OPERATIONS REPORT

ST GEORGE, QLD
AREAS A, B & C
AIRBORNE MAGNETIC, RADIOMETRIC AND ELEVATION SURVEY

TESLA GEOPHYSICS

SEPTEMBER 2001

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1. INTRODUCTION

This report provides details of the St George airborne magnetic, radiometric and elevation survey, carried out in southern Queensland. The survey consists of three adjacent areas, named North St George, Central St George and South St George, Areas A, B & C, respectively. The survey was flown for the Commonwealth of Australia, represented by the Bureau of Rural Sciences (BRS), an agency within Agriculture, Fisheries and Forestry, Australia, and was undertaken by Tesla Airborne Geoscience Pty Ltd.

2. SURVEY DETAILS

2.1 Project Identification

Area Name:	St George
Contractor:	Tesla Airborne Geoscience Pty Ltd
Tesla Job No.:	TA2756

2.2 Survey Location

The survey location is shown in Figures 1 & 2.

Survey boundary coordinates are:

Area A (100m lines)		**Area B (400m lines)**		**Area C (100m lines)**	
-27.864°	148.345°	-28.269°	147.916°	-28.391°	147.787°
-27.643°	148.580°	-27.864°	148.345°	-28.269°	147.916°
-27.861°	148.803°	-28.394°	148.900°	-28.764°	148.465°
-27.909°	148.760°	-28.764°	148.465°	-28.887°	148.322°
-28.364°	149.237°				
-28.425°	149.179°				
-28.282°	149.031°				
-28.394°	149.900°				

(GDA94)

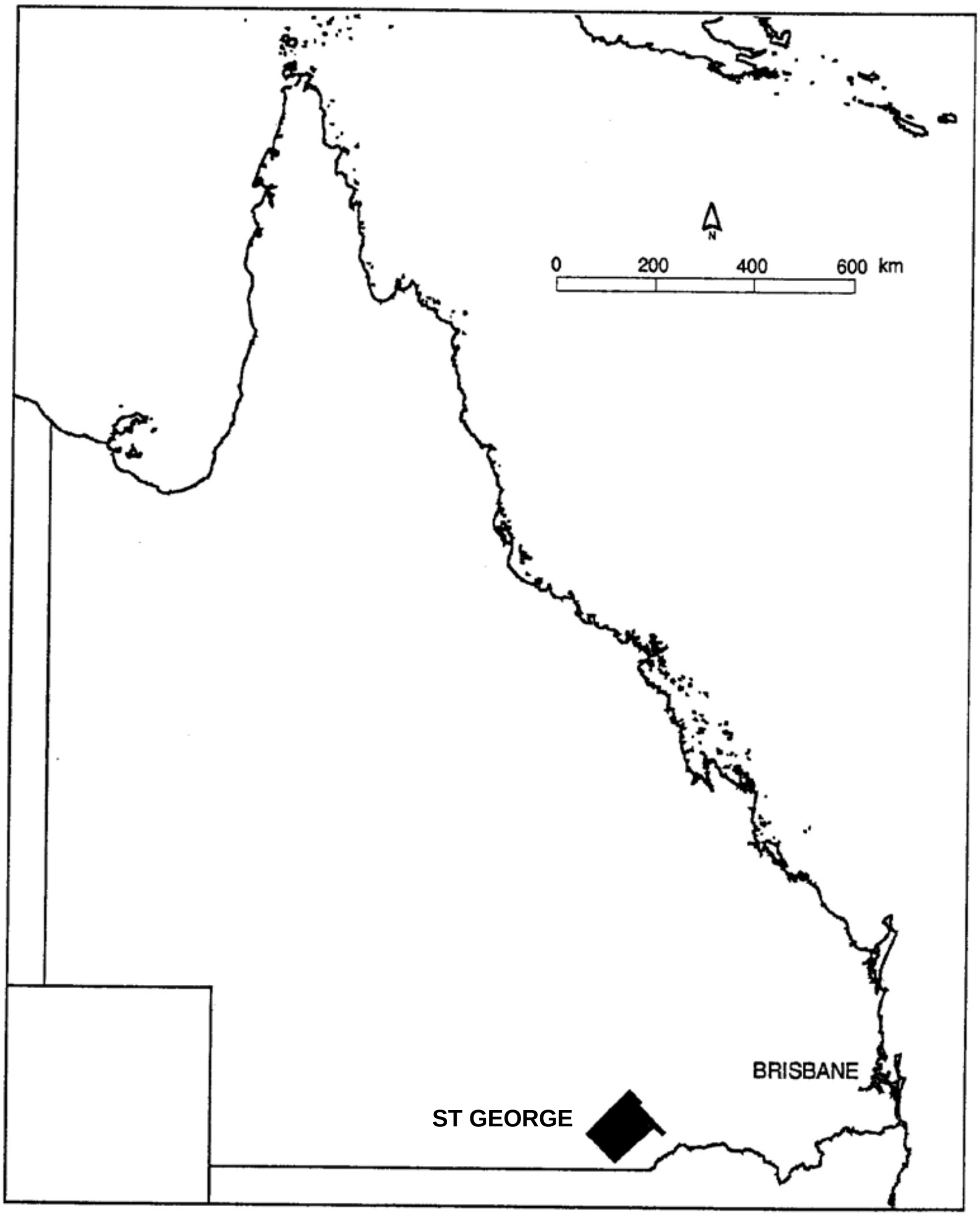


FIGURE 1 – SURVEY LOCATION

ST GEORGE, QLD

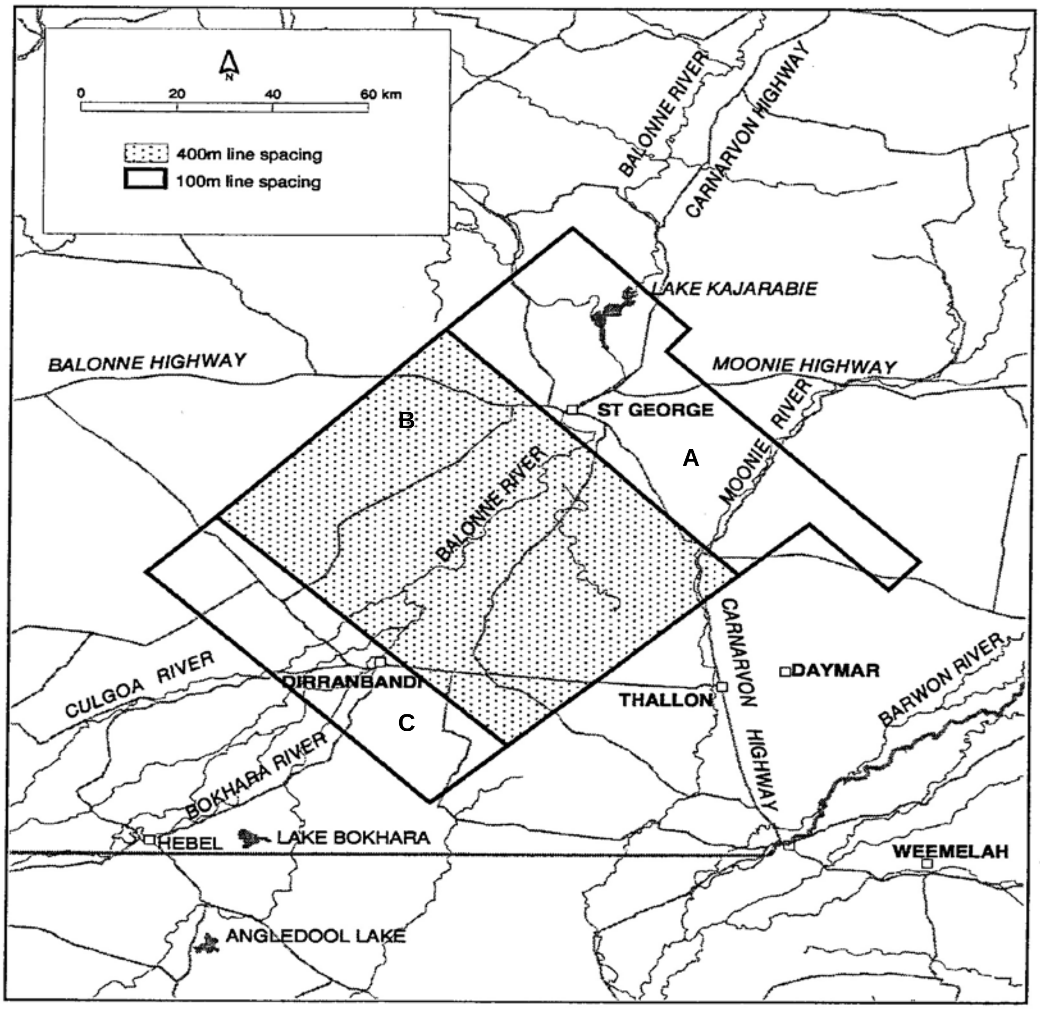


FIGURE 2 – ST GEORGE SURVEY

AREAS A, B & C

2.3 Specifications and Tolerances

AREA A (100m interline) – VH-BNZ:

Approx. line kilometres (including ties)	30,202
Traverse direction	137°-317° True
Traverse spacing	100 m
Number of traverses	345
Tie-line direction	43°-223° True
Tie-line spacing	1,000 m
Number of tie lines	103
Survey height	60m

AREA B (400m interline) – VH-MOK:

Approx. line kilometres (including ties)	13,895
Traverse direction	137°-317° True
Traverse spacing	400 m
Number of traverses	156
Tie-line direction	43°-223° True
Tie-line spacing	4,000 m
Number of tie lines	20
Survey height	60m

AREA C (100m interline) – VH-MOK:

Approx. line kilometres (including ties)	16,509
Traverse direction	137°-317° True
Traverse spacing	100 m
Number of traverses	209
Tie-line direction	43°-223° True
Tie-line spacing	1,000 m
Number of tie lines	77
Survey height	60m

Sample Intervals:

Magnetics (aircraft)	10Hz (approx. 7m)
Radiometrics	1Hz (approx. 70m)
GPS positions	1Hz
Radar altimeter	10Hz
Temperature, pressure & humidity	1Hz
Magnetics (base stations)	5 s
Crystal size	33.6Lt

Contracted tolerances:

Position accuracy	10m absolute; 5m relative
Radar altimeter accuracy	0.3m
Temperature accuracy	1°C
Pressure accuracy	0.1%

Magnetic base stations:	
Noise envelope	0.2nT
Variation	5nT in 5 minutes and less than 1nT from any chord 1 minute long across the diurnal record
Aircraft magnetometer:	
Non-geological noise envelope	0.1nT
Variation with heading	25%
Terrain clearance envelope	50 to 70m
Ground moisture	15% variation in corrected TC

3. PROJECT PERSONNEL

PROJECT SUPERVISION	Rod Pullin – Tesla Geophysics: data acquisition Lisa Nix – Tesla Geophysics: data processing Murray Richardson – AGSO Ross Brodie – AGSO
SURVEY PILOTS	Ken Alonso Hans McKay Dan Pitic Justin Walker
SURVEY OPERATORS	Rob Sharp (Crew Leader VH-BNZ) Matt Owen Tom Jenkins (Crew Leader VH-MOK) Marc Fernandes
DATA PROCESSING	Lisa Nix Michelle Kounnas

4. ACQUISITION

4.1 Aircraft and Equipment

4.1.1 VH-BNZ

Model	Cessna 210N
Acquisition System	
Model	Tesla TAG3
Serial Number	2-0007
Software Version	6.164-4
Total Field Magnetometer	
Tail Stinger	Geometrics G822, serial 75183
Sensitivity	0.001 nT

Vector Magnetometer

Model	Billingsley TFM100-1E
Serial Number	161

Compensator

Model	RMS Instruments Automatic Aeromagnetic Digital Compensator (AADCII)
Serial Number	9706811

Gamma-ray Spectrometer

Model	Exploranium GR820
Serial Number	8270

Crystals

Detectors	Eight all-viewing NaI crystals Total volume: 33.6 litres
Serial Numbers	2536, 2537

Radar Altimeter

Model	Collins Alt-55B

Humidity and Temperature Transmitter

Model	Vaisala HMD 50Y

Barometer

Model	Intellisensor AIR-DB
Serial Number	0458

GPS Receiver

Model	Marconi
Real-time Corrections	Fugro Surveys OmniSTAR link
Fugro Serial Number	353743

4.1.2 VH-MOK

Model	Cessna 210R

Acquisition System

Model	Tesla TAG3
Serial Number	2-0001
Software Version	3.710

Total Field Magnetometer

Tail Stinger	Scintrex CS2, serial 9301100
Sensitivity	0.001 nT

Vector Magnetometer

Model	Billingsley TFM100-1E
Serial Number	161

Compensator

Model	RMS Instruments Automatic Aeromagnetic Digital Compensator (AADCII)
Serial Number	9409661

Gamma-ray Spectrometer

Model	Exploranium GR820
Serial Number	8275

Crystals

Detectors	Eight all-viewing NaI crystals Total volume: 33.6 litres
Serial Numbers	2556, 2557

Radar Altimeter

Model	Collins Alt-55B

Humidity and Temperature Transmitter

Model	Vaisala HMD 50Y
Serial Number	P0250019

Barometer

Model	Vaisala PTB 200A
Serial Number	S2920020

GPS Receiver

Model	Novatel 951R
Real-time Corrections	Fugro Surveys OmniSTAR link
Fugro Serial Number	43106

4.1.3 Base Stations

GPS Receiver

Model	Marconi
Location	See Appendix A

The acquired WGS84 GPS positions (latitude, longitude and altitude) were differentially post-processed in the field. Final coordinates reference GDA94, MGA Zone 55.

Magnetometers

Master Base Station:

Model	Base A: Geometrics G822A Cesium Vapour Serial No. 75114

Auxillary Base Stations:

Models	Base B: Scintrex Envimag Serial No. 9411107 Base C: Scintrex Envimag Serial No. 9607266 Base D: Scintrex Envimag Serial No. 9403058 Base E: Scintrex Envimag Serial No. 9607263
Locations	See Appendix A

4.2 Survey Operations

A summary of the acquisition phase is given in Table 1. Full operations reports for both aircraft are provided in Appendix B. The survey flight logs are provided as Appendix I.

Date	Aircraft	Base	Comment
April 22, 2001	VH-BNZ	St George, Qld	Acquisition Commenced
April 23, 2001	VH-MOK	St George, Qld	Acquisition Commenced
May 15, 2001	VH-BNZ	St George, Qld	Last Day of Acquisition
May 16, 2001	VH- MOK	St George, Qld	Last Day of Acquisition

TABLE 1 - OPERATIONS SUMMARY

4.3 Recorded Parameters

All acquired data are recorded digitally.

The following parameters are recorded at 10 Hz:

Parameter	*Resolution*	*units*
Local time	0.1	s
Fiducial number (time after midnight, local)	1.0	unit
Terrain clearance (radar altimeter)	0.01	m
Uncompensated Total Magnetic Intensity (TMI)	0.001	nT
Fluxgates X, Y & Z	0.01	nT
Fluxgate Total Field	0.01	nT
Uncompensated TMI 4th difference	0.001	nT
Compensated TMI	0.001	nT

The following parameters are recorded at 1 Hz:

Parameter	*Resolution*	*units*
GPS time	1.0	s
Latitude	0.0000001	°
Longitude	0.0000001	°
GPS height	0.01	m
Outside air temperature	1.0	°C
Barometric pressure	0.01	hPa
Barometric altitude	0.01	m
Relative humidity	0.001	%
Full 256-channel gamma-ray spectrum	1.0	cps
Spectrometer livetime	0.001	s
Resolution	0.1	%
Number of satellites	1.0	
Position dilution of precision (PDOP)	0.1	
HDOP	0.1	

4.4 Calibrations and System Checks

4.4.1 Radiometric Calibrations

Pre-survey radiometric calibration results are summarised in Table 2. These tests were conducted respectively for each aircraft, by flying over ocean tests offshore from Bunbury, Western Australia, the dynamic test range at Carnamah, WA, and taking pad tests at Jandakot Airport, WA during late September and early October in 2000.

		VH-MOK	VH-BNZ
Aircraft Background	TC	59.30	70.90
	K	15.56	17.50
	U	0.93	0.13
	Th	0.55	0.95
Cosmic Background	TC	0.951	0.880
	K	0.055	0.054
	U	0.043	0.041
	Th	0.047	0.044
Height Attenuation	TC	0.0072	0.0068
	K	0.0095	0.0091
	U	0.0073	0.0075
	Th	0.0074	0.0068
Stripping	α	0.2668	0.2555
	β	0.4144	0.4123
	γ	0.8305	0.8250
	a	0.0416	0.0438
	b	0.0000	0.0000
	c	0.0000	0.0000
Air/Ground	Dose	25.86	28.26
	K	84.47	98.54
	U	9.62	10.63
	Th	5.33	5.69

TABLE 2 – COEFFICIENTS SUMMARY

4.4.2 Magnetic Compensation

Magnetic compensation sequences were flown before acquisition commenced and after routine maintenance was performed, as required. The resulting coefficients were used for real-time magnetic compensation:

VH-MOK

COMPENSATION 1 April 23, 2001 (Pre-survey, Flt 101)		COMPENSATION 2 May 5, 2001 (Post Maintenance, Flt 123)	
UNC	0.5427	UNC	0.6880
CMP	0.02497	CMP	0.02644
IR	21.7	IR	26
NRM	32.8	NRM	31.8

Graphs of the uncompensated and resulting compensated magnetics for VH-MOK are shown in Figures 3 and 4.

VH-BNZ

COMPENSATION 1 April 22, 2001 (Pre-survey, Flt 001)		COMPENSATION 2 May 4, 2001 (Post Maintenance, Flt 024)
UNC	1.044	Only a check box was flown, of which results showed that no further compensation sequence was required.
CMP	0.03631	
IR	28.7	
NRM	44.2	

Graphs of the uncompensated and resulting compensated magnetics for VH-BNZ are shown in Figures 5 and 6.

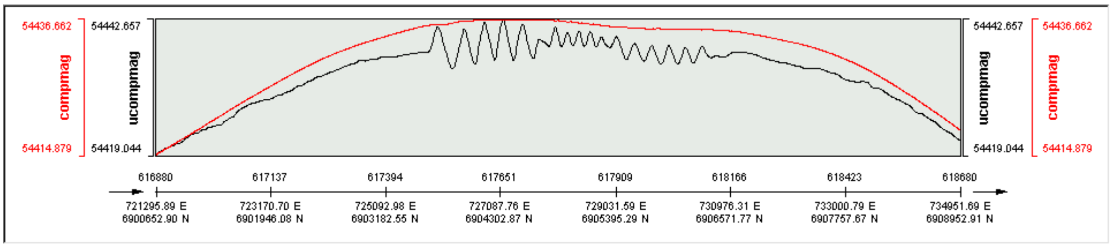
UNC: Standard deviation of uncompensated TMI (nT)
CMP: Standard deviation of compensated TMI (nT)
IR: Improvement ratio (UNC/CMP)
NRM: Vector norm of the interference terms set

4.4.3 Low-level Test Lines

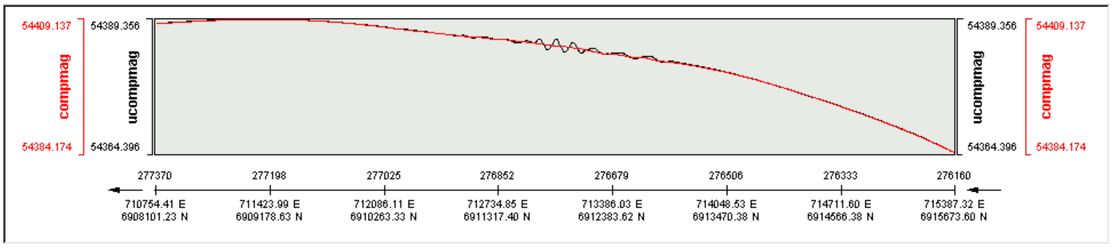
Low-level test lines were flown twice per day at survey height, by each aircraft, in the same flight configuration as on survey. Average radiometric counts were compared to assess system repeatability, soil moisture effects, etc. The location of the low-level test line is shown in Figure 7.

The test line records, resulting statistics and Th graphs are given in Appendix C.

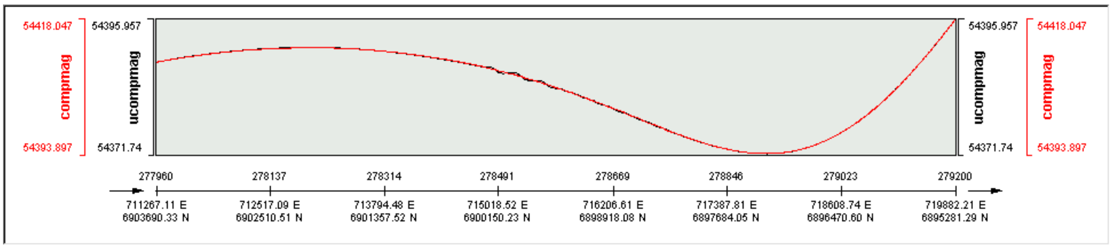
Line 7110



Line 7120



Line 7130



Line 7140

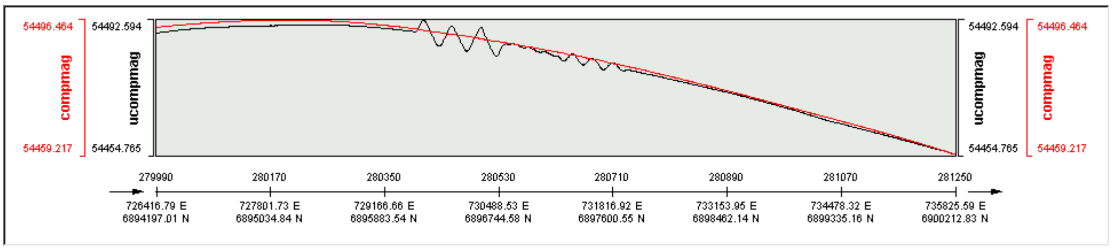
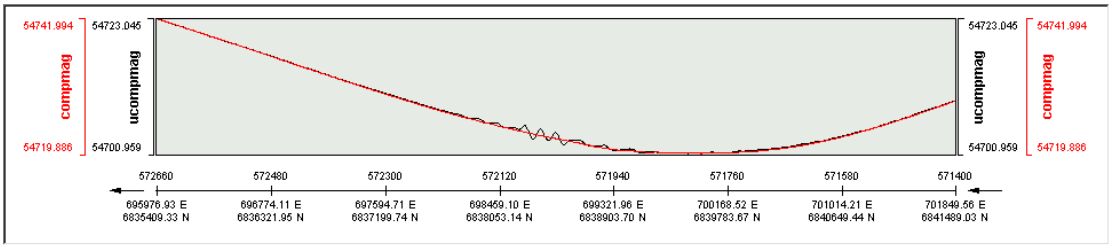
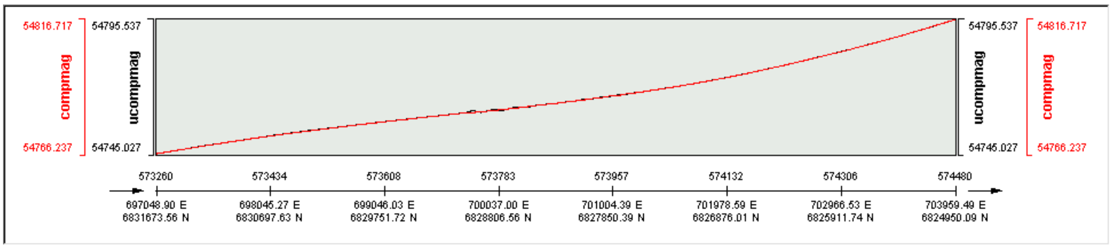


FIGURE 3 – VH-MOK CHECK BOX RESULTS, FLT 101

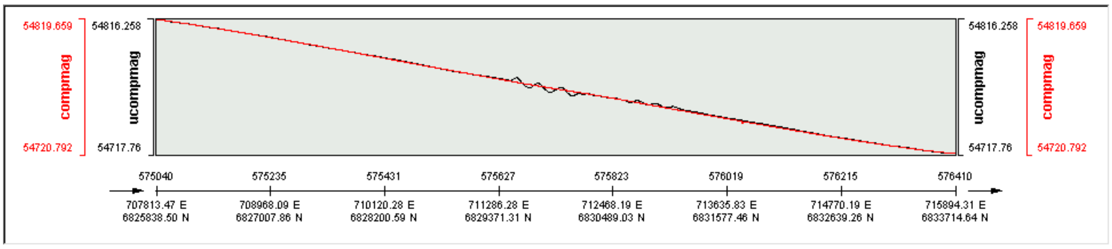
Line 7110



Line 7120



Line 7130



Line 7140

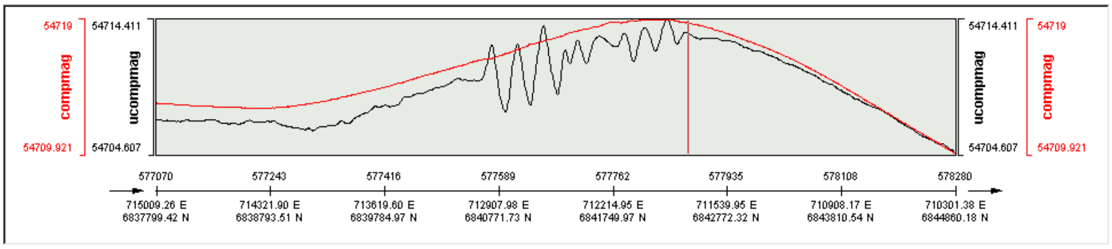
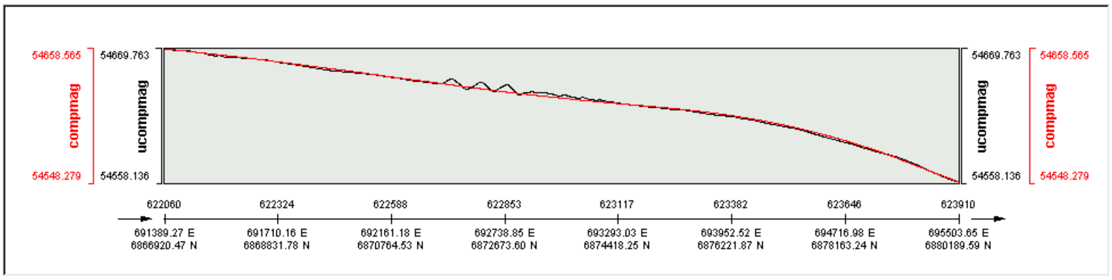
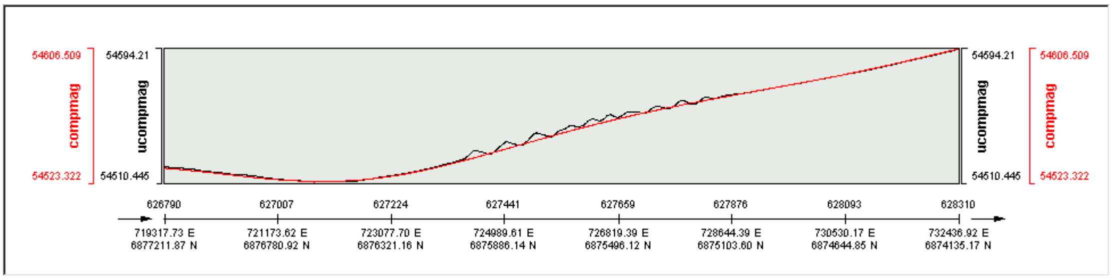


FIGURE 4 – VH-MOK CHECK BOX RESULTS, FLT 123

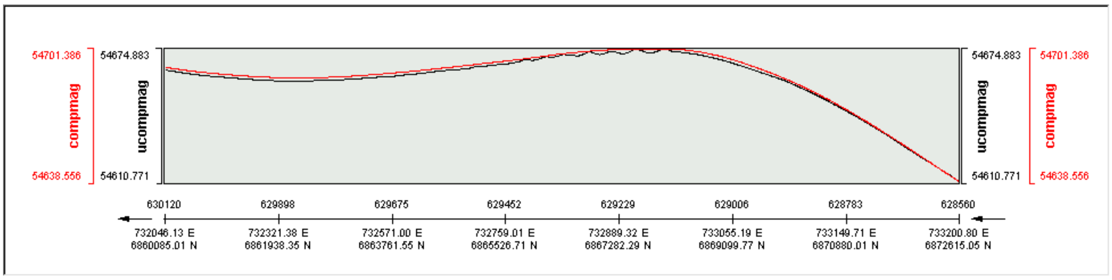
Line 7110



Line 7121



Line 7130



Line 7140

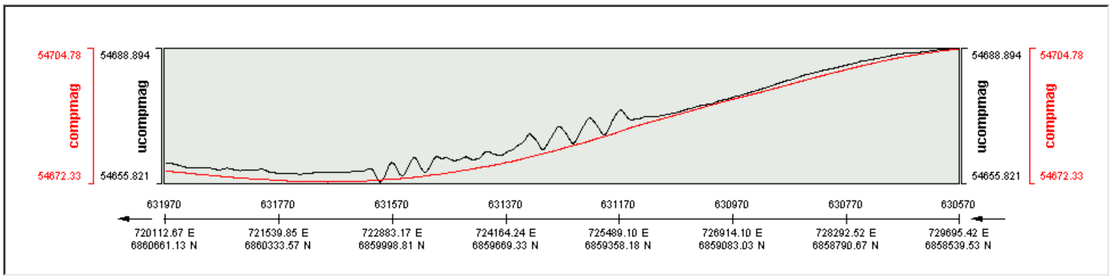
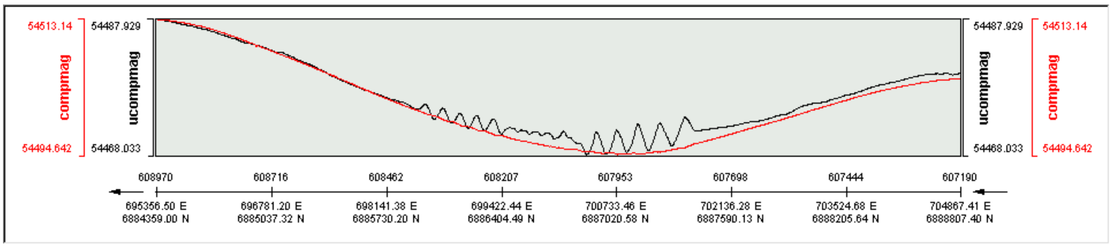


FIGURE 5 – VH-BNZ CHECK BOX RESULTS, FLT 001

Line 7110



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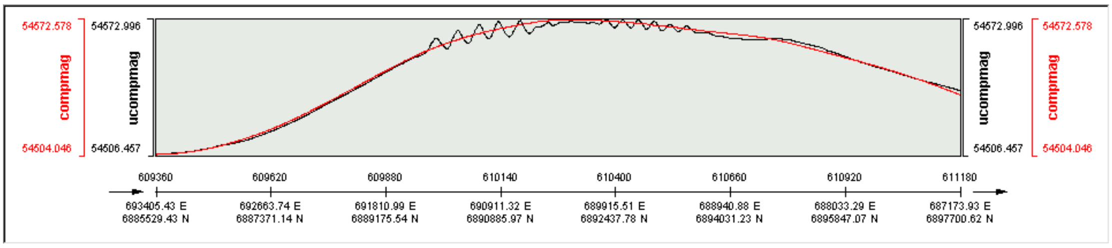
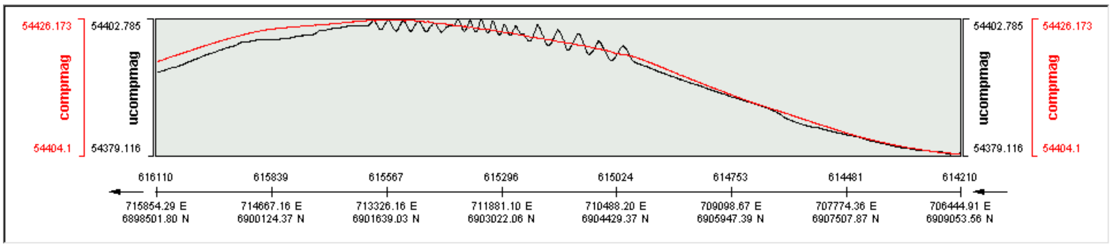


Line 7140



Line 7150

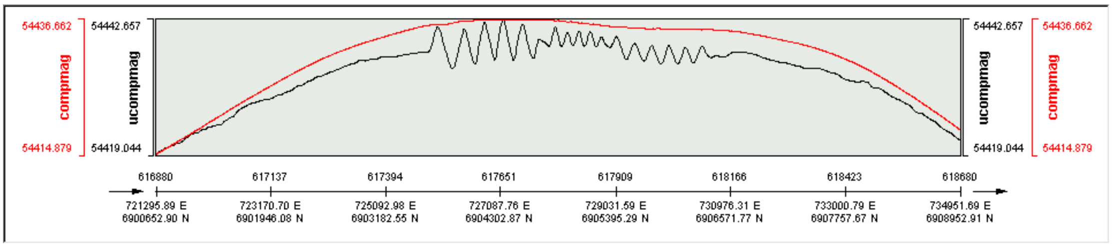
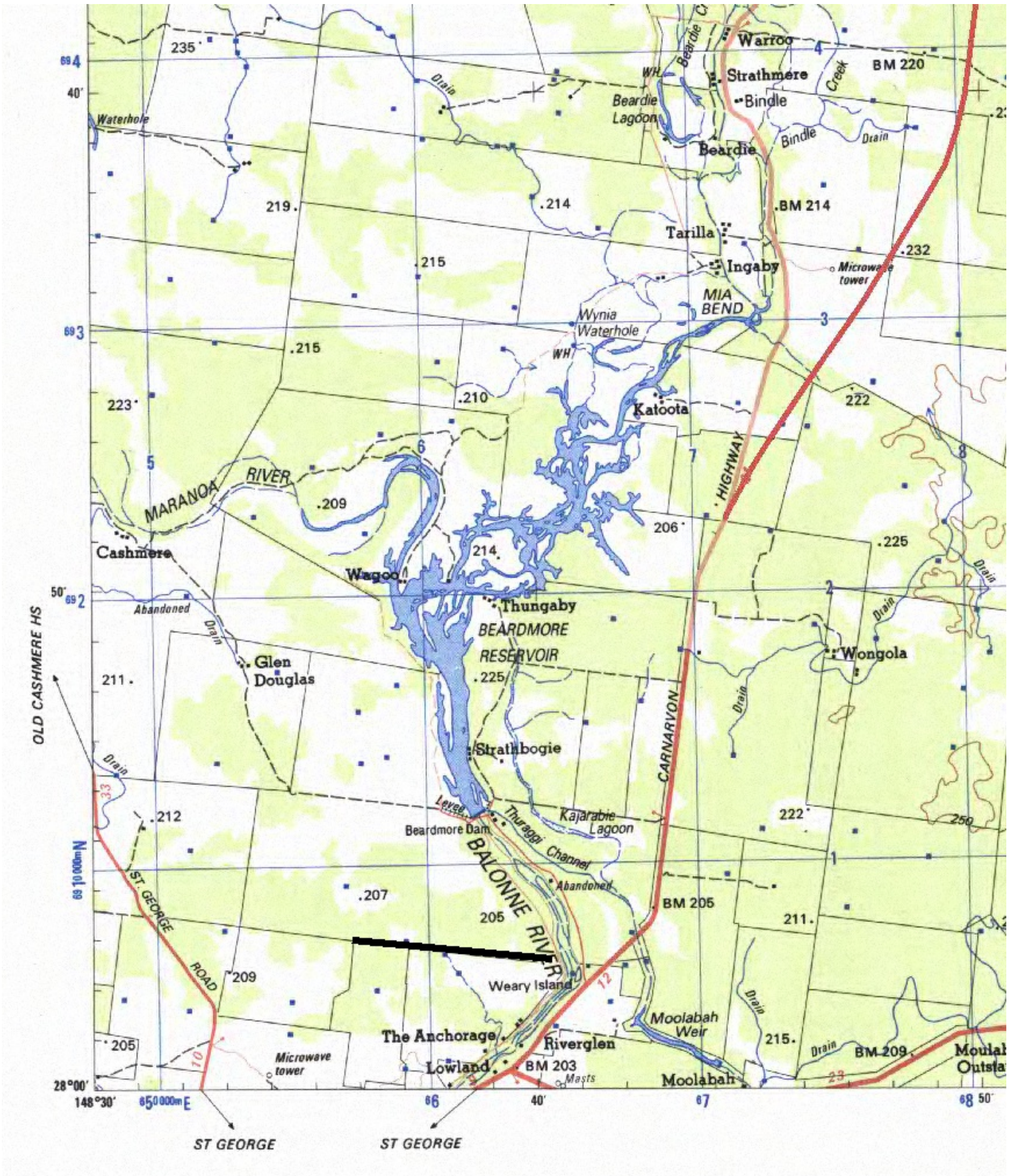


FIGURE 6 – VH-BNZ CHECK BOX RESULTS, FLT 024



LEGEND

Test Line

(Extract from SG55-16
1:250 000 Topographic Map)

Test Line Coordinates:

-27° 57.456' S 148° 40.657' E to

-27° 56.927' S 148° 35.776' E

(Approximately 8.044 Km in length)

FIGURE 7 – ST GEORGE TEST LINE

4.4.4 Radiometric Button Checks

Crystal stabilisation using Thorium was undertaken prior to each day's acquisition, before both the morning and afternoon flights, for each aircraft. Radiometric counts were recorded by locating the Thorium samples underneath the crystal packs, a distance of 40cm below each aircraft. This process was also conducted with the samples removed to determine background radiation.

Resulting statistics and Th graphs are given in Appendix D.

4.4.5 Radar Altimeter Stacks

Prior to commencement of acquisition, radalt stacks were flown for each aircraft as accurately as possible with reference to the radar altimeter indicator, which was set at a pre-determined height. These were flown over the airstrip at St George, Qld. The results are shown in Table 3.

VH-BNZ			**VH-MOK**		
Line Number	Target Height (m)	Radalt Height (m)	Line Number	Target Height (m)	Radalt Height (m)
821.5	0	0.349	881.7	0	0.893
821.0	30	31.564	886.0	30	31.453
821.1	60	66.673	885.0	60	61.263
821.2	80	81.922	884.0	80	79.531
821.3	100	105.033	883.0	100	101.223
821.4	150	154.193	884.0	150	155.231
821.6	300	332.982	881.0	300	299.130

TABLE 3 – RADAR ALTIMETER STACK RESULTS

4.4.6 Navigation Repeatability Checks

A navigation repeatability check was performed for each aircraft prior to and following each day's acquisition. The aircraft were parked in the same position each day, to test the navigation repeatability. The results are shown for each aircraft in Appendix E.

4.4.7 Heading Checks

To verify the ability of the compensator to remove any heading errors, a series of heading checks were performed. This consisted of flying over the same point on survey headings at 10000 feet. Results for each aircraft are shown in Table 4.

VH-BNZ			**VH-MOK**		
Line Number	Direction	Compensated Value	Line Number	Direction	Compensated Value
800	NW	54720.955	800	SW	54578.73
801	SE	54720.42	801	NW	54579.38
803	SW	54720.966	802	NE	54579.38
804	NE	54720.395	803	SE	54579.36

TABLE 4 – HEADING CHECK RESULTS

5. PROCESSING

5.1 Hardware and Software

All data processing was carried out by Tesla-10 Pty Ltd in its Eastern States office at Kariong, near Gosford, on the NSW Central Coast.

Hardware	UNIX workstations Pentium PCs (Windows 98) HP Designjet 650C & 2500CP Plotters HP Compact Disc Writer Iomega Zip Drives
Software	Tesla-10 Pty Ltd in-house software ERMapper 5.5 and 6.2 (imaging only) Geosoft Oasis Montaj 5.0 (gridding only)

5.2 GPS Positioning

5.2.1 Spheroids, Datums and Zones

The acquired GPS positions (latitude, longitude and altitude) were differentially post-processed in the field. Final coordinates reference GDA94, MGA Zone 55.

The 1 Hz position data was linearly interpolated to coordinate all 10 Hz data.

5.2.2 Quality Control

The following position quality control plots were produced:

- flight path
- ground speed
- altitude

5.3 Magnetics

5.3.1 Quality Control

The following quality control plots were produced:

- high-pass magnetic noise
- diurnal variation
- total field
- radar altimeter
- multiplots

This visual aspect of quality control was aided by the determination of statistics (max., min., mean and s.d.) for all parameters for every line.

System spikes were removed from the magnetic data but cultural responses were retained.

5.3.2 Parallax Correction

System parallax adjustments were performed by interpolating the position data to fit the magnetic data. An adjustment of five fiducials was applied for both aircraft.

5.3.3 Diurnal Correction

The magnetic data were corrected for diurnal variations. The correction formula was:

diurnal corrected TMI = compensated TMI *minus* diurnal *plus* mean diurnal value

5.3.4 IGRF Correction

The International Geophysical Reference Field (IGRF) was removed from the data using the 2000 model extrapolated to the survey date (May, 2001). A base value of 54,690nT was returned to the corrected data for both aircraft. The correction formula was:

final corrected TMI = diurnal corrected TMI *minus* local IGRF *plus* 54690

5.3.5 Levelling

Tie line levelling and further micro-levelling produced the final levelled magnetics data.

No polynomials are used in this form of **tie-line levelling** technique, it is a least squares process with varying weights, depending upon local data variability (near the intersections points), gradient and confidence values attributed to data and position.

Constraints are used to control the rate at which adjustments can change along either flight or tie lines, using a single distance parameter, or a wavelength. The **wavelength** is a bending constraint which controls how far along line you allow the adjustments to bend.

A **threshold** is also applied to the line data and is the maximum allowable adjustment at any stage, along line. This parameter is of utmost importance because as well as limiting the adjustments, it is also used to weight the adjustments when they are filtered along line. No reference tie-line is used, all flight and tie lines have equal priority before weights are established.

Rate of allowed variation along line refers to both flight lines and tie lines, and is distance based, so that the greater separation between cross-overs along flight lines c.f. tie lines is correctly compensated for. Data is selected at the cross-overs by application of a non-linear filter of a user selectable length, ie the **filter length** chosen by the user, determines how data is selected at the cross-over points. This filter also establishes the gradient. With magnetic data, this filter is kept reasonably short, but with radiometric data, the filter is kept quite long to compensate for statistical variations.

Wavelength, filter length and threshold are all independent, user-selectable parameters. Levelling is then carried out iteratively, levelling the tie lines and flight lines in turn. Parameters used for tie-line levelling the magnetics data are shown in Table 5.

Area	Wavelength (m)	Filter Length (m)	Threshold (nT)
A	2000	50	50
B	15000	1000	100
C	2000	50	50

TABLE 5 – MAGNETICS TIE LINE LEVELLING PARAMETERS

During **micro-levelling**, a de-corrugation levelling is applied, which has similar constraints on the allowed rate of variation of adjustment along line as described for tie-line levelling. Raw adjustments are simply high-pass filtered data perpendicular to flight lines, the cut-off wavelength being four times the line-spacing at a user selectable grid interval along line. The high-pass filter coefficients are a form of cosine roll-off filter, where the roll-on wavenumber, is equivalent to wavenmuber mulitplied by the line separation, and is a dimensionless unit.

In general a high-pass filter of 0.5 is the highest filter equivalent to half of the shortest wavelength, and the line separation. The value chosen for the high-pass filter is the most effective one, which removes most of the ‘saw-toothing’ in the data, but keeps the overall data integrity. Each grid line is filtered individually, before the constraints are applied along each flight line. The constrained values are the final adjustments to be subtracted from the original data. The most effective parameters used for micro-levelling the magnetics are shown in Table 6.

Area	Wavelength (m)	Filter Length (fids)	Threshold (nT)	High Pass Filter
A	2000	11	1	0.375
B	5000	7	2	0.275
C	5000	5	0.25	0.275

TABLE 6 – MAGNETICS MICRO-LEVELLING PARAMETERS

Statistics were calculated on the difference between the micro-levelled and tie line levelled line data. The results for each area are summarised in Table 9.

5.3.6 Gridding, Grid Merging & Further Enhancements

A minimum curvature algorithm was used to produce gridded data of 20 metre cell size for areas flown at 100m line spacing (Areas A and C), and 100 metre cell size for Area B flown at 400m line spacing. This was achieved using Geosoft Oasis Montaj 5.0.

These 3 areas (A, B and C) were subsequently grid-merged together to create a composite 20 metre cell size grid covering the whole St George survey. The grid merging used was Tesla-10 Pty Ltd in-house grid merging program. The composite TMI gridded data was then reduced to the pole and a first vertical derivative calculated.

5.4 <u>Radiometrics</u>

Radiometric processing closely follows the IAEA publication, “Technical Reports Series No. 323” (1991).

5.4.1 Quality Control

256 channel spectral plots for all flights and source tests were produced. All data were checked for peak stability and count variation.

Statistics for all channels were calculated and checked. Profiles were produced where required. The data were subsequently checked (images, profiles and statistics) after each stage of processing to ensure continued data integrity.

5.4.2 Calibrations and Coefficients

See Section 4.4.

5.4.3 256-Channel Pre-processing

The raw spectra were first smoothed using the NASVD technique, of which 8 principal components were used. Eigenvectors and statistics on the NASVD processing results were supplied to the Client Representative for analysis. The 256 channel data were then pre-processed to obtain data for Radon gas background removal.

Radon corrections are performed using the spectral ratio technique, involving detailed curve-fitting techniques to determine the final count values for various peaks of filtered spectral data (using long filters). Corrections are made for the interference to the 0.609Mev and 1.76Mev peaks from adjacent thorium peaks, in an iterative way, before the final peak values are accepted, then the spectral ratios are established. This method is calibrated using the test range data, before the corrections are applied to the data.

Raw count rates used for final processing were extracted by summing the 256 channel data over the IAEA windows centred on the peak locations, to the nearest channel. The IAEA windows are:

Total Count	0.41 to 2.81 MeV
Potassium	1.37 to 1.57 MeV
Uranium (Bi^{214})	1.66 to 1.86 MeV
Thorium (Tl^{208})	2.41 to 2.81 MeV
Cosmic	>3.0 MeV

A system parallax adjustment of 0.5 fiducials was applied.

5.4.4 Final Processing

A Gaussian-damped sync function filter was applied to height, cosmic and radon channels. These filter lengths are specified in fiducials and were respectively, a filter length of 3 (equivalent to a cut-off wavelength of 90m) , a filter length of 9 (equivalent to a cut-off wavelength of 350m), and a filter length of 7 (equivalent to a cut-off wavelength of 280m). Cosmic, aircraft and Radon backgrounds were then removed.

The Potassium, Uranium and Thorium count rates were corrected for Compton scattering (stripped). The coefficients themselves were corrected to the STP corrected height using theoretical linear corrections for the three primary stripping coefficients.

Corrections to the terrain clearance were made using STP corrected heights and the absorption factors appropriate to the exponentially decreasing count rates with height.

The data was then tie line levelled and micro-levelled where required. Details of levelling procedures are described in Section 5.3.5. Parameters used for levelling the radiometrics are shown in Table 7. Final levelled airborne gamma-ray counts were then converted to the equivalent ground radioelement concentrations.

Tie-Line Levelling for All Areas			
Radioelement	Wavelength (m)	Filter Length (m)	Threshold (cps)
Total Count	10000	5000	1000
K	8000	5000	50
U	15000	5000	100
Th	10000	5000	20

Micro-Levelling				
Radioelement Area A	Wavelength (m)	Filter Length (fids)	Threshold (cps)	High Pass Filter
Total Count	3000	100	9	0.275
K	No	Micro	Levelling	Required
U	3000	7	3	0.275
Th	3000	7	3	0.275
Radioelement Areas B & C	Wavelength (m)	Filter Length (fids)	Threshold (cps)	High Pass Filter
Total Count	5000	50	9	0.275
K	No	Micro	Levelling	Required
U	5000	7	5	0.275
Th	No	Micro	Levelling	Required

TABLE 7 – LEVELLING PARAMETERS FOR RADIOMETRICS

Statistics were calculated on the difference between the micro-levelled and tie line levelled line data. The results for each area are summarised in Table 9.

5.4.5 Gridding and Grid Merging

A minimum curvature algorithm was used to produce gridded data of 20 metre cell size for all 3 areas (Areas A, B and C). This was achieved using Geosoft Oasis Montaj 5.0.

These 3 areas (A, B and C) were subsequently grid-merged together to create a composite 20 metre cell size grid covering the whole St George survey. The grid merging used was Tesla-10 Pty Ltd in-house grid merging program.

5.5 Digital Elevation Model

5.5.1 Processing

The form of the calculation used was:

Digital Terrain = GPS altitude – Radar Altimeter – 1.2m

where,

GPS Altitude is flying height above ellipsoid (WGS84),
Radar Altimeter is flying height above ground and,
a 1.2m correction was made to allow for the vertical distance between the GPS antenna and the radar altimeter.

No system parallax was applied to the Digital Elevation Model. Tie line levelling and further micro-levelling produced the final levelled terrain model. Details of the levelling procedures used are described in detail in Section 5.3.5. The parameters used for levelling the Digital Elevation Model are shown in Table 8.

Tie-Line Levelling			
Area	Wavelength (m)	Filter Length (m)	Threshold (m)
A	15000	1000	100
B	15000	1000	100
C	10000	1000	120

Micro-Levelling				
Area	Wavelength (m)	Filter Length (fids)	Threshold (m)	High Pass Filter
A	3000	7	3	0.275
B	5000	7	3	0.275
C	4000	7	1	0.275

TABLE 8 – LEVELLING PARAMETERS FOR DIGITAL ELEVATION MODEL

Statistics were calculated on the difference between the micro-levelled and tie line levelled line data. The results for each area are summarised in Table 9.

VH-BNZ	Area	Minimum Change	Maximum Change	Mean	Standard Deviation
Magnetics (nT)	A	-1.53	1.62	0.00	0.13
Radiometrics Total Count (cps)	A	-34.25	47.08	0.00	2.82
K (cps)	A	No	Micro	Levelling	Applied
U (cps)	A	-3.92	4.16	0.00	0.77
Th (cps)	A	-4.11	3.89	0.00	0.69
Digital Elevation Model	A	-1.40	1.92	0.00	0.11
VH-MOK					
Magnetics (nT)	B	-2.01	2.24	0.00	0.30
Radiometrics Total Count (cps)	B	-77.45	63.88	0.01	15.65
K (cps)	B	No	Micro	Levelling	Applied
U (cps)	B	-3.88	4.33	0.00	0.87
Th (cps)	B	No	Micro	Levelling	Applied
Digital Elevation Model	B	-3.15	2.36	0.00	0.21
Magnetics (nT)	C	-0.34	0.35	0.00	0.05
Radiometrics Total Count (cps)	C	-61.59	224.60	0.04	9.87
K (cps)	C	No	Micro	Levelling	Applied
U (cps)	C	-5.98	20.67	0.00	0.49
Th (cps)	C	No	Micro	Levelling	Applied
Digital Elevation Model	C	-0.91	0.91	0.00	0.06

TABLE 9 - MICRO-LEVELLING STATISTICS

5.5.2 Australian Height Datum

The terrain surface was subsequently referenced to the AUSLIG 1998 N-values to produce a DEM corrected to the Australian Height Datum. The N-values are calculated and applied separately at each data point using values interpolated from the regular grid values supplied by AUSLIG 1998. The interpolation is done by a form of untensioned bi-cubic spline. The magnitude and statistics of the corrections applied are tabulated in Appendix F, for each aircraft.

5.5.3 Grid Merging

A minimum curvature algorithm was used to produce gridded data of 20 metre cell size for areas flown at 100m line spacing (Areas A and C), and 100 metre cell size for Area B flown at 400m line spacing. This was achieved using Geosoft Oasis Montaj 5.0.

These 3 areas (A, B and C) were subsequently grid-merged together to create a composite 20 metre cell size grid covering the whole St George survey. The grid merging used was Tesla-10 Pty Ltd in-house grid merging program.

6. PRELIMINARY PRODUCTS

6.1 Preliminary Raw Located Data

- 0.1 second magnetics
- 1.0 second 256-channel radiometrics
- 0.1 second digital elevation

Preliminary raw located data is in ASCII format. Descriptions of each are shown in Appendix G.

6.2 Preliminary Gridded Data

Preliminary gridded data was produced in ERMapper format.

St George Areas A, B and C

- Total Magnetic Intensity (TMI), nT
- TMI Reduced To The Pole (TMI RTP), nT
- 1st Vertical Derivative of TMI RTP (1VD TMI RTP), nT/m
- Doserate, nGy/h
- Potassium, %
- Uranium, ppm
- Thorium, ppm
- Digital Elevation Model (DEM), m

7. FINAL PRODUCTS

7.1 Final Located Data

- 0.1 second magnetics
- 1.0 second radiometrics
- 0.1 second digital elevation

Final located data is in ASCII format. Descriptions of each are shown in Appendix H.

7.2 Final Gridded Data

Final gridded data was produced in ERMapper format.

St George Areas A, B, C & Merged Overview

- Total Magnetic Intensity (TMI), nT
- TMI Reduced To The Pole (TMI RTP), nT
- 1st Vertical Derivative of TMI RTP (1VD TMI RTP), nT/m
- Doserate, nGy/h
- Potassium, %
- Uranium, ppm
- Thorium, ppm
- Digital Elevation Model (DEM), m

APPENDIX A

BASE STATION LOGS

APPENDIX B

DAILY OPERATIONS REPORT

APPENDIX C

LOW LEVEL STATISTICS

APPENDIX D

BUTTON CALIBRATION DATA

APPENDIX E

NAVIGATION REPEATABILITY CHECKS

APPENDIX F

GEOID-ELLIPSOID SEPARATION STATISTICS

APPENDIX G

RAW LOCATED DATA FORMATS

APPENDIX H

FINAL LOCATED DATA FORMATS

APPENDIX I

FLIGHT LOGS