NORTHERN TERRITORY
DEPARTMENT OF MINES AND ENERGY

AIRBORNE GEOPHYSICAL SURVEY
ALCOOTA / ALICE SPRINGS, NT

SURVEY DETAILS, TECHNICAL SPECIFICATIONS AND PROCESSING SUMMARY

Undertaken for:

NORTHERN TERRITORY
DEPARTMENT OF MINES AND ENERGY

Survey Flown September – October 1997

By

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Job# 1303

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1. INTRODUCTION

This report summarizes survey logistics, operations and data processing for the Alcoota/Alice Springs Airborne Geophysical Survey performed by World Geoscience Corporation Ltd. (WGC) for the Northern Territory Department of Mines and Energy (NTDME) .

The survey acquired fixed wing aeromagnetic and radiometric data over a single area. A total of 107,286 line kilometres of new data was acquired whilst 105,936 line kilometres was processed and delivered to NTDME (less due to unchargeable overfly). This new data was merged with 29,341 line kilometres of open file data data previously flown by other companies.

Survey data was acquired by two WGC aircraft both owned and maintained by World Geoscience Aviation at Jandakot, Western Australia.

The base of operations for the Survey was Alice Springs. The aircraft used the facilities at Alice Springs Airport. WGC crew were accomodated at the Queen of the Desert Resort.

1.1 PROJECT CREW

The following personnel were employed on this project:

Contracts Manager	-	Brad Larson
Field Operations Manager (Perth)	-	Tim Webber
Processing Perth	-	Peter Chambers
Crew Leader / Processor	-	Grant McGarty
Field Processors	-	Matt Trevenen
Pilots	-	Mike Nelson Simon Gould Grant Hamilton Noel Fuller Stuart Flowers Peter Hiskins
Operators	-	Terry McCambridge Pat Osmond Norman House
Aircraft Engineers	-	Phil Brackfield Bob Lee

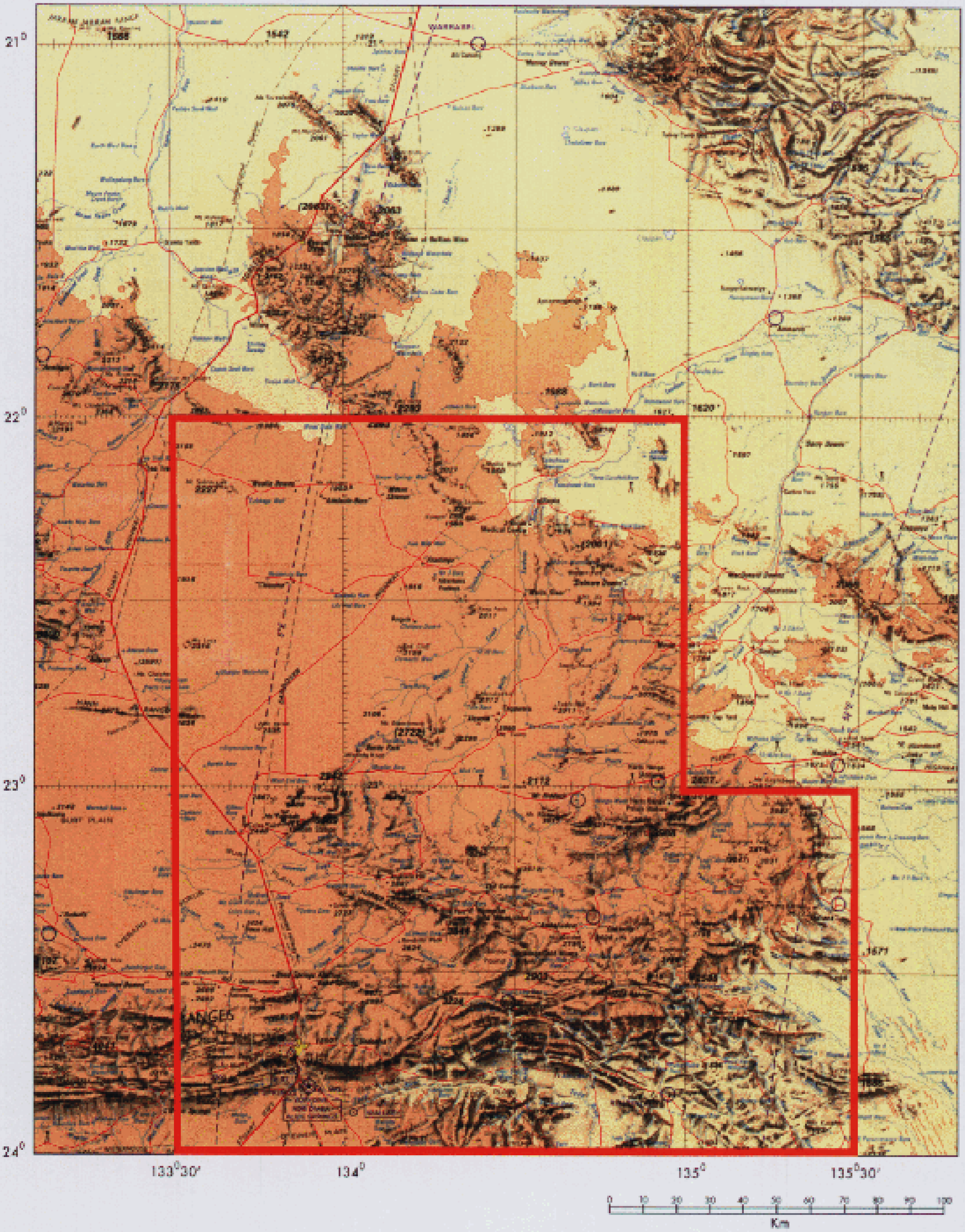
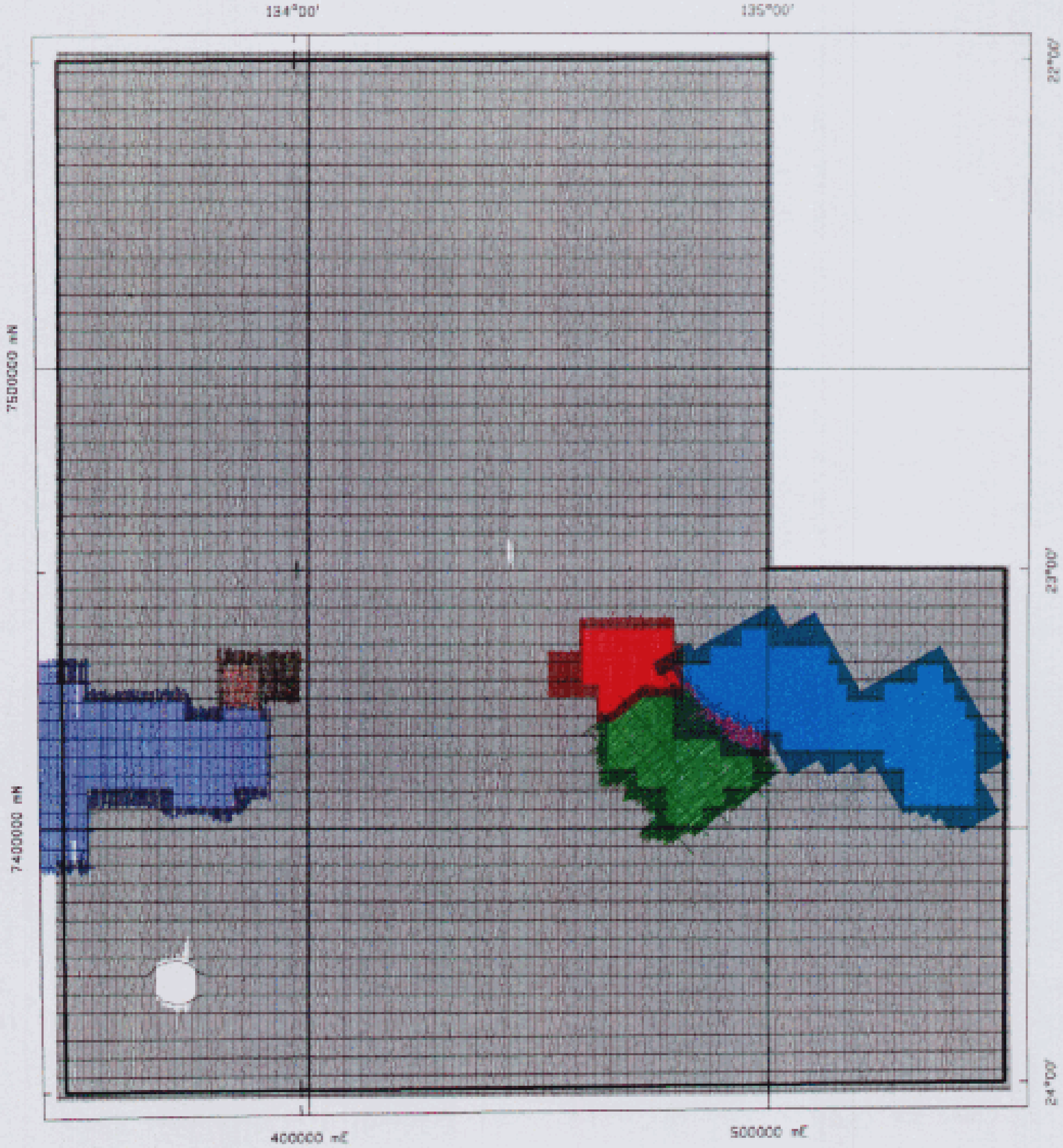


Figure 1: Alcoota/Alice Springs, NT

AIRBORNE GEOPHYSICAL SURVEY



Job : 1303
Area : ALCOOTA/ALICE SPRINGS
Client : NTDME

SURVEY DATA HAS BEEN SUPPLIED BY THE FOLLOWING COMPANIES

- Northern Territory Department of Mines and Energy
- PNC Exploration (Australia) Pty. Ltd.
- Endras Trust No.2 Pty. Ltd.
- CRA Exploration Pty. Ltd.
- Posminco

2. PRODUCTION REPORTS

VH-FGS

Date	Flight No	Flying Hours	Kms Flown	Standby Hours	Weather	Diurnal	Comments
2nd Sept	-	-	-	0			Mobilisation of vehicle/equipment to Alice Sp.
3rd Sept	-						Mobilisation of VH-FGS to Alice Springs
4th Sept	001	6.0	1057	0	Fine	Active, but in spec	Minor problems with Air Traffic Control and a Land Holder
5th Sept	002	9.2	1985	0	Fine	Good	
6th Sept	003	10.7	2002	0	Windy	Good	Mag Compensation Flown
7th Sept	004	10.6	2158	0	AM Fine, PM windy	Good	
8nd Sept	005	10.5	2090	0	Fine	Good	Majority of land holders contacted
9rd Sept	006	6.0	1354	0	Fine	Good	Single sortie due Maintenance
10th Sept	007	5.1	1078	0	Fine	Good	Single sortie due Maintenance
11th Sept	008	11.0	2419	0	Good	Good	Ok
12th Sept	009	10.8	2256	0	Fine	Good	Ok
13th Sept	010	11.2	2407	0	Fine	Good	Ok
14th Sept	011	11.0	2465	0	Fine	Okay	Ok
15th Sept	012	11.4	2083	0	Fine	Good	Equip problem at beginning of PM sortie
16th Sept	013	11.2	2465	0	Fine	Good	No problems
17th Sept	014	11.2	2534	0	Fine	Good	Bird strike, no major damage to A/C
18th Sept	015	11.2	2502	0	Good	Good	Ok
19th Sept	016	5.9	1181	0	Fine	Good	Single sortie due Maintenance
20th Sept	-	-	-	0	Fine	Good	Aircraft grounded
21st Sept	-	-	-	0	Fine	Okay	Aircraft grounded
22nd Sept	-	-	-	0	Good, rain over night	Active early am	Aircraft grounded
23rd Sept	-	-	-	0	Scattered showers	Nil due lightning	Aircraft grounded
24th Sept	-	-	-	0	Good	Good	Aircraft grounded
25th Sept	-	-	-	0	Good	Good	Aircraft grounded, 2 crew re-mobilised
26th Sept	017	10.8	2019	0	Okay	Okay	Aircraft back on-line, 2 crew re-mobilised
27th Sept	018	11.6	2235	0	Good	Okay	Broken line due hill
28th Sept	019	11.4	1982	0	Good	Okay	Okay
29th Sept	020	11.6	2351	0	Good	Very good	No problems
30th Sept	021	11.2	2496	0	Good, afternoon storms	Okay	Survey not affect by rain
1st Oct	022	11.4	2477	0	Okay	Okay	No problems
2nd Oct	023	11.0	2350	0	Okay	Okay	No problems
3rd Oct	025	4.5	582	6	Rain & low cloud	Okay	No rain where working but unable to take off for the second sortie, line scrubbed due turbulence, ½ day stand-by
4th Oct	-	0	0	12	Low cloud	N/A	1 day stand-by due weather
5th Oct	-	0	0	12	Low cloud	N/A	1 day stand-by due weather
6th Oct	025	7.5	1324	3.5	Low cloud delayed AM start	Very good	¼ day stand-by due weather
7th Oct	026	10.9	2064	0	Good	Very good	Reduced Kms due short lines
8thOct	027	11.1	1990	0	Good	Good	No problems
9th Oct	028	11.3	1843	0	Okay	Okay	Reduced Kms due hi-power settings for terrain
10th Oct	029	6.0	1141	0	Rain & thunderstorms	Active	One sortie due A/C engine problem
11th Oct	030	10.7	2119	0	Patchy rain	Okay	No problems
12th Oct	031	11.5	2007	0	Fair	Okay	Call from Indiana Station as a result of station overfly
13th Oct	032	5.8	1084	0	Good	Very good	Single sortie due to propeller change
14th Oct	033	8.3	1399	0	Good	Very good	Reduced Kms due to equip. problems

Date	Flight No	Flying Hours	Kms Flown	Standby Hours	Weather	Diurnal	Comments
15thOct				0	Good	Good	Scheduled aircraft maintenance
16th Oct	034	11.4	2494	0	Very Good	Very good	No problems
17th Oct	035	10.5	2251	0	Good but rough	Very good	Commenced overfly of Alice Springs at 1000'
18th Oct	036	10.8	2294	0	Rough and hazy	Very good	Controlled airspace completed
19th Oct	037	7.3	1509	3	Too rough for afternoon sortie	Very Good	PM sortie cut short due to unsafe weather conditions
20th Oct	038	10.3	2011	0	Turbulence in PM	Very good	Ties completed over Alice Springs
21st Oct	039	11.4	2450	0	Slight rough	Very good	No problems
22nd Oct	040	5.4	1139	0	Good	Very good	No problems, survey flying completed, awaiting final verification from Perth
23rdOct	-	0	0	0	N/a	N/a	No flying
24th Oct	-	0	0	0	N/a	N/a	No flying
25th Oct	041	10.7	2119	0	Good	Active	Reflights, Job completed

VH-AZG

Date	Flight No	Flying Hours	Kms Flown	Standby Hours	Weather	Diurnal	Comments
9rd Sept	201	4.6	582	0	Fine	Good	Mag compensation flown
10th Sept	202	9.7	1615	0	Fine	Good	Xtract bust due to hill on lines 2098/99
11th Sept	203	4.9	814	0	Good	Good	Single sortie due Maintenance
12th Sept	204	2.3	296	0	Fine	Good	Single sortie due Maintenance Baro problem, possible reflight
13th Sept	205	10.0	1747	0	Fine	Good	Ok
14th Sept	206	8.8	1448	0	Fine	Okay	Minor Aircraft problem
15th Sept	207	9.9	1704	0	Fine	Good	Ok
16th Sept	208	7.5	991	0	Fine	Good	Equip problem during AM sortie
17th Sept	209	10.3	1429	0	Good	Good	Minor Equip Problems
18th Sept	210	10.0	1563	0	Fine	Active	Possible reflight due diurnal
19th Sept	211	8.0	1133	0	Fine	Okay	Okay
20th Sept	212	9.7	1541	0	Fine	Okay	Okay
21st Sept	213	9.5	1051	0	Fine	Good	Okay, some reflights flown
22nd Sept	214	10.0	1419	0	Good, rain over night	Active early am	New test line flown
23rd Sept	-	-	-	0	Scattered showers	Nil due lightning	Aircraft maintenance pulled early due rain
24th Sept	215	10.6	1685	0	Good	Good	RTCGPS station gave problems
25th Sept	216	10.6	1648	0	Good	Good	Okay
26th Sept	217	10.1	1516	0	Okay	Okay	Okay
27th Sept	218	10.3	1523	0	Good	Okay	Okay
28th Sept	219	10.4	1511	0	Good	Okay	Okay
29th Sept	220	10.4	1518	0	Good	Very good	No problems
30th Sept	221	10.7	1508	0	Good, afternoon storms	Okay	Survey not affect by rain
1st Oct	222	10.8	1511	0	Okay	Okay	No problems
2nd Oct	223	7.9	969	0	Okay	Okay	Minor equipment problems, AZG area complete, aircraft to de-mobilise

3. AIRCRAFT AND EQUIPMENT

Type:	Shrike Aerocommander AC 500S		
Registration:	VH-FGS (Australian)		
Ownership:	WGC Corporation Ltd/Aerodata Holdings Limited		
Serial No:	3315		
Date of Manufacture:	1978		
Engines:	Twin, I0540-E1B5 Lycoming Piston Type		
Propellers:	Twin, 3 Blade variable pitch Hartzell HC-C3YR-2F		
Dimensions:	Wingspan	49 feet	
	Length	36 feet	
	Height	14 feet 6 inches	
Fuel:	Avgas 100		
Fuel Capacity:	Main Tanks	156 US gallons -	593 litres
	Wing Aux	57 US gallons -	255 litres
	Boot Tank	30 US gallons -	135 litres
		243 US gallons -	984 litres
Endurance:	At 24 US gallons/hour = 10.1 hours. An optional 50 US gallon tank may be fitted to extend the endurance to 12 hours.		
Total Airframe Time:	20,324 hours at 19 October 1997		
Total Survey Time:	17,837 hours at 19 October 1997		
Seating:	Survey Configuration - 3 Pax.		
Flight Instruments	Century III auto pilot		
Radio Equipment:	ASB 850 Collins 331-3S Horizontal Situation Indicator Collins Alt. 50 Altimeter DigiQuartz 223-AS-002 pressure transducer King KMA 20-04 marker beacon King K x 175B/KN72 Nav/Com VHF radio King K x 175B/K1226 Nav/Com VHF radio King KN75 Glideslope King KR87 ADF King KR85 ADF King KN65A International DME King KT76A ATC-SS		

Type:	CESSNA U206G		
Registration:	VH-AZG (Australian)		
Ownership:	WGC Corporation Ltd/Aerodata Holdings Limited		
Serial No:	U20605999		
Date of Manufacture:	1981		
Engines:	Single I0520F Continental Piston Type		
Propellers:	Single 3 Bladed variable pitch Hartzell PHC-J3YF-IRF		
Dimensions:	Wingspan	36 feet	
	Length	29 feet	
	Height	9 feet 7 inches	
Fuel:	Avgas 100		
Fuel Capacity:	Main Tanks	88 US gallons -	335 litres
Endurance:	at 13.5 US gallons/hour = 6.5 hours		
Total Airframe Time:	14,158 hours at 23 October 1997		
Total Survey Time:	13,458 hours at 23 October 1997		
Seating:	Survey Configuration - 2 Pax.		
Flight Instruments	Cessna 400 Series Auto Pilot		
Radio Equipment:	Codan HF multi-channel radiot		
	King KI525A Horizontal Situation Indicator		
	Sperry RT100 Altimeter		
	DigiQuartz 223-AS-002 pressure transducer		
	Cessna Nav/Com VHF radio		
	Cessna ADF		
	King KT76A ATC-SSR		

4. SUMMARY OF SURVEY PARAMETERS AND TOLERANCES

The specifications for the survey were necessarily tight to ensure the highest quality data was collected. WGC's in-field processing and verification system allowed immediate checking of the acquired data and allowed reflights to be readily identified.

Following field verification, the data was immediately sent to WGC's Perth office where it underwent further stringent QC tests. The results of these tests were forwarded to NTDME as they became available.

4.1 SURVEY PARAMETERS

Flight line spacing	-	400 m
Flight line direction	-	North-South
Tie line spacing	-	4,000 m
Tie line direction	-	East-West
Sensor height	-	60 m
Magnetometer sample interval	-	~7m
Magnetometer cycle rate	-	10Hz (0.1 sec), less than 7m
Magnetometer resolution	-	0.001 nT
Radar altimeter cycle rate	-	10Hz (0.1 sec), less than 7m
Barometric altimeter cycle rate	-	10Hz (0.1 sec), less than 7m
Humidity sensor cycle rate	-	10Hz (0.1 sec), less than 7m
Temperature sensor cycle rate	-	10Hz (0.1 sec), less than 7m
3 Axes Fluxgate Magnetometer	-	10Hz (0.1 sec), less than 7m
Spectrometer sample interval	-	~80m
Spectrometer cycle rate	-	1Hz (1 sec), less than 70m
GPS cycle rate	-	1Hz (1 sec), less than 70m
Base station magnetometer cycle rate	-	5 seconds

4.2 SYSTEM NOISE

The maximum permitted total magnetometer noise envelope from all sources for the survey was +/- 0.1nT peak to peak. Reflights were required where this was exceeded over an along track distance of more than 100 readings.

4.3 NAVIGATION TOLERANCE

Where the flight or tie line separations exceeded 1.5 times the nominated spacing over a distance of 5km or more, that portion of the line was reflown crossing at least two tie lines.

Where the altitude envelope (40-80m) was exceeded continuously for 5km on any line then that portion of the line was reflown. This specification was not enforced in situations where it would have breached air safety regulations or, in the opinion of the pilot, put the aircraft and crew at risk.

4.4 MAGNETIC DIURNAL

Data was reflown when the magnetic diurnal exceeded 5nT in 5 minutes as a non linear effect.

5. FLIGHT PLANS

```
JOB_Number 1303.1
CLIENT     NTDME
AREA_NAME  ALCOOTA / ALICE SPRINGS
PLANNED_BY BRAD LARSON       29/08/1997 Boundary change Info
|
SPHEROID    3 AUSTRALIAN_NAT. 6378160.0 298.25 0.9996
DELTAXYZ   116.00   50.47   -141.69   0.230 0.390 0.344 -0.0983E-6
HEMISPHERE SOUTH
UTM_ORIGIN 53  135  135
BOUNDARY   1  346000  7568000 -21.985671 +133.508330 -215908.4 +1333030.0 12 *
BOUNDARY   2  500000  7568000 -21.992452 +135.000000 -215932.8 +1350000.0 12 *
BOUNDARY   3  500000  7456471 -23.000004 +135.000000 -230000.0 +1350000.0 12 *
BOUNDARY   4  551241  7456471 -22.999214 +135.499993 -225957.2 +1353000.0 12 *
BOUNDARY   5  551241  7344000 -24.015107 +135.503842 -240054.4 +1353013.8 12 *
BOUNDARY   6  346000  7344000 -24.008456 +133.485932 -240030.4 +1332909.4 12 *
SQUARE_KMS 40259.127
|
NAVTYPE    NOVATEL
NAVMODE    U.T.M
PLAN_TYPE  Normal
LINE_TYPE  S.LINE
HEADING    090
SPACING    4000
OVER_LINE  0
OVERFLY    1000
MIN_LENGTH 5
FIRST_LINE 10
INCREMENT  10
X_TRACK    100
MASTER_PT  1  500000 6000000 -36.144593 +135.000000
MASTER_NEW 0  Not implemented.
KM_in_AREA 10418
KM+OVERFLY 10585
```

```
JOB_Number 1303.2
CLIENT    NTDME
AREA_NAME  ALCOOTA / ALICE SPRINGS
PLANNED_BY  BRAD LARSON        01/09/1997 Boundary change
I
SPHEROID    3  AUSTRALIAN_NAT. 6378160.0 298.25 0.9996
DELTAXYZ   116.00    50.47    -141.69   0.230 0.390 0.344 -0.0983E-6
HEMISPHERE  SOUTH
UTM_ORIGIN 53   135   135
BOUNDARY   1  346000  7568000 -21.985671 +133.508330 -215908.4 +1333030.0 12 *
BOUNDARY   2  500000  7568000 -21.992452 +135.000000 -215932.8 +1350000.0 12 *
BOUNDARY   3  500000  7456471 -23.000004 +135.000000 -230000.0 +1350000.0 12 *
BOUNDARY   4  543616  7456471 -22.999432 +135.425592 -225958.0 +1352532.1 12 *
BOUNDARY   5  543616  7424000 -23.292742 +135.426519 -231733.9 +1352535.5 12 *
BOUNDARY   6  543190  7424000 -23.292754 +135.422354 -231733.9 +1352520.5 12 *
BOUNDARY   7  543190  7428000 -23.256622 +135.422240 -231523.8 +1352520.1 12 *
BOUNDARY   8  540744  7428000 -23.256685 +135.398327 -231524.1 +1352354.0 12 *
BOUNDARY   9  540744  7432000 -23.220553 +135.398220 -231314.0 +1352353.6 12 *
BOUNDARY  10  538360  7432000 -23.220610 +135.374920 -231314.2 +1352229.7 12 *
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BOUNDARY  13  531562  7432000 -23.220755 +135.308479 -231314.7 +1351830.5 12 *
BOUNDARY  14  524727  7432000 -23.220871 +135.241676 -231315.1 +1351430.0 12 *
BOUNDARY  15  524727  7428000 -23.257004 +135.241741 -231525.2 +1351430.3 12 *
BOUNDARY  16  517543  7428000 -23.257096 +135.171507 -231525.5 +1351017.4 12 *
BOUNDARY  17  517543  7432000 -23.220964 +135.171461 -231315.5 +1351017.3 12 *
BOUNDARY  18  515279  7432000 -23.220986 +135.149333 -231315.6 +1350857.6 12 *
BOUNDARY  19  515279  7436000 -23.184854 +135.149293 -231105.5 +1350857.5 12 *
BOUNDARY  20  513203  7436000 -23.184872 +135.129008 -231105.5 +1350744.4 12 *
BOUNDARY  21  513203  7440000 -23.148739 +135.128974 -230855.5 +1350744.3 12 *
BOUNDARY  22  500774  7440000 -23.148791 +135.007560 -230855.7 +1350027.2 12 *
BOUNDARY  23  500774  7444000 -23.112658 +135.007558 -230645.6 +1350027.2 12 *
BOUNDARY  24  493896  7444000 -23.112647 +134.940388 -230645.5 +1345625.4 12 *
BOUNDARY  25  493896  7440000 -23.148780 +134.940372 -230855.6 +1345625.3 12 *
BOUNDARY  26  486818  7440000 -23.148739 +134.871231 -230855.5 +1345216.4 12 *
BOUNDARY  27  486818  7436000 -23.184872 +134.871196 -231105.5 +1345216.3 12 *
BOUNDARY  28  479214  7436000 -23.184793 +134.796896 -231105.3 +1344748.8 12 *
BOUNDARY  29  479214  7444000 -23.112528 +134.797005 -230645.1 +1344749.2 12 *
BOUNDARY  30  459194  7444000 -23.112155 +134.601494 -230643.8 +1343605.4 12 *
BOUNDARY  31  459194  7344000 -24.015410 +134.598760 -240055.5 +1343555.5 12 *
BOUNDARY  32  391185  7344000 -24.012201 +133.930100 -240043.9 +1335548.4 12 *
BOUNDARY  33  391185  7424000 -23.289713 +133.935960 -231723.0 +1335609.5 12 *
BOUNDARY  34  389254  7424000 -23.289584 +133.917081 -231722.5 +1335501.5 12 *
BOUNDARY  35  389254  7436000 -23.181206 +133.917955 -231052.3 +1335504.6 12 *
BOUNDARY  36  381071  7436000 -23.180636 +133.838015 -231050.3 +1335016.9 12 *
BOUNDARY  37  381071  7424000 -23.289011 +133.837076 -231720.4 +1335013.5 12 *
BOUNDARY  38  373483  7424000 -23.288444 +133.762891 -231718.4 +1334546.4 12 *
BOUNDARY  39  373483  7428000 -23.252320 +133.763225 -231508.4 +1334547.6 12 *
BOUNDARY  40  351531  7428000 -23.250484 +133.548681 -231501.7 +1333255.3 12 *
BOUNDARY  41  351531  7432000 -23.214363 +133.549072 -231251.7 +1333256.7 12 *
BOUNDARY  42  346000  7432000 -23.213855 +133.495034 -231249.9 +1332942.1 12 *
SQUARE_KMS  27624.531
NAVTYPE    NOVATEL
NAVMODE    U.T.M
PLAN_TYPE  Normal
LINE_TYPE  S.LINE
HEADING   000
SPACING   400
OVER_LINE  1
OVERFLY   800
MIN_LENGTH 5
FIRST_LINE 10
INCREMENT  10
X_TRACK   100
MASTER_PT  1   500000  6000000 -36.144593 +135.000000
MASTER_NEW  0  Not implemented.
KM_in_AREA  69520
KM+OVERFLY  71071
```

```
JOB_Number 1303.3
CLIENT    NTDME
AREA_NAME  ALCOOTA / ALICE SPRINGS
PLANNED_BY  BRAD LARSON       29/08/1997 Boundary change Info
I
SPHEROID    3  AUSTRALIAN_NAT. 6378160.0 298.25 0.9996
DELTAXYZ   116.00    50.47    -141.69   0.230 0.390 0.344 -0.0983E-6
HEMISPHERE  SOUTH
UTM_ORIGIN 53   135   135
BOUNDARY    1   346000  7392000 -23.575048 +133.490946 -233430.2 +1332927.4 12 *

BOUNDARY    2   352058  7392000 -23.575613 +133.550294 -233432.2 +1333301.1 12 *
BOUNDARY    3   352058  7408000 -23.431134 +133.551874 -232552.1 +1333306.7 12 *
BOUNDARY    4   370000  7408000 -23.432664 +133.727463 -232557.6 +1334338.9 12 *
BOUNDARY    5   370000  7404000 -23.468786 +133.727117 -232807.6 +1334337.6 12 *
BOUNDARY    6   384800  7404000 -23.469902 +133.872006 -232811.6 +1335219.2 12 *
BOUNDARY    7   384800  7408000 -23.433777 +133.872313 -232601.6 +1335220.3 12 *
BOUNDARY    8   391185  7408000 -23.434216 +133.934807 -232603.2 +1335605.3 12 *
BOUNDARY    9   391185  7344000 -24.012201 +133.930100 -240043.9 +1335548.4 12 *
BOUNDARY   10   346000  7344000 -24.008456 +133.485932 -240030.4 +1332909.4 12 *
SQUARE_KMS 2735.712
I
NAVTYPE    NOVATEL
NAVMODE    U.T.M
PLAN_TYPE  Normal
LINE_TYPE  S.LINE
HEADING    000
SPACING    400
OVER_LINE  1
OVERFLY    800
MIN_LENGTH 5
FIRST_LINE 10
INCREMENT  10
X_TRACK    100
MASTER_PT  1  500000 6000000 -36.144593 +135.000000
MASTER_NEW 1  369200 7391200 -23.584314 +133.718166
KM_in_AREA 7056
KM+OVERFLY 7291
```

6. AIRBORNE DATA ACQUISITION EQUIPMENT AND SPECIFICATIONS

The Airborne Data Acquisition system utilised on this project consisted of the following sub-systems:

- Data Acquisition System
- Navigation System
- Magnetometer Sensors
- Gamma Ray Spectrometer System
- GPS System
- Altimeter Systems
- Temperature and Relative Humidity System

6.1 DATA ACQUISITION SYSTEM

6.1.1 PDAS 1000 Data Acquisition System

The Picodas PDAS 1000 Data Acquisition System (PDAS) was the central airborne data logging system used. The PDAS is based on the IBM PC architecture and was configured with the following processing boards:

- magnetometer processor board
- frequency processor board
- 12 channel, 16-bit analogue processor board
- PGAM spectrometer master transputer board
- 10 channel GPSCard
- GPS 1 PPS interface board
- disk, parallel, serial I/O board
- EL screen display adaptor

The PDAS computer executes a proprietary Survey program for data acquisition and recording. This data is presented both numerically and graphically in real time on an electro-luminescent or liquid-crystal display for verification and quality control.

Specifications

Model	-	Picodas PDAS 1000
Processor	-	Intel i486 DX33
Operating System	-	MS-DOS 6.2
Storage		
Hard disk	-	240 MB
Floppy disk	-	1.44 MB
Tape Backup Drive	-	120 MB QIC-80 format

6.1.2 PDAS 1000A Power Console

A PDAS 1000A power console is used in conjunction with the PDAS 1000. This console contains the power supplies for providing regulated power to instruments such as caesium and fluxgate magnetometers, humidity, temperature, and barometric pressure transducers. It also provides the interconnect to all analogue signals.

6.2 NAVIGATION SYSTEM

The Picodas PNAV 2001 Navigation Computer was used for real time navigation. The PNAV computer loads a preprogrammed flight plan from disk which contains boundary coordinates, line start and end coordinates, local coordinate system parameters, line spacing, and cross track definitions. The WGS-84 latitude and longitude positional data received from the NovAtel GPSCard contained in the PDAS 1000 computer is transformed to the local coordinate system for calculation of the cross track and distance to go values. This information, along with ground heading and ground speed, is displayed to the pilot numerically and graphically on a two line LCD display, and on an analog HSI indicator. It is also presented on an EL screen in conjunction with a pictorial representation of the survey area, survey lines, and ongoing flight path. The PNAV is interlocked to the PDAS computer for autoselection and verification of the line to be flown.

Specifications

Model	-	Picodas PNAV 2001
Update Rate	-	2 Hz

6.3 MAGNETOMETER SENSORS

6.3.1 Caesium Vapour Magnetometer Sensor

Caesium Vapour magnetometer sensors were utilised on the aircraft for the project. The sensor consists of the sensor head and cable, and the sensor electronics. The sensor head was housed at the end of a three metre kevlar stinger, and held by a rotatable clamp that permits orientating the sensor head for optimum coupling with the ambient magnetic field direction. The sensor electronics were mounted in the base end of the stinger. The magnetometer was powered by a dedicated power supply in the PDAS 1000A power console. Power was connected to the magnetometer using coaxial cable. The Larmor frequency output of the magnetometer is modulated onto this power cable for input to the magnetometer processor board in the PDAS 1000 computer.

Specifications

Model	-	Scintrex CS-2
Operating Voltage	-	30 Vdc
Operating Range	-	15,000 - 100,000 nT
Heading Error	-	± 0.25 nT
Gradient Tolerance	-	40,000 nT/m

6.3.2 Magnetometer Processor Board

Picodas magnetometer processor boards were used for decoupling and processing the Larmor frequency output of the magnetometer sensor. The processor board interfaces with the PDAS 1000 computer, which initiates data sampling and transfers for precise sample intervals.

Specifications

Model	-	Picodas Mag Processor MGP193
Sample Rate	-	10 Hz
Bandwidth	-	2 Hz
Resolution	-	0.001 nT

6.3.3 Fluxgate Magnetometer

Bartington three axis fluxgate magnetometers were used for determination of the aircraft attitude. This data is used in the reduction of noise on the measured magnetic total field. This noise comes from the complex, three dimensional magnetic signature of the airframe. This changes with the airframe attitude, pitch, roll, yaw and rates of change of these elements in the Earth's magnetic field. Permanent, induced, and eddy current effects are compensated by this method, as are the residual heading effects of the caesium vapour magnetometer.

Specifications

Model	-	MAG-03MC
Sample Rate	-	10 Hz
Output Signal Scaling	-	10μT/V
Measuring Range	-	±100μT

6.4 GAMMA RAY SPECTROMETER SYSTEM

The Picodas PGAM 1000 Gamma Ray Spectrometer system was utilised for the airborne radiometric data acquisition. The system consisted of two shock mounted fibreglass/perspex casings, each containing four NaI(Tl) crystals, giving a system volume of 33.56 litres. Each crystal has its own low and high voltage power supplies, analog to digital conversion unit, EEPROM for calibration coefficients, and supporting circuitry for peak detection, adjustable threshold, and coincidental recognition, fitted to the neck of its photomultiplier tube. Each casing contains a sub transputer for event processing and transfer of individual crystal spectra to a master transputer contained in the PDAS 1000. The master transputer performs real time gain corrections on the individual spectra based on the tracking of the Tl-208 or K-40 photo peaks. Real time non-linearity corrections are applied according to individual coefficients determined during calibration under controlled conditions. For normal survey operation the summed 256 channel spectrum is transferred to the PDAS 1000 for display and recording. For pre and post flight calibrations, the 256 channel spectra for individual crystals are transferred for resolution determination and verification. In addition to the 256 channel summed spectra, individual energy windows may be defined for display and recording on the PDAS 1000. These are typically the IAEA defined energy windows as described by the ROI in Definitions 36.

Specifications

Model	-	Picodas PGAM 1000 Ver. 6.11
Detector Volume	-	33.56 litres
Energy Channels Processed	-	1024
Energy Channels Recorded	-	256
Lower Energy Threshold	-	410 KeV
Cycle Rate	-	1 Hz

6.5 GPS SYSTEM

6.5.1 GPS Receiver

The NovAtel GPSCard 951R was utilised for airborne positioning and navigation. The GPSCard is contained in the PDAS 1000 computer and provides positional and satellite range data via the PDAS bus for display and recording, and positional data via a serial port to the PNAV 2001 for navigation. The GPSCard accepts RTCM 104 differential corrections via a serial port for real time differential solutions. Satellite range data is recorded for generating post processed differential solutions.

Specifications (GPS Receiver)

Model	-	NovAtel GPSCard 951R
Channels	-	10 Channels dedicated tracking
Position Update Rate		
	-	PDAS 1000 @ 1 Hz
	-	PNAV 2001 @ 2 Hz
Raw Data Update Rate	-	1 Hz
Datum for Positional Data	-	WGS-84
Time Sync	-	1 PPS output

6.5.2 Differential GPS Demodulator

The Racal Surveys' LANDSTAR differential GPS service was utilised for providing real time differential corrections. The LANDSTAR system broadcasts RTCM 104 format corrections via the Optus satellite for nine reference stations around Australia. These corrections are received at the aircraft using an OmniSTAR demodulator and the data for the user selected reference station are provided to the GPSCard via a serial link.

Specifications

Model	-	LANDSTAR Mk3
Typical Received Update Rate	-	1 - 5 seconds
Data Format	-	RTCM 104 Ver. 2
Reference Stations Used	-	Australia - Virtual

6.6 ALTIMETER SYSTEMS

6.6.1 Radar Altimeter

A Sperry RT100 radar altimeter was utilised for determining absolute altitude. The altimeter outputs a voltage proportional to height above terrain. This output has two scales for the indicated heights of 0 - 500 feet, and 500 to full scale output. This signal is available to a dashboard analog indicator for the pilot, and to the PDAS 1000 computer for display and recording. Prior to commencement of the project, coefficients are determined for accurately converting the two stage output signal to equivalent height. The calculated height and the measured signal are both recorded.

Specifications

Model	-	Sperry RT100
Accuracy	-	40 to 200 ft± 6 ft
	-	200 to 500 ft± 3%
	-	500 to 2000 ft± 3.5%
	-	2000 to 2500 ft± 4.5%
Sample Rate	-	10 Hz

6.6.2 Barometric Altimeter

The output of a Digiquartz pressure transducer was used for calculating the barometric altitude of the aircraft. The atmospheric pressure is taken from a gimble mounted probe projecting 0.5 metres from the wing tip of the aircraft and fed to the transducer mounted in the aircraft fuselage. The transducer uses a precise quartz crystal resonator whose frequency of oscillation varies with pressure induced stress. A Picodas frequency processor board in the PDAS 1000 computer is used to measure the frequency of the output, and in combination with the QNH pressure and ambient temperature, the barometric altitude is calculated. This calculated altitude and the raw frequency are recorded to enable levelling to the post flight QNH pressure.

Specifications

Model	-	Digiquartz 215A-101
Range	-	0 - 0.10 Mpa
Accuracy	-	0.01%
Resolution	-	1×10^{-8}
Sample Rate	-	10 Hz

6.7 TEMPERATURE AND RELATIVE HUMIDITY SYSTEM

Vaisala humidity and temperature transmitters were utilised for measuring the relative humidity and temperature of the atmosphere external to the aircraft. These transmitters produce a linear voltage that is measured by the analogue processor board in the PDAS 1000 computer.

Specifications

Model	-	Vaisala HMP133Y
Sample Rate	-	10 Hz
<u>Relative Humidity</u>		
Measuring Range	-	0 - 100 %RH
Accuracy	-	±1 %RH (0..90 %RH)
Sensor	-	HUMICAP® H-sensor
<u>Temperature</u>		
Measuring Range	-	-20 .. +60 °C
Accuracy	-	±0.2 °C
Sensor	-	Pt 100 RTD

6.8 SYSTEM TIMING

The system time is syncronised to the GPS time. Data sampling is syncronised to the Pulse Per Second output from the GPS receiver.

7. GROUND DATA ACQUISITION EQUIPMENT AND SPECIFICATIONS

The Ground Data Acquisition equipment utilised on this project consisted of the following systems:

- GPS Base Station System
- Base Magnetometer System

7.1 GPS BASE STATION SYSTEM

The GPS base station was located in the field office at the Queen of the Desert Resort.

7.1.1 Ashtech Ranger XII Base GPS Specifications

Receiver	-	auto all in view, 12 channel C/A code tracking
Position accuracy	-	Differential mode = 1-3m (PDOP<6) SEP
Receiver(s) update rate	-	2 per second
Velocity	-	>1200m / sec.
Antenna	-	Kinematic
Power Required	-	10 Watts

7.2 BASE MAGNETOMETER SYSTEM

The aircraft had two Geometrics G-856 memory Proton magnetometers operating for this project. The units were located at the Alice Springs airport. Small areas surrounding these locations were "mini surveyed" to determine a magnetically quiet position for each sensor.

The units were time checked prior to each survey flight commencement against the GPS receiver time in the aircraft, which is the time base for all acquired data.

Specifications

Model	-	G-856AX memory magnetometer
Displays	-	Six digit display of Magnetic field to resolution of
0.1nT or time		to nearest second.
	-	Additional three digit display of station, day of year, and record number.
Resolution	-	0.1 nT
Accuracy	-	1 nT, limited by remnant magnetism in sensor and crystal oscillator accuracy.
Internal Clock	-	Julian clock with stability of ~1 second per day.
Data Memory	-	Approximately 12,500 readings.
Output	-	RS-232 serial output in Ascii format.

8. EQUIPMENT AND DATA ACQUISITION CALIBRATIONS

Prior to commencement of the survey, a series of calibrations were performed. The results of these calibrations are provided to the data processor who makes adjustments to the raw data as required.

8.1 RADIOMETRIC CALIBRATION RANGE

Prior to the mobilisation of the survey aircraft to the survey area, each aircraft spectrometer was calibrated using a defined radiometric calibration range in Carnamah WA. This test range is located in farming country and is centred on 29° 44'S and 115°58'40"E.

The results used for the final processing of the data are tabled below.

VH-FGS				
1.	**Stripping Coefficients**			
	Alpha:	0.2442	delta:	0.0360
	Beta:	0.3692	b:	0
	Gamma:	0.7380	g:	0
2.	**Aircraft and Cosmic Removal**			
		Slope Cosmic	**Offset – Aircraft Background**	
	Total Count:	1.6		-93.0
	Potassium:	0.0787	-13.0	
	Uranium:	0.0700	-5.1	
	Thorium:	0.0740	-1.9	
3.	**Ground Concentration Factors**			
	Potassium:			127.76
	Uranium:			13.021
	Thorium:			6.623

Table 1. VH-FGS Radiometric calibration results

VH-AZG				
1.	**Stripping Coefficients**			
	Alpha:	0.2489	delta:	0.0358
	Beta:	0.3868	b:	0
	Gamma:	0.7100	g:	0
2.	**Aircraft and Cosmic Removal**			
		Slope Cosmic	**Offset – Aircraft Background**	
	Total Count:	1.53		-99.2
	Potassium:	0.0773	-15.6	
	Uranium:	0.0678	-3.2	
	Thorium:	0.0730	-2.18	
3.	**Ground Concentration Factors**			
	Potassium:			126.7
	Uranium:			11.503
	Thorium:			5.853

Table 2. VH-AZG Radiometric calibration results

It was found that the standard IAEA attenuation coefficients produced the optimum grids:

Tota Count:	0.0067
Potassium:	0.0082
Uranium	0.0084
Thorium	0.0066

8.2 DAILY SPECTROMETER CALIBRATION

The resolution of each crystal was calculated daily throughout the duration of the survey with a thorium source placed at least 50cm from each detector pack. The calculated system resolution remained less than 7%.

Average spectra for each flight line were plotted daily. PhotoPeak positions of Potassium, 1461KeV and Thorium, 2615 KeV were calculated to one tenth of a channel and indicated on the Average spectrum plot. For flight lines less than 1000 seconds duration, dependent on the initial accuracy of the calculated peak position for the average spectra on the flight line, spectra from pre and post acquired lines were used to average spectra for 1000 seconds duration. If the Thorium photopeak 2615KeV and Potassium photopeak 1461KeV were found to shift by more than +/-0.5 channels respectively then the spectra were energy calibrated prior to sampling the conventional channels.

A test line was flown each day to monitor the sensitivity of the system in the air. WGC had the capability to determine real-time statistics on every test or survey line. The test line was flown before and after each day's production at survey altitude to monitor the effects of soil moisture and verify that the system was functioning correctly. If the background and height corrected rate in the thorium window varied by more than +/- 15% from the mean of the previous measurements, flights were suspended until the count rate returned to acceptable levels.

The test line locations are presented in Table 3. Daily results are presented in Appendix 1.

AIRCRAFT	FLIGHTS	EASTING	START NORTHING	END NORTHING
VH-FGS	01-23	392,130	7,343,000	7,351,000
	24-28	440,080	7,449,000	7,457,000
	29-41	392,130	7,335,000	7,343,000
VH-AZG	201-213	374,930	7,414,000	7,422,000
	214-223	448,930	7,449,000	7,457,000

Table 3. Test line locations.

8.3 RADAR ALTIMETER CALIBRATIONS

The radar altimeter is calibrated every 12 months and involves the aircraft flying a line over water to allow an accurate calibration of the radar altimeter height. This line consists of several climbs and decents, as one line, between 50 feet and 3000 feet. A look-up table is generated which relates the raw output from the Radar Altimeter in mV to altitude in metres.

8.4 PARALLAX CHECK

Parallax error is caused by the physical difference in distance between the various sensors, the electronic delay and software timing in the acquisition system. Hence all variables are subjected to a displacement from the GPS coordinates. If these variables are processed without a position offset a parallax error will occur. The most suitable way to treat this problem is to use the 1 second radiometric data as a base with a zero correction. This will prevent interpolation of important variables (a filtering process). The coordinates were moved by linear interpolation and other data variables were displaced onto the radiometric data, without change, in multiples of 0.1 seconds.

AIRCRAFT	VARIABLE	PARALLAX
VH-FGS	Mag.	-1.1
	Rad Alt.	-1.2
	Baro. Alt	-1.2
	Radiometrics	0
	GPS Positioning	-1.4
VH-AZG	Mag.	-1.2
	Rad Alt.	-0.5
	Baro. Alt	-1.4
	Radiometrics	0
	GPS Positioning	-1.5

Table 4. Parallax values.

8.5 DYNAMIC MAGNETOMETER COMPENSATION

To eliminate aircraft manoevure effects from the magnetic data which can be of the same frequency as the geology, a compensation box was flown in a low magnetic gradient area close to the survey. This involves flying a series of tests on the survey line heading and also 15^{o} either side to accommodate cross wind flying conditions. The data for each heading consists of a series of aircraft manoeuvres, pitches, rolls and yaws. This is done to artificially create the worst possible attitude the aircraft may encounter whilst on survey and compensate for any magnetic noise induced by the aircraft's attitude in the naturally occurring magnetic field. This data is down loaded to the field PC and processed, using software developed by WGC, to obtain the best possible magnetic dynamic compensation coefficients in the form of 16 mathematical terms. These coefficients are applied in real time as well as in post processing.

8.6 HEADING ERROR CHECKS

Historically, heading error checks have been part of the aeromagnetic data acquisition procedure but their use nowdays is negligible. WGC now calculates these effects using the aircraft magnetic compensation system and specially developed software. The precision to which these effects are now calculated and corrected for is far in excess of what is measurable using the manual technqiues for the past.

8.7 CALIBRATION NUMBERING SYSTEM

The following line numbering formula was employed for this survey:

C1501	CAESIUM SOURCE	180 Secs	Daily	AM SPEC CALS
C1502	URANIUM SOURCE	180 Secs	Daily	" " "
C1503	THORIUM SOURCE	180 Secs	Daily	" " "
C1504	BACKGROUND	180 Secs	Daily	" " "
C1507	REVERSE TEST LINE	5 Kms	if required	" " "
C1508	LOW LEVEL TEST LINE	5 Kms	Daily	" " "
C1509	HIGH LEVEL TEST LINE	200 Secs	Daily	" " "

C1511	Pre #1 SORTIE BARO CAL	BARO GROUND CALS
C1611	Post #1 SORTIE BARO CAL	" " "
C1512	Pre #2 SORTIE BARO CAL	" " "
C1612	Post #2 SORTIE BARO CAL	" " "
C1513	Pre #3 SORTIE BARO CAL	" " "
C1613	Post #3 SORTIE BARO CAL	" " "
C1514	Pre #4 SORTIE BARO CAL	" " "
C1614	Post #4 SORTIE BARO CAL	" " "

C1800 - C1810 HEADING CHECKS

C1811 - C1820 COMP BOXES

C1821 BARO ALTIMETER STACKS (one line 100,200,300,400,600,800,1000,1200,1500,2000 ft) for 30 secs

C1826 - C1830 PARALLAX CHECKS

C1831 - C1847 HIGH LEVEL SPEC STACKS (5000 - 10000 ft @ 1000 ft Increments up then down) for 300 secs.
C1848 - C1860 LOW LEVEL SPEC STACKS (150,200,250,300,350,400,450,1000,1500,2000ft) over DTR.

C1861 - C1865	PAD CALS	(PACK #1)	Background , Pottassium , Uranium , Thorium
C1866 - C1870	PAD CALS	(PACK #2)	" " " "
C1871 - C1875	PAD CALS	(PACK #3)	" " " "

C1881 - C1890 RADAR ALTIMETER CHECKS (100,200,300,400,600,800,1000,1500,2000,2500 ft) for 30 secs.

C1607	REVERSE TEST LINE	5 Kms	if required	PM SPEC CALS
C1608	LOW LEVEL TEST LINE	5 Kms	Daily	" " "
C1609	HIGH LEVEL TEST LINE	200 Secs	Daily	" " "
C1601	CAESIUM SOURCE	180 Secs	Daily	" " "
C1602	URANIUM SOURCE	180 Secs	Daily	" " "
C1603	THORIUM SOURCE	180 Secs	Daily	" " "
C1604	BACKGROUND	180 Secs	Daily	" " "

S1990 - S1999 TEST AND SCRUB LINES
T1701 etc TIE LINES

The last three numbers of the line number (eg 501) is the line number.
The first number of the line number (eg 1) is the area number, this could be two digits (eg 12).

If any line is scrubbed then the next attempt is entered as the same line number with an increment of one decimal point.

9. FIELD DATA PROCESSING

The following data processing steps were applied by WGC's crew on location in Alice Springs.

- Download raw aircraft data from 120 MB QIC-80 fomat tapes on to the Field Processing PC.
- Back-up GPS base station data from the GPS logging computer on to 120 MB QIC-80 fomat tapes and then down load on to Field Processing PC.
- Dump Mag base station data on to Field Processing PC.
- Edit line headers to correct wrong line numbering or directions entered in real time by the operator.
- Process GPS data.
- Check flight path.
- Check magnetometer noise levels.
- Backup all data.
- Fill reports and fax to Perth office.

To check the magnetometer noise levels the following quality control checks were run on each days data:

- Vertical derivative to verify compensation.
- Backward difference to detect level shifts and diurnal problems.
- Polynomial residual to detect instrumentation noise.
- 4th difference to detect spikes.

10. FINAL DATA PROCESSING

There are three separate streams of raw data collected by separate acquisition systems. All three sets of data are treated as discrete units and are post-processed accordingly before being merged.

10.1 RAW DATA COLLECTION

10.1.1 Aircraft Data

Data collected by the aircraft includes:

- TMI via the Cesium Vapour Magnetometer
- 256 Channel spectrometer
- 3 axis fluxgate magnetometer
- radar altimeter
- pressure
- humidity
- temperature
- fiducial
- time
- GPS Positioning information (including time and satellite info.)

10.1.2 Magnetic Base Station Data

Whilst the aircraft was collecting data, two Geometrics G-856 memory Proton magnetometers were collecting data from the base station at Alice Springs airport.

10.1.3 Global Positioning System Base Station Data

An Ashtek Ranger II 12 channel GPS receiver was used for the GPS base station at the crew headquarters. This instrument recorded variables such as location, time and satellite information to be used later for post processing of the aircraft location.

10.2 AIRCRAFT LOCATION

The aircraft's location each second was determined by differentially post processing the syncronised GPS data recorded on both the aircraft and GPS base station. Where small gaps occurred in the differential data, positions were calculated using the GPS velocities. This data is recorded in the WGS-1984 datum and merged with the aircraft data.

10.3 MAGNETIC DATA PROCESSING

Data collected by each of the 3 sources above is checked for spikes and noise by complex procedures. A stringent series of quality checks were carried out daily on all aspects of the data. Whenever these checks proved that the data was unacceptable the affected lines or part lines were reflown. The process is summarized below:

a. Apply any spike corrections to the raw magnetic variables.

b. Interpolate undefined magnetic values.

c. Coordinate the data with post processed GDA coordinates.

d. Apply fluxgate corrections and compensate the data with post-processed compensation files.

e. Diurnal values were appropriately filtered and subtracted from individual magnetic readings. A diurnal base of 53,620nT was used.

f. Apply parallax correction

g. IGRF (1995 Model). Regional effects of the earth's magnetic field were removed by subtracting the calculated IGRF value from each reading. An IGRF base of 2,500nT was used.

10.4 LEVELLING MAGNETIC DATA

The high quality of the final data was assured through WGC's in-house processing system which offers some of the most powerful levelling capabilities available in the industry. The tie lines are used to level the dataset after the removal of the diurnal, parallax and heading errors.

Using the tie lines (flown at 90 degrees to the traverse lines) a set of miss-tie values were determined. These miss-tie values reflected the differences in the magnetic value between the tie lines and the traverse lines over the same geographical point. Using a least squares fit algorithm, which also takes into account the statistical variation inherent in DGPS positioning, a series of corrections were applied to the traverse line data. These allowed the data to be levelled to the same base value.

Following this, a WGC proprietary micro-levelling process was applied in order to more subtly level the data. This process removes sub-gamma pulls evident only under image enhancement algorithms. Since the correction values applied were based upon a least squares fit equation, the tie lines were then re-levelled to the traverse lines. This eliminated any "bulls-eyeing" effect which may be found when tie lines and traverse lines are used to generate a single grid.

The altitude variation between the flight lines and tie lines was accounted for when computing line corrections. A proprietary algorithm was applied to the magnetic data and a correction was made to remove this height effect.

10.5 RADIOMETRIC DATA PROCESSING

The radiometric data was processed using the standard IAEA window processing technique. The IAEA (window processing) technique is summarized below:

1. If there is evidence of peak drift in the 256 channel data then the data is energy calibrated.
2. Rewindow the 256 channel data using the IAEA standard windows.
3. Apply spike corrections to the radar altimeter, temperature and pressure values.
4. Coordinate the data with post processed GDA coordinates.
5. Apply parallax corrections.
6. Calculate the equivalent terrain clearance at STP (standard temperature and pressure).
7. Remove aircraft background.
8. Remove cosmic background.
9. Remove radon background.
10. Apply stripping ratios.
11. Apply height corrections.
12. Convert Potassium, Uranium, Thorium to ground concentrations.

10.5.1 Dead-Time Correction

Gamma-ray spectrometers require a finite time to process each pulse from the detectors. While one pulse is being processed, any other pulse that arrives will be rejected. Consequently the 'live' time of a spectrometer is reduced by the time taken to process all pulses reaching the multi channel analyser. The Picodas PGAM 1000 system has analogue to digital converters associated with each detector, and as such, the total dead-time, even at ground level is extremely small, and as such was omitted.

10.5.2 Energy Calibration

The spectral drift was checked by monitoring the position of Potassium, Uranium and Thorium peaks on average spectra along flight lines. The peak positions were determined by removing the Compton continuum and applying a gradient search technique on the residual spectrum. The original 256 channel data was mapped onto the corrected peak positions and a new 256 channel data set was generated by interpolation.

To verify the calibration, spectra was checked by comparing the before and after energy calibration plots. Where any spectra showed errors in recalibration, or any other abnormalities, the lines were reflown.

10.5.3 Window Definitions

After energy calibration, the corrected 256 channel data were summed into the standard IAEA windows defined in Table 5.

Window	Peak Energy (keV)	Energy Window (keV)			PGAM Channel Window		
Total Count	-	410	-	2810	35	-	240
Uranium Low	609	540	-	680	46	-	58
Potassium	1460	1370	-	1570	117	-	134
Uranium	1760	1660	-	1860	142	-	159
Thorium	2615	2410	-	2810	206	-	240
Cosmic	-	3000	-	6000	255	-	255

Table 5. IAEA window definitions.

10.5.4 Cosmic Aircraft Background Removal

The cosmic and aircraft backgrounds for each channel are of the form:

N = a + bC
where

N = combined cosmic & aircraft background in each spectral window
a = aircraft backgroung in the window
C = cosmic channel count
b = cosmic stripping factor

The aircraft background radiation was removed by subtracting the computed aircraft background from the Total Count, Potassium, Uranium and Thorium windows. The effect of cosmic radiation was removed from each window by multiplying the cosmic channel by the cosmic stripping factor for each window and subtracting the result from the window data.

10.5.5 Atmospheric Radon

The method of radon removal differs to that of Grasty and Minty (A Guide to the Technical Specifications for Airborne Gamma-Ray Surveys. Record 1995/60 p.34, Australian Geological Survey Organisation) and is proprietary but its effectiveness is evident in the quality of the final product.

10.5.6 Stripping

As radiometric energy emission spectra of potassium (K), uranium (U) and thorium (Th) series overlap, the investigation of any one spectral window, designed to detect one radioelement, requires removal of spectral overlap. The process of removal is known as stripping. The stripping procedure uses spectral stripping ratios determined experimentally using concrete calibration pads of known K, U and Th concentration.

Spectral overlap occurs due to: Compton scattering in the ground, air, aircraft, detector crystals, incomplete absorption of gamma radiation in the detector and spectral lines from differing radioelements in a common window. The PGAM system detects and discards gamma rays which are incompletely absorbed in the detector crystals.

A stripping ratio notation has been adopted in which **alpha**, **beta** and **gamma** represent the change to a lower energy window by a relatively high energy source, and **a**, **b**, and **g** represent the effect on a higher energy window by a relatively lower energy source.

Ratio	Definition			
alpha	Thorium	into	Uranium	stripping ratio for a Thorium source
beta	Thorium	into	Potassium	stripping ratio for a Thorium source
gamma	Uranium	into	Potassium	stripping ratio for a Uranium source
a	Uranium	into	Thorium	stripping ratio for a Uranium source
b	Potassium source	into	Thorium	stripping ratio for a Potassium
g	Potassium source	into	Uranium	stripping ratio for a Potassium

Table 6. Definition of Stripping Ratios.

Owing to scattering of gamma rays in the air, the three stripping ratios **alpha**, **beta** and **gamma** increase with altitude above the ground. In practice the stripping ratios are computed at ground level and then are scaled using the measured STP altitude. No correction was applied to the reverse stripping ratios **a**, **b** and **g** as they are very small and have little effect on the stripped count rate.

The stripping ratios used in the processing are listed in 8.1.

10.5.7 STP Altitude

The data was converted to effective height at standard temperature and pressure using the expression:

STPAlt = Ralt * (P/103) * (273 / (T+273))
where

RAlt =	the observed radar altitude in metres
T =	the measured air temperature in degrees C
P =	the barometric pressure in millibars

In areas of significant topographic variation, height correction problems can be induced by sudden jumps in the radar altimeter data. To overcome this, the radar altimeter data was lightly filtered.

10.5.8 Conversion to Ground Concentration Units

System sensitivity coefficients are the constants which convert aircraft counts per second to ground concentrations (%K, ppm eU, ppm eTh and air absorbed dose rate nG/h). They are used to compare and merge the results from different airborne systems. The constants were computed by comparing the ground spectrometer and aircraft results over the calibration range.

The ground concentration for each window can be determined from the following:

C = N / S	
where	
S =	airborne sensitivity
N =	fully corrected window count rate at the nominal survey height
C =	ground concentration

The sensitivies are listed in 8.1.

10.6 DIGITAL TERRAIN MODEL

The radar altimeter data were subtracted from the GPS height data to provide a digital terrain model height above the GDA ellipsoid. A correction for the ellipsoid/geoid separation was then applied to reduce the data to the AHD.

10.7 GEODETIC DATUM

The post flight differentially corrected co-ordinate data are WGS84 co-ordinates. According to AUSLIG, Geocentric Datum of Australia (GDA) co-ordinates are practically equivalent to WGS84 co-ordinates and so no WGS84 to GDA co-ordinate transformation need be done.

The GDA geographical co-ordinates were projected to grid co-ordinates using a Transverse Mercator projection, Zone 53.

All final products were presented in GDA.

10.8 COMPANY DATA

The entire final data set comprises data newly acquired by the NTDME and older data acquired by private companies who in turn supplied a copy to the NTDME. The company data was supplied to WGC in the form of final located data. The processing done to the company data was as follows:

1. Transform the co-ordinates from AGD84 to GDA.

2. Grid magnetic, total count, potassium, uranium and thorium channels to produce grids for each company data set. No DTM grids were made as no company DTM data existed. The potassium, uranium and thorium channels were all supplied in counts per second. They were converted to approximate ground concentration by dividing potassium by 126.7, uranium by 11.503 and thorium by 5.853.

3. Merge NTDME and company grids as described in 10.9.

As each company data set was originally acquired as separate surveys duplicate line numbers existed between data sets. To avoid this possibly causing problems with future processing each company data set was assigned a unique prefix and all line numbers converted into a 7 digit line number with the appropriate prefix. The line number prefix and the name of the company that supplied the data set are presented in Table 7,

LINE NUMBER	COMPANY NAME
1??????	P.N.C. Exploration (Australia) Pty. Ltd.
2??????	P.N.C. Exploration (Australia) Pty. Ltd.
3??????	Endras Trust No.2 Pty. Ltd.
4??????	CRA Exploration Pty. Ltd.
5??????	Pasminco
6??????	CRA Exploration Pty. Ltd.

Table 7. Line numbering of Company Data.

10.9 GRIDDING AND MERGING

A proprietary gridding algorithm using bi-directional polynomial interpolation was used to grid the final levelled NTDME data as well as to produce grids from the final company data.

Not all the company survey lines were flown in the same direction and at the same line spacing as the NTDME data so each data set was gridded separately. The separate grids were then merged together to produce a final merged grid for each of the magnetic, total count, potassium uranium and thorium channels. No merged grid was produced for the digital terrain model as no company supplied data existed for this channel. The grid cell size and the grid angle used to produce the grids prior to merging is presented in Table 8. Prior to the final merge, each grid was rotated to a grid angle of 0 degrees and interpolated to a grid cell size of 50 metres.

LINE NUMBER	GRID CELL SIZE	GRID ANGLE
NTDME	100 m	90 deg
1??????	50 m	30 deg
2??????	50 m	40 deg
3??????	62.5 m	90 deg
4??????	60 m	90 deg
5??????	50 m	90 deg
6??????	100 m	90 deg

Table 8. Grid cell size and grid angle for each data set.

11. PRODUCT DELIVERIES

11.1 MAP PRODUCTS

11.1.1 1:250,000 Products

The survey was covered by three (3) 1:250,000 map sheets:

SF53/10 ALCOOTA
SF53/14 ALICE SPRINGS
SF53/15 ILLOGWA CREEK

For each map sheet the following products were delivered:

- Magnetic intensity black ink contours on mylar.
- Magnetic intensity colour contours on paper, laminated.
- Total count colour contours on paper, laminated.

11.1.2 1:100,000 Products

The survey was covered by fourteen (14) 1:100,000 maps sheets:

5650 ALICE SPRINGS
5651 BURT
5652 BUSHY PARK
5653 WOOLLA
5750 UNDOOLYA
5751 LAUGHLEN
5752 ALCOOTA
5753 WOODGREEN
5850 FERGUSSON RANGE
5851 RIDDOCH
5852 DELNY
5853 UTOPIA
5950 LIMBLA
5951 QUARTZ

For each map sheet the following products were delivered:

- Magnetic intensity black ink contours on mylar.
- Flight path recovery, black ink on mylar.
- Stacked magnetic profiles, every line, black ink on mylar
- Stacked magnetic profiles, every 4th line, black ink on mylar
- Total count colour contours on paper, laminated.
- Potassium colour contours on paper, laminated.
- Uranium colour contours on paper, laminated.
- Thorium colour contours on paper, laminated.

11.2 DIGITAL PRODUCTS

All digital products were supplied on new, original 5 gigabyte Exabyte tapes in Unix TAR format.

The located data was supplied in ASEG-GDF (II) format and the grids were in ERMapper format. These formats are described in detail in Appendix 2.

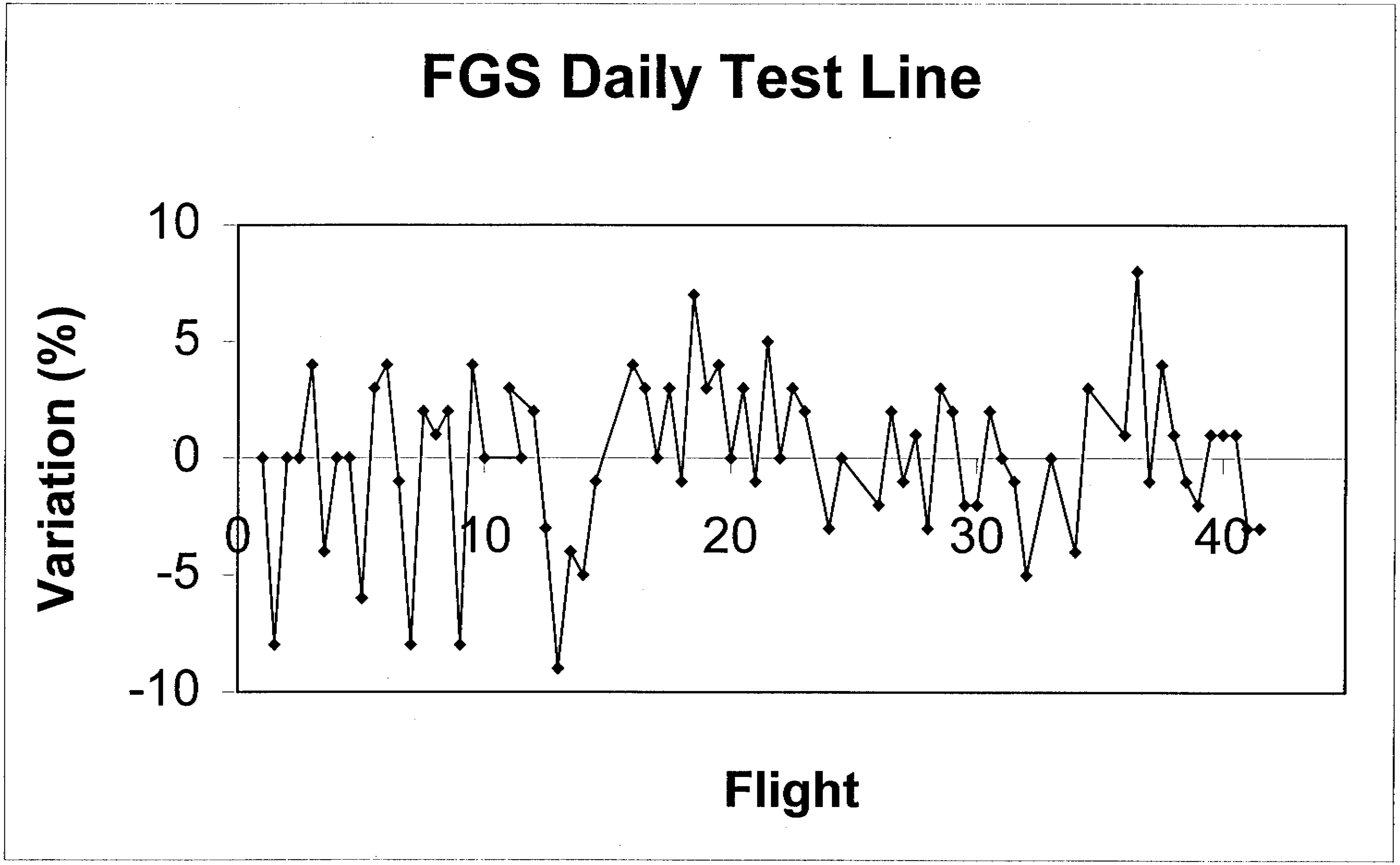
The following digital products were supplied:

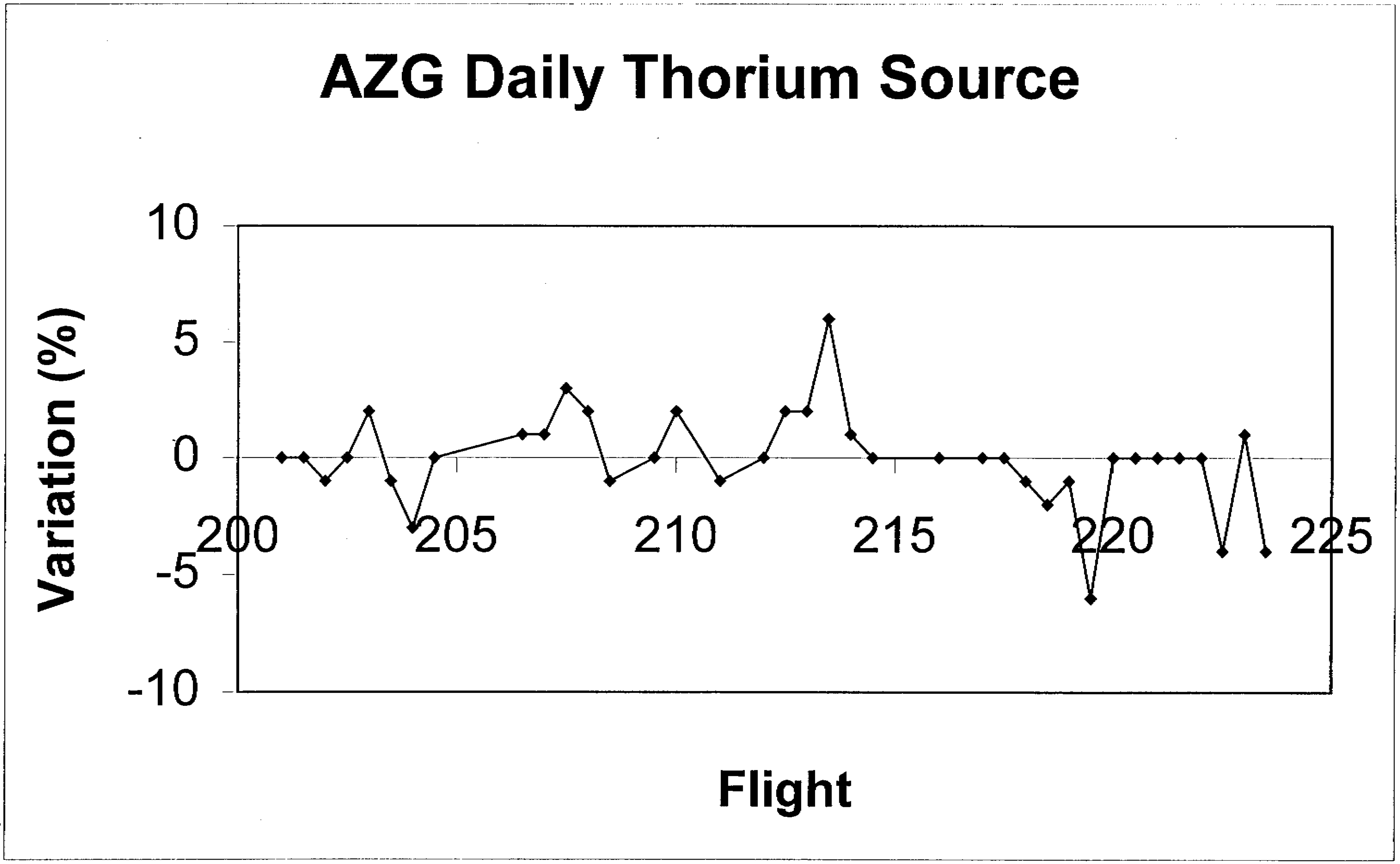
- Each map product in HPGL format.
- The contours of each map in Microstation DGN format.
- Two copies of located data containing all NTDME survey data and the company survey data.
- Two copies of the testline and calibration data.
- Two copies of located NTDME and company data organised by 1:100,000 map sheet including a 1.2 km wide border around each map sheet.
- 1 copy of located 256 channel radiometric data, NTDME data only (no 256 channel company data existed).
- 1 copy in ER Mapper format of final grids of:
    - Magnetic intensity
    - Magnetic intensity 1st vertical derivative
    - Total count
    - %Potassium
    - eUranium
    - eThorium
    - Digital terrain model

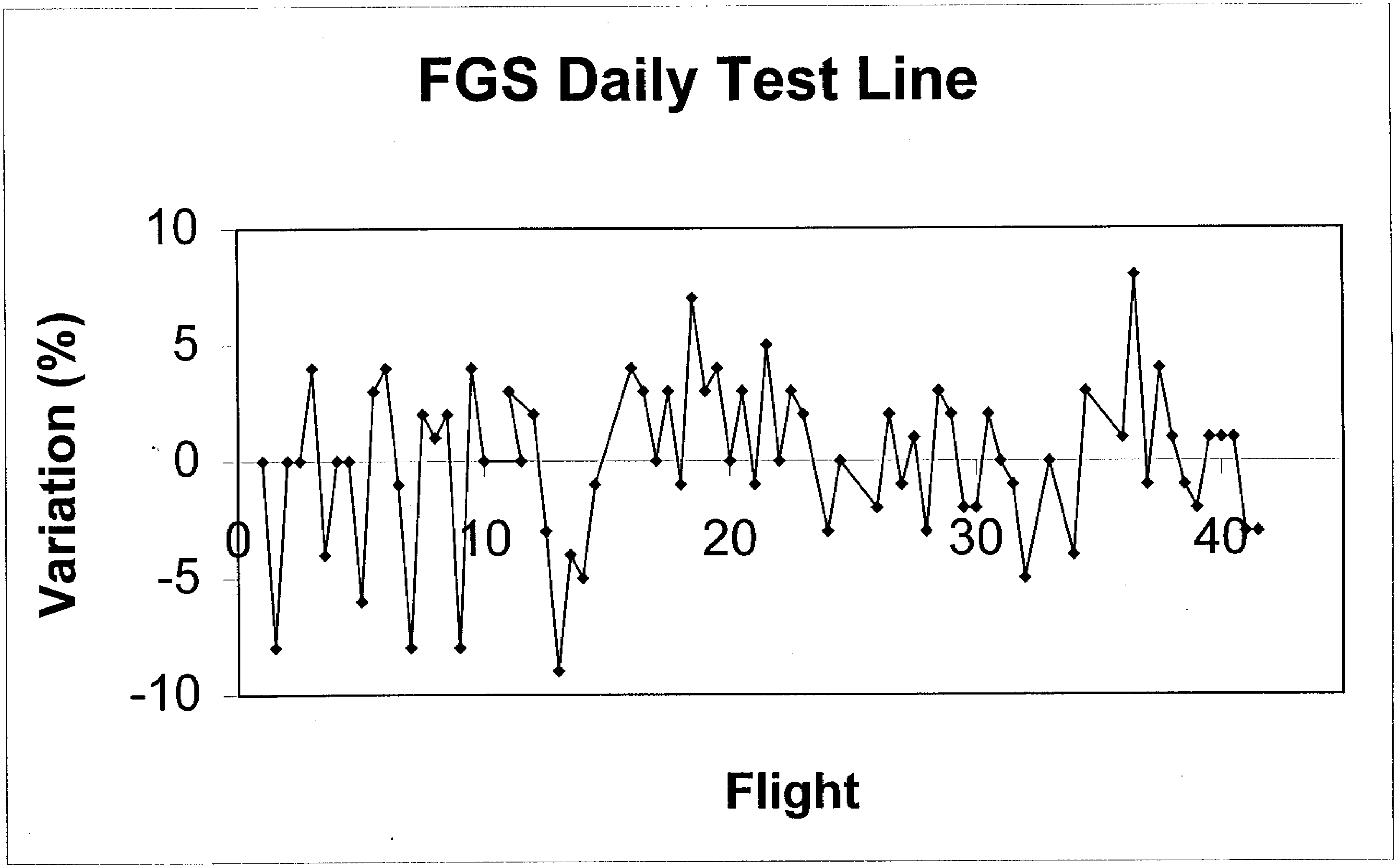
Although not contractual WGC also supplied a reduced to the pole magnetic intensity grid as well as an RTP 1st vertical derivative grid, both in ER Mapper format.

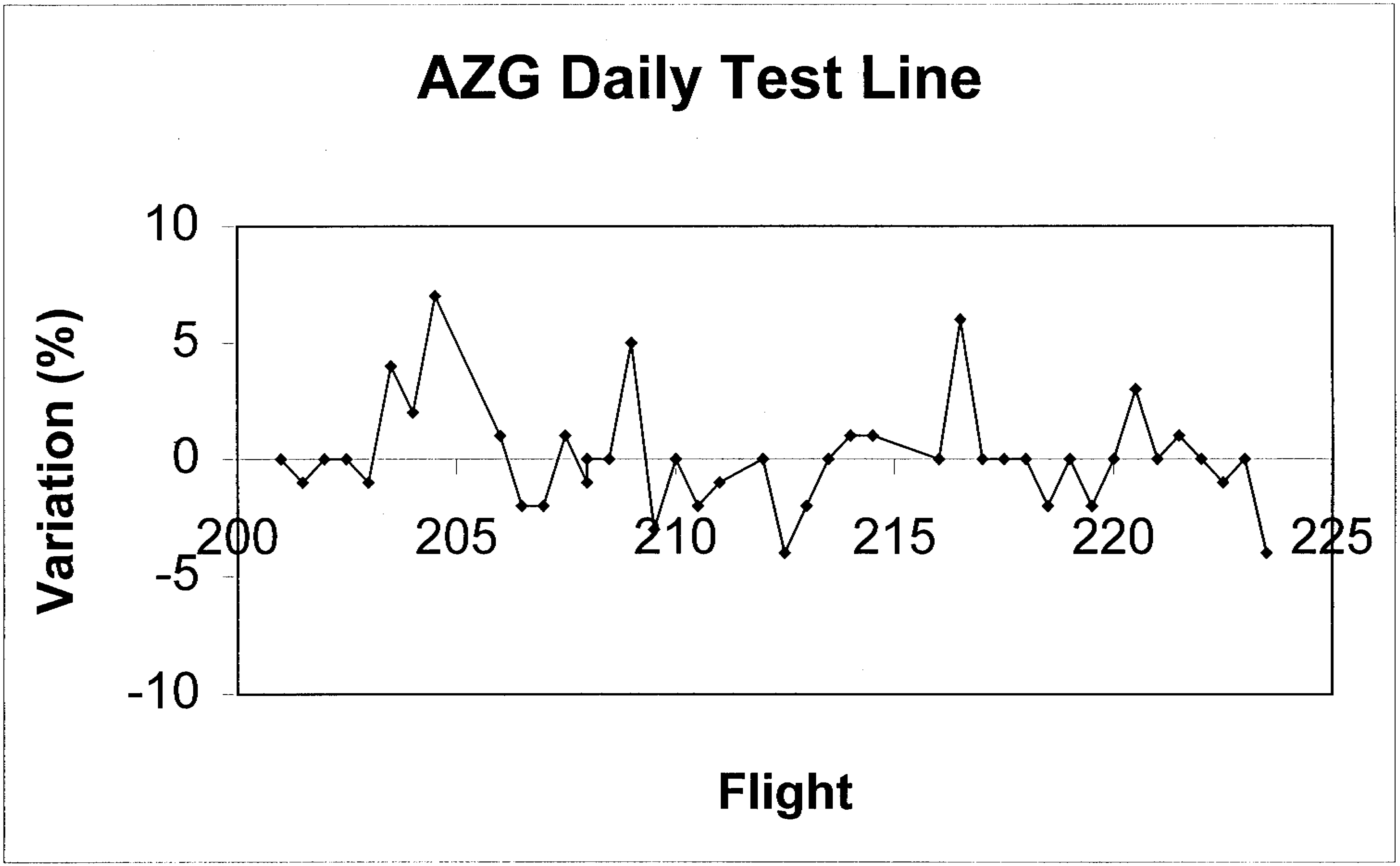
APPENDIX 1

DAILY RADIOMETRIC TEST RESULTS


FGS Daily Test Line
10
5
0
-5
-10
Variation (%)
0
10
20
30
40
Flight


AZG Daily Thorium Source
Variation (%)
10
5
0
-5
-10
200
205
210
215
220
225
Flight


FGS Daily Test Line
10
5
0
-5
-10
Variation (%)
0
10
20
30
40
Flight


AZG Daily Test Line
10
5
0
-5
-10
Variation (%)
200
205
210
215
220
225
Flight

APPENDIX 2

DIGITAL DATA FORMATS

Example of located data DFN and COM files for TMI and IAEA Radiometric Window data:

```
COMM NOTES
COMM
COMM Job number:                         1303
COMM Company:                            N.T. DEPARTMENT OF MINES AND ENERGY
COMM Flown:                              SEPTEMBER 1997 to JANUARY 1998
COMM Survey company:                     World Geoscience Corporation Ltd.
COMM Area name:                          ALCOOTA/ALICE SPRINGS
COMM State:                              NORTHERN TERRITORY
COMM Data creation date:                 980210
COMM
COMM This data set comprises the survey data flown for the NTDME
COMM and older data acquired by private companies who in turn
COMM supplied a copy to the NTDME. The NTDME survey lines have 5
COMM digit line numbers. The company survey lines have 7 digit
COMM line numbers.
COMM The company data was supplied by the following companies:
COMM 1?????? - P.N.C. EXPLORATION (AUSTRALIA) PTY. LTD.
COMM 2?????? - P.N.C. EXPLORATION (AUSTRALIA) PTY. LTD.
COMM 3?????? - ENDRAS TRUST No.2 PTY. LTD.
COMM 4?????? - CRA EXPLORATION PTY. LTD.
COMM 5?????? - PASMINCO
COMM 6?????? - CRA EXPLORATION PTY. LTD.
COMM This data set contains all survey lines covering the
COMM 1:100,000 map sheet 5851 plus a 1.2 km border.
COMM
COMM NTDME SURVEY SPECIFICATIONS
COMM
COMM AIRCRAFT               - VH-FGS ROCKWELL SHRIKE COMMANDER AC500S
COMM                        - VH-AZG CESSNA STATIONAIR U206G
COMM
COMM MAGNETOMETER           - Split beam cesium Scintrex VIW2321-CS2
COMM RESOLUTION             - 0.001 nanotesla
COMM CYCLE RATE             - 0.1 second
COMM SAMPLE INTERVAL        - 7 metres
COMM
COMM SPECTROMETER           - 256 channel PGAM-1000
COMM VOLUME                 - 33.56 litres
COMM CYCLE RATE             - 1.0 second
COMM SAMPLE INTERVAL        - 70 metres
COMM
COMM DATA ACQUISITION       - Picodas PDAS-1000
COMM
COMM FLIGHT LINE SPACING    - 400 metres
COMM FLIGHT LINE DIRECTION  - 090 - 270 degrees
COMM TIE    LINE SPACING    - 4000 metres
COMM TIE    LINE DIRECTION  - 000 - 180 degrees
COMM
COMM SURVEY HEIGHT          - 60 metres - mean terrain clearance
COMM
COMM NAVIGATION             - GPS navigation system
COMM
COMM FLIGHT PATH RECOVERY   - Post-flight differentially corrected GPS
COMM
COMM DATA PROCESSING
COMM
COMM Aircraft VH-FGS flew flight numbers between 001 - 199
COMM Aircraft VH-AZG flew flight numbers between 200 - 299
COMM Where the aircraft processing parameters differ, they have
COMM been given accordingly.
COMM
COMM GEODETIC DATUM    : GDA
COMM Projection        : MGA
```

```
COMM Central meridian : 135 deg.
COMM
COMM CO-ORDINATES
COMM FGS parallax correction applied : -1.4 fiducials.
COMM AZG parallax correction applied : -1.5 fiducials.
COMM Data used in processing is flagged as follows:
COMM Recovery status: 0  interpolated position.
COMM                  1  GPS located point.
COMM
COMM MAGNETICS:
COMM Final magnetic intensity corrections:
COMM IGRF model 1995 removed, base value added : 2500 nanoteslas.
COMM IGRF has been calculated at an elevation of 670 metres above
COMM the ellipsoid at the time recorded for each fiducial.
COMM Diurnal correction applied : base value 53620 nanoteslas.
COMM FGS parallax correction applied : -1.1 fiducials.
COMM AZG parallax correction applied : -1.2 fiducials.
COMM Levelled using tie line information.
COMM Tie lines force levelled to the flight lines.
COMM
COMM RADAR ALTIMETER:
COMM FGS parallax correction applied: -1.2 fiducials.
COMM AZG parallax correction applied: -0.5 fiducials.
COMM
COMM BAROMETRIC ALTIMETER:
COMM FGS parallax correction applied: -1.2 fiducials.
COMM AZG parallax correction applied: -1.4 fiducials.
COMM A level correction using the linear drift between the
COMM morning and afternoon test lines has been applied.
COMM
COMM GPS HEIGHT:
COMM FGS parallax correction applied: -1.4 fiducials.
COMM AZG parallax correction applied: -1.5 fiducials.
COMM
COMM DIGITAL ELEVATION:
COMM Computed by subtracting the aircraft's height above the
COMM ground from the GPS height of the aircraft.
COMM A correction for the ellipsoid/geoid separation has been applied.
COMM
COMM BAROMETRIC PRESSURE:
COMM FGS parallax correction applied: -1.2 fiducials.
COMM AZG parallax correction applied: -1.4 fiducials.
COMM
COMM TEMPERATURE:
COMM FGS parallax correction applied: 0 fiducials.
COMM AZG parallax correction applied: 0 fiducials.
COMM
COMM RADIOMETRICS:
COMM FGS Processing Co-efficients
COMM Aircraft background:    Total count : -93.0
COMM                         Potassium   : -13.0
COMM                         Uranium     : -5.1
COMM                         Thorium     : -1.9
COMM Cosmic coefficient:     Total count : 1.6000
COMM                         Potassium   : 0.0787
COMM                         Uranium     : 0.0700
COMM                         Thorium     : 0.0740
COMM Stripping coefficients: Alpha       : 0.2442
COMM                         Beta        : 0.3692
COMM                         Gamma       : 0.7380
COMM                         Delta       : 0.0360
COMM                         g           : 0
COMM                         b           : 0
COMM Stripping Height Variation Factors:
COMM                         Alpha       : 0.00049
COMM                         Beta        : 0.00065
```

```
COMM                         Gamma        : 0.00069
COMM Altitude  coefficients: Total count : .0067
COMM                         Potassium   : .0082
COMM                         Uranium     : .0084
COMM                         Thorium     : .0066
COMM Ground concentration factors:
COMM                         Potassium   : 127.76
COMM                         Uranium     : 13.021
COMM                         Thorium     : 6.623
COMM Parallax correction:    0 fiducials.
COMM
COMM AZG Processing Co-efficients
COMM Aircraft background:    Total count : -99.20
COMM                         Potassium   : -15.60
COMM                         Uranium     : -3.20
COMM                         Thorium     : -2.18
COMM Cosmic coefficient:     Total count : 1.5300
COMM                         Potassium   : 0.0773
COMM                         Uranium     : 0.0678
COMM                         Thorium     : 0.0730
COMM Stripping coefficients: Alpha       : 0.2489
COMM                         Beta        : 0.3868
COMM                         Gamma       : 0.7100
COMM                         Delta       : 0.0358
COMM                         g           : 0
COMM                         b           : 0
COMM Stripping Height Variation Factors:
COMM                         Alpha       : 0.00049
COMM                         Beta        : 0.00065
COMM                         Gamma       : 0.00069
COMM Altitude  coefficients: Total count : .0067
COMM                         Potassium   : .0082
COMM                         Uranium     : .0084
COMM                         Thorium     : .0066
COMM Ground concentration factors:
COMM                         Potassium   : 126.7
COMM                         Uranium     : 11.503
COMM                         Thorium     : 5.853
COMM Parallax correction:    0 fiducials.
COMM

DEFN    ST=RECD,RT=COMM;RT:A4;COMMENTS:A74
DEFN  1 ST=RECD,RT=;LINE      :   F7.0  :UNITS=                      ,NULL=9999999      ,NAME=LINE
NUMBER
DEFN  2 ST=RECD,RT=;FLIGHT    :   F4.0  :UNITS=                      ,NULL= 999         ,NAME=FLIGHT
NUMBER
DEFN  3 ST=RECD,RT=;HEADING   :   F4.0  :UNITS=degrees               ,NULL= 999         ,NAME=COMPASS
HEADING
DEFN  4 ST=RECD,RT=;DATE      :   F7.0  :UNITS=YYMMDD                ,NULL= 999999      ,NAME=DATE
DEFN  5 ST=RECD,RT=;FIDUCIAL  :   F9.1  :UNITS=                      ,NULL= 999999.9
,NAME=FIDUCIAL NUMBER
DEFN  6 ST=RECD,RT=;TIME      :   F8.1  :UNITS=seconds               ,NULL= 99999.9     ,NAME=TIME
,seconds from midnight
DEFN  7 ST=RECD,RT=;RECSTAT   :   F3.0  :UNITS=                      ,NULL= -1
,NAME=RECOVERY STATUS                      ,see CO-ORDINATES
DEFN  8 ST=RECD,RT=;EASTING   :   F9.1  :UNITS=metres                ,NULL= 999999.9    ,NAME=EASTING
,MGA
DEFN  9 ST=RECD,RT=;NORTHING  :   F10.1 :UNITS=metres                ,NULL= 9999999.9
,NAME=NORTHING                            ,MGA
DEFN 10 ST=RECD,RT=;LONG      :   F13.7 :UNITS=degrees               ,NULL= 9999.9999999
,NAME=LONGITUDE                           ,GDA
DEFN 11 ST=RECD,RT=;LAT       :   F12.7 :UNITS=degrees               ,NULL= 999.9999999
,NAME=LATITUDE                            ,GDA
DEFN 12 ST=RECD,RT=;MAGFIN    :   F9.2  :UNITS=nanoteslas            ,NULL= 99999.99    ,NAME=FINAL
TMI
DEFN 13 ST=RECD,RT=;1VDFIN    :   F11.6 :UNITS=nanoteslas per metre ,NULL= 999.999999  ,NAME=FINAL
TMI FIRST VERTICAL DERIVATIVE
DEFN 14 ST=RECD,RT=;TOTF      :   F8.1  :UNITS=becquerels            ,NULL= 99999.9     ,NAME=FINAL
TOTAL COUNT
DEFN 15 ST=RECD,RT=;POTF      :   F9.5  :UNITS=%Potassium            ,NULL= 99.99999    ,NAME=FINAL
%POTASSIUM
DEFN 16 ST=RECD,RT=;URAF      :   F9.5  :UNITS=ppm eUranium          ,NULL= 99.99999    ,NAME=FINAL
eURANIUM
```

```
DEFN 17 ST=RECD,RT=;THOF      :   F10.5 :UNITS=ppm eThorium         ,NULL= 999.99999    ,NAME=FINAL
eTHORIUM
DEFN 18 ST=RECD,RT=;TOPO      :   F7.1  :UNITS=metres               ,NULL= 9999.9
,NAME=ALTIMETER DERIVED TERRAIN
DEFN 19 ST=RECD,RT=;MAGRAW    :   F9.2  :UNITS=nanoteslas           ,NULL= 99999.99     ,NAME=RAW TMI
DEFN 20 ST=RECD,RT=;IGRF      :   F9.2  :UNITS=nanoteslas           ,NULL= 99999.99     ,NAME=IGRF
DEFN 21 ST=RECD,RT=;DIURNAL   :   F9.2  :UNITS=nanoteslas           ,NULL= 99999.99     ,NAME=DIURNAL
DEFN 22 ST=RECD,RT=;GPSHGT    :   F7.1  :UNITS=metres               ,NULL= 9999.9       ,NAME=GPS
HEIGHT
DEFN 23 ST=RECD,RT=;RADALT    :   F7.1  :UNITS=metres               ,NULL= 9999.9       ,NAME=RADAR
ALTIMTER
DEFN 24 ST=RECD,RT=;BAROALT   :   F7.1  :UNITS=metres               ,NULL= 9999.9
,NAME=BAROMETRIC HEIGHT
DEFN 25 ST=RECD,RT=;TOTR      :   F8.1  :UNITS=becquerels           ,NULL= 99999.9      ,NAME=RAW
TOTAL COUNT
DEFN 26 ST=RECD,RT=;POTR      :   F7.1  :UNITS=becquerels           ,NULL= 9999.9       ,NAME=RAW
POTASSIUM
DEFN 27 ST=RECD,RT=;URAR      :   F7.1  :UNITS=becquerels           ,NULL= 9999.9       ,NAME=RAW
URANIUM
DEFN 28 ST=RECD,RT=;THOR      :   F7.1  :UNITS=becquerels           ,NULL= 9999.9       ,NAME=RAW
THORIUM
DEFN 29 ST=RECD,RT=;COSMIC    :   F7.1  :UNITS=becquerels           ,NULL= 9999.9       ,NAME=COSMIC
DEFN 30 ST=RECD,RT=;PRESSURE  :   F8.2  :UNITS=hectopascals         ,NULL= 9999.99
,NAME=BAROMETRIC PRESSURE
DEFN 31 ST=RECD,RT=;TEMP      :   F5.1  :UNITS=degrees Celsius      ,NULL= 99.9
,NAME=TEMPERATURE
DEFN 32 ST=RECD,RT=;END DEFN
```

Example of located data DFN and COM files for 256 channel data:

```
COMM NOTES
COMM
COMM Job number:                          1303
COMM Company:                             N.T. DEPARTMENT OF MINES AND ENERGY
COMM Flown:                               SEPTEMBER 1997 to JANUARY 1998
COMM Survey company:                      World Geoscience Corporation Ltd.
COMM Area name:                           ALCOOTA/ALICE SPRINGS
COMM State:                               NORTHERN TERRITORY
COMM Data creation date:                  980218
COMM
COMM This data set comprises only the survey data flown for the NTDME
COMM as no 256 channel data exists for the company data.
COMM
COMM NTDME SURVEY SPECIFICATIONS
COMM
COMM AIRCRAFT              - VH-FGS ROCKWELL SHRIKE COMMANDER AC500S
COMM                       - VH-AZG CESSNA STATIONAIR U206G
COMM
COMM DATA ACQUISITION      - Picodas PDAS-1000
COMM
COMM FLIGHT LINE SPACING   - 400 metres
COMM FLIGHT LINE DIRECTION - 090 - 270 degrees
COMM TIE    LINE SPACING   - 4000 metres
COMM TIE    LINE DIRECTION - 000 - 180 degrees
COMM
COMM SURVEY HEIGHT         - 60 metres - mean terrain clearance
COMM
COMM NAVIGATION            - GPS navigation system
COMM
COMM FLIGHT PATH RECOVERY  - Post-flight differentially corrected GPS
COMM
COMM DATA PROCESSING
COMM
COMM Aircraft VH-FGS flew flight numbers between 001 - 199
COMM Aircraft VH-AZG flew flight numbers between 200 - 299
COMM Where the aircraft processing parameters differ, they have
COMM been given accordingly.
COMM
COMM GEODETIC DATUM   : GDA
COMM Projection       : MGA
COMM Central meridian : 135 deg.
COMM
COMM CO-ORDINATES
COMM FGS parallax correction applied : -1.4 fiducials.
COMM AZG parallax correction applied : -1.5 fiducials.
COMM Data used in processing is flagged as follows:
COMM Recovery status: 0  interpolated position.
COMM                  1  GPS located point.
COMM
COMM RADAR ALTIMETER:
COMM FGS parallax correction applied: -1.2 fiducials.
COMM AZG parallax correction applied: -0.5 fiducials.
COMM
COMM BAROMETRIC ALTIMETER:
COMM FGS parallax correction applied: -1.2 fiducials.
COMM AZG parallax correction applied: -1.4 fiducials.
COMM A level correction using the linear drift between the
COMM morning and afternoon test lines has been applied.
COMM
COMM GPS HEIGHT:
COMM FGS parallax correction applied: -1.4 fiducials.
COMM AZG parallax correction applied: -1.5 fiducials.
COMM
```

```
COMM BAROMETRIC PRESSURE:
COMM FGS parallax correction applied: -1.2 fiducials.
COMM AZG parallax correction applied: -1.4 fiducials.
COMM
COMM TEMPERATURE:
COMM FGS parallax correction applied: 0 fiducials.
COMM AZG parallax correction applied: 0 fiducials.
COMM
```

```
DEFN    ST=RECD,RT=COMM;RT:A4;COMMENTS:A74
DEFN  1 ST=RECD,RT=;LINE      :   F7.0  :UNITS=                       ,NULL=9999999       ,NAME=LINE
NUMBER
DEFN  2 ST=RECD,RT=;FLIGHT    :   F4.0  :UNITS=                       ,NULL= 999          ,NAME=FLIGHT
NUMBER
DEFN  3 ST=RECD,RT=;HEADING   :   F4.0  :UNITS=degrees                ,NULL= 999          ,NAME=COMPASS
HEADING
DEFN  4 ST=RECD,RT=;DATE      :   F7.0  :UNITS=YYMMDD                 ,NULL= 999999       ,NAME=DATE
DEFN  5 ST=RECD,RT=;FIDUCIAL  :   F9.1  :UNITS=                       ,NULL= 999999.9
,NAME=FIDUCIAL NUMBER
DEFN  6 ST=RECD,RT=;TIME      :   F8.1  :UNITS=seconds                ,NULL= 99999.9      ,NAME=TIME
,seconds from midnight
DEFN  7 ST=RECD,RT=;RECSTAT   :   F3.0  :UNITS=                       ,NULL= -1
,NAME=RECOVERY STATUS                    ,see CO-ORDINATES
DEFN  8 ST=RECD,RT=;EASTING   :   F9.1  :UNITS=metres                 ,NULL= 999999.9     ,NAME=EASTING
,MGA
DEFN  9 ST=RECD,RT=;NORTHING  :   F10.1 :UNITS=metres                 ,NULL= 9999999.9
,NAME=NORTHING                           ,MGA
DEFN 10 ST=RECD,RT=;LONG      :   F13.7 :UNITS=degrees                ,NULL= 9999.9999999
,NAME=LONGITUDE                          ,GDA
DEFN 11 ST=RECD,RT=;LAT       :   F12.7 :UNITS=degrees                ,NULL= 999.9999999
,NAME=LATITUDE                           ,GDA
DEFN 12 ST=RECD,RT=;GPSHGT    :   F7.1  :UNITS=metres                 ,NULL= 9999.9       ,NAME=GPS
HEIGHT
DEFN 13 ST=RECD,RT=;RADALT    :   F7.1  :UNITS=metres                 ,NULL= 9999.9       ,NAME=RADAR
ALTIMTER
DEFN 14 ST=RECD,RT=;BAROALT   :   F7.1  :UNITS=metres                 ,NULL= 9999.9
,NAME=BAROMETRIC HEIGHT
DEFN 15 ST=RECD,RT=;PRESSURE  :   F8.2  :UNITS=hectopascals           ,NULL= 9999.99
,NAME=BAROMETRIC PRESSURE
DEFN 16 ST=RECD,RT=;TEMP      :   F5.1  :UNITS=degrees Celsius        ,NULL= 99.9
,NAME=TEMPERATURE
DEFN 17 ST=RECD,RT=;RAD256    :256F7.1  :UNITS=becquerels             ,NULL= 9999.9       ,NAME=256
CHANNEL RADIOMETRICS
DEFN 18 ST=RECD,RT=;END DEFN
```

Example of ERMapper header file:

```
datasetheader begin
  version = "4.1"
  sensorname = "ALCOOTA 1VD"
  datasettype = erstorage
  datatype = raster
  byteorder = msbfirst
coordinatespace begin
  datum = "gda"
  projection = "sutm53"
  coordinatetype = en
  units = "metres"
  rotation = 0:0:0.0
coordinatespace end
rasterinfo begin
  celltype = ieee4bytereal
  nroflines = 4516
  nrofcellsperline = 4144
  nrofbands = 1
  nullcellvalue = -99999
  registrationcellx = 0.0
  registrationcelly = 0.0
  cellinfo begin
    xdimension = 50.00
    ydimension = 50.00
  cellinfo end
  registrationcoord begin
    eastings = 345100.00
    northings = 7569050.00
  registrationcoord end
  bandid begin
    value = "1VD"
    units = "nT/m"
  bandid end
rasterinfo end
datasetheader end
```