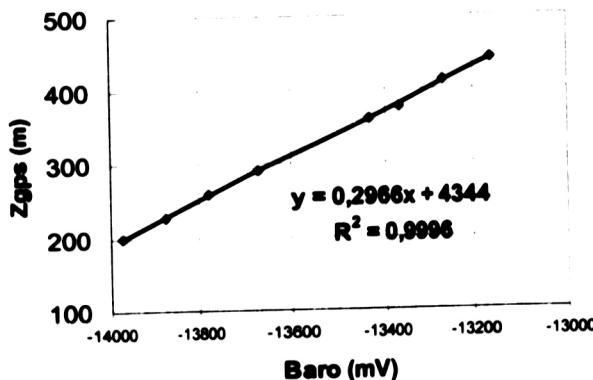
Test above Fort-Simpson Airport (elevation: 171 metres)

| Plan. Alt. (feet) | Radar Raw (mV) | GPS-Z (m) | Baro Raw (mV) | Baro Calc. (m) | Radar theo. (m) | Radar Calc. (m) |
|----------------------|-------------------|--------------|------------------|-------------------|--------------------|--------------------|
| 800 | 583.8 | 440.3 | -13161 | 440.4 | 289.3 | 270.5 |
| 700 | 516.5 | 410.4 | -13268 | 408.8 | 239.4 | 238.7 |
| 600 | 446.1 | 375.0 | -13368 | 379.0 | 204.0 | 205.3 |
| 500 | 404.8 | 360.4 | -13435 | 359.1 | 189.4 | 185.7 |
| 400 | 288.3 | 291.0 | -13665 | 290.8 | 120.0 | 121.1 |
| 300 | 200.0 | 258.9 | -13778 | 257.4 | 87.9 | 88.7 |
| 200 | 132.6 | 227.2 | -13877 | 227.9 | 56.2 | 56.8 |
| 100 | 69.6 | 198.7 | -13973 | 199.5 | 27.7 | 26.9 |

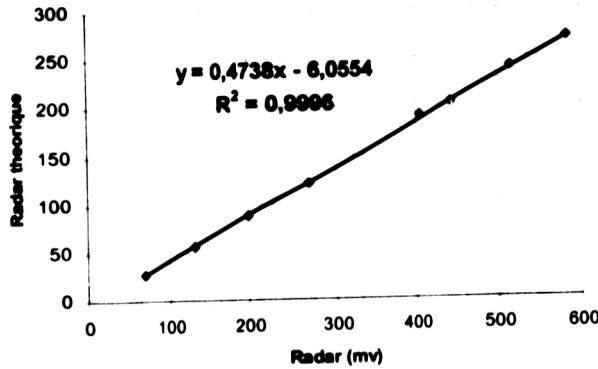
FUGRO AIRBORNE SURVEYS



BARO/ZGPS



RAD Theo./RAD



FUGRO AIRBORNE SURVEYS



**AIRCRAFT
Cheyenne PA-31 II
Registration C-GHRM**

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FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
HEADING TEST - FEBRUARY 25th, 2002
Aircraft: C-GHRM

MAGR = raw (uncompensated) mag , MAGC = compensated mag

* values have been diurnally and lag corrected.

Mean magnetometer base value : 58185 nT.

Theoretical heading point: N61°24.9850 W121°05.7262

| Line | Heading | Fiducial heading point | GPS altitude (m) | MAGR (nT) | MAGC * (nT) | Heading corrected MAGC (nT) |
|------|---------|------------------------|------------------|-----------|-------------|-----------------------------|
| 11 | South | 1018.8 | 379.0 | 59179.98 | 59179.91 | 59178.21 |
| 51 | South | 1284.1 | 378.6 | 59180.96 | 59180.60 | 59178.90 |
| 22 | West | 1460.0 | 376.6 | 59184.37 | 59180.30 | 59177.57 |
| 42 | West | 1746.2 | 373.8 | 59181.21 | 59182.26 | 59179.53 |
| 41 | North | 885.2 | 381.5 | 59174.44 | 59176.28 | 59178.20 |
| 61 | North | 1176.7 | 380.5 | 59175.55 | 59179.98 | 59178.90 |
| 12 | East | 1364.7 | 375.5 | 59174.62 | 59176.00 | 59178.50 |
| 52 | East | 1599.4 | 374.3 | 59176.14 | 59176.11 | 59178.61 |

RESULTS : Max-Min = 59179.53 - 59177.57 = 1.96 < 2.00 nT

FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
F.O.M. TEST 1 – FEBRUARY 25th, 2002
AIRCRAFT: C-GHRM

- MAG1 = RAW MAG , CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 3 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE MAX PEAK TO PEAK MANEUVERS.

| NORTH (360°) | FID | MAG1 | CMA1 |
|---------------------|-------------|--------------|--------------|
| PITCH | 104.4-107.3 | 4.673 | 0.191 |
| ROLL | 121.7-124.5 | 3.726 | 0.175 |
| YAW | 141.2-145.6 | 0.691 | 0.126 |
| TOTAL | | 9.090 | 0.492 |

| SOUTH (180°) | FID | MAG1 | CMA1 |
|---------------------|-------------|---------------|--------------|
| PITCH | 198.6-302.5 | 6.925 | 0.129 |
| ROLL | 320.4-322.5 | 3.255 | 0.110 |
| YAW | 341.2-343.4 | 1.230 | 0.079 |
| TOTAL | | 11.410 | 0.318 |

| WEST (270°) | FID | MAG1 | CMA1 |
|--------------------|-------------|---------------|--------------|
| PITCH | 438.4-441.3 | 5.993 | 0.137 |
| ROLL | 462.1-464.4 | 4.475 | 0.161 |
| YAW | 482.2-485.4 | 0.735 | 0.127 |
| TOTAL | | 11.203 | 0.425 |

| EAST (90°) | FID | MAG1 | CMA1 |
|-------------------|-------------|--------------|--------------|
| PITCH | 212.6-216.2 | 4.875 | 0.196 |
| ROLL | 233.1-234.9 | 2.749 | 0.155 |
| YAW | 253.5-257.2 | 0.678 | 0.009 |
| TOTAL | | 8.302 | 0.441 |

| TOTAL VALUES | MAG1 | CMA1 |
|---------------------|--------------|--------------|
| | 40.00 | 1.676 |

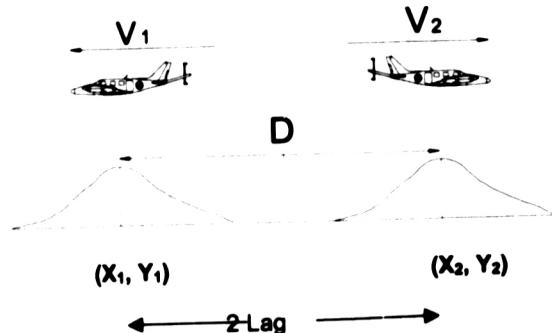
FUGRO AIRBORNE SURVEYS



FORT-SIMPSON NWT
LAG TEST
AIRCRAFT : C-GHRM

Project: 734
Location: Fort Simpson
Client: Non-Ex
Date: 25/02/2002
Target: antenna

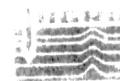
Pilot: Eric Picaud
Operator: Kenneth Bernier
Compiled by: Jeremy Weber
Aircraft : C-GHRM



| Pass | Fiducial | X (meters) | Y (meters) | Speed (m/sec) | Magnetic Field |
|-------|----------|---------------|---------------|------------------|-------------------|
| L2260 | 1925.6 | 593681.2 | 6847036.5 | 86.33 | 59352.05 |
| L2270 | 2095.7 | 593582.4 | 6847126.5 | 80.22 | 59299.6 |

$$\begin{aligned}
 \text{MEAN SPEED} &= (V_1 + V_2) / 2 \\
 \text{DISTANCE} &= \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2} \\
 \text{LAG} &= \text{DISTANCE} / (2 * \text{MEAN SPEED})
 \end{aligned}$$

$$\begin{aligned}
 \text{MEAN SPEED} &= 83.275 \text{ m/s.} \\
 \text{DISTANCE} &= 133.78 \text{ m.} \\
 \text{LAG} &= 0.62 \text{ sec.}
 \end{aligned}$$

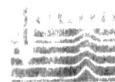


FORT SIMPSON NWT
ALTIMETER TEST – FEBRUARY 17th, 2002
AIRCRAFT: C-GHRM

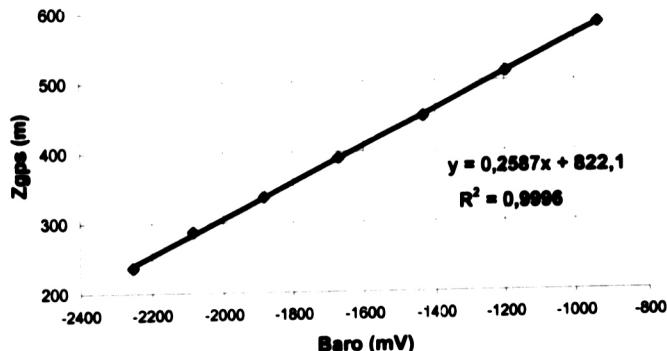
Test above Fort-Simpson Airport (elevation: 171 metres)

| Plan. Alt. (feet) | Radar Raw (mV) | GPS-Z (m) | Baro Raw (mV) | Baro. calc. (m) | Radar Theo. (m) | Radar Calc. (m) |
|----------------------|-------------------|--------------|------------------|--------------------|--------------------|--------------------|
| 200 | 215.9 | 236.0 | -2252 | 3676.1 | 65.0 | 96.2 |
| 400 | 395.4 | 286.6 | -2085 | 3725.5 | 115.6 | 181.3 |
| 600 | 578.7 | 335.9 | -1884 | 3785.3 | 164.9 | 268.1 |
| 800 | 750.6 | 390.3 | -1670 | 3848.7 | 219.3 | 349.6 |
| 1000 | 957.8 | 449.3 | -1434 | 3918.7 | 278.3 | 447.8 |
| 1250 | 1150.4 | 512.4 | -1195 | 3989.6 | 341.4 | 539.0 |
| 1500 | 1386.2 | 580.9 | -935 | 4066.7 | 409.9 | 650.7 |

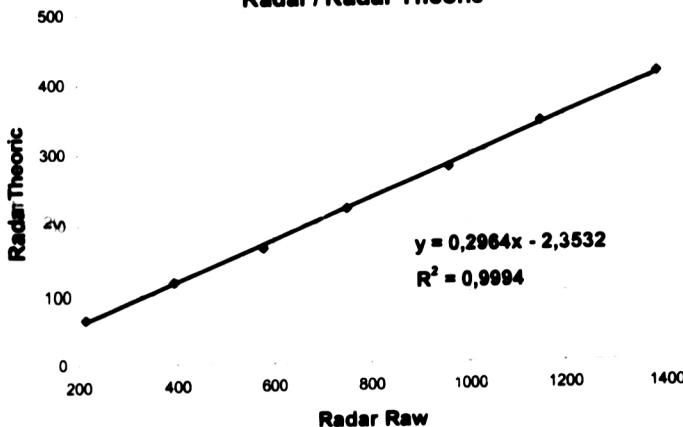
FUGRO AIRBORNE SURVEYS



BARO/ZGPS



Radar / Radar Theoric



FUGRO AIRBORNE SURVEYS



AIRCRAFT
Cessna 404
Registration C-FYAU

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FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
HEADING TEST - AUGUST 22nd, 2001
Aircraft: C-FYAU

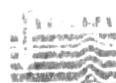
* values have been diurnally and lag corrected.

Mean magnetometer base value : 59215 nT.

| LINE | HEADING | FIDUCIAL | MAG (nT) | CMAG (nT) | BASEA (nT) |
|------|---------|----------|-------------|--------------|---------------|
| 361 | NORTH | 8041 | 59115.10 | 59126.55 | 59214.42 |
| 181 | SOUTH | 7748.4 | 59111.80 | 59128.20 | 59215.95 |
| 91 | EAST | 7577.6 | 59113.00 | 59126.14 | 59213.28 |
| 271 | WEST | 8202.4 | 59114.11 | 59129.23 | 59216.88 |

RESULTS : CMA1 : Max-Min = 87.88 - 87.14 = 0.74 < 2.00 nT

FUGRO AIRBORNE SURVEYS



FORT SIMPSON NWT
F.O.M. TEST 1 – August 21st, 2001
AIRCRAFT: C-FYAU

- MAG1 = RAW MAG , CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 3 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE MAX PEAK TO PEAK MANEUVERS.

| NORTH (360°) | FID | MAG1 | CMA1 |
|---------------------|---------------|--------------|--------------|
| PITCH | 6446.4-6448.4 | 3.178 | 0.02 |
| ROLL | 6466.3-6468.0 | 0.789 | 0.006 |
| YAW | 6492.4-6493.1 | 0.341 | 0.007 |
| TOTAL | | 4.308 | 0.033 |

| SOUTH (180°) | FID | MAG1 | CMA1 |
|---------------------|---------------|--------------|--------------|
| PITCH | 6173.6-6175.1 | 1.042 | 0.059 |
| ROLL | 6196.2-6197.9 | 0.783 | 0.005 |
| YAW | 6224.1-6224.9 | 0.219 | 0.05 |
| TOTAL | | 2.044 | 0.114 |

| WEST (270°) | FID | MAG1 | CMA1 |
|--------------------|---------------|--------------|--------------|
| PITCH | 6318.8-6321.1 | 1.698 | 0.087 |
| ROLL | 6340.3-6341.9 | 0.655 | 0.024 |
| YAW | 6360.5-6361.4 | 0.19 | 0.066 |
| TOTAL | | 2.843 | 0.177 |

| EAST (90°) | FID | MAG1 | CMA1 |
|-------------------|---------------|--------------|--------------|
| PITCH | 6053.3-6055.1 | 2.453 | 0.011 |
| ROLL | 6085.0-6086.0 | 0.508 | 0.024 |
| YAW | 6099.0-6100.1 | 0.396 | 0.099 |
| TOTAL | | 3.357 | 0.134 |

| TOTAL VALUES | MAG1 | CMA1 |
|---------------------|---------------|--------------|
| | | |
| | 12.252 | 0.458 |

FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
F.O.M. TEST 2 – September 19th, 2001
AIRCRAFT: C-FYAU

- MAG1 = RAW MAG , CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 3 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE **MAX PEAK TO PEAK** MANEUVERS.

| NORTH (360°) | FID | MAG1 | CMA1 |
|---------------------|---------------|--------------|--------------|
| PITCH | 6304.5-6305.9 | 4.042 | 0.129 |
| ROLL | 6256.3-6257.6 | 0.754 | 0.084 |
| YAW | 6276.5-6277.5 | 0.681 | 0.088 |
| TOTAL | | 5.477 | 0.301 |

| SOUTH (180°) | FID | MAG1 | CMA1 |
|---------------------|---------------|-------------|--------------|
| PITCH | 6823.4-6824.7 | 1.799 | 0.049 |
| ROLL | 6846.2-6847.6 | 0.751 | 0.067 |
| YAW | 6868.6-6869.8 | 0.510 | 0.173 |
| TOTAL | | 3.06 | 0.289 |

| WEST (270°) | FID | MAG1 | CMA1 |
|--------------------|---------------|--------------|--------------|
| PITCH | 6401.8-6403.2 | 2.397 | 0.114 |
| ROLL | 6417.1-6418.6 | 0.791 | 0.089 |
| YAW | 6445.5-6446.6 | 0.650 | 0.097 |
| TOTAL | | 3.838 | 0.300 |

| EAST (90°) | FID | MAG1 | CMA1 |
|-------------------|---------------|--------------|--------------|
| PITCH | 6663.4-6664.8 | 3.576 | 0.116 |
| ROLL | 6678.7-6679.9 | 0.762 | 0.121 |
| YAW | 6703.8-6705.1 | 1.414 | 0.056 |
| TOTAL | | 5.752 | 0.293 |

| TOTAL VALUES | MAG1 | CMA1 |
|---------------------|---------------|--------------|
| | 18.127 | 1.183 |

FUGRO AIRBORNE SURVEYS



FORT SIMPSON NWT
F.O.M. TEST 3 – October 15th, 2001
AIRCRAFT: C-FYAU

- MAG1 = RAW MAG , CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 3 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE MAX PEAK TO PEAK MANEUVERS.

| NORTH (360°) | FID | MAG1 | CMA1 |
|---------------------|-------------------|--------------|--------------|
| PITCH | 66976.5 – 66977.5 | 0.9805 | 0.081 |
| ROLL | 67028.2 – 67030.2 | 1.017 | 0.155 |
| YAW | 67075.6 – 67076.6 | 0.532 | 0.111 |
| TOTAL | | 2.529 | 0.347 |

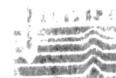
| SOUTH (180°) | FID | MAG1 | CMA1 |
|---------------------|-------------------|-------------|--------------|
| PITCH | 67405.2 – 67406.0 | 1.723 | 0.91 |
| ROLL | 67442.3 – 67443.9 | 0.844 | 0.077 |
| YAW | 67483.6 – 67484.2 | 0.131 | 0.082 |
| TOTAL | | 2.39 | 0.250 |

| WEST (270°) | FID | MAG1 | CMA1 |
|--------------------|-------------------|--------------|--------------|
| PITCH | 67615.0 – 67616.4 | 1.909 | 0.094 |
| ROLL | 67662.0 – 67664.1 | 0.708 | 0.098 |
| YAW | 67715.9 – 67717.0 | 0.556 | 0.078 |
| TOTAL | | 3.173 | 0.270 |

| EAST (90°) | FID | MAG1 | CMA1 |
|-------------------|-------------------|--------------|--------------|
| PITCH | 67189.2 – 67190.6 | 2.590 | 0.201 |
| ROLL | 67228.3 – 67229.8 | 0.610 | 0.085 |
| YAW | 67264.7 – 67265.8 | 0.607 | 0.147 |
| TOTAL | | 3.807 | 0.433 |

| TOTAL VALUES | MAG1 | CMA1 |
|---------------------|---------------|-------------|
| | 11.799 | 1.30 |

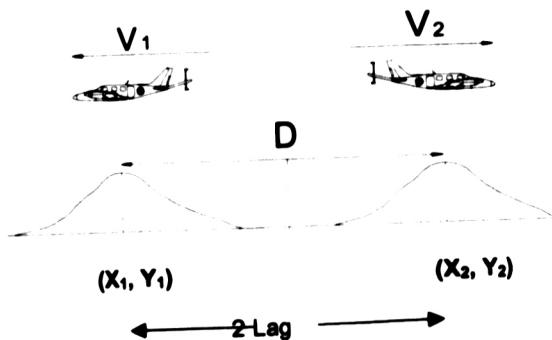
FUGRO AIRBORNE SURVEYS



FORT-SIMPSON NWT
LAG TEST
AIRCRAFT : C-FYAU

Project: 734
Location: Fort Simpson
Client: Non-Ex
Date: 21/08/2002
Target: antenna

Pilot:
Operator:
Compiled by: Sarah Forté
Aircraft : C-FYAU



| Pass | Fiducial | X (meters) | Y (meters) | Speed (m/sec) | Magnetic Field |
|------|----------|---------------|---------------|------------------|-------------------|
| 1 | 8765.5 | 594279 | 6846625 | 91 | 18.5 |
| 2 | 8883.9 | 594405 | 6846646 | 80 | 22.4 |

MEAN SPEED = $(V_1 + V_2) / 2$
 DISTANCE = $\sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2}$
 LAG = DISTANCE / (2 * MEAN SPEED)

MEAN SPEED = 85.5 m/sec
 DISTANCE = 127.73 meters
 LAG = 0.75 sec.

FUGRO AIRBORNE SURVEYS

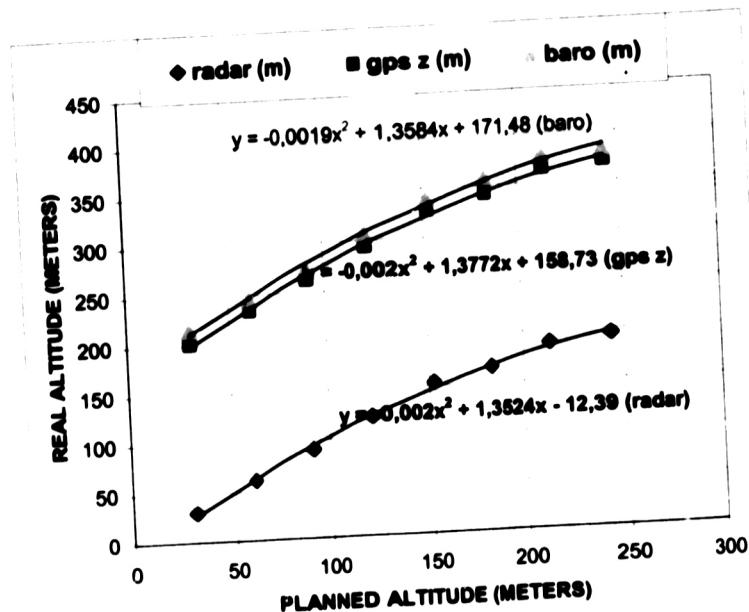


FORT SIMPSON NWT
ALTIMETER TEST - AUGUST 21st, 2001
AIRCRAFT: C-GYAU

Test above Fort-Simpson Airport (elevation: 171 metres)

| Plan. alt. (feet) | Plan. Alt. (m) | Radar Raw (m) | GPS-Z (m) | Baro Raw (m) |
|----------------------|-------------------|------------------|--------------|-----------------|
| 800 | 243.9 | 195 | 371 | 382 |
| 700 | 213.4 | 188 | 365 | 378 |
| 600 | 182.9 | 166 | 342 | 357 |
| 500 | 152.4 | 153 | 328 | 339 |
| 400 | 122 | 121 | 294 | 306 |
| 300 | 91.5 | 90 | 263 | 272 |
| 200 | 61 | 61 | 234 | 245 |
| 100 | 30.5 | 30 | 202 | 216 |

FUGRO AIRBORNE SURVEYS



FUGRO AIRBORNE SURVEYS



AIRCRAFT
Cessna 208B
Registration C-FZLK

5610 Chemin Bois-Franc St-Laurent, Montreal, QC H4S 1A9 Canada Telephone: +514 339-2999 Telex: +514 339-2997

FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
HEADING TEST - MAY 12th, 2002
Aircraft: C-FZLK

MAGR = raw (uncompensated) mag , MAGC = compensated mag

* values have been diurnally and lag corrected.

Mean magnetometer base value : 58799 nT

Theoretical heading point: N61°24.9850 W121°05.7262

| Line | Heading | Fiducial heading point | GPS altitude (m) | MAGR (nT) | MAGC * (nT) | Heading corrected MAGC (nT) |
|------|---------|------------------------|------------------|-----------|-------------|-----------------------------|
| 11 | South | 66502.8 | 333.2 | 59174.72 | 59182.71 | 59182.92 |
| 51 | South | 67396.3 | 331.0 | 59175.54 | 59182.45 | 59182.24 |
| 22 | West | 68380.1 | 335.8 | 59172.54 | 59183.97 | 59183.45 |
| 42 | West | 68771.0 | 337.0 | 59170.42 | 59182.86 | 59182.34 |
| 41 | North | 67198.5 | 337.6 | 59167.93 | 59182.85 | 59182.89 |
| 61 | North | 67626.5 | 338.1 | 59168.86 | 59183.18 | 59183.22 |
| 12 | East | 68194.4 | 331.1 | 59164.22 | 59182.50 | 59182.77 |
| 52 | East | 68927.5 | 337.7 | 59162.17 | 59181.20 | 59181.47 |

RESULTS : Max-Min = 59183.45 - 59181.47 = 1.98 < 2.00 nT

FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
F.O.M. TEST 1 – February 17th, 2002
AIRCRAFT: C-FZLK

- MAG1 = RAW MAG , CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 3 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE **MAX PEAK TO PEAK** MANEUVERS.

| NORTH (360°) | FID | MAG1 | CMA1 |
|---------------------|-----------------|--------------|--------------|
| PITCH | 77783.7-77786.1 | 0.042 | 0.056 |
| ROLL | 77821.7-77823.8 | 0.039 | 0.068 |
| YAW | 77857.0-77860.2 | 0.104 | 0.038 |
| TOTAL | | 0.185 | 0.162 |

| SOUTH (180°) | FID | MAG1 | CMA1 |
|---------------------|-----------------|--------------|--------------|
| PITCH | 77387.7-77389.1 | 1.680 | 0.023 |
| ROLL | 77420.1-77422.6 | 1.066 | 0.053 |
| YAW | 77461.5-77463.4 | 0.292 | 0.189 |
| TOTAL | | 3.038 | 0.265 |

| WEST (270°) | FID | MAG1 | CMA1 |
|--------------------|-----------------|--------------|--------------|
| PITCH | 76989.2-76991.1 | 0.394 | 0.117 |
| ROLL | 77029.2-77030.7 | 0.617 | 0.067 |
| YAW | 77071.0-77074.5 | 0.475 | 0.040 |
| TOTAL | | 1.486 | 0.233 |

| EAST (90°) | FID | MAG1 | CMA1 |
|-------------------|-----------------|--------------|--------------|
| PITCH | 77587.5-77589.5 | 1.770 | 0.180 |
| ROLL | 77623.4-77625.0 | 1.610 | 0.020 |
| YAW | 77659.1-77660.8 | 0.208 | 0.060 |
| TOTAL | | 3.588 | 0.260 |

| TOTAL VALUES | MAG1 | CMA1 |
|---------------------|--------------|--------------|
| | 8.297 | 0.920 |

FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
F.O.M. TEST 2 – MARCH 28th, 2002
AIRCRAFT: C-FZLK

- MAG1 = RAW MAG , CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 3 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE **MAX PEAK TO PEAK** MANEUVERS.

| NORTH (360[°]) | FID | MAG1 | CMA1 |
|--------------------------------|-------------|--------------|--------------|
| PITCH | 77848-77853 | 0.246 | 0.583 |
| ROLL | 77880-77884 | 0.003 | 0.869 |
| YAW | 77909-77912 | 0.006 | 0.226 |
| TOTAL | | 0.246 | 1.678 |

| SOUTH (180[°]) | FID | MAG1 | CMA1 |
|--------------------------------|-------------|--------------|--------------|
| PITCH | 77450-77457 | 0.206 | 1.730 |
| ROLL | 77487-77491 | 0.035 | 0.544 |
| YAW | 77530-77534 | 0.058 | 0.416 |
| TOTAL | | 0.299 | 2.690 |

| WEST (270[°]) | FID | MAG1 | CMA1 |
|-------------------------------|-------------|--------------|--------------|
| PITCH | 77673-77679 | 0.272 | 1.191 |
| ROLL | 77704-77708 | 0.024 | 1.099 |
| YAW | 77738-77741 | 0.026 | 0.257 |
| TOTAL | | 0.322 | 2.547 |

| EAST (90[°]) | FID | MAG1 | CMA1 |
|------------------------------|-------------|--------------|--------------|
| PITCH | 76908-76913 | 0.237 | 0.519 |
| ROLL | 76946-76949 | 0.042 | 0.502 |
| YAW | 76975-76982 | 0.033 | 0.169 |
| TOTAL | | 0.312 | 1.190 |

| TOTAL VALUES | MAG1 | CMA1 |
|---------------------|--------------|--------------|
| | 8.105 | 1.179 |

FUGRO AIRBORNE SURVEYS

FORT SIMPSON NWT
F.O.M. TEST 3 – APRIL 27th, 2002
AIRCRAFT: C-FZLK

- MAG1 = RAW MAG , CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 3 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE MAX PEAK TO PEAK MANEUVERS.

| NORTH (360°) | FID | MAG1 | CMA1 |
|--------------|-------------|--------------|--------------|
| PITCH | 72296-72306 | 0.220 | 0.065 |
| ROLL | 72310-72318 | 0.757 | 0.120 |
| YAW | 72322-72330 | 0.143 | 0.032 |
| TOTAL | | 1.120 | 0.217 |

| SOUTH (180°) | FID | MAG1 | CMA1 |
|--------------|-------------|--------------|--------------|
| PITCH | 71942-71956 | 1.084 | 0.089 |
| ROLL | 71963-71974 | 0.520 | 0.193 |
| YAW | 71979-71989 | 0.281 | 0.063 |
| TOTAL | | 1.855 | 0.345 |

| WEST (270°) | FID | MAG1 | CMA1 |
|--------------|-------------|--------------|--------------|
| PITCH | 72143-72153 | 0.210 | 0.065 |
| ROLL | 72159-72167 | 0.361 | 0.205 |
| YAW | 72174-72183 | 0.064 | 0.072 |
| TOTAL | | 0.635 | 0.342 |

| EAST (90°) | FID | MAG1 | CMA1 |
|--------------|-------------|--------------|--------------|
| PITCH | 72438-72450 | 0.621 | 0.065 |
| ROLL | 72454-72463 | 0.915 | 0.131 |
| YAW | 72496-72509 | 0.183 | 0.030 |
| TOTAL | | 1.719 | 0.226 |

| TOTAL VALUES | MAG1 | CMA1 |
|--------------|--------------|--------------|
| | 5.359 | 1.130 |

FUGRO AIRBORNE SURVEYS**FORT SIMPSON NWT
F.O.M. TEST 4 – MAY 6th, 2002
AIRCRAFT: C-FZLK**

- MAG1 = RAW MAG, CMA1 = COMPENSATED MAG
- VALUES DETERMINED USING 6 SECONDS HIGHPASS FILTER.
- VALUES DETERMINED USING THE **MAX PEAK TO PEAK** MANEUVERS.

| NORTH (360°) | MAG1 | CMA1 |
|---------------------|--------------|--------------|
| PITCH | 0.288 | 0.071 |
| ROLL | 0.798 | 0.041 |
| YAW | 0.138 | 0.091 |
| TOTAL | 1.224 | 0.203 |

| SOUTH (180°) | MAG1 | CMA1 |
|---------------------|--------------|--------------|
| PITCH | 0.322 | 0.088 |
| ROLL | 0.327 | 0.042 |
| YAW | 0.080 | 0.070 |
| TOTAL | 0.729 | 0.200 |

| WEST (270°) | MAG1 | CMA1 |
|--------------------|--------------|--------------|
| PITCH | 0.874 | 0.069 |
| ROLL | 0.411 | 0.048 |
| YAW | 0.246 | 0.057 |
| TOTAL | 1.561 | 0.174 |

| EAST (90°) | MAG1 | CMA1 |
|-------------------|--------------|--------------|
| PITCH | 0.700 | 0.078 |
| ROLL | 1.032 | 0.036 |
| YAW | 0.163 | 0.056 |
| TOTAL | 1.895 | 0.170 |

| TOTAL VALUES | MAG1 | CMA1 |
|---------------------|--------------|--------------|
| | 5.409 | 0.747 |

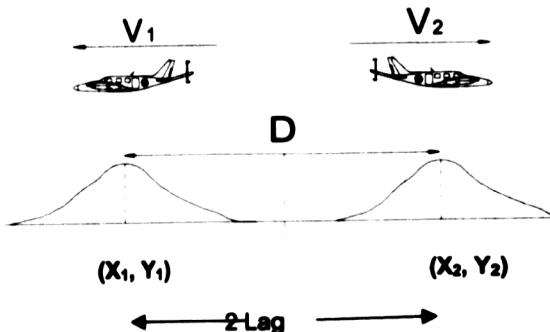
FUGRO AIRBORNE SURVEYS



**FORT-SIMPSON NWT
LAG TEST
AIRCRAFT : C-FZLK**

Project: 734
Location: Fort Simpson
Client: Non-Ex
Date: 27/04/2002
Target: antenna

Pilot:
Operator:
Compiled by: Sarah Forté
Aircraft : C-FZLK



| Pass | Fiducial | X (meters) | Y (meters) | Speed (m/sec) | Magnetic Field |
|------|----------|---------------|---------------|------------------|-------------------|
| 1 | 70921.4 | 593597.9 | 6847110.5 | 107.5 | 72.6 |
| 2 | 71021.6 | 593681.1 | 6847086.1 | 116.9 | 76.6 |

MEAN SPEED = $(V_1 + V_2) / 2$
 DISTANCE = $\sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2}$
 LAG = DISTANCE / (2 * MEAN SPEED)

MEAN SPEED = 74.6 m/sec
 DISTANCE = 86.7 meters
 LAG = 0.58 sec

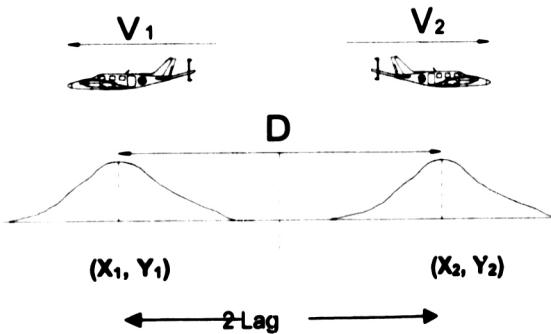
FUGRO AIRBORNE SURVEYS



FORT-SIMPSON NWT
LAG TEST
AIRCRAFT : C-FZLK

Project: 734
Location: Fort Simpson
Client: Non-Ex
Date: May 5th, 2002
Target: antenna

Pilot:
Operator:
Compiled by: Sarah Forté
Aircraft : C-FZLK



| PASSE | FIDUCIAL | X (meters) | Y (meters) | Radar (meters) | SPEED (m/s) | Magnetic Field |
|-------|----------|---------------|---------------|-------------------|----------------|-------------------|
| A | 99928.5 | 589732.6 | 6850074.2 | 105.3 | 82.3 | 59223.55 |
| B | 100137.7 | 589745.3 | 6850072.6 | 92.0 | 80.1 | 59225.38 |
| C | 100037.3 | 589767.1 | 6850168.2 | 99.0 | 72.0 | 59223.46 |
| D | 100254.5 | 589769.3 | 6850172.4 | 82.9 | 73.0 | 59223.78 |

Using A & C

$$\text{MEAN SPEED} = (V_1 + V_2) / 2 = 77.2 \text{ m/s}$$

$$\text{DISTANCE} = \{ (X_2 - X_1)^2 + (Y_2 - Y_1)^2 \}^{1/2} = 100.1 \text{ m}$$

$$\text{LAG} = \text{DISTANCE} / (\text{2*MEAN SPEED}) = 0.65 \text{ s}$$

FUGRO AIRBORNE SURVEYS



Using A & D

| | | | |
|-------------|---|---|----------|
| MEAN SPEED= | $(V_1 + V_2) / 2$ | = | 77.7 m/s |
| DISTANCE = | $\{ (X_2 - X_1)^2 + (Y_2 - Y_1)^2 \}^{1/2}$ | = | 104.8 m |
| LAG = | DISTANCE / (2*MEAN SPEED) | = | 0.68 s |

Using B & C

| | | | |
|-------------|---|---|----------|
| MEAN SPEED= | $(V_1 + V_2) / 2$ | = | 76.1 m/s |
| DISTANCE = | $\{ (X_2 - X_1)^2 + (Y_2 - Y_1)^2 \}^{1/2}$ | = | 98.1 m |
| LAG = | DISTANCE / (2*MEAN SPEED) | = | 0.65 s |

Using B & D

| | | | |
|-------------|---|---|----------|
| MEAN SPEED= | $(V_1 + V_2) / 2$ | = | 76.6 m/s |
| DISTANCE = | $\{ (X_2 - X_1)^2 + (Y_2 - Y_1)^2 \}^{1/2}$ | = | 102.6 m |
| LAG = | DISTANCE / (2*MEAN SPEED) | = | 0.67 s |

AVERAGE LAG : 0.66 seconds



FORT SIMPSON NWT
ALTIMETER TEST - MARCH 9th, 2002
AIRCRAFT: C-FZLK

Test above Fort-Simpson Airport (elevation: 171 metres)

| Plan. Alt. (feet) | Radar Raw (mV) | GPS-Z (m) | Baro Raw (mV) | Baro Calc. (m) | Radar Theo. (m) | Radar Calc. (m) |
|----------------------|-------------------|--------------|------------------|-------------------|--------------------|--------------------|
| 800 | 798.6 | 414.9 | 1610 | 416.5 | 243.9 | 245.3 |
| 600 | 588.0 | 354.0 | 1359 | 350.5 | 183.0 | 181.5 |
| 400 | 383.6 | 291.9 | 1142 | 293.4 | 120.9 | 119.5 |
| 200 | 187.5 | 229.5 | 899 | 229.6 | 58.5 | 60.0 |

