NORTHERN TERRITORY DEPARTMENT OF MINES & ENERGY

Operations and Processing Report

Airborne Geophysical Survey
MARY RIVER
Northern Territory

- September 2000

FLOWN AND PROCESSED BY KEVRON GEOPHYSICS FOR AND ON BEHALF OF THE NORTHERN TERRITORY DEPARTMENT OF MINES & ENERGY

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INTRODUCTION

The Mary River airborne geophysical survey lies on 1:250,000 maps Darwin (SD52-04), Alligator River (SD52-01), Pine Creek (SD53-08), Mount Evelyn (SD53-05) and Katherine (SD53-09). A total of 47,555 line kilometres of magnetic, radiometric and digital elevation data were acquired and processed. It is intended that the acquired geophysical data will constitute a major addition to the fundamental geological database of the Northern Territory and will stimulate mineral exploration activity with a view to possible discovery and development of economic mineral deposits.

The project was managed by the Northern Territory Department of Mines & Energy, under the supervision of the Superintendent Mr. Richard Brecianini and Inspecting Officer, Mr. Roger Clifton. The data acquisition, quality control, data processing and mapping were carried out by Kevron Geophysics Pty Ltd of 10 Compass Road, Jandakot Airport, Western Australia.

Darwin and Katherine were used as the bases of operations for the duration of the Mary River survey. Mobilisation of crew commenced on 3rd July 2000 and all crew members were on site on 6th July 2000. Production commenced on 6th July and was completed on 18th August 2000. A total of 83 sorties were flown.

Acquisition was undertaken using a twin engine Aero Commander ‘Shrike’ 500s aircraft, registration VH KAV. Periodic maintenance was performed by Kevron Aviation staff at Aboriginal Aircraft Maintenance facilities in Alice Springs and on the ground at Darwin and Katherine.

The fixed wing traverse lines were flown at an interline spacing of 400 m, with a tie line spacing of 4000m. Traverse lines and tie lines were oriented 090° and 000E respectively. An average ground clearance of 80m was specified for both magnetic and radiometric sensors.

In field data verification and quality control was undertaken on a post flight basis on-site using a combination of Kevron proprietary software and ChrisDBF. QC products produced in the field included magnetometer 4th difference noise plots, flight path deviation plots of cross-track and elevation and radiometric summed spectra plots. Diurnal plots of the Cs vapour base station magnetometer were plotted and assessed to ensure contract compliance. Some reflights were necessary due to excessive magnetic variation. Back-ups of all field data were written to compact disk and an additional copy sent to Kevron’s data processing center in Perth where further QC products were produced and data processing undertaken.

1. SURVEY AREAS AND PARAMETERS

1.1 SURVEY AREA

Total line kilometres for the MARY RIVER AREA was calculated to be 47,555 inclusive of tie lines and boundary overlap. A breakdown of the survey follows:

MARY RIVER NORTH (ZONE 52)

	Direction	Spacing	Shortest	Longest	Lines	Total
Traverse	90-270	400 m	3.3km	74.3km	335	16,190
Tie Lines	0-180	4000m	8.9km	134.2km	33	1,636.6
					Total Line Kilometres	**17,826.6**

MARY R IVER SOUTH (ZONE 53)

	Direction	Spacing	Shortest	Longest	Lines	Total
Traverse	90-270	400 m	6.0km	164.2km	364	26,927.3
Tie Lines	0-180	4000m	2.1km	121.9 km	47	2,801.1
					Total Line Kilometres	**29,728.4**

The Mary River survey covers parts of the following 1:250 000 map sheets:

- Darwin SD52-4
- Alligator River SD53-1
- Pine Creek SD52-8
- Mt Evelyn SD53-5
- Katherine SD53-9

Mean daily maximum temperatures for Katherine (located on the Southern Boundary of the survey area) from July to September is 31 deg C.
Mean daily minimum temperatures for the same period is 14 deg C.
Mean daily maximum temperatures for Darwin (located on the North West of the survey area) from July to September is 33 deg C .
Mean daily minimum temperatures for the same period is 14 deg C .

The following geographic coordinates based on the GDA94 datum and spheroid define the survey boundary.

1. 12°17'S, 131°30'E,
   Then east along the coastline to
   12°18'S, 132°05'E,
   then southwest along the boundary of Kakadu National Park to
   12°31'S, 131°53'E,
   12°55'S, 131°52'E,
   12°55'S, 132°04'E,
   13°10'S, 132°04'E,
   13°10'S, 131°52'E,
   then south-east along the boundary of Kakadu National Park to
   13°48'S, 132°22'E,
   13°48'S, 132°41'E,

14^{o}S, 132^{o}41’E,
14oS, 133^{o}E,
14^{o}30’S, 133^{o}E,
14^{o}30’S, 132^{o}E,
14^{o}S, 132^{o}E,
14^{o}S, 131^{o}30’E,
13^{o}39’S, 131^{o}30’E,
13^{o}39’S, 131^{o}39’E,
13^{o}52’S, 131^{o}56’E,
13^{o}39’S, 131^{o}47’E,
13^{o}39’S, 132^{o}E,
13^{o}25’S, 131^{o}58’E,
13^{o}25’S, 131^{o}49’E,
13^{o}10’S, 131^{o}40’E,
13^{o}06’S, 131^{o}40’E,
13^{o}06’S, 131^{o}38’E,
13^{o}04’S, 131^{o}38’E,
13^{o}03’S, 131^{o}32’E,
12^{o}47’S, 131^{o}31’E,
12^{o}47’S, 131^{o}15’E,
12^{o}44’S, 131^{o}15’E,
12^{o}44’S, 131^{o}13’E,
12^{o}39’S, 131^{o}13’E, and
12^{o}39’S, 131^{o}30’E.

Refer to ***Appendix 1*** for survey area location diagram.

1.2 SURVEY PARAMETERS

Flight line direction	090° - 270°
Flight line spacing	400 metres
Tie line direction	000° - 180°
Tie line spacing	4000 metres
Mean Terrain Clearance	80 metres

Time Base and approximate sampling interval (in still air):

• Magnetics	0.1 second (7 metres approx.)
• Radar altimeter	0.1 second (7 metres approx)
• Radiometrics	1.0 second (70 metres approx.)
• GPS system	1.0 second (70 metres approx.)

2. LOGISTICS

2.1 OPERATIONS BASE AND SURVEY DATES

Base Airfield	Latitude	Longitude	Elevation
Darwin	12E 24.9' S	130E 52.6' E	103 ft
Katherine	14E 31.3' S	132E 22.7' E	443 ft

Darwin was selected as the initial operating base for the northern area. It provided all the facilities required for the safe operation of an airborne geophysical survey in a designated remote area. The southern half of the survey was carried out from Katherine.

Both Darwin and Katherine offer comfortable accommodation and eating establishments, important for crew morale on large projects. A regular service by Ansett subsidiary Air North allowed for the rapid dispatch of data to the DPC in Perth and the ability to rotate crews smoothly with little or no loss of production. Down time due to instrument failure was also minimised as replacement components could be despatched and delivered the following day.

Darwin airport has two bitumen runways: runway 11/29 being 3354 m in length and runway 18/36 being 1524 m in length. Navigation aids include VOR (DN 112.6), NDB (DN 334) and DME (DN 73X/112.6). AVGAS was readily available at reasonable cost from the Shell distributor..
Katherine / Tindal airport has a bitumen runway: runway 14/32 being 2744 m in length. Navigation aids include VOR (TDL 112.3), NDB (TDL 356). AVGAS was readily available at reasonable cost from the Shell / BP distributor.

Crew Accommodation:

DARWIN
Darwin Highway Inn
Stuart Highway
Winnellie

KATHERINE
Knotts Crossing Resort
Katherine

2.1.1 Survey Dates and Production Summary

Refer to ***APPENDIX 4*** for detailed production summary.

Mobilisation	06/07/00
Production flying commenced	12/07/00
Production flying completed	24/09/00
Demobilisation	25/09/00
Total days on job	83
Total number of flights	83
Total production days	67
Total days lost due to weather	0
Total days lost due to aircraft maintenance	13
Total days lost due to Mag storms	2.5
Total days lost due to other causes	6
Total kilometres flown	50,184.1
Average acquisition rate - km per flight	604.6km
km per production day	749km

2.2 SURVEY AIRCRAFT AND FIELD CREW

Aircraft Twin engine Rockwell Aero Commander 500S 'Shrike': Registration VH KAV

Field Crew	Pilots	Operators
	P. Hillier	D. Anderson
	T. Eleftheriadis	D. Little
	M. Rooney	R. Deopel
	D. Chappell	D. Gay
	R. Jamieson	B. Gribble
	M.Cote	

Crew Leader & Field QC D. Gay / B.Gribble

3. SURVEY EQUIPMENT, OPERATION AND QUALITY CONTROL

3.1 MAJOR EQUIPMENT SUMMARY

Aircraft Magnetometer	Geometrics G-822A Caesium vapour
Magnetic Compensator	RMS Instruments Automatic Aeromagnetic Digital Compensator (AADC)
Base station magnetometer	Geometrics G856 proton precession
Gamma-ray spectrometer	Geometrics GR820D, 256 channels
Gamma-ray detector	NaI(T1) crystals; 33.6L down;
Altimeter	Sperry AA-210 radio altimeter
Barometer	Rosemount 1241m
Thermometer	Rosemount Model 22000 temperature sensor
Navigation system	Ashtech XII "Ranger" GPS receivers in real time differential mode
Flight Track Recording	VHS video tracking camera with wide-angle lens
Data acquisition system	RMS Instruments DAS-8 digital acquisition system
Analogue recorder	RMS Instruments GR3A 20-channel recorder

3.2 MAGNETOMETER AND COMPENSATOR

A Geometrics G-822A optically pumped caesium vapour magnetometer was used for the survey with the sensor mounted in a tail stinger on each aircraft. The magnetometer sensor was coupled to a RMS Instruments Automatic Aeromagnetic Digital Compensator (AADC) to produce real time compensation for the effects of the aircraft's motion, changes in attitude and heading. The AADC interference coefficients were calculated from compensation flights carried out before the survey commenced and after aircraft maintenance. The AADC output data, with a resolution and sensitivity of 0.001 nT at a sampling rate of ten (10) times per second, were recorded digitally and in analogue form. The noise envelope for compensated magnetometer readings was less than 0.1 nT

3.2 BASE STATION MAGNETOMETER

A caesium vapour base station magnetometer was used to measure the daily variations of the Earth's magnetic field. The base station was established in an area of low gradient, away from cultural influences. These data were displayed and recorded on a Libretto laptop computer. The base station was run continuously throughout the survey flying period with a sampling interval of 1 seconds and a sensitivity of 0.01 nT.

In addition to the caesium vapour base station, a Geometrics G856 proton precession magnetometer base station recording at 5 second intervals was established at the base airstrip, primarily as a storm monitor.

The base station data were closely examined after each days production flying to determine if any data had been acquired during periods of out-of-specification diurnal variation.

3.3 SPECTROMETER

A Geometrics GR-820D double buffered, 256-channel gamma ray spectrometer with automatic crystal gain and temperature control was used to record 256 channels of data in addition to the data from five pre-set spectral windows. Total downward crystal array volume was 33.6 litres. System sample time and live time were also recorded. The digital data and four channels of analogue data were recorded once per second.

The pre-set spectral window limits were:

	Spectrometer channel number		Equivalent energy levels (keV)	
Window	**Lower**	**Upper**	**Lower**	**Upper**
Total Count	34	254	402	3 005
K-40	116	132	1 373	1 562
Bi-141	141	157	1 668	1 858
Tl-208	204	237	2 414	2 804
Cosmic	255	255	3 017	6 000

The analogue data were corrected for dead time, normalised and stripped for Compton scattering.

3.4 ALTIMETERS

A Sperry AA-210 Radio Altimeter system was used to measure ground clearance. The radio altimeter indicator provides an absolute altitude display from 0 - 750 metres (0 - 2,500 feet) with a sensitivity of 4 mV/ft.

A Rosemount 1241m barometer, with an output sensitivity of 0.666 mV/ft, was used to measure atmospheric pressure and barometric altitude of the aircraft.

Data from both altimeters were recorded on digital tape and on the analogue chart.

The radar altimeter system was checked prior to commencement of production flying. This involved flying the aircraft at 30 metre height intervals, up to a height of 300 metres over the base of operations airstrip using the aircraft's barometric altimeter as the height reference. Radar altimeter and GPS height data were recorded for each flight interval flown. A comparison of these data with the aircraft's barometric altimeter verified that the system was operating satisfactorily.

Altimeter data (radar and barometric) were digitally recorded every 0.1 seconds.

3.5 NAVIGATION AND FLIGHT PATH RECOVERY

Aircraft navigation was controlled by real-time differential GPS using an Ashtech XII "Ranger" receiver in the aircraft with pseudo range corrections obtained through the commercial FUGRO system transmitting via the OPTUS B satellite. The horizontal position of the aircraft was fixed and recorded once per second. The on-board pilot guidance steering signal was updated once every half second.

The pseudo range information was recorded every 5 seconds at both the aircraft receiver and also at a base station receiver located at the Hotel accommodation at both Bases of Operation (***APPENDIX 2***). The raw GPS data were differentially corrected post flight to give corrected GPS positional data accurate to 5 metres or less RMS.

The position of the base station GPS receiver was accurately determined by differential GPS surveying using the 2nd order trigonometrical station.:

Latitude	-19° 39' 14.7328" S
Longitude	134° 12' 45.0241" E
Height	412.618 m AHD.

The determined base station GPS coordinates (WGS 84) were:

	Darwin	Katherine
Latitude	-12° 25' 27.23540" S	-14° 31' 55.27710" S
Longitude	130° 52' 02.24675" E	132° 16' 05.22331" E
Ellipsoidal Ht.	78.98 m	437.26 m

The post-processed flight path data were inspected after each flight for any deviations of flight path from specifications and for any gaps caused by momentary loss of satellites. Flight path quality was confirmed at Kevron's processing centre by maps, plotted from the real time data recorded on magnetic tape, highlighting any portions of lines which exceeded the specified horizontal and altitude tolerances.

3.6 FLIGHT TRACK RECORDING SYSTEM

The flight path of the aircraft was recorded with a National CCD colour video camera and a VHS video recorder. Line and fiducial numbers were recorded on the video image.

3.7 DATA ACQUISITION

A RMS Instruments DAS-8 Data Acquisition System was used to record all data in digital format onto a PC 6 gigabyte hard disk drive. Analogue information was recorded on a RMS Instruments GR-33A printer-plotter.

In general, the following parameters were recorded at the scales indicated; however, each analogue chart was stamped with the parameters and scales recorded:

Parameter	**Scale on Chart**
K 40	500 counts FSD
BI-214	500 counts FSD
TL-208	500 counts FSD
Total count	5000 counts FSD
Mag Fine	200 nT FSD
Mag Coarse	2000 nT FSD
Radar Altimeter	200 ft/cm
Barometric Altimeter	200 ft/cm

The analogue chart recorder and various digital displays were used by the Operator to monitor data quality during a flight.

3.8 GENERAL QUALITY CONTROL

Rigorous in-field quality control was undertaken on-site and various QC products were produced in the field using a combination of Kevron proprietary software, ChrisDBF software and AGSO software. QC plots were produced for each flight and included:

- Flight path maps displaying cross track and height deviations.
- Magnetic 4^{th} difference noise plots
- Radiometric Summed spectra plots
- Diurnal plots

Lines selected at random from each flight were subjected to further QC checks. Profiles were generated for all variables recorded and inspected for data quality. Any lines found to be outside the specified tolerances were identified and reflown.

A running log of each flight was maintained recording details of all lines flown. Transcribed flight logs are included in ***APPENDIX 3***. Equipment tests and calibrations are described in Section 4 and tabulations of the calibration and test flight data are in ***APPENDIX 6.***

Field data were sent to Kevron's processing centre in Perth where they were further inspected for data quality and conformance to specifications before commencing processing.

3.10 SAFETY MANAGEMENT

All aircraft operations, including pilot flying hours and aircraft maintenance, complied with the requirements of the Federal Civil Aviation Safety Authority

(CASA) and the CASA-approved procedures set out in Kevron's Aircraft Operations Manual.

The ground support vehicle was equipped with adequate radio equipment to enable two-way communication with the aircraft and/or the RFDS. Search and Rescue times for vehicles in remote areas are a Company requirement.

4. CALIBRATIONS

4.1 MAGNETICS

Compensation coefficients for the AADC were established by flying a "compensation box" test (a series of pitch, roll and yaw manoeuvres in each of the four cardinal headings) before survey production commenced, and again after aircraft servicing where components were changed that may effect the magnetic field of the aircraft.

Compensation flights were flown in an area of low gradient approx. 35 nm SW of Tennant Creek at an altitude of 8000 to 10000 feet above mean sea level.

The AADC calculates basic statistics, which reflect the degree of merit of the compensation. These include the standard deviation of the recorded data without corrections applied, the standard deviation with the correction applied, the improvement ratio (the ratio of the standard deviation of the recorded data without and with corrections applied) and the vector norm (the degree of difficulty in calculating the corrections. The table below shows statistics recorded from compensation flights with the aircraft in survey configuration, ie Air conditioner on, Transponder off, DME off, HF on, ADF on, #1 COM on, #2 NAV/Com on .

Test Date	Aircraft	SDU	SDC	IR	VN
13th July 2000	KAV	.05593	.03976	14.1	29.6
SDU, SDC= Respectively, the standard deviation of uncompensated and compensated data; IR (Improvement Ratio) = SDU/SDC; VN = Vector Norm, measure of degree of difficulty in calculating coefficients.					

4.2 RADIOMETRICS

4.2.1.Background Correction Plots and Equations

The following procedure was used to determine the aircraft background radiation. There were no changes to the system between the date of this test and the survey.

a) A stack of nine lines were flown over water, west of the Perth coast, at altitudes from 1 000 ft to 9 000 ft. with increments of 1 000 feet.

b) The counts in the Potassium, Uranium, Thorium, Total Count and Cosmic channels were corrected for dead time and scaled to counts per second for all lines.

The measured 256 channel spectra are each the sum of the aircraft component (constant) and the cosmic component. The measured spectra are used to calculate the aircraft gamma energy spectrum and the normalised cosmic gamma energy spectrum.

Aircraft and Cosmic background spectra are estimated as follows:

$$N_i = a_i + b_i N_{cos}$$

Where:

N_i = aircraft + cosmic background count rate in the (*i*)th channel

N_{cos} = cosmic window count rate

a_i = aircraft background in the (*i*)th channel

b_i = cosmic background in the (*i*)th channel normalised top unit counts in the cosmic window.

A linear regression of the cosmic window count rate on any channel gives the cosmic sensitivity (slope of regression line) and aircraft background (zero intercept) for that channel.

The aircraft and cosmic background spectra are subtracted from the dead-time corrected and energy calibrated observed spectra, The conventional radiometric windows are extracted from the 256 channel data.

4.2.2 Pre and Post Flight Checks

Hand sample checks, using thorium, uranium and caesium-137 samples, were carried out before and after flights. A statistical summary of the checks is presented in ***APPENDIX 6***.

4.2.3 Test Line

A test line approximately 8 kilometres long was chosen at each Base of Operations. The start and end co-ordinates are as follows;

	Latitude (°S)	Longitude (°E)
DARWIN		
West End	12E40’ 07”	131E10’ 17”
East End	12E42’ 31”	131E10’ 22”
KATHERINE		
West End	14E22’ 43”	132E10’ 44”
East End	14E23’12 ”	132E12’ 31”

4.2.4 Compton Stripping Coefficients

The following Compton stripping coefficients, derived from calibrations over test pads in Perth were used to correct the count rates displayed on the analogue chart and in subsequent processing:

VH KAV	alpha (Tl-208 into Bi-214)	0.243
	beta (Tl-208 into K-40)	0.414
	gamma (Bi-214 into K-40)	0.739
	a	0.059

4.2.5 Spectrometer Countrate Sensitivities

Broad source sensitivities for each of the radio-element windows were obtained from a flight line flown at a height of 60 m over the Carnamah Test Range and a corresponding line on the ground surveyed with a calibrated hand-held spectrometer supplied by Tesla Geoscience. The Carnamah Test Range is located approximately 10 kilometres east of Carnamah, 200 kilometres north of Perth, on the Carnamah-Belvoir Road. The Test Range follows the power line south for eight kilometres crossing undulating wheat crops and rocky scrub covered hills.

The aircraft acquisition system was not changed between the date of the calibration flight and the survey dates. The following values were obtained:

VH KAV 2nd July, 2000

Element	Corrected mean countrate (cps)	Average ground concentration	Countrate sensitivity
Potassium	363.87	2.95 %K	123.16315 cps/%K
Uranium	53.09	4.75 ppm eU	11.16 cps/ppm eU
Thorium	217.86	34.69 ppm eTh	6.28 cps/ppm eTh
Total Count	5004.48	157.82 nG/h (nGh^{-1})	31.70872 cps/nGh

4.3 PARALLAX

The parallax error was established immediately after completion of the survey by flying over a suitable anomaly in opposite directions. The parallax for each aircraft system was resolved to following:

Magnetics 5 fiducials (all flights)

Radiometrics No parallax correction was applied to the radiometrics

5. DATA PROCESSING

5.1 DATA VERIFICATION AND EDITING

The field data were sent regularly to Kevron's processing centre in Perth for verification and editing with in-house software installed on Sun Sparc 20 workstations.

The data were loaded into a database and a statistical report generated for each variable on a line by line basis. The data were then edited for scrubbed or duplicate lines and checked for spikes, steps or high noise levels. Lines with any out-of-specification data were flagged for reflight.

5.2 FLIGHT PATH RECOVERY

The differentially corrected GPS data were converted to Universal Transverse Mercator coordinates using the Australian National Spheroid.

The survey area is in grid UTM Zone 52 with a central meridian of 132° East.

Flight path maps were generated to verify the off-line tolerances and to make sure all necessary data had been loaded into the geophysical data base.

5.3 MAGNETIC PROCESSING

After correcting the magnetic data for diurnal variations, the International Geomagnetic Reference Field (IGRF) was subtracted and the data were tie line levelled.

These processes are described more fully below.

5.3.1 Diurnal Correction

The diurnal data were edited to keep only those readings taken during flight time. The data were visually checked on the computer screen for spikes, noise and any apparent cultural magnetic events.

After editing, the data were low pass filtered using a twenty-term, spatial domain filter, which removed periods of less than thirty seconds. The data were again checked visually for integrity after the filtering process.

The filtered data were synchronised with the airborne data, interpolated and subtracted from the airborne data, one sample at a time. After subtraction, the mean diurnal value was added back to the airborne data for each line to produce diurnally corrected data.

5.3.2 Subtraction of the IGRF

The International Geomagnetic Reference Field (IGRF) was removed from the diurnally-corrected data by fitting a second order polynomial surface to thirteen coefficients computed from the IGRF model and then subtracting the IGRF values on a sample by sample basis.

The IGRF 1995 model updated to the survey date was used with the following values:

IGRF updated to	2000.67	
	Southern	Northern
Magnetic Declination	4.0454 °	3.7711 °
Magnetic Inclination	-43.265 °	-41.629 °
Total Field Strength	47055.26 nT	46341.61 nT

5.3.3 Tie Line Levelling

The diurnally corrected and IGRF-removed data were processed by a Kevron proprietary levelling program.

The program compares the magnetic differences at intersections of the flight lines and tie lines and calculates individual magnetic field biases for each flight line based on the tie line intersection. The miss-ties are minimised in a least-squares sense for all intersections. The biases are manually evaluated and selectively applied. Further reduction of the miss-ties can be removed by fitting a polynomial to produce levelled magnetic data.

The levelled data were then gridded on a 100 x 100 metre mesh using a minimum curvature algorithm based on Briggs (1974). The gridded data were displayed on an image processor to check data integrity and data levelling.

5.3.4 Micro Levelling

The data were microlevelled using Kevron in-house proprietary software. Kevron's micro-levelling process is line based rather than grid based. Pseudo lines are extracted perpendicular to the traverse line direction. These are low pass filtered and mis-tied to the traverse lines using the tie line levelling software.

The mis-tie values are bounded spatially by a series of polygons edited through ER Mapper.

5.4 RADIOMETRIC PROCESSING

5.4.1 System Deadtime and Energy Calibrations

Following correction for system deadtime, the 256 channel spectrometer data were energy calibrated using the following procedure:

For each line, the individual 256 channel data from each sample point were stacked to produce a single spectrum. The peak positions of the standard potassium and thorium windows were found by performing a gaussian fit to the spectral data for the energy range of each window after first removing the Compton continuum slope. If the measured peak positions were shifted by more than one channels for the thorium peak or 0.5 channels for the potassium peak, an energy recalibration was performed to obtain the correct spectral channel positions for the lower and upper bounds of each of the required windows. Using these corrected channel limits, new window counts were then extracted from the 256 channel data for each

1 second data sample on the line.

5.4.2 Maximum Noise Fraction (MNF)

Statistical noise reduction of the 256 channel data was performed using the Maximum Noise Fraction (MNF) method described by Dickson and Taylor (1998). This method constructs a noise covariance model from the survey data, which is then decorrelated and re-scaled so that the model has unit variance and no channel-to-channel correlation.

A principal component transformation of the noise-whitened data is performed, and the number of components to be saved is determined by ranking the eigenvectors by signal-to-noise ratio. The signal-rich components are retained, and the spectral data reconstructed without the noise fraction. Typically, 32-42 MNF components are retained during this process. Channels 30-250 only are noise-cleaned, as these contain the regions of interest and are not dominated by the lower end of the Compton continuum.

Radon removal		
Stripping		
Stripping Ratios:	alpha	0.243
	Beta	0.414
	Gamma	0.739
	A	0.059
Height Attenuation to 80m		
Height Attenuation coeffs:		
total cnt -		-0.0066
potassium -		-0.0084
uranium		-0.0076
thorium -		-0.0066
Conversion to sensitivities		
Sensitivity coefficients:		
	total cnt	31.80
	potassium	124.03
	uranium	11.16
	thorium	6.29

Data has been tie-levelled and micro-levelled to remove minor residual errors.

5.4.3 Aircraft and Cosmic Background Removal

Aircraft and cosmic background were removed from the data using the normalised 256 channel cosmic spectrum for the aircraft, and the aircraft 256 channel background spectrum. Cosmic & Aircraft background removal

Aircraft Background Coefficients	
Total Count	45.00
Potassium	8.93
Uranium	0.95
Thorium	1.00

Aircraft CosmicCoefficients	
Total Count	0.770
Potassium	0.042
Uranium	0.036
Thorium	0.043

5.4.4 Airborne radon removal

Data were corrected for airborne radon using Minty (1996 – Alt Method B) two component spectral ratio method

Calibration constants for Method B derived directly from observed radon and ground spectra at a height of 60m STP. $C_{1,}$ *and* $C_{2,}$ are the ratios between the 0.609 MeV peak count rate and the conventional U window count rate for a radon spectrum and a composite K, U and Th ground spectrum respectively.

Calibration Constants for Method B	
C1	1.944
C2	0.859

5.4.5 Effective Altitude Calculations and Compton Scattering Corrections

At this point, the conventional radiometric windows are extracted from the 256 channel data and all further gamma-ray corrections are performed using three-window radiometric data processing.

Following reduction of the altitude data to effective altitude at standard temperature and pressure as described in Grasty and Minty (1995), Compton scattering stripping was carried out on the background corrected count rates in the potassium, uranium and thorium channel data using the coefficients listed in Section 4.2.4.

5.4.6 Height attenuation corrections

A height attenuation factor was applied to reduce the data for each channel to a nominal datum of 80 m above ground level. The program used limits corrections to data at terrain clearances between 30m and 250m. Data recorded at terrain clearances outside these limits are corrected assuming they are at these limits.

The attenuation factors used are listed below and were determined from tests carried out over the Carnamah Test Range.

Total Count	Potassium	Uranium	Thorium
-0.006696	-0.009267	-0.004445	-0.007040

5.4.7 Conversion -Ground Element Concentrations

Data were converted to equivalent ground concentrations using the method described in Grasty and Minty (1995) using, for each window, the equation:

$$\mathbf{C_i = N_i / S_i}$$

where C_i = ground concentration of radio-element "i" (%K, ppm eU or ppm eTh);
N_i = corrected count rate for window "i"; and
S_i = broad source sensitivity for window "i" as tabled in Section 4.2.5.

5.4.8 Levelling

The corrected and reduced radiometric data were tie-line levelled and mirco-levelled using the procedure described above for the magnetic data.

5.5 DIGITAL ELEVATION MODEL

A digital elevation model (DEM) was computed by subtracting the terrain clearance measured by the radar altimeter from the GPS measured aircraft altitude to obtain a nominal ground elevation. The nominal ground elevation data were tie-line levelled and micro-levelled using the same technique described for the levelling of the magnetic data.

Allowance was made for the constant 3.9 m elevation difference between the radar altimeter and the GPS antenna.

A set of geoid-ellipsoid separation values were obtained from AUSLIG, gridded and values interpolated for each point along the survey lines. The interpolated separation values were subtracted from the nominal ground elevation to produce the final located DEM.

The DEM data were tie line levelled and micro-levelled using the procedure described above for the magnetic and radiometric data.

5.6 DELIVERABLE ITEMS

The following survey data items were produced and delivered:

1. Flight line plots and Location maps. ***(APPENDIX 1)***
2. GPS Base station location diagram. ***(APPENDIX 2)***
3. Flight index, flight logs and list of flight lines and tie lines **(*APPENDIX 3*)**
4. Production summaries week by week for each aircraft. **(*APPENDIX 4)***
5. Base Station Magnetometer plots ***(APPENDIX 5)***
6. Tabulations of calibration and test flight data **(*APPENDIX 6*)**
7. Background and Attenuation plots for the mobilised aircraft.***(APPENDIX 7)***
8. Located digital records in the specified format **(*APPENDIX 8*)**
9. Equipment Technical Specifications **(*APPENDIX 9*)**
10. Height difference crossovers **(APPENDIX 10)**

5.7 FINAL PRODUCTS

The following map products were produced at a scale of 1:250,000 for the entire area. All maps were produced using a combination of Kevron's proprietary software and ER Mapper.

Preliminary maps, images and grids were produced for assessment of data quality.

(a) Hardcopy located images at 1:250 000 scale of;

(i) colour gradient enhanced total magnetic intensity and,
(ii) colour gradient enhanced total magnetic intensity RTP
(iii) greyscale first vertical derivative of RTP TMI and,
(iv) colour gradient enhanced total-count and,
(v) colour gradient enhanced potassium and,
(vi) colour gradient enhanced uranium and,
(vii) colour gradient enhanced thorium and,
(viii) ternary gamma-ray spectrometrics and,
(ix) colour gradient enhanced digital elevation model.

(c) DGN files were supplied for the following;

(i) Flight Path
(ii) Total magnetic intensity colour contours,
(iii) Total-count colour contours,
(iv) Potassium colour contours,
(v) Uranium colour contours
(vi) Thorium colour contours

(vii) Magnetic Stacked Profiles

(d) Mosaic hard copy maps were supplied at a scale of 1:250,000 for the following:

(i) Flight Path
(ii) TMI colour contours
(iii) TC colour contours
(iv) Potassium colour contours
(v) Uranium colour contours
(vi) Thorium colour contours
(vii) Magetic stacked profiles

REFERENCES

Briggs, I.C., 1974. Machine Contouring Using Minimum Curvature. Geophysics, v.39: p. 39 - 48.

Grasty, R.L., Wilkes, P.G.; and Kooyman, R., 1988. Background Measurements in Gamma-ray Surveys. Geological Survey of Canada Paper 88-11.

R.L. Grasty and B.R.S Minty, 1995: A Guide To The Technical Specifications For a Airborne Gamma-Ray Survey. AGSO Record 1995/60.

Hovgaard, J., (1997). A new processing technique for airborne gamma-ray spectrometer data (Noise Adjusted Singular Value Decomposition). Danish Emergency Management Agency.

Hovgaard, J. and Grasty, R.L, (1997). Reducing noise in airborne gamma-ray data through spectral component analysis. Exploration 97, Ontario Geological Survey.

Minty, B.R.S., 1996. The analysis of multichannel airborne gamma-ray spectra. PhD Thesis, Australian National University.

APPENDIX 1 – SURVEY AREAS AND FLIGHT PATH PLOTS

APPENDIX 2 – GPS BASE STATION LOCATION

APPENDIX 3 – OPERATORS FLIGHT REPORTS

(Note: Flights 1 through 14 were void.)

APPENDIX 4 – WEEKLY PRODUCTION SUMMARIES

(Note: Flights 1 through 14 were void.)

APPENDIX 5 – BASE STATION MAGNETOMETER PLOTS

(Note: Flights 1 through 14 were void.)

APPENDIX 6 – RADIOMETRIC CALIBRATIONS

(Note: Flights 1 through 14 were void.)

APPENDIX 7 – RADIOMETRIC BACKGROUND PLOTS

(Note: Flights 1 through 14 were void.)

APPENDIX 8 – LOCATED DATA TAPE FORMATS

```
DEFN   ST=RECD,RT=COMM;RT:A4;COMMENTS:A76
DEFN 1 ST=RECD,RT=;LINE:A8:NULL=-999999,NAME=Line number
DEFN 2 ST=RECD,RT=;FLIGHT:I4:NULL=-99,NAME=Flight number
DEFN 3 ST=RECD,RT=;DATE:A9:NULL=-9999999,NAME=Date (YYYYMMDD)
DEFN 4 ST=RECD,RT=;TIME:F9.5:NULL=-9.99999,UNIT=hours,NAME=Time (CST)
DEFN 5 ST=RECD,RT=;FIDUCIAL:F10.0:NULL=-9999999.,NAME=Fiducial
DEFN 6 ST=RECD,RT=;LATITUDE:F11.6:NULL=-99.999999,UNIT=dega,NAME=Latitude
DEFN 7 ST=RECD,RT=;LONGITUD:F11.6:NULL=-99.999999,UNIT=dega,NAME=Longitude
DEFN 8 ST=RECD,RT=;ZONE:I3:NULL=-9,NAME=Zone
DEFN 9 ST=RECD,RT=;EAST:F11.2:NULL=-999999.99,UNIT=metres,NAME=MGA Easting
DEFN 10 ST=RECD,RT=;NORTH:F11.2:NULL=-999999.99,UNIT=metres,NAME=MGA Northing
DEFN 11 ST=RECD,RT=;RAW_TC:F7.0:NULL=-9999.,UNIT=cps,NAME=Raw total count
DEFN 12 ST=RECD,RT=;RAW_K:F5.0:NULL=-99.,UNIT=cps,NAME=Raw potassium
DEFN 13 ST=RECD,RT=;RAW_U:F5.0:NULL=-99.,UNIT=cps,NAME=Raw uranium
DEFN 14 ST=RECD,RT=;RAW_TH:F5.0:NULL=-99.,UNIT=cps,NAME=Raw thorium
DEFN 15 ST=RECD,RT=;COSMIC:F5.0:NULL=-99.,UNIT=cps,NAME=Cosmic
DEFN 16 ST=RECD,RT=;TC:F9.2:NULL=-9999.99,UNIT=nGy/h,NAME=Total count
DEFN 17 ST=RECD,RT=;K:F9.2:NULL=-9999.99,UNIT=%,NAME=Potassium
DEFN 18 ST=RECD,RT=;U:F9.2:NULL=-9999.99,UNIT=ppm,NAME=Uranium
DEFN 19 ST=RECD,RT=;TH:F9.2:NULL=-9999.99,UNIT=ppm,NAME=Thorium
DEFN 20 ST=RECD,RT=;LIVETIME:F6.0:NULL=-999.,UNIT=ms,NAME=Live time
DEFN 21 ST=RECD,RT=;PRESS:F7.1:NULL=-999.9,UNIT=hPa,NAME=Pressure
DEFN 22 ST=RECD,RT=;TEMP:F5.1:NULL=-9.9,UNIT=degrees C,NAME=Temperature
DEFN 23 ST=RECD,RT=;HUMID:F5.1:NULL=-9.9,UNIT=%,NAME=Humidity
DEFN 24 ST=RECD,RT=;RADALT:F7.1:NULL=-999.9,UNIT=metres,NAME=Radar altitude
DEFN 25 ST=RECD,RT=;BAROALT:F7.1:NULL=-999.9,UNIT=metres,NAME=Barometric altitude
DEFN 26 ST=RECD,RT=;GPSALT:F7.1:NULL=-999.9,UNIT=metres,NAME=GPS altitude;END DEFN
```

```
COMM LOCATED DATA FORMAT:
COMM
COMM From To    Null     Variable                          Format
COMM   1  8    -999999 * Line number .........................  I8
COMM   9  4        -99 * Flight number .......................  I4
COMM  13  9   -9999999 * Date (YYYYMMDD)......................  I9
COMM  22  9   -9.99999 * Time (local CST hrs).................  F9.5
COMM  31 10   -9999999 * Kevron Fiducial number ..............  I10
COMM  41 11 -99.999999 * Latitude (dega)......................  F11.6
COMM  52 11 -99.999999 * Longitude (dega).....................  F11.6
COMM  63  3         -9  * MGA Zone ...........................  I3
COMM  66 11 -999999.99 * MGA Easting (m)......................  F11.2
COMM  77 11 -999999.99 * MGA Northing (m).....................  F11.2
COMM  88  7     -9999.  * Raw total count (cps)................  F7.0
COMM  95  5       -99.  * Raw potassium count (cps)............  F5.0
COMM 100  5       -99.  * Raw uranium count (cps)..............  F5.0
COMM 105  5       -99.  * Raw thorium count (cps)..............  F5.0
COMM 110  5       -99.  * Raw cosmic count (cps)...............  F5.0
COMM 115  9   -9999.99 * Estimated Dose Rate (nG/hr)..........  F9.2
COMM 124  9   -9999.99 * Eq. ground conc. (percent K) ........  F9.2
COMM 133  9   -9999.99 * Eq. ground conc. (eppm U) ...........  F9.2
COMM 142  9   -9999.99 * Eq. ground conc. (eppm Th) ..........  F9.2
COMM 151  6    -999     * Live Time (millisec).................  I6
COMM 157  7    -999.9  * Barometric pressure (hPa)............  F7.1
COMM 164  5      -9.9  * Temperature (degC)...................  F5.1
```

COMM 169 5 -9.9 * Humidity (percent)................... F5.1
COMM 174 7 -999.9 * Altitude (radar altimeter) F7.1
COMM 181 7 -999.9 * Baro height (m)...................... F7.1
COMM 188 7 -999.9 * GPS height (m)....................... F7.1
COMM 195 5 -999 * Spec Channel 1...................... F6.0
COMM 200 5 -999 * Spec Channel 2...................... F6.0
COMM 205 5 -999 * Spec Channel 3...................... F6.0
COMM 210 5 -999 * Spec Channel 4...................... F6.0
COMM 215 5 -999 * Spec Channel 5...................... F6.0
COMM 220 5 -999 * Spec Channel 6...................... F6.0
COMM 225 5 -999 * Spec Channel 7...................... F6.0
COMM 230 5 -999 * Spec Channel 8...................... F6.0
COMM 235 5 -999 * Spec Channel 9...................... F6.0
COMM 240 5 -999 * Spec Channel 10...................... F6.0
COMM 245 5 -999 * Spec Channel 11...................... F6.0
COMM 250 5 -999 * Spec Channel 12...................... F6.0
COMM 255 5 -999 * Spec Channel 13...................... F6.0
COMM 260 5 -999 * Spec Channel 14...................... F6.0
COMM 265 5 -999 * Spec Channel 15...................... F6.0
COMM 270 5 -999 * Spec Channel 16...................... F6.0
COMM 275 5 -999 * Spec Channel 17...................... F6.0
COMM 280 5 -999 * Spec Channel 18...................... F6.0
COMM 285 5 -999 * Spec Channel 19...................... F6.0
COMM 290 5 -999 * Spec Channel 20...................... F6.0
COMM 295 5 -999 * Spec Channel 21...................... F6.0
COMM 300 5 -999 * Spec Channel 22...................... F6.0
COMM 305 5 -999 * Spec Channel 23...................... F6.0
COMM 310 5 -999 * Spec Channel 24...................... F6.0
COMM 315 5 -999 * Spec Channel 25...................... F6.0
COMM 320 5 -999 * Spec Channel 26...................... F6.0
COMM 325 5 -999 * Spec Channel 27...................... F6.0
COMM 330 5 -999 * Spec Channel 28...................... F6.0
COMM 335 5 -999 * Spec Channel 29...................... F6.0
COMM 340 5 -999 * Spec Channel 30...................... F6.0
COMM 345 5 -999 * Spec Channel 31...................... F6.0
COMM 350 5 -999 * Spec Channel 32...................... F6.0
COMM 355 5 -999 * Spec Channel 33...................... F6.0
COMM 360 5 -999 * Spec Channel 34...................... F6.0
COMM 365 5 -999 * Spec Channel 35...................... F6.0
COMM 370 5 -999 * Spec Channel 36...................... F6.0
COMM 375 5 -999 * Spec Channel 37...................... F6.0
COMM 380 5 -999 * Spec Channel 38...................... F6.0
COMM 385 5 -999 * Spec Channel 39...................... F6.0
COMM 390 5 -999 * Spec Channel 40...................... F6.0
COMM 395 5 -999 * Spec Channel 41...................... F6.0
COMM 400 5 -999 * Spec Channel 42...................... F6.0
COMM 405 5 -999 * Spec Channel 43...................... F6.0
COMM 410 5 -999 * Spec Channel 44...................... F6.0
COMM 415 5 -999 * Spec Channel 45...................... F6.0
COMM 420 5 -999 * Spec Channel 46...................... F6.0
COMM 425 5 -999 * Spec Channel 47...................... F6.0
COMM 430 5 -999 * Spec Channel 48...................... F6.0
COMM 435 5 -999 * Spec Channel 49...................... F6.0
COMM 440 5 -999 * Spec Channel 50...................... F6.0
COMM 445 5 -999 * Spec Channel 51...................... F6.0
COMM 450 5 -999 * Spec Channel 52...................... F6.0
COMM 455 5 -999 * Spec Channel 53...................... F6.0
COMM 460 5 -999 * Spec Channel 54...................... F6.0
COMM 465 5 -999 * Spec Channel 55...................... F6.0
COMM 470 5 -999 * Spec Channel 56...................... F6.0

COMM 475 5 -999 * Spec Channel 57...................... F6.0
COMM 480 5 -999 * Spec Channel 58...................... F6.0
COMM 485 5 -999 * Spec Channel 59...................... F6.0
COMM 490 5 -999 * Spec Channel 60...................... F6.0
COMM 495 5 -999 * Spec Channel 61...................... F6.0
COMM 500 5 -999 * Spec Channel 62...................... F6.0
COMM 505 5 -999 * Spec Channel 63...................... F6.0
COMM 510 5 -999 * Spec Channel 64...................... F6.0
COMM 515 5 -999 * Spec Channel 65...................... F6.0
COMM 520 5 -999 * Spec Channel 66...................... F6.0
COMM 525 5 -999 * Spec Channel 67...................... F6.0
COMM 530 5 -999 * Spec Channel 68...................... F6.0
COMM 535 5 -999 * Spec Channel 69...................... F6.0
COMM 540 5 -999 * Spec Channel 70...................... F6.0
COMM 545 5 -999 * Spec Channel 71...................... F6.0
COMM 550 5 -999 * Spec Channel 72...................... F6.0
COMM 555 5 -999 * Spec Channel 73...................... F6.0
COMM 560 5 -999 * Spec Channel 74...................... F6.0
COMM 565 5 -999 * Spec Channel 75...................... F6.0
COMM 570 5 -999 * Spec Channel 76...................... F6.0
COMM 575 5 -999 * Spec Channel 77...................... F6.0
COMM 580 5 -999 * Spec Channel 78...................... F6.0
COMM 585 5 -999 * Spec Channel 79...................... F6.0
COMM 590 5 -999 * Spec Channel 80...................... F6.0
COMM 595 5 -999 * Spec Channel 81...................... F6.0
COMM 600 5 -999 * Spec Channel 82...................... F6.0
COMM 605 5 -999 * Spec Channel 83...................... F6.0
COMM 610 5 -999 * Spec Channel 84...................... F6.0
COMM 615 5 -999 * Spec Channel 85...................... F6.0
COMM 620 5 -999 * Spec Channel 86...................... F6.0
COMM 625 5 -999 * Spec Channel 87...................... F6.0
COMM 630 5 -999 * Spec Channel 88...................... F6.0
COMM 635 5 -999 * Spec Channel 89...................... F6.0
COMM 640 5 -999 * Spec Channel 90...................... F6.0
COMM 645 5 -999 * Spec Channel 91...................... F6.0
COMM 650 5 -999 * Spec Channel 92...................... F6.0
COMM 655 5 -999 * Spec Channel 93...................... F6.0
COMM 660 5 -999 * Spec Channel 94...................... F6.0
COMM 665 5 -999 * Spec Channel 95...................... F6.0
COMM 670 5 -999 * Spec Channel 96...................... F6.0
COMM 675 5 -999 * Spec Channel 97...................... F6.0
COMM 680 5 -999 * Spec Channel 98...................... F6.0
COMM 685 5 -999 * Spec Channel 99...................... F6.0
COMM 690 5 -999 * Spec Channel 100...................... F6.0
COMM 695 5 -999 * Spec Channel 101...................... F6.0
COMM 700 5 -999 * Spec Channel 102...................... F6.0
COMM 705 5 -999 * Spec Channel 103...................... F6.0
COMM 710 5 -999 * Spec Channel 104...................... F6.0
COMM 715 5 -999 * Spec Channel 105...................... F6.0
COMM 720 5 -999 * Spec Channel 106...................... F6.0
COMM 725 5 -999 * Spec Channel 107...................... F6.0
COMM 730 5 -999 * Spec Channel 108...................... F6.0
COMM 735 5 -999 * Spec Channel 109...................... F6.0
COMM 740 5 -999 * Spec Channel 110...................... F6.0
COMM 745 5 -999 * Spec Channel 111...................... F6.0
COMM 750 5 -999 * Spec Channel 112...................... F6.0
COMM 755 5 -999 * Spec Channel 113...................... F6.0
COMM 760 5 -999 * Spec Channel 114...................... F6.0
COMM 765 5 -999 * Spec Channel 115...................... F6.0
COMM 770 5 -999 * Spec Channel 116...................... F6.0

COMM 775 5 -999 * Spec Channel 117...................... F6.0
COMM 780 5 -999 * Spec Channel 118...................... F6.0
COMM 785 5 -999 * Spec Channel 119...................... F6.0
COMM 790 5 -999 * Spec Channel 120...................... F6.0
COMM 795 5 -999 * Spec Channel 121...................... F6.0
COMM 800 5 -999 * Spec Channel 122...................... F6.0
COMM 805 5 -999 * Spec Channel 123...................... F6.0
COMM 810 5 -999 * Spec Channel 124...................... F6.0
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COMM 820 5 -999 * Spec Channel 126...................... F6.0
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COMM 875 5 -999 * Spec Channel 137...................... F6.0
COMM 880 5 -999 * Spec Channel 138...................... F6.0
COMM 885 5 -999 * Spec Channel 139...................... F6.0
COMM 890 5 -999 * Spec Channel 140...................... F6.0
COMM 895 5 -999 * Spec Channel 141...................... F6.0
COMM 900 5 -999 * Spec Channel 142...................... F6.0
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COMM 910 5 -999 * Spec Channel 144...................... F6.0
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COMM 985 5 -999 * Spec Channel 159...................... F6.0
COMM 990 5 -999 * Spec Channel 160...................... F6.0
COMM 995 5 -999 * Spec Channel 161...................... F6.0
COMM 1000 5 -999 * Spec Channel 162...................... F6.0
COMM 1005 5 -999 * Spec Channel 163...................... F6.0
COMM 1010 5 -999 * Spec Channel 164...................... F6.0
COMM 1015 5 -999 * Spec Channel 165...................... F6.0
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COMM 1145 5 -999 * Spec Channel 191...................... F6.0
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COMM 1190 5 -999 * Spec Channel 200...................... F6.0
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COMM 1290 5 -999 * Spec Channel 220...................... F6.0
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COMM 1300 5 -999 * Spec Channel 222...................... F6.0
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COMM 1325 5 -999 * Spec Channel 227...................... F6.0
COMM 1330 5 -999 * Spec Channel 228...................... F6.0
COMM 1335 5 -999 * Spec Channel 229...................... F6.0
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COMM 1345 5 -999 * Spec Channel 231...................... F6.0
COMM 1350 5 -999 * Spec Channel 232...................... F6.0
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COMM 1365 5 -999 * Spec Channel 235...................... F6.0
COMM 1370 5 -999 * Spec Channel 236...................... F6.0

COMM 1375 5 -999 * Spec Channel 237...................... F6.0
COMM 1380 5 -999 * Spec Channel 238...................... F6.0
COMM 1385 5 -999 * Spec Channel 239...................... F6.0
COMM 1390 5 -999 * Spec Channel 240...................... F6.0
COMM 1395 5 -999 * Spec Channel 241...................... F6.0
COMM 1400 5 -999 * Spec Channel 242...................... F6.0
COMM 1405 5 -999 * Spec Channel 243...................... F6.0
COMM 1410 5 -999 * Spec Channel 244...................... F6.0
COMM 1415 5 -999 * Spec Channel 245...................... F6.0
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COMM 1425 5 -999 * Spec Channel 247...................... F6.0
COMM 1430 5 -999 * Spec Channel 248...................... F6.0
COMM 1435 5 -999 * Spec Channel 249...................... F6.0
COMM 1440 5 -999 * Spec Channel 250...................... F6.0
COMM 1445 5 -999 * Spec Channel 251...................... F6.0
COMM 1450 5 -999 * Spec Channel 252...................... F6.0
COMM 1455 5 -999 * Spec Channel 253...................... F6.0
COMM 1460 5 -999 * Spec Channel 254...................... F6.0
COMM 1465 5 -999 * Spec Channel 255...................... F6.0
COMM 1470 5 -999 * Spec Channel 256...................... F6.0
COMM 1475 char/record

APPENDIX 9 – EQUIPMENT TECHNICAL SPECIFICATIONS

SURVEY EQUIPMENT:

Aircraft:	Rockwell Aerocommander 500S VH-KAV
Magnetometer:	Geometrics G-822A Cesium Vapour
Magnetometer Resolution (nT):	0.001
Magnetometer Compensation:	RMS AADCII operating in real time
Magnetometer Sample Rate (s):	0.1
Magnetometer Sample Interval (m):	approx 7.0 metres
Base Station Magnetometer:	Geometrics G856
Base Station Magnetometer Resolution (nT):	.1
Base Station Magnetometer Sample Rate (s):	5
Base Station Magnetometer Location(s):	Darwin Airport
Spectrometer:	Exploranium GR-820
Crystal volume:	32 litres
Spectrometer Sample Rate (s):	1.0
Spectrometer Sample Interval (m):	approx 70.0 metres
Data Acquisition System:	RMS DAS8
Flight Path Navigation System:	GPS
Navigation Equipment:	Fugro Omnistar and Ashtech G12 GPS
Radar Altimeter:	Sperry AA200

APPENDIX 10 – HEIGHT DIFFERENCE CROSS-OVERS

Supplied digitally as floppy – xover_north & xover_south