AERODATA HOLDINGS LTD.

REPORT ON THE LITCHFIELD SOUTH

AEROMAGNETIC AND RADIOMETRIC SURVEY

Job No 650

on behalf of

THE NORTHERN TERRITORY

DEPARTMENT OF MINES AND ENERGY

1. INTRODUCTION

On the 19th July, 1984 Aerodata was contracted by the Northern Territory Department of Mines and Energy to carry out an aeromagnetic survey in the Daly River area. Flying commenced on the 20th August, 1984 and was completed on the 29th October, 1984.

Data processing to final flight path, stacked profiles and preliminary contour stage was carried out at Adelaide River, Northern Territory. Final processing was carried out in Perth, Western Australia and final maps were delivered to the Northern Territory Department of Mines and Energy on 30th November, 1984.

2. GENERAL SURVEY SPECIFICATIONS

2.1 LOCATION OF SURVEY AREAS

The survey area is located on the Greenwood, Daly River, Tipperary, Moyle, Wingate Mountains and part of Fitzmaurice 1:100,000 sheets, Northern Territory. For detailed location see Figure 1.

2.2 FLYING SPECIFICATIONS

Flight Line Direction	090° and 270°
Tie Line Direction	000° and 180°
Flight Line Spacing	500 metres
Tie Line Spacing	5,000 metres
Nominal Sensor Height	100 metres
Maximum Sensor Height	250 metres
Magnetometer Cycle Rate	0.20 seconds
Spectrometer Cycle Rate	0.80 seconds
Magnetometer Sample Interval	12 metres
Spectrometer Sample Interval	48 metres
Aircraft Ground Speed	115 Knots
Magnetometer Resolution	0.05 nT
Magnetometer Noise Envelope	<1.00 nT

3. EQUIPMENT USED FOR FLYING SURVEY

3.1 AIRCRAFT

A Rockwell Shrike Commander 500S - VH-MEH. This aircraft has been extensively modified for survey work.

3.2 MAGNETOMETER

The magnetometer system is based on the Scintrex V-201 cesium vapour magnetometer. The system consists of a stinger mounted Scintrex VIW 2321 HG single cell split beam cesium magnetometer sensor with associated sensor electronics. This system outputs a continuous sinusoidal signal which has a Lamour frequency proportional to the total magnetic field at the sensor. The frequency of the Lamour signal is counted by an Aerodata designed system which is connected to the acquisition system computer by an HPIB interface. The rate at which the Lamour frequency is determined (i.e. the cycle rate) can be set from 0.1 second to 1.5 seconds in 0.1 second steps.

3.3 CRYSTAL AND SPECTROMETER SYSTEM

Two Geometrics DET 1024 NaI slab crystals with a total volume of 33.56 litres was used. The crystals were connected to a Geometrics GR800B 256 channel spectrometer through a GR900 crystal controller. The spectrometer was used in such a manner that although 256 channels were available for spectral plotting only five were used for this survey.

3.4 RADAR ALTIMETERS

A Sperry AA100A Radar Altimeter was used. The altimeter provided a visual display of height above terrain to the pilot and also supplied a voltage proportional to height. This voltage was fed to the chart recorders and the acquisition system such that the altimeter was digitally recorded. The output of the altimeter was only linear up to 500'.

3.5 TRACKING SYSTEM

An Aerodata Video Tracking System was used for aircraft location. The system comprises:

A Sony Ch-1400CE Black and White Video Camera feeding a "For-A" (TG-160) Title Generator fitted with an interface which allows the aircraft's computer to display Job No., Line No., Direction and Fid No. This is recorded on a Sony SL-FIE (Beta Format) Video Recorder and displayed on a Toshiba C531 Video Monitor. All units have been modified to allow powering from Aircraft 28V DC supply. A Vinten MKIII 16mm tracking camera was also used for aircraft location. This camera was triggered by the acquisition system which also generated 10's and 100's marks on the appropriate frames to aid in film editing.

3.6 ANALOG RECORDER

A Watanabe 8 channel 10" analog recorder with pen offset compensation was used to record the analog data. Two channels were used for the magnetics, one at 50 nT full scale and the other at 500 nt full scale.

The other channels recorded were the radar altimeter and the radiometric data as total count, potassium, uranium and thorium. The radiometric data was recorded in stripped form (see section 7.3 for stripping ratios).

The chart recorder was driven at a constant speed and had event marks placed on it by the acquisition system such that the chart could be suitably edited.

3.7 DIGITAL ACQUISITION AND RECORDING SYSTEM

The acquisition system used was designed and built by Aerodata and is based around a Hewlett Packard 9825 Computer, a Dylon 'A' Tape Formatter and a Kennedy 9 Track digital tape transport.

The system accepts data from the magnetometer directly into the computer and at intervals set by the cycle rate of the system digital data is fed directly from the spectrometer to the tape drive. Analog altimeter data is fed into the acquisition system which then passes this data in digital form to the computer via a HPIB interface. The same HPIB interface also carries commands from the computer to the acquisition system to control the camera, mark the analog charts and output the analogs for the magnetics to the analog recorder.

This interface is also used to connect the tape drive to the computer. The computer also carries as a peripheral a real time clock such that the month, day, hour, minute and second of the start and end time of each line is recorded. For each fid 7 digits of magnetic data was recorded. On every fourth fiducial altimeter and spectrometer data was recorded as follows:

Altimeter	3 digits (metres)
Radiometrics	27 bytes including total count, K, U, Th and cosmic channels
Doppler	6 digits containing doppler velocity information

A line header record was also recorded which holds a variety of data along with line number, line direction, start and end fid number and start and end time of the line.

4. PHOTOGRAPHY NAVIGATION AND FLIGHT PATH RECOVERY

Peter Livings & Associates provided Army photography and supplied Aerodata with one set of 1:80,000 contact prints and two sets of 1:25,000 enlargement.

One set of enlargements were used for flight planning and visual navigation. The other set was used for flight path recovery. Recovery was carried out in the field. Infill lines were flown if flight line separation exceeded 150% of the planned line separation over a distance of 5 km or more.

AMG control supplied by Peter Livings & Associates was then transferred to the flight path recovery enlargements.

Delivery of photography and control from the Army caused delays both at the start and during the course of the survey.

5. MAGNETIC BASE STATION

5.1 LOCATION OF MAGNETIC BASE STATION

The Base Station was located near the Adelaide River township, Northern Territory in an area of low magnetic gradient away from any cultural effects.

5.2 DESCRIPTION OF BASE STATION SYSTEM

The heart of the system was a Geometrics G826 Magnetometer modified to 1/4 nT sensitivity and interfaced to Hewlett Packard 41CV Calculator and printer by HPIL interface system. The calculator with a real time clock was able to cycle the magnetometer at 20 second intervals and read the magnetic field value. This value along with the date and time of the reading could then be printed out on the printer for immediate evaluation.

The systems are designed such that they are powered by rechargeable sealed batteries which can be float charged by the mains or by lead acid batteries and solar panels.

5.3 METHOD IN WHICH BASE STATION DATA WAS USED

The data from the base station was used as a monitor for abnormal diurnal variation. On days when magnetic variations greater than 5 nT occurred in five minutes or less flying, if not already commenced, was cancelled. When variations were greater than 10 nT in 5 minutes for flight lines or 5 nT in 5 minutes for tie lines any airborne data collected during that period was reflown at Aerodata's expense.

The base station data was also used to diurnally level all lines flown during the survey. The magnetic base level chosen was 47,000 nT.

6. PROCESSING

6.1 INTRODUCTORY REMARKS

For all processing of the magnetic data to final maps the following corrections were applied.

i) Diurnal variation from base level of 47,000nT.
ii) Flight lines levelled to tie lines.
iii) IGRF model 1980 and secular variation model 1984 removed
iv) Parallax 36m

6.2 DIGITISING

AMG co-ordinates were generated for each recovered fiducial by digitizing the AMG controlled photography. The digitized data was stored on a line by line basis in digital form on magnetic data cassettes.

6.3 SPEED CHECKING

All flight path co-ordinates were run through a program that listed the speed of the aircraft in metres/second such that any flight path recovery or digitising errors became obvious. The average speed of the aircraft and the standard deviation of the aircraft's speed along with the average distance per reading and the length of the line was listed for each line.

6.4 FLIGHT PATH PLOTS

The flight path co-ordinate data with doppler assisted interpolation between recovered points was used to generate flight path plots. These sheets were suitably annotated with the Australian Map Grid co-ordinates.

The flight path plots were produced at a scale of 1:100,000 with sheet boundaries corresponding to the standard 1:100,000 sheet breakdown. Fiducial marks were plotted at intervals of 200 fiducials and recovered fiducials were also plotted.

6.5 STACKED PROFILES

Stacked profiles were plotted at a scale of 1:100,000 according to the standard 1:100,000 sheet breakdown. A magnetic base of 47,550 nT was used with a vertical scale of 100 nT/cm. The line number was plotted at the start and end of each line.

6.6 RECORDING OF DATA ON NINE TRACK TAPE

DATA TAPES

(a) An XY located digital record of raw and corrected data was provided on a line by line basis.
(b) Calibration and test data was provided on separate tapes at 1600 bpi in ASCII code.
(c) Item (a) was provided on 9 track tape at 1600 bpi in ASCII code formatted to SADME specifications.
(d) Item (a) was divided into sets of tapes corresponding to particular 1:100,000 map sheets covered by the survey.
(e) Comprehensive format documentation of the above items was provided.

6.7 MAGNETIC CONTOURS

The magnetic contour maps were hand drawn over computer generated cuts plotted along the flight lines. Final maps were produced at a scale of 1:100,000 according to the standard sheet breakdown to a contour interval of 5 nT. In addition 4 1:250,000 scale sheets were produced from reductions of these maps and the maps from an earlier survey to the North, flown by Austirex.

7. SYSTEM CALIBRATION AND CHECKS

7.1 MAGNETIC HEADING ERRORS

The aircraft was statically compensated for magnetic heading on the ground in an area of low magnetic gradient before the survey.

Prior to the flying of the area the heading error was checked and finally tuned by flying over a point with very low gradient in many different directions.

Pitch and roll tests were also conducted. The heading error flying checks were recorded in both digital and analog modes. The result of these checks was that heading errors were maintained throughout the survey to a value less than 1 nT.

7.2 RADAR ALTIMETER CALIBRATION

The radar altimeter was electronically calibrated prior to the altitude attenuation checks which were flown with reference to the barometric altimeter at heights of 30, 60, 100, 150, 200 and 300 metres over Batchelor airstrip. This data was recorded in analog and digital form before and after the survey.

7.3 SPECTROMETER CHECKS

The spectrometer was set up such that the total count channel recorded all counts between 0.321 MeV and 2.995 MeV.

Potassium channel recorded all counts between 1.368 and 1.568 MeV.

Uranium channel (using 214 bi peak) recorded all counts between 1.653 and 1.854 MeV.

The Thorium channel (using the 208 Ti peak) recorded all counts between 2.393 and 2.795 MeV.

Before and after each days flying the following tests were carried out:

(a) The gain in each photomultiplier tube was checked and the gain recorded on the daily spectrometer checks chart.

(b) Ground hand sample checks were done on the spectrometer using samples of potassium, uranium and thorium. These were preceded and followed by a background check. Each check was given a unique line no. with digital and analog records aquired over a period of 100 seconds.

The samples are designed to relocate accurately under the aircraft fuselage.

Daily averages were calculated for these checks and entered on a checks sheet. A computer printout of the check averages was provided to a Northern Territory Department of Mines & Energy representative at the end of the survey.

(c) A fixed test line was flown for 5 kms at survey height and speed in a constant direction with digital and analog records acquired.

(d) A high level background test at 2,000' above ground level with digital and analog records acquired for 200 seconds.

All spectrometer data that was recorded digitally was unstripped and was normalised to counts/second. All analog data was recorded in stripped form normalised to counts/second. The stripping coefficients were:

Alpha	0.34
Beta	0.47
Gamma	0.80

7.4 BMR SPECTROMETER TEST LINES, DALGETY, NSW

On 21st January, 1985 several test lines were flown over the BMR test range at Dalgety in NSW. This north-south line was flown at heights above ground level of 30m, 60m, 80m, 100m, 120m, 150m, 200m and 300m. Each line was flown so that it overflew the first line as closely as possible, starting and ending at common points.

Analog and digital data were acquired for each line. The analog charts were delivered with this report and the digital data was included on a calibration test 9 track tape in ASCII Code at 1600 bpi.

7.5 COSMIC AND AIRCRAFT BACKGROUND

Prior to commencement of the survey, Aerodata flew a series of spectrometer test lines over the ocean near Perth, Western Australia to assess cosmic and aircraft background. Digital and analog data were acquired for 2 minute periods at altitudes of 500m to 3,000m in 500m steps. A report on these tests by D.G. Sands (Aerodata - Chief Geophysicist) is included.

8. SURVEY LOGISTICS

8.1 OPERATING BASE

All day to day aircraft operations for this job were carried out from Batchelor Airstrip. After each flight the survey aircraft returned to Batchelor where mains power was available for maintaining power to the crystal heater overnight and providing auxillary power to the aircraft for ground running.

8.2 PERSONNEL

The following Aerodata employees were involved with the flying and processing of the data:

PILOTS :	A. McCambridge
	J. Doyle
NAVIGATORS :	G. Reudavey
	L. Coremans
OPERATORS	K. Harrington
TECHNICIAN :	K. Harrington
FLIGHT PATH RECOVERY:	V. Clifton
DATA PROCESSING:	P. Chambers
	W. Hitch

8.3 PRODUCTION SUMMARY

Flying commenced	20th August, 1984.
Flying completed	29th October, 1984.

8.4 TOTAL LINE KMS FLOWN

For internal purposes the survey was divided into 4 areas as follows:

AREA	1:100,000 SHEET/S INVOLVED
1.	Tipperary and Daly River
2.	Greenwood
3.	Wingate Mountains and Moyle
4.	Fitzmaurice

	FLIGHT LINE KMS	TIE LINE KMS	REFLIGHT KMS	TOTAL
AREA 1	12,782	3,068	11	15,839
AREA 2	5,084	Included Above	-	5,084
AREA 3	12,134	Included Above	252	11,882
AREA 4	6,446	622	121	6,947

TOTAL LINE KILOMETRES FLOWN WITHIN SURVEY BOUNDARY 39,752kms

WITH ALLOWANCE FOR OVERFLY 40,000kms

Reflight kilometres are deducted as non-chargeable

Ian Cook.

I.C. COOK
OPERATIONS MANAGER
AERODATA HOLDINGS LTD.

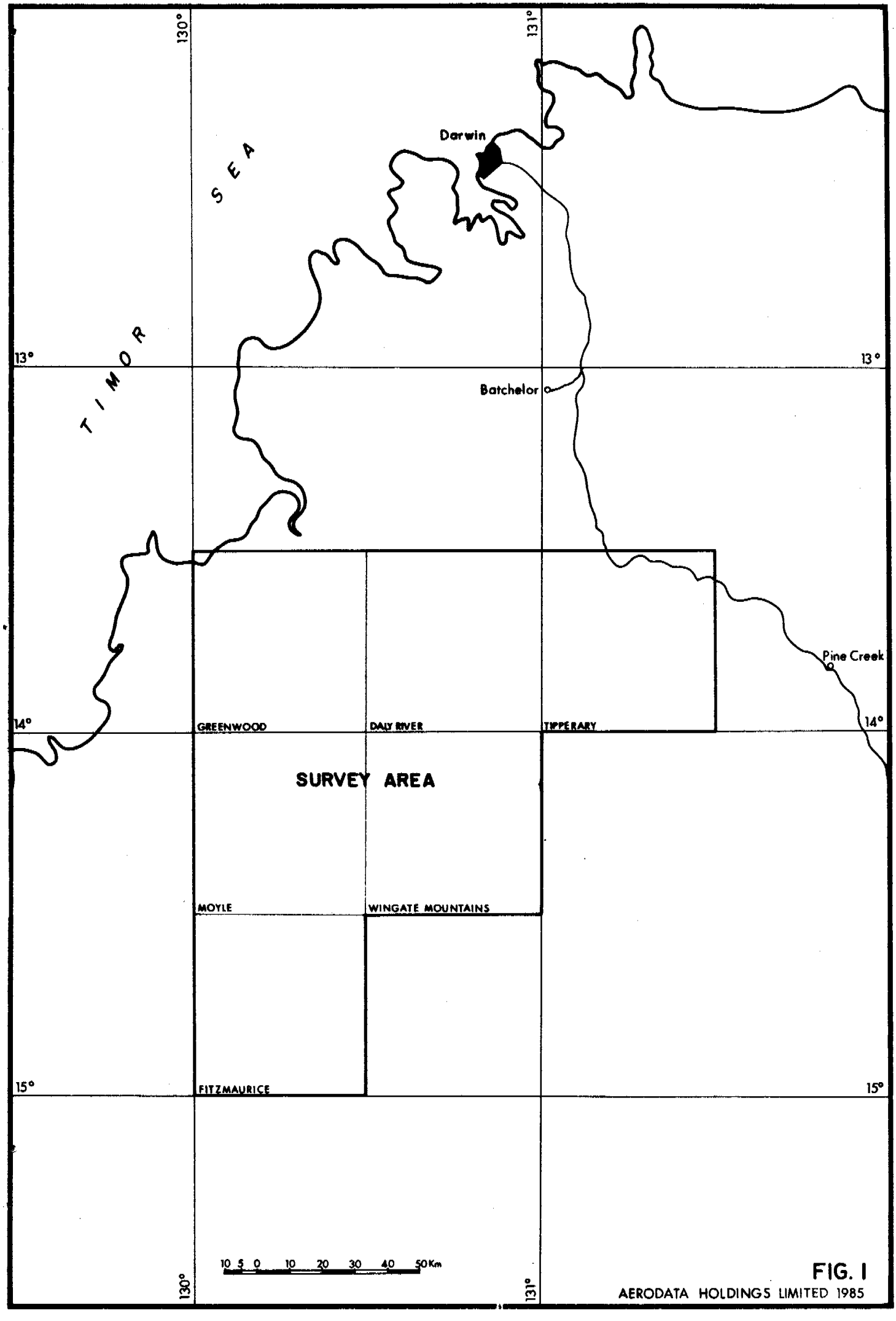

FIG. 1

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