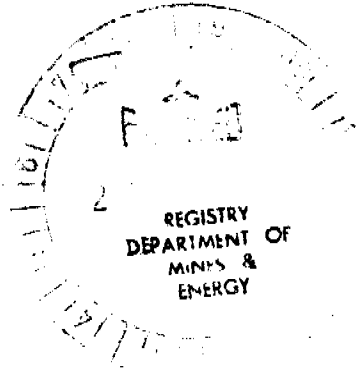


**OPEN FILE**

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→ Bruce S  
Any comments?

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DEPARTMENT OF MINES & ENERGY

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OPERATIONAL REPORT

OF

AIRBORNE GEOPHYSICAL SURVEY TB 20062/82 (HUCKITTA EAST)

JOB No 290

BY

AUSTIREX INTERNATIONAL LTD

D  
559.429  
1983/023

GS 83 / 23 1

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1. STATISTICS:

*Contract:* TB 20062/82, dated March 18, 1983.

*For:* Department of Mines & Energy,  
Northern Territory of Australia.

*Contractor:* Austirex International Pty Ltd

*Type of Survey:* Airborne geophysical for acquisition of  
magnetic and radiometric data

*Area of Survey:* Huckitta East within the 1:100,000 map sheets;  
Tarlton, Marqua and Mount Barrington

*Aircraft:* Nomad N22B Registration number VH-CPX

*Personnel:*

<i>Pilots:</i>	W. Hay
	D. Gibson
<i>Navigators:</i>	R. Macdonald
	R. McLernon
<i>Engineers:</i>	J. Robins
	P. Carr
<i>Technicians:</i>	R. Butler
	D. Morrison
	P. Robinson

*Duration:* 24 March to 24 April 1983.

*Climatic Conditions:* Generally dry during the period of  
survey except for rain recorded on 2,11,  
12, April which precluded data acquisition  
on those days.

*Geomagnetic Conditions:* No diurnal disturbances were recorded  
during the period of survey.

2. SURVEY SPECIFICATIONSArea:

Approximately 8500 square kilometres.

Flight Lines: 207 lines spaced at nominal 500 metre intervals  
Direction 180° - 360°.

Tie Lines: 23 lines spaced at nominal 5 kilometre intervals  
Direction 090° - 270°.

Linear Distance Surveyed: 19,592.5 Kilometres

Flight:

Aircraft/Detector Elevation: nominal 100 metres terrain clearance.

Navigation: Visual from aerial photo assemblage with doppler guidance.

Instrumentation:

Flight Path: vertical tracking film record. Fiducial recovery onto aerial photographs at an average interval of 10 Km.

Magnetic Data: airborne and ground station proton precession magnetometers were used for the recording of total field intensity magnetics.

Radiometric Data: a multi-channel gamma-ray spectrometer was used for the recording of total radiation intensity measurement. Spectrum windows were set at 0.4 - 3.0 MeV for Total Count, 1.37 - 1.57 MeV for potassium, 1.66 - 1.86 MeV. for uranium, 2.40 - 2.80 MeV for thorium and 3.0 - 6.0 MeV for cosmic background.

Data Acquisition: digital recording of all sensor and flight information on to 9 track 800 b.p.i. magnetic tape. Analogue recording of all magnetic, radiometric and radar altimeter data on to multi-channel records. Sample interval 0.7 seconds.

3. EQUIPMENT SPECIFICATIONS

- Aircraft: Government Aircraft Factories NOMAD 22B. Twin turbo-prop engines.
- Altimeters: Radar altimeter - Collins ALT-50, range 0-610 metres. Barometric altimeter - Penny and Giles.
- Doppler System: Sperry Decca type 72 with Tactical Air Navigation System computer 9447D. Digital recording of long and cross track pulses and of compass heading.
- Airborne Magnetometer: Geometrics G.813 proton precession magnetometer with auto tuning. Recording precision 0.01 nT. The sensor is mounted as a tail stinger installation.
- Ground Magnetometer: Geometrics G.866 proton precession magnetometer. Recording precision 0.1 nT. Time controlled total field recording at 6 second intervals on to data cassette and 54 second intervals onto digital printout.
- Spectrometer: Geometrics GR-800/900. 256 channels for the main downward detector and 128 channels for the upward detector.
- Crystal detectors: Geometrics DET-3072/512R. Sodium iodide crystals, 50.34 litres main packs and 8.39 litres for the upward packs.
- Calibration Sources: Standards of Cesium, Uranium, and Thorium used for daily pre and post flight ground calibrations.
- Data Acquisition System: Sonotek IGSS-1 using a Fabritek MP-12 computer with two Digi Data 9 track tape decks.
- Analogue Recorder: Exploranium MARS-6, a six channel recorder for magnetic, radiometric, radar altimeter and fiducial data. Hewlett-Packard 7155 dual channel recorder for radiometric calibrations and spectral plots.
- Tracking Camera: 35 mm Geocam 75 SF camera fitted with a 17 mm wide angle lens. Continuous strip mode with fiducial numbers imposed on film exposures.

4. SURVEY PROCEDURES

*Operations:* For the survey the Jervois Mine was used as the base for flight and field operations, where all accumulated flight and sensor data was subjected to infield quality control. A subsequent office computer evaluation of all digital data was made to ensure that all systems and information were recorded properly and as a final acceptance of the raw data.

*Logistics:* Aviation turbine fuel in 200 litre drum containers was supplied from Alice Springs and road freighted to the landing field at Jervois Mine.

*Instrument Calibrations:* Prior to survey commencement, airborne tests were conducted for magnetic heading calibrations and systems parallax. These tests were repeated at the conclusion of the survey.

During the course of the survey ground pre and post flight spectrometer calibrations were performed to ensure that systems stability and response were within normal tolerance limits.

Airborne pre and post flight tests were conducted over a 5 kilometre length line at survey altitude to confirm all systems repeatability and for the assessment of ground water conditions.

For the prequalification test altitude stacks were flown over the Dalgety test range.

5. DATA REDUCTION

The data processing procedure follows the flow shown in the Schematic diagram.

*Preprocessing:* Tapes from the field were decoded and then corrected, if necessary, to remove duplicated fiducials and to change line numbers. All lines deleted in the field were removed. The data then went through an automatic edit where spikes were removed and the doppler was filtered. For each line both the raw and corrected data was plotted (as well as spectral plots for calibrations and test lines). Any errors that were not corrected in the automatic edit were manually corrected.

*Flight Path:* The flight path was recovered in the field as flying proceeded by visual comparison of detail in the aircraft tracking film with that of the recovery photographs, marking equivalent points and recording the relevant fiducials.

Both photographs and control points (from aerial triangulation) for each survey area were obtained from Natmap. The control points on each photographs were digitised and then transformed using a least square fit (Helmert Transformation) to obtain photograph coordinates.

The individual photographic recovery points were then digitised and transformed using a perspective transformation determined by the control points. The recovery was checked for gross errors by a simple speed check and then by a doppler comparison to check on smaller errors.

Photography used: - RC9 photographs (nominal scale 1:83,000)  
Hay River 1971 - runs 1,2,3,4

Tobermory 1970 - runs 5,6,7,8

The flight path was then plotted as a final check on positioning and if any errors still remained, these were manually corrected.

*Diurnal:* The diurnal was read off the cassettes, edited to remove spikes and then filtered to remove magnetic noise. Raw profiles showing original and corrected data were then plotted and any errors remaining were manually corrected. A diurnal datum of 55100 nT was selected from examination of the records and removed from the diurnal values. The diurnal was then incorporated into a data base which was used in magnetic reductions.

**Magnetics:** The diurnal was interpolated to produce a diurnal correction for every fiducial. This was subtracted from the magnetic values along with the IGRF value. The IGRF model used was the 1980 model with secular variation and is computed for every fiducial. The data is then corrected for system parallax and a new set of coordinates for each fiducial is computed. Tie line levelling was used to remove any linear level variations between traverse lines. Any non linear level variations were removed by manual levelling. The resultant levelled and corrected data was filtered prior to gridding using a light filter with cutoff frequency of 0.33 cycles per data interval.

For the 1:100,000 maps a grid cell of 75 metres was used and for the 1:250,000 maps a grid cell of 175 metres was used. Prior to contouring a two dimensional filter was used with a cutoff frequency of 0.1 cycles/data interval and a termination frequency of 0.15 cycles/data interval.

**Radiometrics:** The following reduction procedures were applied to the radiometric data:

(1) Dead time (fixed for our system at 8 microseconds) and normalisation of data to counts per second from counts per scan.

(2) Removal of aircraft background (determined from high altitude tests). This removes any counts due to sources within the aircraft and system.

(3) Spectral reduction - a matrix operator reduces the data to Compton stripped K, U, Th and Total Count and also removes effects due to cosmic. Stripping ratios used were:

$$\alpha = 0.295, \quad \beta = 0.453 \quad \text{and} \quad \delta = 0.83.$$

(4) Atmospheric correction and altitude attenuation corrections. The atmospheric correction is computed from the upward total count data and corrected for the geometric factor (from the relationship of upward and downward crystals) and for the shield leakage factor (the amount of downward counts that 'leak' into the upward counts). All factors are altitude dependant and are corrected from 'look up' tables. Both atmospheric and altitude data are filtered to remove anomalous effects.

(5) Conversion to ground concentration: Element sensitivities are computed from test area of known concentrations. This enables us to convert count rates to percentages or relevant elements. For U and Th  $e_U$  and  $e_{Th}$  are computed. The "e" is used to denote "equivalent" in recognition of the fact that these analysis have been made on radiation emitted from daughter products in a series. Total Count data are expressed as "ur" units. This unit is defined as the concentration of uranium in the sample (ground) which would generate the measured count rate if all the counts were originating from uranium series radiation in equilibrium.



(6) Prior to gridding an along line filter was applied with a cut off frequency of 0.25 cycles/data interval. The grid cells used for the 1:100,000 maps was 75 metres and for 1:250,000 maps was 175 metres.

(7) Prior to contouring a two dimensional filter was applied with a cut off frequency of 0.15 cycles/data interval and a termination frequency of 0.2 cycles/data interval.

*Line Number Structure: The last digit on all lines is used as an attempt number, --.1 is the first attempt, --.2 is the second and so on.*

*Test Lines: Pre Flight 1.1  
Post Flight 2.1*

*Calibrations: Pre Flight Cs 137 10.1  
U 11.1  
Th 12.1  
Background 13.1  
Post Flight Background 17.1  
Th 16.1  
U 15.1  
Cs 137 14.1*

*Parallax Test: Same as Test Lines*

*Attenuation Test/Altimeter*

*Check: 50.1 to 59.1*

*Heading Test: 60.1 to 69.1*

*Traverses: 101.1 to 307.1*

*Tie Lines: 901.1 to 923.1*

## Field Data Tape Format:

- (1) One (1) type of Block containing:-  
 A: Data Block Header  
 B: Three (3) Data Scans
- (2) The data block header contains the following information (in four (4) bit units) in either BCD or BIN as set out below:-

<u>No. of 4 bit units</u>	<u>Code</u>	<u>Meaning - Content</u>
4	None	Marker (HEX F)
2	BCD	Day
2	BCD	Month
2	BCD	Year (last 2 digits)
2	None	Marker (HEX F)
4	BCD	Scan type
2	None	Marker
2	BCD	Unassigned
2	None	Marker (HEX F)
4	BCD	Tape number
2	None	Marker (HEX F)
4	BCD	Block number
2	None	Marker (HEX F)
6	BCD	Line number
2	None	Marker (HEX F)
4	BCD	Flight number
2	None	Marker (HEX F)
<hr/>		
48		

- (3) Each of the Three Data Scans contains the following information.

<u>No. of 4 bit units</u>	<u>Code</u>	<u>Meaning - Content</u>
6	BCD	Fiducial number
2	None	Marker (HEX F)
6	BIN	24 bit count of acquisition period of spectrometer, for this scan in units of 1/10th of a millisecond.
6	BIN	24 bit count COSMIC, DOWN
6	BIN	" " " K - 40, "
6	BIN	" " " Bi-214, "
6	BIN	" " " Tl-208, "
6	BIN	" " " TOTAL, "
6	BIN	" " " 1.0 - 2.3 MeV UP
6	BIN	" " " TOTAL UP
1024	BIN	256 x 16 bit counts, channels $\emptyset$ - 255, Spectrometer, DOWN.
256	BIN	128 x 9 bit counts, channels $\emptyset$ - 127, Spectrometer, UP.
2	BIN	8 bit checksum for all Spectrometer channels excluding itself.

<u>No. of 4 bit units</u>	<u>Code</u>	<u>Meaning - Content</u>
2	None	All zero marker 00
6	None	Marker (HEX F)
1	BCD	If 1 = West, If 2 = East
3	BCD	Longitude, degrees
2	BCD	Longitude, minutes
2	BCD	Longitude, seconds
1	BCD	If 4 = South, if 8 = North
2	BCD	Latitude, degrees
2	BCD	Latitude, minutes
2	BCD	Latitude, seconds
3	BCD	Heading, degrees
2	BCD	Heading, minutes
6	BCD	Unassigned
4	BCD	Doppler along-heading pulse count
4	BCD	Doppler Across-heading pulse count, right
4	BCD	Doppler across-heading pulse count, left
2	BCD	Time hours
2	BCD	Time minutes
2	BCD	Time seconds
2	BCD	Identifier 00 - Fixed
4	BCD	Data from analogue channel 00 Temperature in Celsius in format 000.0°C
2	BCD	Identifier 01 - Fixed
4	BCD	Data from analogue channel 01 Altitude in metres in format 000.0 m
2	BCD	Identifier 02 - Fixed
4	BCD	Data from analogue channel 02 Air pressure in millibars in format 0000 mb
2	BCD	Identifier 03, - Fixed
4	BCD	Data from analogue channel 03 Auxiliary input for channel 02
2	BCD	Identifier 04 - Fixed
4	BCD	Data from analogue channel 04 Unassigned
2	BCD	Identifier 05 - Fixed
8	BCD	Magnetometer data in format 00000.000 nT
4	BCD	Marker (HEX F)

1438 Four (4) Bit Units, or 719 bytes

Total Record Length

Block header	24 bytes
3 Scans x 719	2157 bytes
<b>TOTAL</b>	<b>2181 bytes</b>

**Located Data Tape Format:**

Three sets of data tapes are provided.

Each located data tape is 9 track, 800 b.p.i., ASCII.

The tapes form a multi tape file. When an EOT is found, the program completes writing the current block and then writes an EOF. The multi tape file has the following structure:

1. Character Set record - 49 Chars + New Line (repeated 3 times)
2. Survey Header - (69 Chars + New Line/record) (repeated 3 times)
3. Comments Header - (69 Chars + New Line/record)
4. EOF mark
5. Line data records
6. EOF mark

The Survey Header records are:

- (1) Survey Header
- (2) Survey code
- (3) Survey area name
- (4) Exploration licence
- (5) Area size - Sq Km
- (6) Who flew
- (7) Who processed
- (8) For whom
- (9) A or D acquisition + Control
- (10) Traverse separation - m
- (11) Tie separation - m
- (12) Average altitude ASL - m
- (13) Nominal ground clearance - m
- (14) Nominal line bearing from north - deg
- (15) Length of non header records - bytes
- (16-) 100,000 sheet numbers - 1 / record

The Data Record format for the corrected data follows:

Block size = 4800 bytes; Data record length = 120 bytes:

Date (I6,I1),

Flight number (I3),

Line number (I6),

Fiducial number (I6)

Time (sec) (I6,I1)

Recovery longitude (deg) (F10.5),

Recovery latitude (deg) (F10.5),

Recovery longitude, corrected for mag parallax (deg) (F10.5)

Recovery latitude, corrected for mag parallax (deg) (F10.5)

Terrain clearance (m) (F5.1),

Mag intensity, corrected for diurnal and IGRF removed (nT)  
(I1,F8.2)

Mag diurnal correction (nT) (I1,F8.2),

Total radioelement (Ur) (F6.2),

Potassium (per cent) (F5.2),

Uranium (eppm) (F6.2),

Thorium (eppm) (F6.2),

Uranium air (eppm) (F5.2)

## Notes:

- (1) Any undefined data is shown as an \*
- (2) An EOF mark is written at the end of all the line data.

For the raw data tapes, the Data Record format is:  
Block size = 4480 bytes; Data record length = 112 bytes:

Date (I6,I~~X~~)  
Flight number (I3),  
Line number (I6),  
Fiducial number (I6)  
Time (sec) (I6,I~~X~~),  
Heading (deg) (F5.1),  
Recovery longitude (deg) (F10.5)  
Recovery latitude (deg) (F10.5)  
Doppler long track (pulses/sec/knot) (I~~X~~,F6.1)  
Doppler cross track (pulses/sec/knot) (I~~X~~,F6.1)  
Terrain clearance (m) (F5.1),  
Mag intensity (nT) (I~~X~~,F8.2)  
Total 1 (counts) (F6.1),  
Potassium (counts) (F5.1),  
Uranium 1 (counts) (F5.1),  
Thorium 1 (counts) (F5.1),  
Cosmic (counts) (F5.1)  
Total 2 up (counts) (F5.1)

## Notes:

- (1) Any undefined data is shown as an \*
- (2) An EOF mark is written at the end of all the line data.

For the test lines tapes, the Data Record format is:  
Block size = 4600 bytes; Data record length = 92 bytes:

Date (I6,I~~X~~),  
Flight number (I3),  
Line number (I6),  
Fiducial number (I6)  
Time (sec) (I6,I~~X~~),  
Heading (deg) (F5.1),  
Doppler long track (pulses/sec/knot) (I~~X~~,F6.1)  
Doppler cross track (pulses/sec/knot) (I~~X~~,F6.1)  
Terrain clearance (m) (F5.1),  
Mag intensity (nT) (I~~X~~,F8.2)  
Total 1 (counts) (F6.1),  
Potassium (counts) (F5.1),  
Uranium 1 (counts) (F5.1),  
Thorium 1 (counts) (F5.1),  
Cosmic (counts) (F5.1).  
Total 2 up (counts) (F5.1)

## Notes:

- (1) Any undefined data is shown as an \*.
- (2) An EOF mark is written at the end of all the line data.

APPENDICES

### HEADING CHECKS

Three tests were flown, one prior to commencement, one during the survey and one at the completion of the survey. The results are shown below:-

	FLT 02		FLT 21		FLT 36	
	Ave.	Ave. -Mean	Ave.	Ave. -Mean	Ave.	Ave. -Mean
N	40.5	+0.3	44.4	+0.9	30.5	+0.2
S	41.4	+1.2	44.4	+0.9	30.9	+0.6
E	40.1	-0.1	42.5	-1.0	29.6	-0.7
W	38.6	-1.6	42.4	-1.1	26.8	-3.5
Mean	40.1		43.5		30.3	

The datums used were:- Flt 02 59000nT, Flt 21 52600 nT and Flt 36 52400 nT.

Tests show a wide variability. This is largely due to the inherent problem of accurately picking the crossover point. To position the aircraft accurately the test must be flown as low as possible but in flying low, micro magnetic anomalies cause wide fluctuations.



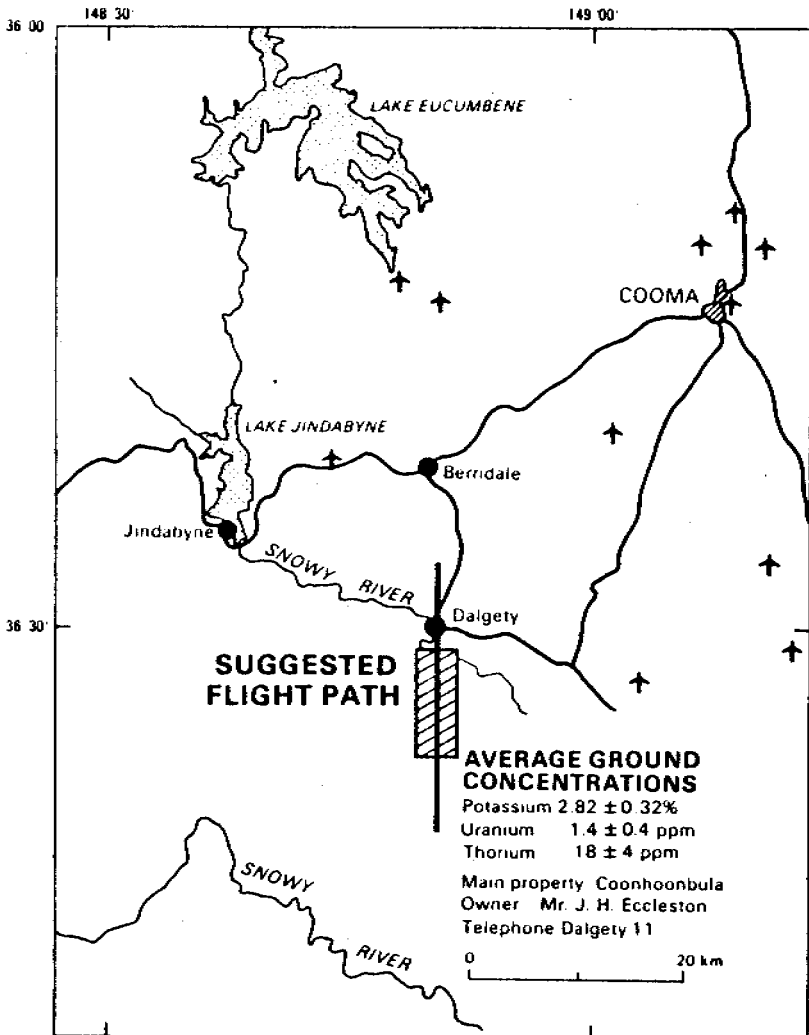
PARALLAX TESTS

Parallax tests were conducted on flights 04 and 35. The lines used were the test line which covered an area of high magnetic gradients on the road from the Jervois Mine to the Plenty River highway. The peaks and troughs of each magnetic trace were picked to the nearest tenth of a fiducial from multiplots. These points were transferred from the tracking film of one line to the other and the fiducial difference computed. These were then converted to metres using the speed determined from the doppler pulses.

Mean difference 1.77 fiducials

Parallax correction 38.4 metres

Speed 62.0 metres/second



**DALGETY TEST SITE**

TEST RANGE

For prequalification the Dalgety test range was flown. Two altitude stacks were flown from 30 m to 300 m. The weather at the time of the test was sunny with light scattered cloud, however in the week prior to commencement of flying, heavy rainfall was recorded in the general area.

The reduced values recorded on the test range for each element are shown below:-

Thorium (mean values eppm)			Uranium (mean values eppm)	
Altitude (m)				
30	10.83	10.79	1.32	1.25
60	10.71	10.65	1.44	1.49
80	10.60	10.49	1.56	1.75
100	10.63	10.64	1.32	1.26
120	10.84	10.74	1.16	1.02
150	10.75	10.70	0.81	1.06
200	11.04	11.08	0.11	0.26
300	11.94	12.07	-1.86	-0.75
Average both tests	10.91		0.83	
Standard deviation	0.46		0.96	

Potassium (mean values %)			Total Radioelement (mean values ur)	
Altitude (m)				
30	2.77	2.75	11.84	11.74
60	2.61	2.60	11.90	11.91
80	2.51	2.53	11.92	12.06
100	2.47	2.47	11.78	11.72
120	2.40	2.43	11.73	11.66
150	2.37	2.36	11.55	11.62
200	2.27	2.22	10.98	10.93
300	2.13	2.13	9.18	10.08
Average both tests	2.44		11.41	
Standard deviation	0.19		0.78	

The values recorded are lower than those recorded by the BMR however this may be in part due to the ground moisture still being high at the time of the test and causing a general reduction in the values.