NORTHERN TERRITORY DEPARTMENT OF MINES AND ENERGY

LOGISTICS REPORT

OF

PETERMAN AIRBORNE GEOPHYSICAL SURVEY, TB.1703/89

BY

AUSTIREX INTERNATIONAL LIMITED

A. SURVEY DETAILS OF DATA ACQUISITION

1. Area

Approximately 18,000 square kilometres in the Petermann Ranges area, Northern Territory.

2. General survey description

Flight line direction	- 0 - 180 degrees
Flight line spacing	- 500 metres
Tie line direction	- 90 - 270 degrees
Tie line spacing	- 5000 metres
Mean terrain clearance	- 100 metres

3. Photography and Navigation

Navigation was visual, assisted by Doppler, from black and white enlargements of RC10 photography. Control was provided by P. Livings and Associates.

4. Flight path recovery

Flight path recovery was carried out using a combination of visual recovery from the tracking film on a duplicate set of photographs provided for navigation and the information recorded from the Doppler navigation equipment.

The average distance between recovered points was 5 kilometres along traverse lines and tie lines where sufficient photographic detail was present.

Where the flight line separation exceeded 750 metres over a distance of 5 kilometres or more, fill-in lines which cross tie lines at their extremeties were flown.

5. Spectrometer

A differential gamma-ray spectrometer was used to measure the energy windows encompassing the standard gamma radiation windows for Tl-208, Bi-214, K-40 and total count, as well as a cosmic window.

The NaI(Tl) detector volume was 2048 cubic inches (33.56 litres).

6. Altimeter

Terrain clearance was recorded by a radio-altimeter with a sensitivity of 0.1 metres and an operating range from ground level to 2000 feet (0 - 610 metres).

7. Magnetometer

Readings of the magnetic field were recorded at a sensitivity of 0.1 nanoTeslas or better at a 0.25 second reading interval.

8. Base station magnetometer

The base station magnetometer was sited as close to the survey area as practical. The magnetometer recorded to a sensitivity of 0.25 nanoTeslas at an interval of 10 seconds. The sensor was placed in a low gradient area beyond the influence of any cultural interference. The noise envelope was less than 2.5 nanoTeslas peak to peak. No tie line data was accepted where-in the departure of the diurnal field exceeded 5 nanoTeslas in 5 minutes and for flight lines 10 nanoTeslas in 5 minutes.

9. Time base

All magnetometer readings were acquired on a constant time basis of 0.25 seconds, all other parameters were recorded at a constant time basis of 0.75 seconds.

10. Analogue recording

A multi-channel recorder was used to record four channels of radiometric data, altimeter and coarse and fine scale magnetic data. Full scale deflections were suitably chosen and the fiducials marked on each chart.

11. Digital recording

For each 0.75 second acquisition interval the following was recorded on magnetic tape:-

Fiducial number
Time
Altitude
Magnetometer readings (Three)
Radiometric channels
Doppler and navigation aid plus the appropriate flight and line numbers.

12. Acquisition System

The acquisition system records all data required onto a 9 track magnetic tape deck at 800bpi in ASCII format. All data was transferred to tape in blocks of ten fiducials.

B. SYSTEM CALIBRATIONS AND CHECKS

1. System calibration

The aircraft system checks comprise the following:-

1. Hand sample checks using Cs,U and Th sources were completed before and after each day's production and noted on calibration logs. The background was also recorded.

2. Resolution of the gamma ray spectrometer were carried out using a Cs137 source.

3. Test lines were flown prior to and after each day's production.

2. Data acquisition checks

The checks performed on the data acquisition system involve a read after write check on the tape.

On receipt of data from the field, statistics of each variable are computed, as well as each production line is profiled and the results checked for data integrity.

3. Spectral resolution

The results of the daily resolution check are shown on the daily calibration logs.

4. Spectrum stabilization and calibration

The results of these checks are shown on the calibration logs.

5. Correction coefficients

1. Analogue stripping

The following stripping coefficients are applied to the data prior to presentation on the analogues

Thorium/Uranium	0.3
Thorium/potassium	0.5
Uranium/potassium	0.7

2. Digital stripping

The following coefficients are to be used for stripping the digital data:-

Thorium/uranium	0.251
Thorium/potassium	0.448
Uranium/potassium	0.834
Uranium/thorium	0.050

3. Aircraft background and cosmic correction

These coefficients were determined from high altitude flights flown in September, 1985. The aircraft background is to be removed before stripping (see also appendix 2).

	Aircraft Background	Cosmic Correction	Correlation Coefficient
Total count	222.51	2.482	0.996
Potassium	17.86	0.130	0.968
Uranium	7.57	0.121	0.977
Thorium	3.85	0.138	0.995

4. Spectral windows

	Channel from	to	Energy (MeV) from	to
Total count	2	254	0.321	2.995
Potassium	101	120	1.368	1.579
Uranium	128	147	1.653	1.853
Thorium	198	236	2.393	2.805
Cosmic	255	255	2.995	6.000

5. Magnetometer & Spectrometer Parallax

The magnetometer parallax is - 0.88 fiducials
The spectrometer parallax is - 1.50 fiducials

C. SURVEY LOGISTIC REPORT

1. Operating Base

Operating Base was Yulara N.T. where AVGAS was available. The diurnal was also sited at Yulara.

2. Operating field crew

Pilot	- D. Gibson, D. Kalatay
Navigator	- G. Macdonald
Engineer	- P. McAuliffe
Data Technician	- R. Gardner
	- D. Keith

3. Aircraft

Survey aircraft - Aerocommander 500S VH-FGS

4. Flight Summary

Production flights number	- 59
Survey commencement	- 20 September 1985
Survey finish	- 28 October 1985
Duration	- 39 days
Total kilometres	- 38,000 approx.

D. GENERAL TECHNICAL SPECIFICATIONS AND DETAILS

1. Aircraft

Type	- Aerocommander 500S
Registion	- VH-FGS

2. Magnetometer

Type	- Scintex VIW 2321-H6 alkali vapour
Resolution	- 0.005 nanoTeslas
Operating range	- 17,000 - 95,000 nanoTeslas
Mounting	- Tail stinger
Compensator	- Sonotek AADC 2C1AB

3. Altimeter

Type	- Collins ALT-50 radio altimeter
Resolution	- 0.1 metres
Range	- 0 - 610 metres

4. Ground Magnetometer

Type	- Geometrics G826 A proton precession
Resolution	- 0.25 nanoTeslas
Sampling interval	- 10 second
Recording interval	- 10 second
Recording unit	- MFE450

5. Navigation

Doppler type	- Decca model 72
Compass type	- Sperry GM9 gyro compass
Navigation aids	- Decca Tans 9447D - GNS VLF/Omega
Tracking camera	- Geocam 75SF, 35mm continuous strip
Camera lens	- 17mm wide angle
Barometric altimeter	- Penny and Giles

6. Data Acquisition system

System type	- Geometrics G714
Digital output	- Digidata 9 track 800 BPI tape deck
Analogue output	- Exploranium MARS6, six channel recorder

7. Spectrometer

Type	- Geometrics GR800/900D
Crystals	- Geometrics DET 2048 Thallium doped Sodium Iodide
Crystal volume	- 33.56 litres
Resolution	- less than 12% FWHM on Cs137 peak at 0.552 MeV.
Spectral range	- 0.3 - 6.0 MeV.
Channels	- 256
Analogue windows	- Total 0.320 - 2.995 MeV, channels 2-254 Uranium 1.653 - 1.864 MeV, channels 128-147 Potassium 1.368-1.579 MeV, channels 101-230 Thorium 2.393-2.805 MeV, channels 198-236
System deadtime	- 8 microseconds per total count

APPENDIX 1

Field Tape Format

Block size	1,310 bytes
Record size	131 bytes
No. of records per block	10
Storage Format	ASCII

Record contents

First byte	Last byte	No. of bytes	Example	Description
1	7	7	Y85D162	Date
8	16	9	H12M10S23	Time
17	20	4	1011	QNH
21	21	1		
22	24	3	102	Flight no.
25	25	1		
26	28	3	121	Tape no.
29	32	4		
33	37	5	11023	Fiducial no.
38	41	4	1022	Line no.
42	45	4	7777	Heading
46	49	4	1300	Doppler long track
50	53	4	102	Doppler cross track
54	60	7	4578883	Magnetic intensity (0)
61	64	4	8883	Magnetic intensity (-2)
65	69	5	78883	Magnetic intensity (-1)
70	73	4	4042	Total count
74	76	3	320	Potassium
77	79	3	101	Uranium
80	82	3	151	Thorium
83	85	3	100	Cosmic
86	101	16		unused
102	107	6	+5,200	Radar altitude
108	113	6	+0.020	Zero input for radar altitude
114	119	6	+4.555	Pressure
120	125	6	+3.950	Uncompensated magnetic intensity (C)
126	131	6	+0.395	Uncompensated magnetic intensity (F)

APPENDIX 2

COSMIC AND AIRCRAFT BACKGROUND TESTS

For prequalification, a series of high level test lines were flown to determine the cosmic and aircraft background corrections. The area flown was southwest of Perth over the water to reduce, as much as possible, the effect from atmospheric radon. From previous tests, it has been noted that atmospheric radon extends up to 3000 metres and that only lines flown over that height are suitable for cosmic tests.

The results from the tests are shown below (all figures are in counts/second, altitude in metres).

Altitude	Total count	Potassium	Uranium	Thorium	Cosmic
2500	531	35	24	20	120
2500	610	38	32	23	121
2750	576	38	26	23	142
2750	581	37	26	23	142
3000	645	40	28	27	169
3000	636	39	27	27	169
3200	683	42	30	29	184
3200	679	41	30	29	185
3350	728	46	32	33	201
3350	716	44	32	31	202
3400	738	44	33	32	205
3400	741	45	33	33	211
3475	762	46	35	34	215
3475	761	47	34	34	216
3550	783	48	35	35	225
3550	783	48	33	35	227
3600	802	48	35	36	233
3600	790	47	35	37	229
3650	817	48	37	37	242

To compute aircraft background and cosmic correction, a linear regression of counts in each window against cosmic counts, disregarding all counts affected by atmospheric radon i.e.

compute $Y = cX + b$

where
Y = cosmic counts
X = counts in window
c = cosmic correction
b = aircraft background

This leads to the determination of the cosmic correction and aircraft background as -

	Aircraft Background	Cosmic Correction	Correlation Coefficient
Total count	222.51	2.482	0.996
Potassium	17.86	0.130	0.968
Uranium	7.57	0.121	0.977
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APPENDIX 3

DALGETY TEST RANGE TESTS

For prequalification, two altitude stacks were flown over the Dalgety test range. The lines ranged in height above ground from 50 metres to 350 metres. The lower altitude line, as requested by the Department, was not flown due to the difficulty of maintaining constant height at that level.

The weather at the time of the test was sunny with scattered cloud. Some rain had been recorded in the area during the week before the test but did not appear to affect the results.

Due to the difficulty of determining the amount of atmospheric radon in the area and also that no upward looking crystals were carried in the aircraft at the time of the test, the same height stacks were also flown over Eucumbene Dam (the nearest suitable large body of fresh water (see map)) to determine the approximate value of atmospheric radon.

The raw results from the test range are listed below -

Planned Height	Mean Actual Height	Total	Potassium	Uranium	Thorium	Cosmic
50	43.9	4,306	463	95	124	50
50	43.2	4,250	451	96	124	50
75	70.3	3,664	367	85	104	50
75	70.1	3,681	370	87	106	50
100	96.3	3,210	310	78	91	50
125	119.9	2,901	270	74	79	50
125	121.4	2,888	268	74	80	51
150	149.2	2,515	223	69	67	52
150	148.2	2,538	226	69	70	51
200	190.3	2,087	174	61	54	52
200	185.4	2,130	178	63	58	53
250	245.6	1,676	132	53	43	55
250	241.3	1,696	135	53	46	55
300	288.8	1,413	108	47	37	55
300	282.2	1,456	112	48	39	56
350	349.2	1,196	87	44	32	58
350	346.1	1,197	88	43	32	58

Note: All heights are in metres. All counts are in counts/second and are dead time corrected.

To reduce the data, the following correction are applied

1. Removal of aircraft background
2. Stripping and cosmic correction
3. Removal of atmospheric radon
4. Altitude attenuation
5. Conversion to ground concentrations

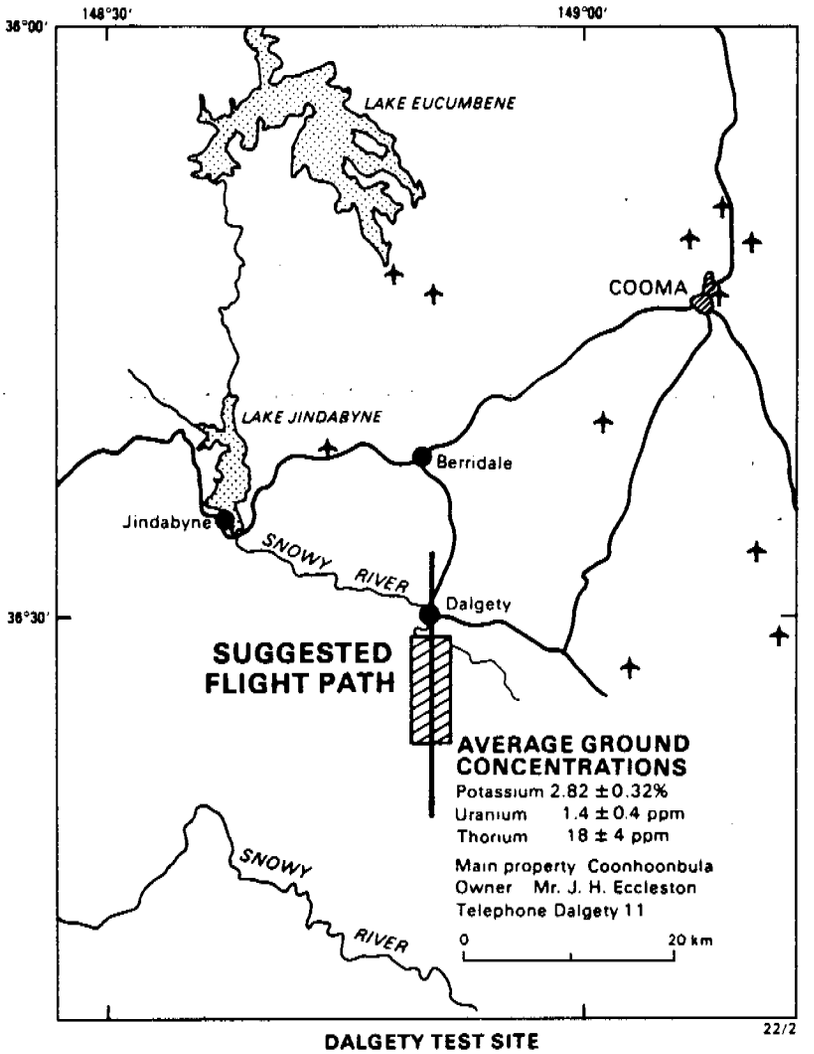
After these corrections the following results were obtained:-

Height (m)	Total (ur)	Potassium (%)	Uranium eppm	Thorium eppm
50	12.05	2.45	1.97	10.43
50	11.82	2.34	2.01	10.40
75	11.71	2.29	1.91	10.24
75	11.75	2.30	2.00	10.35
100	11.70	2.30	1.88	10.35
125	11.90	2.33	2.05	10.15
125	11.93	2.33	2.04	10.47
150	11.82	2.28	2.13	10.01
150	11.90	2.31	2.08	10.48
200	11.79	2.29	2.04	10.04
200	11.76	2.24	2.08	10.44
250	11.88	2.39	1.86	10.51
250	11.76	2.40	1.79	11.07
300	11.65	2.47	1.56	11.22
300	11.74	2.48	1.67	11.28
350	11.92	2.60	1.53	12.08
350	11.92	2.71	1.48	12.27
Mean	11.82	2.38	1.89	10.69
Standard Deviation	0.10	0.13	0.21	0.67

A previous test over the Dalgety range (TB 20062/82, Huckitta East) recorded the following -

Total	10.91 ur
Potassium	2.44%
Uranium	0.83 eppm
Thorium	11.41 eppm

These results compare favourably to the above, considering the Huckitta East Survey was flown by a different aircraft using a crystal volume of 50.34 litres. The results are still lower than those recorded by the BMR (see map).



DALGETY TEST SITE