Airborne Geophysical Survey

Survey Report

GEOSCIENCE AUSTRALIA

Billa Kalina (Area 8B), SA

Airborne Magnetic, Radiometric and Digital Elevation Survey

Contract Number: D2017-123223

Project Number: P1300

Prepared by

MAGSPEC Airborne Surveys Pty Ltd

Reference Number: 1068

Contents

1. GENERAL PROJECT INFORMATION

Project Details		
Project Number	1300	
Contract Number	D2017-123223	
MAGSPEC Project Number	1068	
Client	Geoscience Australia	
Survey Area Name	Billa Kalina (R8B)	
Survey Size (line kms delivered)	90,556.16 kms	
Survey Type	Airborne Magnetics, Radiometrics, Digital Elevation	
Aircraft		
Aircraft Locations	Coober Pedy airstrip	
	William Creek airstrip	
Aircraft Make/Model	Cessna 210	
Aircraft Registration	VH-MDG	
Personnel		
Field Operations Bases	Oasis Tourist Park, Coober Pedy	
	William Creek Hotel, William Creek	
Field Crew	**Name**	**Position**
	Kevin Patchett	Pilot
	Daniel Wright	Pilot
	Andrew Twine	Pilot
	Andreas Nicolaou	Pilot
	William Bennett	Operator
	Matthew Wall	Operator
Project Management / QC	Peter Spencer	Operations Manager
Final Data Processing	Cameron Johnston	Data Processing Manager
Reporting	Michael Lees	Sales Manager
Technical Support	Peter McMullen	Consultant Technician

1.1 Survey Acquisition Summary

On 9th October 2017, the survey aircraft (Cessna 210 registration VH-MDG) commenced mobilisation to the initial base of operations for the Billa Kalina survey at William Creek, South Australia.

The aircraft had previously flown the Whyalla Test lines (on 9th February 2017 for project P1281). As this occurred within 12 months, a repeat of the Test Lines was not required for this project.

An on-site safety meeting was completed by the crew, base stations were set up, a reconnaissance flight was carried out and a radiometric test line was established. The first production flight was flown on 10th October 2017.

Production initially commenced with the north-south survey lines, starting from the eastern side of the block, working westwards.

From 12th November 2017 the crew relocated to Coober Pedy, for more efficient production of the western portion of the block.

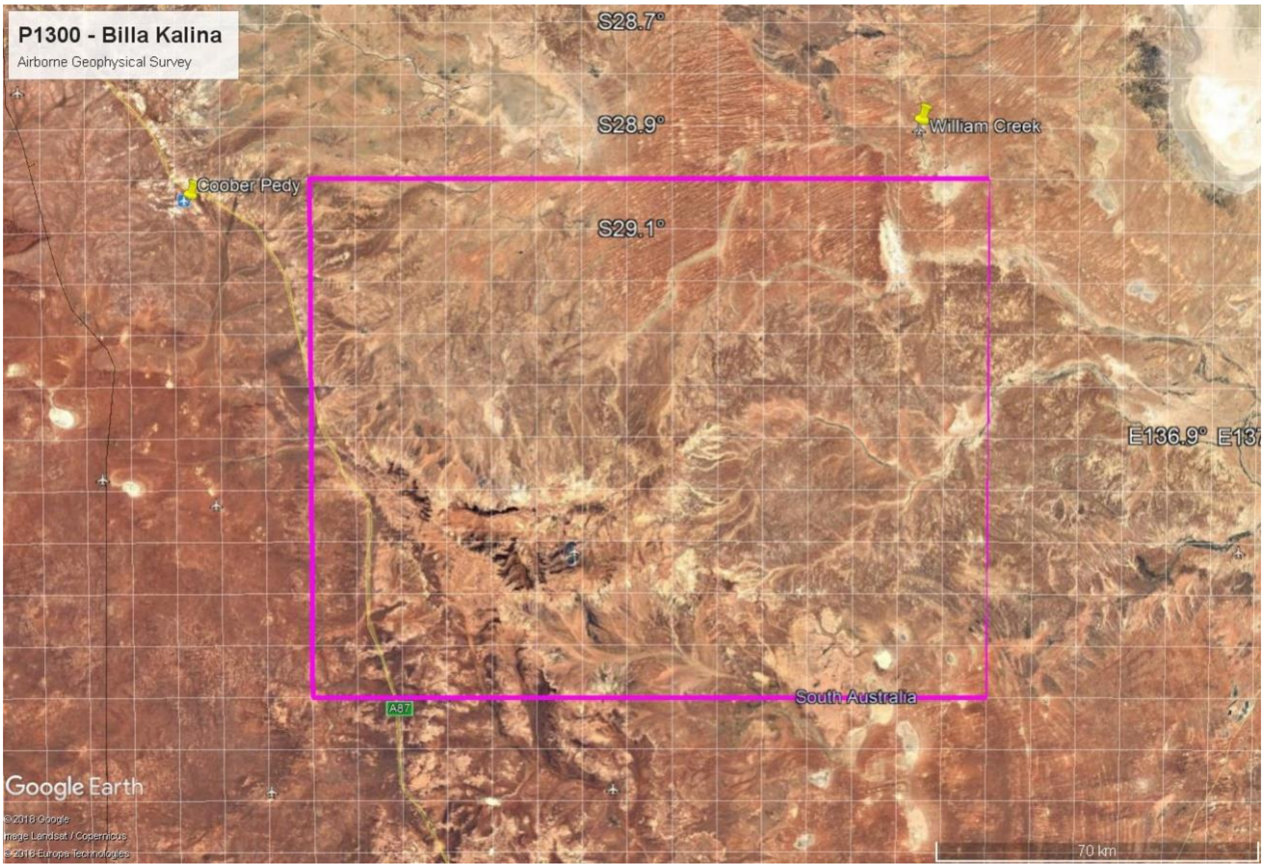
Scheduled 100-hourly maintenance was conducted at William Creek airport.

The final production flight (flight 92) was on 18th December 2017.

Conditions varied throughout the survey, with temperatures increasing to very hot by the end of the flying period. Rain, dust storms and periods of active diurnal caused some downtime.

1.2 Survey Area and Flight Specifications

The Billa Kalina survey area is located southeast of Coober Pedy, South Australia, as indicated in the following diagram: -



Billa Kalina (Area 8B) – Google Earth

GDA94 Coordinates

Longitude	Latitude
136.5	-29.0
136.5	-30.0
135.0	-30.0
135.0	-29.0

Area Name	Traverse Line spacing (m)	Traverse Line Direction	Tie Line Spacing (m)	Tie Line Direction	Sensor Height (m)	Line Kilometres
Billa Kalina(8B)	200	North-South	2,000	East-West	60	90,556.16

2. SURVEY EQUIPMENT

2.1 Aircraft

The aircraft used for the survey was a Cessna 210, specially modified for geophysical survey with a tail boom and various other survey configuration modifications.

Registration - VH-MDG

Survey Aircraft

2.2 Data Acquisition System

High speed digital data acquisition system.

- Sample rates up to 20 Hz
- Integrated Novatel OEM GPS receiver providing positional information that is used to tag incoming data streams in addition to providing pilot navigation guidance
- High precision Caesium vapour magnetometer
- Visual real time on-screen system monitoring / error messages to limit re-fights due to equipment failure

2.3 Magnetometer

The survey was flown with a single tail-mounted sensor (stinger housing).

- Model / Type - G-822 Cesium vapour magnetometer
- Resolution - 0.001 nT resolution
- Sensitivity - 0.01 nT sensitivity
- Sample Rate - 20 Hz
- Compensation - 3-axis fluxgate magnetometer
- Magnetometer Counter - Kroum KMAG4

2.4 Gamma-ray Spectrometer

An RSI RS-500 gamma-ray spectrometer was used, incorporating 2x RSX-4 detector packs.

- Total Crystal Volume - 32 L (downward looking)
- Recorded Channels - 256
- Sample Rate - 1 Hz
- Stabilisation - Multi-peak automatic gain

2.5 Altimeters / Ancillaries

A Bendix/King KRA 405 radar altimeter was used.

- Resolution - 0.3 m
- Sample Rate - 20 Hz
- Range - 0-760 m

A Renishaw ILM-500-R laser altimeter was used.

- Resolution - 0.1 m
- Sample Rate - up to 20 Hz
- Range - 0-500 m

Barometric pressure sensor: -

- Accuracy - RSS ±0.25% FS (at constant temp)
- Range - 600-1100 hPa

2.6 Magnetic Base Stations

Scintrex Envimag & Geometrics G-856 proton precession base station magnetometers.

- Resolution - 0.1 nT
- Accuracy - 0.5 nT
- Sample Rate - 0.2 – 0.5 Hz

2.7 Navigation and Flight Path Recovery

Integrated Novatel OEM719 DGPS receiver:

- Bands - L1/L2 + GLONASS Multi Frequency
- Channels - 555
- Sample Rate - 2 Hz

Navigation information is supplied to the pilot via an LCD steering indicator. All data were synchronised to the GPS time.

3. CALIBRATIONS AND CHECKS

3.1 Magnetometer

A compensation box was flown early in the survey. The compensation consisted of a series of pitch, roll and yaw manoeuvres in reciprocal survey headings at high altitude. The measured output from the 3-axis fluxgate magnetometer was recorded and used to resolve a compensation solution. This solution was applied when post-compensating all survey magnetometer data to remove manoeuvre effects and heading error. Post-flight compensation is performed using 18 terms. Refer to Appendix 2 – Calibrations.

3.2 Altimeters

Prior to commencement of survey production, the radar and laser altimeters were checked for linearity by way of a height stack over flat terrain. Refer to Appendix 2 – Calibrations.

3.3 Spectrometer

3.3.1 Prior to survey

The Gamma-Ray spectrometer was calibrated for channel interaction (stripping ratios). A cosmic – background stack was performed to determine cosmic and background radiation ratios. The Carnamah radiometric test range was flown to calculate conversion factors from counts per second to concentrations. Refer to Appendix 2 – Calibrations.

3.3.2 During survey

The system sensitivity and resolution was monitored pre- and post-flight using a thorium source ensuring stability of the spectrometer. The results were tabulated daily and closely monitored. A suitable test line was selected close to the survey area. This test line was flown at survey height each day. The data from the test line was assessed to ensure system stability and compared on daily basis to the test lines flown prior. Refer to Appendix 2 – Calibrations.

4. QUALITY CONTROL

4.1 During Flight

During survey, the pilot was notified of any deviation in system health by prompts on the navigation screen. Whenever any errors occurred, the flight was aborted and the survey did not recommence until system errors were resolved.

The diurnal base stations were monitored by the ground crew.

4.2 Post Flight

Upon completion of each flight all survey data were transferred from the acquisition system to the infield data processing computer. Using customised techniques, the data were checked for any errors and compliance with specifications.

All profiles were visually checked. The flight path was plotted with colour-coded indicators of any out of specification height or cross-track. The data were gridded and visually inspected for errors and compared for continuity with previous flights.

The summed 256-channel spectra were plotted and inspected. The test line and pre- and post-flight ground calibration data were tabulated and reviewed.

5. DATA PROCESSING

5.1 Magnetics

The following steps were performed during the magnetics processing:

- Review or application of compensation
- Parallax correction
- Diurnal filtering and subtraction
- IGRF correction using the updated current IGRF model
- Tie line levelling
- Micro levelling

Compensation of the magnetometer data was applied using the recorded XYZ fluxgate data using Geometrics MagComp Airborne compensation software. A suitable compensation flight (comp box) was processed to obtain the optimum compensation solution which was then applied to all survey data.

The base station magnetometer data were reviewed, de-spiked if necessary and filtered with an 11-point non-linear filter. These data were then subtracted from the measured aircraft data using time that was synchronised to both the acquisition system and the base mag unit.

The IGRF correction was applied using the updated IGRF 2015 model adjusted for height of the aircraft. This correction was calculated and applied at each point.

Tie line levelling was applied by way of a least squares minimisation procedure using a polynomial fit of order 0 over the cross over errors calculated between the traverse and tie line intersections. A fit to ties process was selectively applied and constrained by several parameters such as cross over height differences and maximum and minimum allowable corrections.

Using MAGPSEC Airborne Surveys' proprietary micro levelling techniques, some selective micro levelling was carefully applied and the resulting channel was then considered final.

At all stages of processing the data were stringently checked against and compared to the previous processing stage to ensure the integrity of the data were protected and no detail was removed or altered.

5.2 Radiometrics

Radiometric processing consisted of the following steps:

- 256-channel spectral noise reduction in the form of NASVD on a per-flight basis
- Dead time, cosmic and background radiation corrections
- Energy recalibration
- Channel interaction correction (stripping) and extraction of ROIs

- Height corrections using STP altitude to the nominal survey height
- Radon removal using the Spectral Ratio method
- Levelling if required

Gamma-ray Spectrometric Data Processing

The raw spectra were first smoothed using the Noise Adjusted Singular Value Decomposition (NASVD) method, (Hovgaard and Grasty, 1997).

For the NASVD process twenty (20) principal components were generated. These components were visually inspected and the final number of components for reconstructing the spectra were determined. Eight (8) components were used to reconstruct the spectra, following consultation with the Client.

For all spectrometers, spectral drift was checked, by monitoring the potassium and thorium channel positions from average spectra along flight lines. The procedure for determining peak positions was the same as used during calibration. If the thorium peak is found to move more than 1 channel or the potassium peak by more than 0.5 channel, energy calibration is performed to determine the count rates in the standard windows.

Both the aircraft 256-channel background spectra and the scaled 256-channel cosmic spectra were subtracted from the 256-channel data. Refer to Appendix 2 – Calibrations.

Deadtime corrections were applied to each spectrum channel or window.

Radon background removal was performed using the Minty Spectral Ratio method (1992).

In areas of significant topographic variation, the altimeter data were first lightly filtered to smooth sudden jumps that can arise when flying over steep terrain (which cause problems when height-correcting the data). These data were then converted to effective height (h_e) at standard temperature and pressure (STP).

The background-corrected count rates in the 3 windows were stripped to give the counts in the potassium, uranium and thorium windows that originate solely from the potassium, uranium and thorium decay series. The window stripping ratios α, β, γ, *a* and *g* were estimated from measurements over calibration pads, where:

α - is the thorium into uranium stripping ratio, (equal to the ratio of counts detected in the uranium window to those detected in the thorium window from a pure thorium source);

ß - is the thorium into potassium stripping ratio for a pure thorium source;

γ - is the uranium into potassium stripping ratio for a pure uranium source;

a - is the reversed stripping ratio, uranium into thorium, (equal to the ratio of counts detected in the thorium window to those detected in the uranium window from a pure source of uranium);

g - is the reverse stripping ratio, potassium into uranium for a pure potassium source.

The 3 principal stripping ratios (α, ß and γ) increase with altitude above the ground as shown in the Table 1.1.

Table 1.1. Stripping ratio increase with Aircraft altitude at STP.

Stripping Ratio	Increase per metre
α	0.00049
β	0.00065
γ	0.00069

Each of the 3 main stripping ratios were adjusted for altitude before stripping was carried out. If 5 stripping ratios are used, then the stripped count rates in the potassium, uranium and thorium channels (N_K, N_U, N_{Th}) are given by:

$$N_K = \frac{\left[n_{Th}(\alpha\gamma - \beta) + n_U(a\beta - \gamma) + n_K(1 - a\alpha)\right]}{A}, \quad \text{(A5)}$$

$$N_U = \frac{\left[n_{Th}(g\beta - \alpha) + n_U - n_K g\right]}{A}, \quad \text{(A6)}$$

$$N_{Th} = \frac{\left[n_{Th}(1 - g\gamma) - n_U a + n_K a g\right]}{A}, \quad \text{(A7)}$$

where

$$A = 1 - g\gamma - a(\alpha - g\beta). \quad \text{(A8)}$$

The background-corrected and stripped count rates were corrected for variations in the altitude of the detector using the equation:

$$N_{corr} = N_{obs}\, e^{-\mu(h_0 - h)}, \quad \text{(A9)}$$

where: -

N_{corr} = the count rate normalized to the nominal Survey altitude, h_o;
N_{obs} = the background corrected, stripped count rate at STP height h;
μ = the attenuation coefficient for that window.

Where the STP height above ground level exceeds 300 m, a value of *h* =300 is used in equation A9.

The resulting potassium, uranium, thorium and total count (cps) were converted to concentrations using the coefficients derived from the Carnamah radiometric test line. Refer to Appendix 2 – Calibrations.

Where required, tie line levelling is applied to the Total Count and Uranium channels to remove any effects caused by residual radon background. A least-squares/median filter procedure applied over the calculated cross over errors at each intersection of the flight and tie lines generated a correction value. A new tie-line levelled channel is then output by application of this correction value to the original channel.

Where required, using MAGPSEC Airborne Surveys' proprietary micro levelling techniques, some selective micro levelling is carefully applied and the resulting channel is then considered final.

At all stages of processing the data were stringently checked against and compared to the previous processing stage to ensure the integrity of the data was protected and no detail was removed or altered.

5.3 Digital Elevation Model

DEM processing consisted of the following steps:

- Inspection of height channels
- Parallax correction of radar and laser altimeters
- Subtraction of radar and laser altimeters from GPS height
- Tie line and micro levelling

The GPS, radar and laser heights were visually inspected for errors and any spikes were carefully corrected.

The altimeter data were then subtracted from the GPS height to create the Digital Elevation channels (laser and radar).

Tie line levelling was applied by way of a least squares minimisation procedure using a polynomial fit of order 0 over the cross over errors calculated between the traverse and tie line intersections. Using MAGPSEC Airborne Surveys' proprietary micro levelling techniques, some selective micro levelling was carefully applied and the resulting channel was then considered final. At all stages of processing the data were stringently checked against and compared to the previous processing stage to ensure the integrity of the data was protected and no detail was removed or altered.

APPENDIX 1 FIELD OPERATIONS AND PROJECT MANAGEMENT

Operational Bases

The aircraft and crew were based in William Creek and Coober Pedy in South Australia. Production of the survey started on the 10th October 2017 and ended on the 18th December 2017. Field crew were regularly rotated as required.

Base Station Magnetometers

The base station magnetometers were positioned near the William Creek and Coober Pedy airstrips as shown below: -

William Creek Airstrip

Base station 1 (Envimag) location co-ordinates (GDA94): -28.906302°S; 136.341575°E
Base station 2 (G856) location co-ordinates (GDA94): -28.906411°S; 136.341387°E

Coober Pedy Airstrip

Base station 1 (Envimag) location co-ordinates (GDA94): -29.035556°S; 134.721049°E
Base station 2 (G856) location co-ordinates (GDA94): -29.035572°S; 134.721265°E

Base station 1 at each location was used for all diurnal corrections.

APPENDIX 2 CALIBRATIONS

Radiometrics

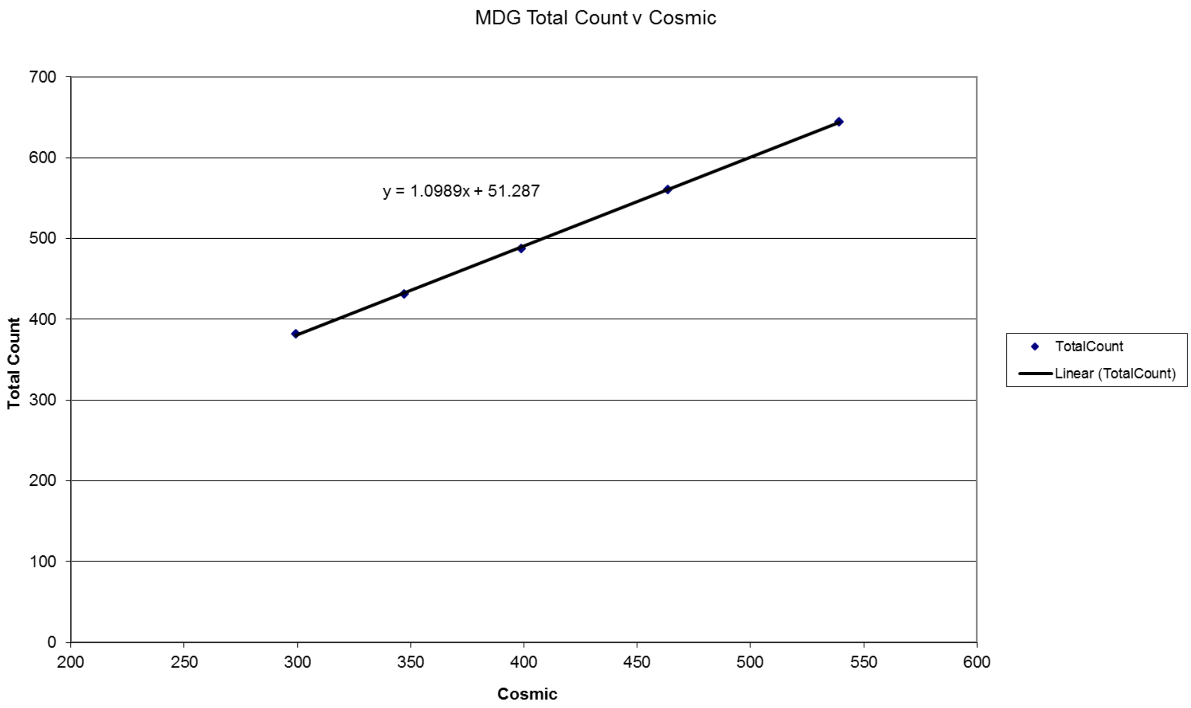
Stripping Ratios

On 1st February 2017, the aircraft's radiometric system was calibrated over background, potassium, uranium and thorium test pads at Jandakot airport in Perth, using standard calibration procedures. The resulting stripping coefficients are tabled below: -

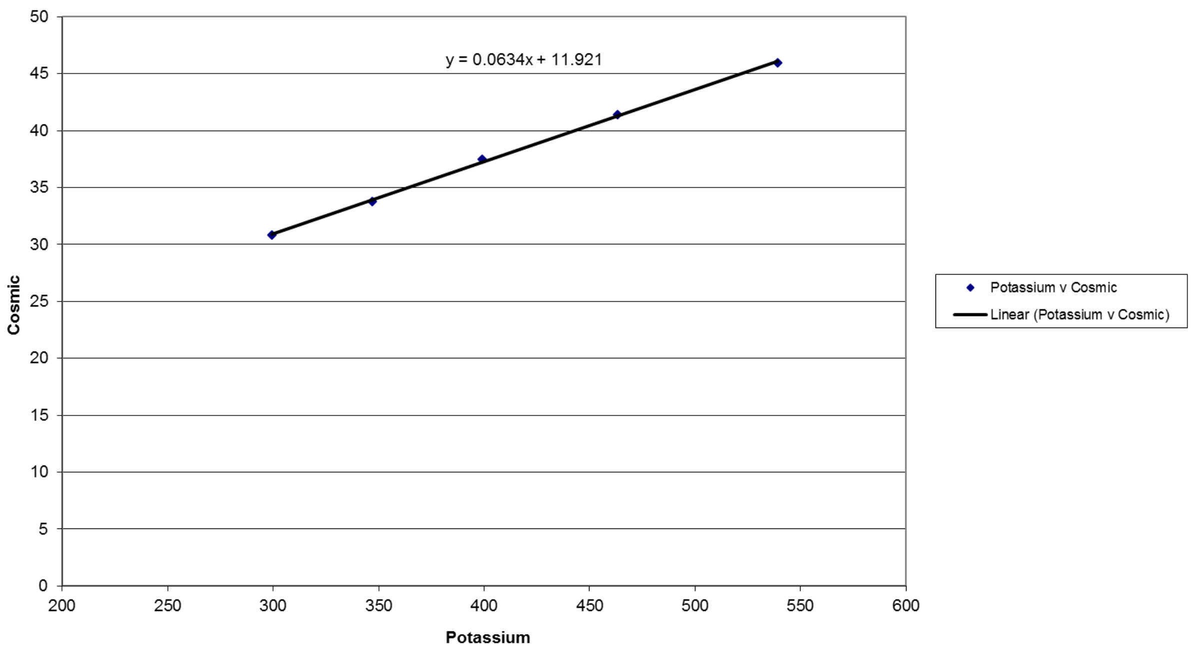
Stripping Constant	Coefficient
Alpha	0.2845
Beta	0.4517
Gamma	0.7986
A	0.0470
B	0.0011
G	-.0209

Aircraft Cosmic Background Test Flight

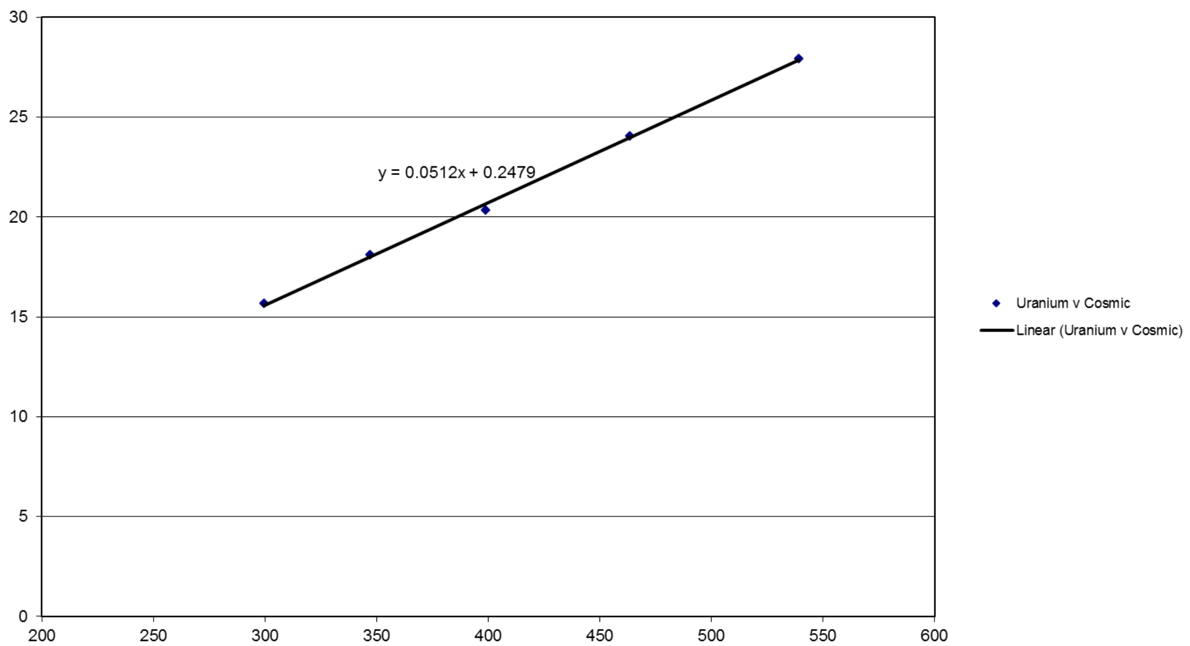
On 1st February 2017, the aircraft was flown offshore Western Australia at high altitude to derive the following plots: -

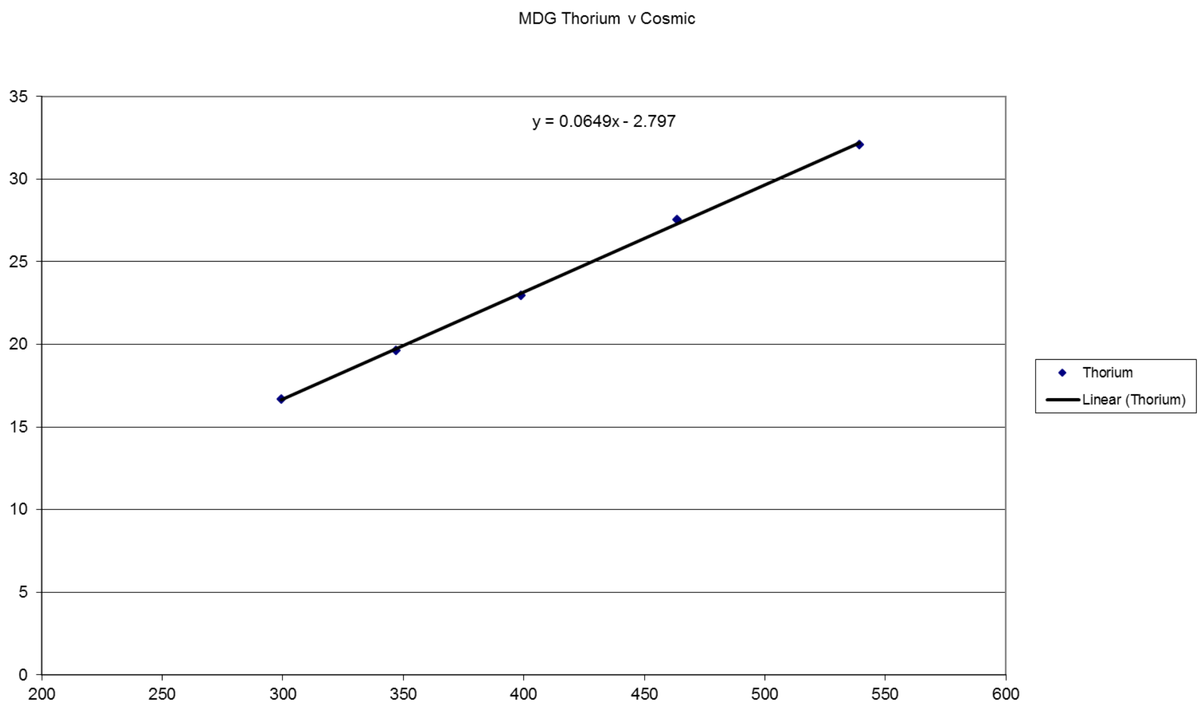


MDG Potassium v Cosmic



MDG Uranium v Cosmic

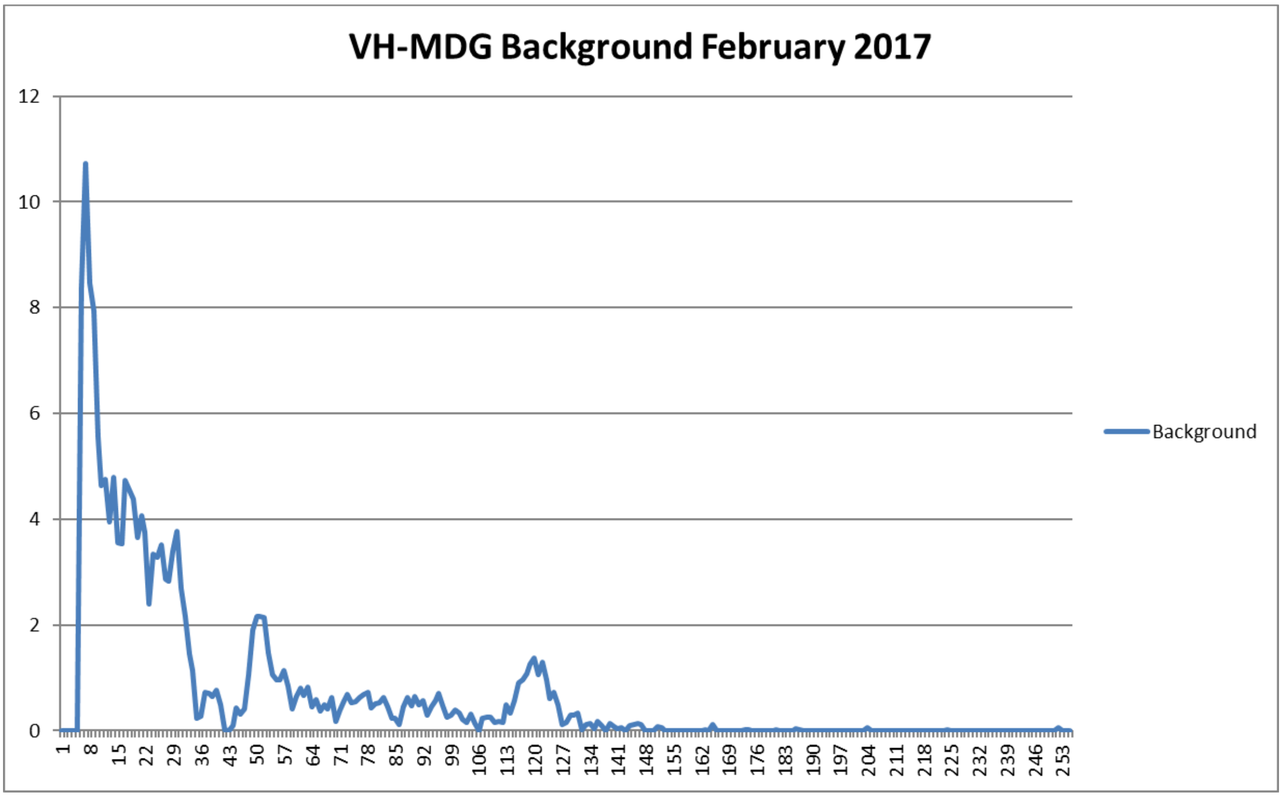




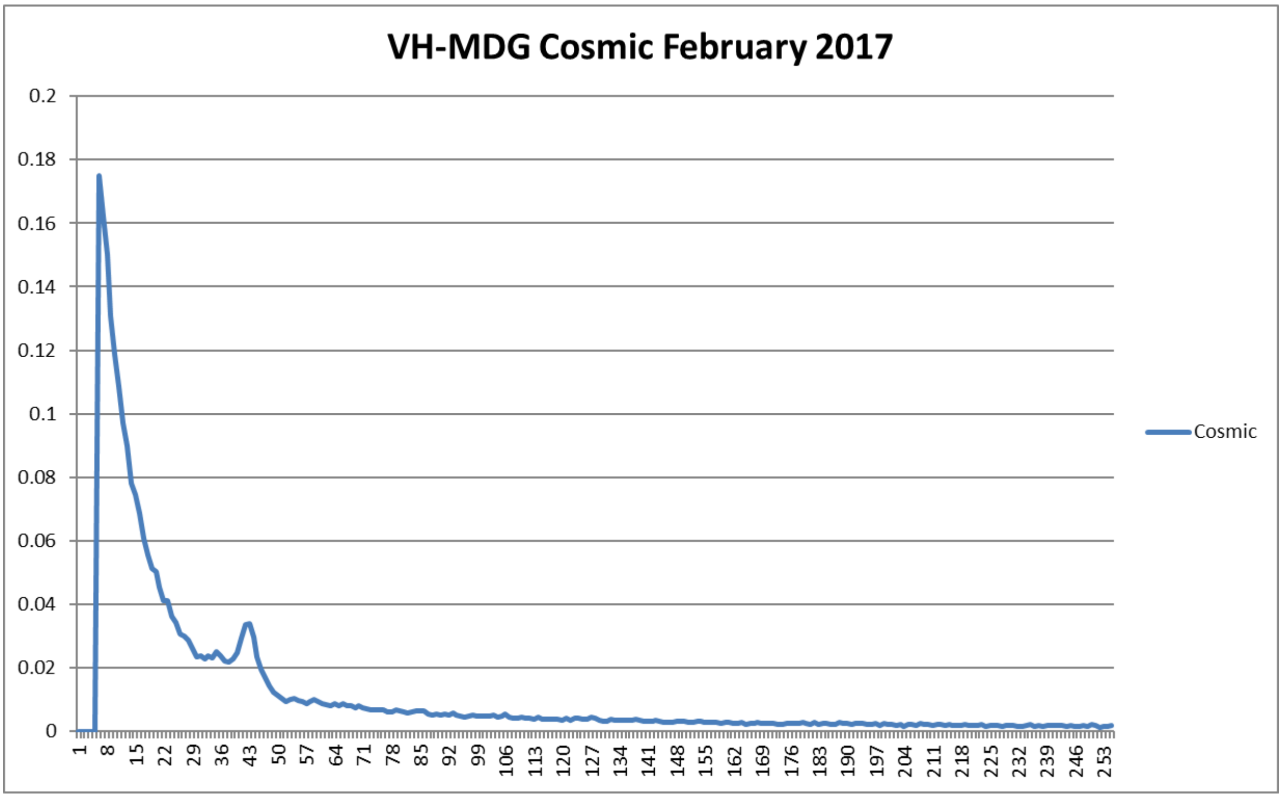
Aircraft Background Cosmic Coefficients

Parameter	Total Count	Potassium	Uranium	Thorium
Aircraft Background	51.287	11.921	0.2479	0.0000
Cosmic	1.0989	0.0634	0.0512	0.0649

Aircraft Background Spectra



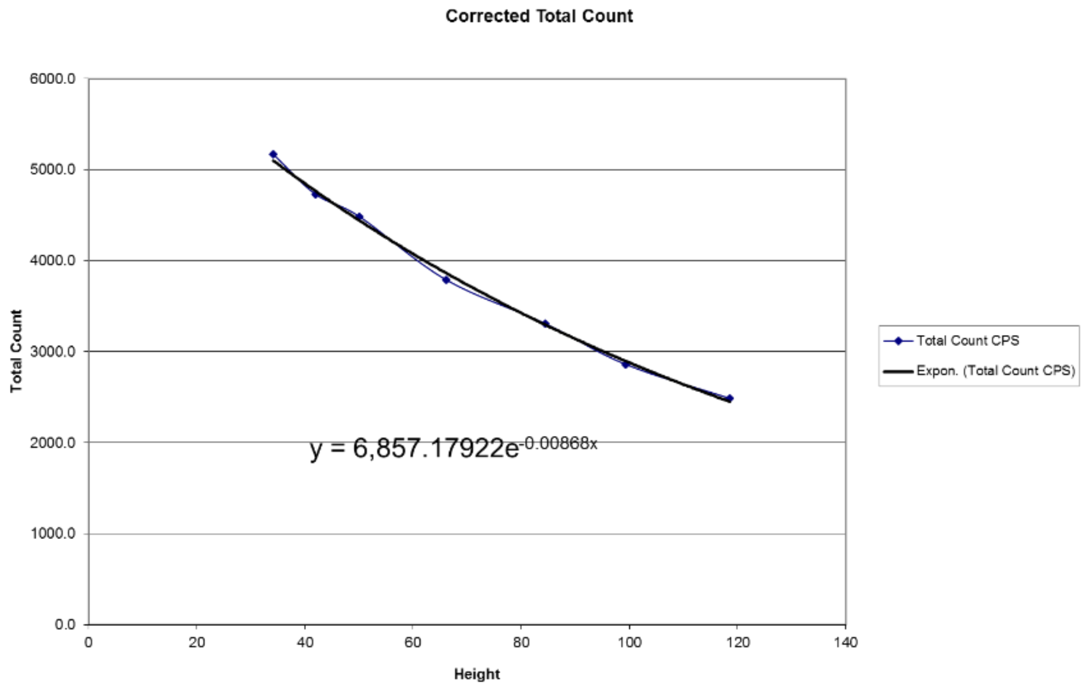
Cosmic Spectra

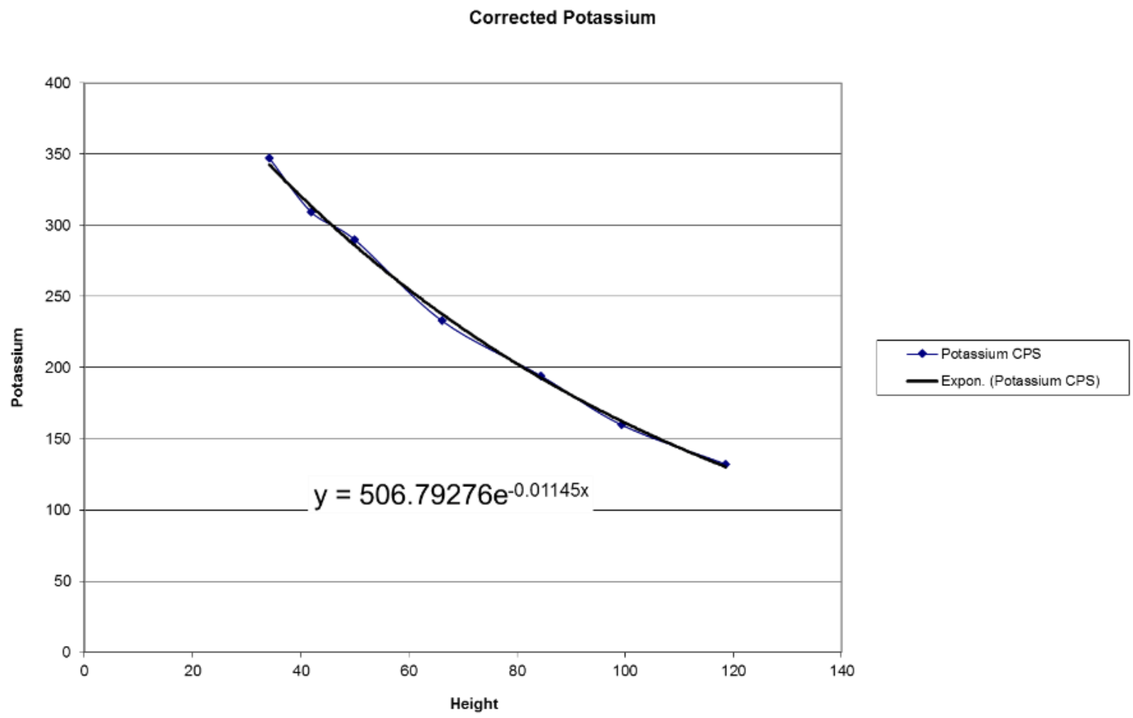


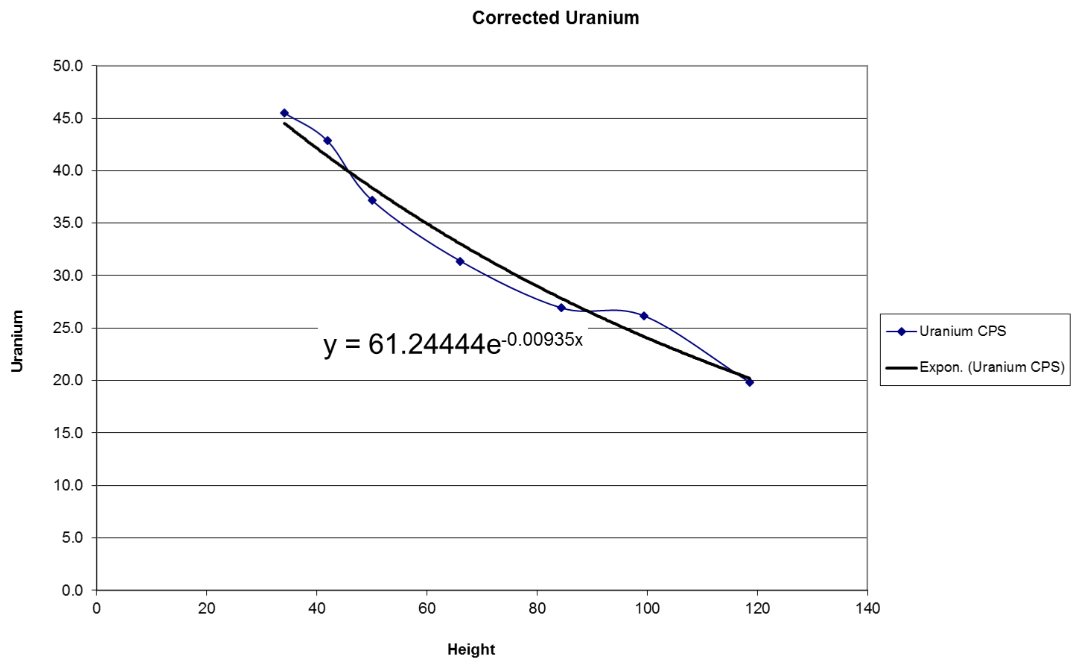
Carnamah Radiometric Test Range

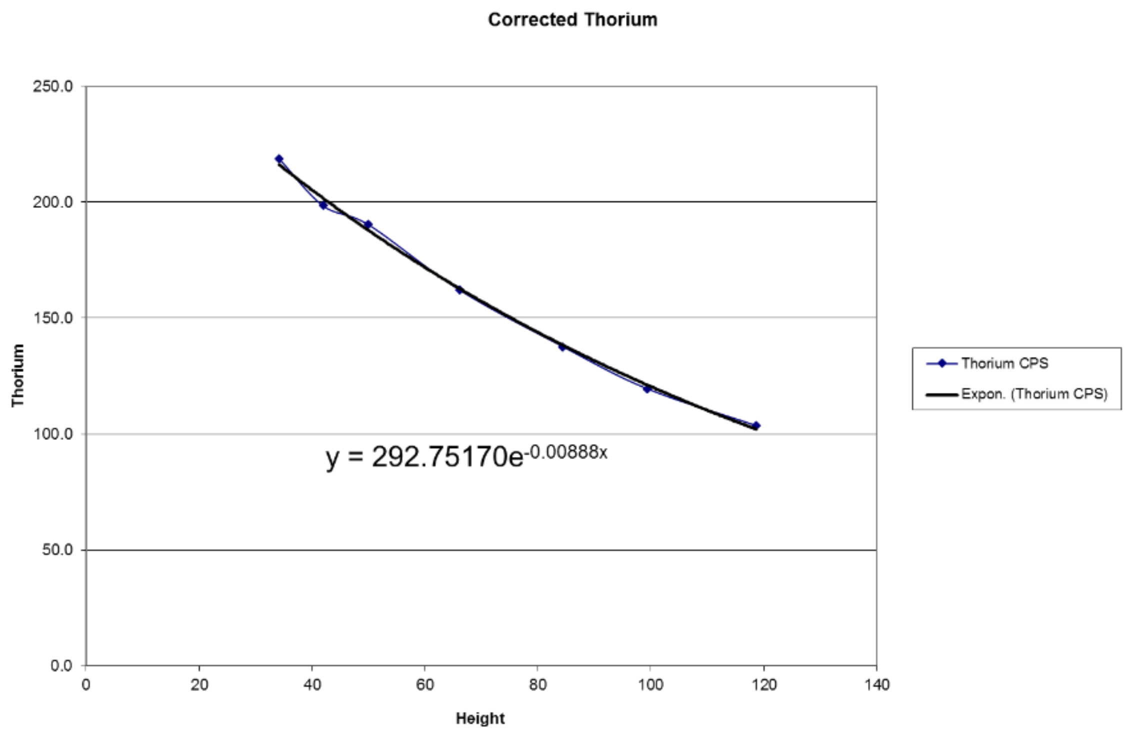
The Carnamah Test Range, north of Perth, was flown by the aircraft on 2nd February 2017.

Aircraft Test Range Flight Plots









The following theoretical height attenuation coefficients are used, based on testing and IAEA values:

Parameter	Total Count	Potassium	Uranium	Thorium
Height Attenuation	-0.0074	-0.0094	-0.0084	-0.0074

Test Range Ground Station Readings

The radiometric concentrations were measured along the Carnamah Test Range, using a hand-held spectrometer, yielding the following results at each station:

Station	K (%)	U (ppm)	Th (ppm)
4	4.44	6.32	46.48
7	3.37	3.08	17.26
10	3.14	2.56	25.50
14	2.64	2.05	26.09
17	2.94	2.54	29.83
20	2.93	3.61	29.60
23	2.93	3.41	41.98
26	3.28	3.41	21.67
28	3.15	2.91	22.85
31	3.44	3.20	24.22
34	3.04	2.18	20.02
37	1.96	2.96	24.33
40	2.34	2.85	20.80
43	3.75	3.42	34.89
46	2.64	2.55	22.71
49	2.42	3.08	24.24
52	2.15	6.98	55.04
55	1.68	4.96	50.48
58	1.70	1.99	15.83
61	1.69	3.48	40.89
64	1.93	2.69	39.40
67	1.35	5.27	31.30
70	1.59	2.86	25.89
73	1.79	1.90	18.26
76	1.44	1.75	20.81
Average	**2.55**	**3.28**	**29.21**

Aircraft Sensitivity Coefficients

Nominal Ht	K cps	K Sens	U cps	U Sens	Th cps	Th Sens	Total cps	Total Sens		Range concentrations		
40	337.8	132.5	45.5	13.9	218.8	7.5	5166.9	39.8				
50	299.5	117.5	42.8	13.0	198.5	6.8	4728.6	36.4		k%	2.55	
60	281.6	110.4	37.2	11.3	190.3	6.5	4485.7	34.6		U ppm	3.28	
80	224.7	88.1	31.4	9.6	162.1	5.5	3789.3	29.2		Th ppm	29.21	
100	189.6	74.4	26.9	8.2	137.7	4.7	3308.8	25.5		A	129.79	
120	152.6	59.8	26.2	8.0	119.5	4.1	2858.2	22.0				
140	127.1	49.8	19.8	6.0	103.6	3.5	2484.9	19.1				
200	74	29.0	11.8	3.6	67.7	2.3	1612.9	12.4				
300	29.7	11.6	6.2	1.9	33.5	1.1	817.1	6.3				

Magnetics

Magnetometer Parallax

On 9th February 2017, a magnetometer parallax test was conducted near Whyalla, by flying the same line in opposite directions. Magnetic profiles of the test are shown below, with the parallax correction determined to be -2.7 fiducials: -

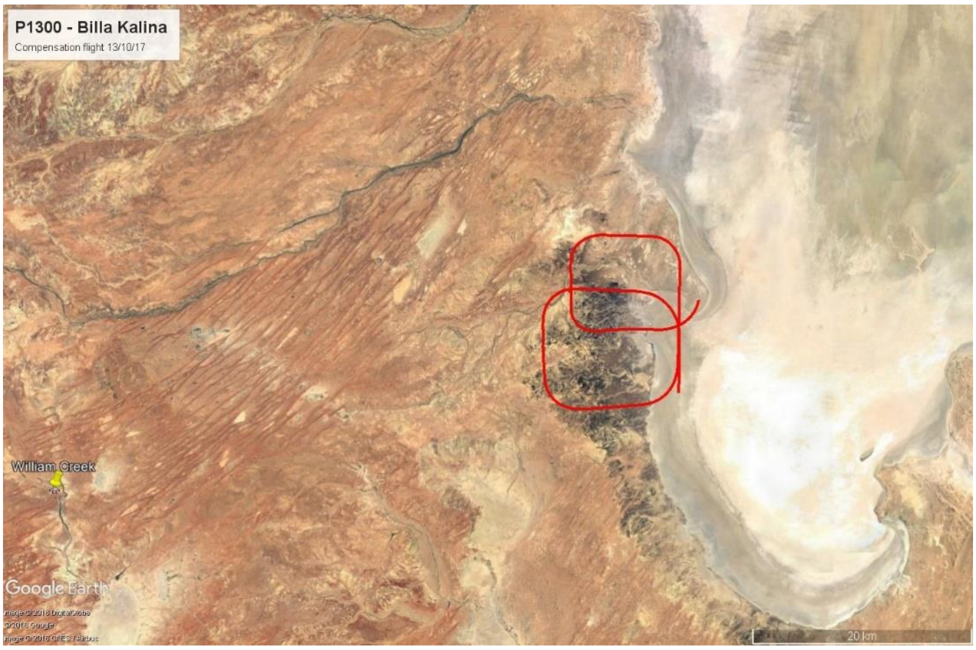
Magnetic profiles before parallax application

Magnetic profiles after parallax application

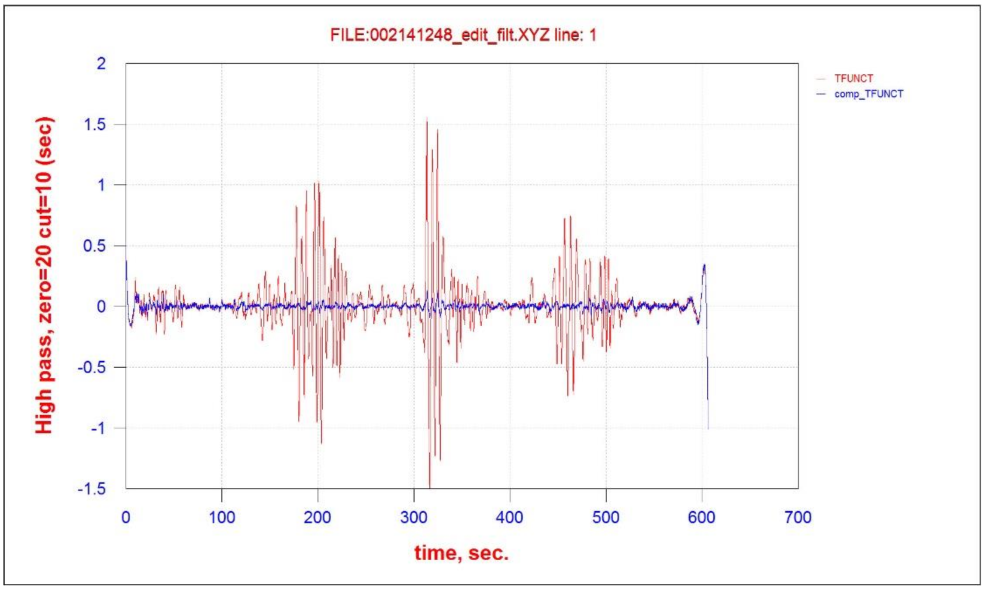
Magnetometer Compensation

William Creek

On 13th October 2017, a magnetometer compensation flight was conducted near William Creek, South Australia.



The results of the compensation box are shown below:

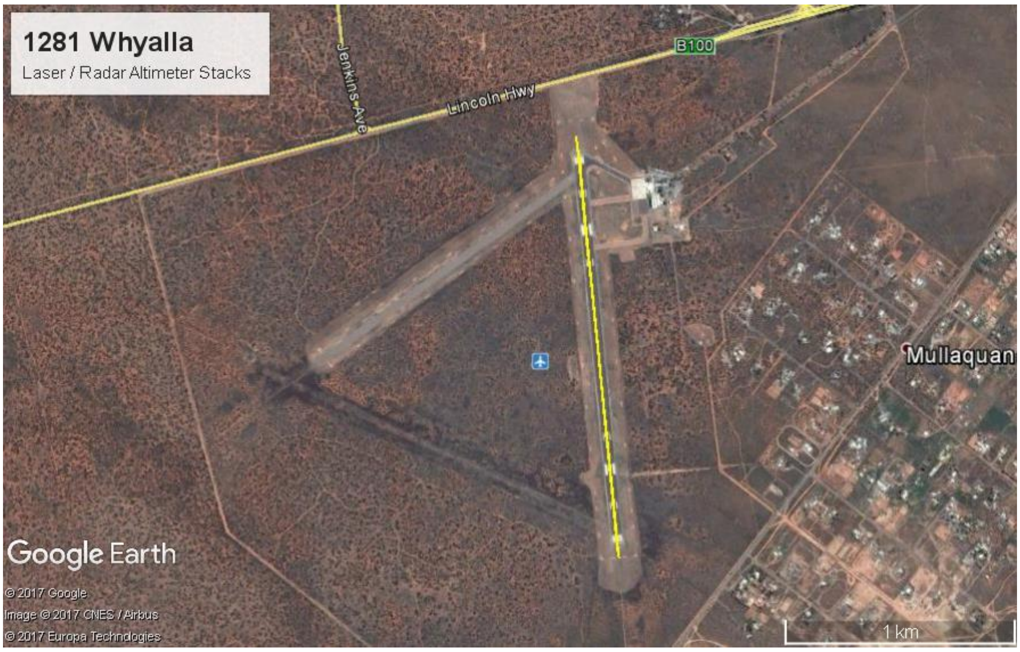


Sensor Channel	Line number	original RMS	compensated RMS	IR
TFUNCT	1	0.237	0.021	11.185

Altimeters

Whyalla

On 9th February 2017, height stacks were performed over the airstrip at Whyalla, South Australia to check and calibrate the radar and laser altimeters. The GPS height of the airstrip. 8.84m, was removed from the GPS height. Physical offsets between the GPS, radar altimeter and laser altimeter sensors were taken into account.



	Altimeter offsets (m)
GPS to airstrip	1.97
Laser to airstrip	1.72
GPS to Laser	0.25
GPS to Radar	1.25

Altimeter Stacks

Flying Height (m)	Adjusted GPS (m)	Adjusted Laser (m)	GPS - Laser Difference (m)	Adjusted Radar (m)	GPS-Radar Difference (m)
Airstrip (0)	0.00	0.00	0.00	0.00	0.00
30	36.51	36.19	0.32	33.06	3.46
60	64.41	64.65	-0.23	61.93	2.48
80	83.39	83.54	-0.15	80.94	2.45
100	102.37	102.87	-0.50	100.61	1.76
150	151.39	151.68	-0.29	149.87	1.52
300	296.00	295.28	0.72	299.60	-3.60

William Creek

On 2nd November 2017, further height stacks were performed over the airstrip at William Creek, South Australia.

Flying Height (m)	Laser (m)	Radar (m)	Laser-Radar Difference (m)
Airstrip (0)	1.08	2.04	0.96
30	29.52	30.30	0.78
60	58.47	59.24	0.77
80	78.67	79.28	0.61
100	98.96	99.53	0.58
150	147.50	148.24	0.74
300	299.62	300.28	0.66

Daily Calibrations

Ground Calibrations

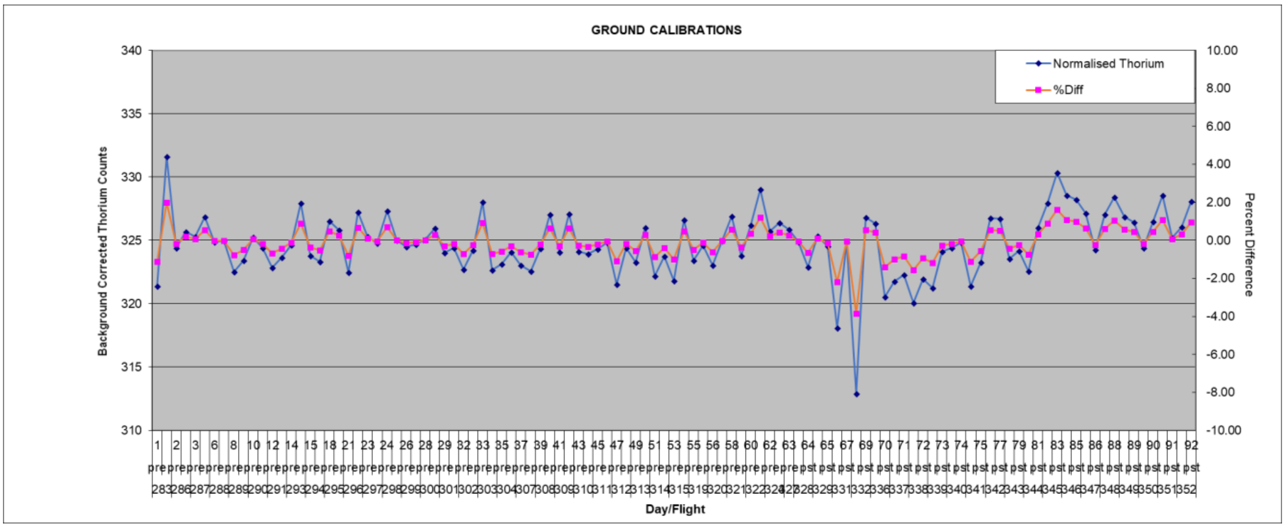
During the survey, pre- and post- flight ground calibration checks were undertaken, to confirm the health of the radiometric system: -

Date	Flight #	Thorium Peak Ch #	Th Peak Resolution	Raw Th Count (cps)	Background Count (cps)	Background corrected (BC) Th (cps)	BC running average Th (cps)	% change in BC Th average
10/10/2017	1	217.33	4.74	414.37	92.97	321.40	321.40	-1.12
	1	217.40	4.68	429.38	97.76	331.62	326.51	2.00
13/10/2017	2	217.30	4.73	415.52	91.10	324.41	325.81	-0.18
	2	217.38	4.70	418.65	92.97	325.68	325.78	0.21
14/10/2017	3	217.37	4.80	417.77	92.49	325.29	325.68	0.09
	5	217.44	4.77	421.47	94.64	326.84	325.87	0.56
15/10/2017	6	217.40	4.73	418.98	94.08	324.90	325.73	-0.03
	7	217.38	4.74	418.89	93.93	324.95	325.64	-0.01
16/10/2017	8	217.27	4.69	416.34	93.83	322.51	325.29	-0.77
	9	217.30	4.76	420.49	97.06	323.44	325.10	-0.48
17/10/2017	10	217.45	4.80	420.77	95.52	325.25	325.12	0.08
	11	217.30	4.68	421.18	96.77	324.40	325.06	-0.18
18/10/2017	12	217.29	4.83	419.16	96.32	322.85	324.89	-0.67
	13	217.40	4.82	420.47	96.84	323.63	324.80	-0.42
20/10/2017	14	217.33	4.86	418.61	93.98	324.63	324.79	-0.11
	14	217.41	4.81	423.40	95.48	327.92	324.98	0.89
21/10/2017	15	217.18	4.76	419.19	95.39	323.80	324.91	-0.37
	17	217.39	4.86	420.66	97.33	323.33	324.83	-0.52
22/10/2017	18	217.26	4.76	422.48	95.94	326.54	324.92	0.47
	20	217.38	4.89	421.40	95.59	325.82	324.96	0.25
23/10/2017	21	217.21	4.68	418.77	96.32	322.45	324.84	-0.79
	22	217.44	4.79	422.61	95.38	327.23	324.95	0.68
24/10/2017	23	217.34	4.82	420.01	94.70	325.31	324.97	0.10
	23	217.26	4.70	420.28	95.49	324.79	324.96	-0.06
25/10/2017	24	217.36	4.80	422.75	95.44	327.32	325.05	0.71
	25	217.38	4.87	422.12	97.10	325.01	325.05	0.00
26/10/2017	26	217.45	4.87	419.18	94.69	324.49	325.03	-0.16
	27	217.29	4.71	417.99	93.30	324.70	325.02	-0.09
27/10/2017	28	217.29	4.81	418.68	93.62	325.06	325.02	0.02
	28	217.40	4.93	420.41	94.43	325.98	325.05	0.30
28/10/2017	29	217.40	4.88	414.32	90.29	324.03	325.02	-0.30
	31	217.47	4.91	417.75	93.37	324.39	325.00	-0.19
29/10/2017	32	217.21	4.71	416.71	94.00	322.70	324.93	-0.71
	32	217.34	4.71	423.01	98.79	324.22	324.91	-0.24
30/10/2017	33	217.34	4.78	422.28	94.27	328.01	325.00	0.92
	34	217.33	4.89	415.61	92.95	322.67	324.93	-0.72
31/10/2017	35	217.27	4.71	414.36	91.23	323.14	324.88	-0.58
	36	217.36	4.72	417.86	93.79	324.07	324.86	-0.29
3/11/2017	37	217.26	4.79	417.30	94.24	323.06	324.82	-0.60
	38	217.36	4.86	417.42	94.84	322.58	324.76	-0.75
4/11/2017	39	217.30	4.97	416.03	91.69	324.34	324.75	-0.20
	40	217.37	4.89	424.58	97.53	327.05	324.80	0.63
5/11/2017	41	217.38	4.84	420.94	96.87	324.07	324.79	-0.29
	42	217.42	4.84	416.98	89.88	327.10	324.84	0.64
6/11/2017	43	217.20	4.84	412.89	88.79	324.11	324.82	-0.28
	44	217.36	4.87	416.73	92.77	323.96	324.81	-0.32

7/11/2017	45	217.37	4.81	416.80	92.50	324.30	324.79	-0.22
	46	217.45	4.76	421.06	96.24	324.82	324.79	-0.06
8/11/2017	47	217.31	4.79	416.42	94.91	321.51	324.73	-1.08
	48	217.43	4.83	420.57	96.16	324.41	324.72	-0.18
9/11/2017	49	217.20	4.77	419.19	95.93	323.26	324.69	-0.54
	50	217.37	4.83	420.86	94.87	325.99	324.72	0.30
10/11/2017	51	217.27	4.82	419.92	97.71	322.21	324.67	-0.87
	52	217.31	4.90	419.51	95.79	323.72	324.65	-0.39
11/11/2017	53	217.40	4.92	416.80	94.98	321.82	324.60	-0.99
	54	217.44	4.96	416.95	90.34	326.61	324.64	0.49
15/11/2017	55	217.39	4.76	410.74	87.35	323.40	324.62	-0.50
	55	217.40	4.78	413.62	89.04	324.58	324.61	-0.13
16/11/2017	56	217.24	4.76	412.23	89.21	323.02	324.59	-0.61
	57	217.48	4.86	416.41	91.45	324.96	324.59	-0.01
17/11/2017	58	217.33	4.79	416.67	89.78	326.88	324.63	0.58
	59	217.46	4.83	414.29	90.49	323.80	324.62	-0.37
18/11/2017	60	217.40	4.83	416.11	89.92	326.18	324.64	0.36
	61	217.46	4.78	419.38	90.37	329.01	324.71	1.22
20/11/2017	62	217.41	4.79	413.94	88.20	325.74	324.73	0.23
	62	217.44	4.76	413.84	87.47	326.38	324.75	0.42
23/11/2017	63	217.40	4.87	415.08	89.23	325.85	324.77	0.26
24/11/2017	64	217.42	4.79	414.47	89.60	324.87	324.77	-0.04
	64	217.39	4.82	412.65	89.78	322.88	324.74	-0.66
25/11/2017	65	217.41	4.90	414.06	88.71	325.35	324.75	0.11
	65	217.44	4.84	413.95	89.40	324.54	324.75	-0.14
27/11/2017	66	217.48	4.81	408.99	90.91	318.08	324.66	-2.17
	67	217.18	4.78	415.51	90.64	324.87	324.66	-0.04
28/11/2017	68	217.42	4.91	401.30	88.39	312.91	324.50	-3.86
	69	217.40	4.87	416.83	90.01	326.82	324.53	0.56
2/12/2017	70	217.41	4.76	415.07	88.72	326.35	324.55	0.41
	70	217.57	4.78	409.14	88.61	320.53	324.50	-1.39
3/12/2017	71	217.33	4.80	410.52	88.76	321.76	324.47	-1.01
	71	217.40	4.77	410.95	88.66	322.29	324.44	-0.84
4/12/2017	72	217.37	4.86	408.95	88.90	320.05	324.38	-1.55
	72	217.39	4.70	412.79	90.82	321.97	324.36	-0.94
5/12/2017	73	217.43	4.85	410.43	89.19	321.24	324.32	-1.17
	73	217.42	4.76	413.30	89.18	324.11	324.31	-0.27
6/12/2017	74	217.47	4.79	414.21	89.78	324.42	324.32	-0.18
	74	217.41	4.85	414.68	89.84	324.84	324.32	-0.05
7/12/2017	75	217.46	4.86	412.47	91.09	321.38	324.29	-1.13
	75	217.37	4.79	413.84	90.59	323.25	324.28	-0.54
8/12/2017	76	217.27	4.76	416.29	89.53	326.76	324.30	0.54
	77	217.43	4.82	415.92	89.20	326.72	324.33	0.53
9/12/2017	78	217.29	4.85	412.43	88.86	323.58	324.32	-0.44
	79	217.46	4.86	415.39	91.21	324.17	324.32	-0.26
10/12/2017	80	217.40	4.84	414.01	91.45	322.56	324.30	-0.76
	81	217.36	4.89	417.09	91.07	326.02	324.32	0.31
11/12/2017	82	217.50	4.94	419.19	91.23	327.96	324.36	0.90
	83	217.45	4.92	420.80	90.44	330.36	324.42	1.62
12/12/2017	84	217.56	4.84	419.15	90.62	328.53	324.47	1.07
	85	217.42	4.85	418.78	90.54	328.24	324.50	0.99
13/12/2017	86	217.43	4.80	416.90	89.77	327.12	324.53	0.65
	86	217.41	4.93	418.03	93.78	324.26	324.53	-0.23
14/12/2017	87	217.51	4.76	417.47	90.44	327.03	324.55	0.62
	88	217.44	4.90	418.41	90.00	328.41	324.59	1.04
15/12/2017	89	217.45	4.90	417.49	90.63	326.85	324.61	0.57
	89	217.42	4.97	418.38	91.93	326.45	324.63	0.44
16/12/2017	90	217.33	4.90	414.93	90.50	324.43	324.63	-0.18

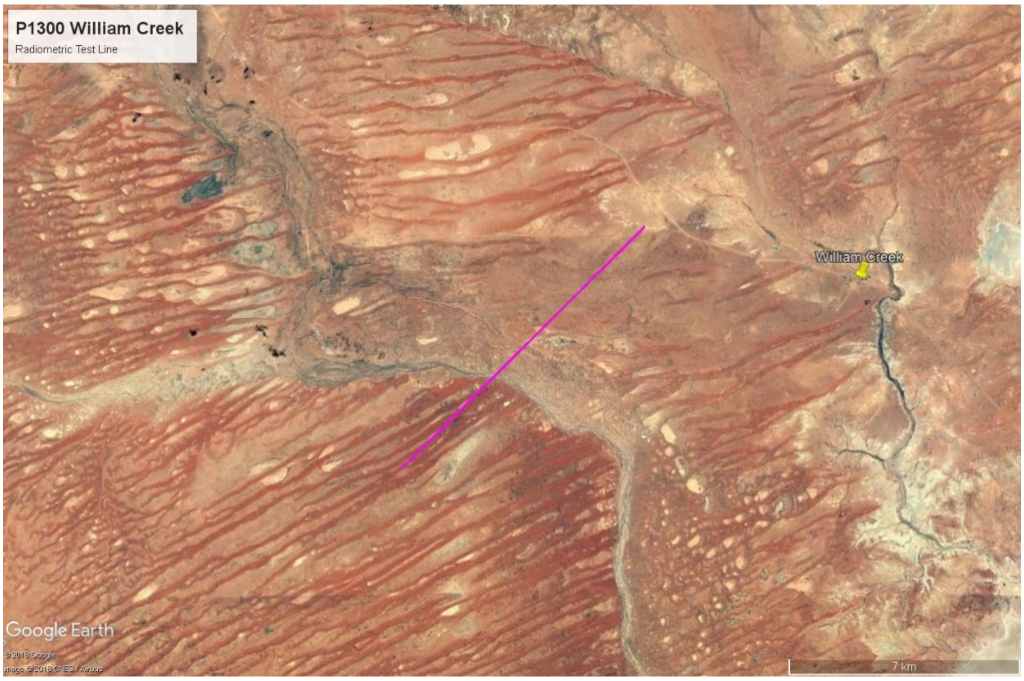
	90	217.39	4.81	416.29	89.83	326.46	324.65	0.45
17/12/2017	91	217.39	4.99	419.41	90.85	328.55	324.68	1.08
	91	217.37	4.85	417.37	92.16	325.21	324.69	0.06
18/12/2017	92	217.45	4.95	418.05	92.00	326.06	324.70	0.32
	92	217.46	5.06	419.72	91.63	328.09	324.73	0.94

A summary plot of the ground calibrations for the duration of the project is shown below: -

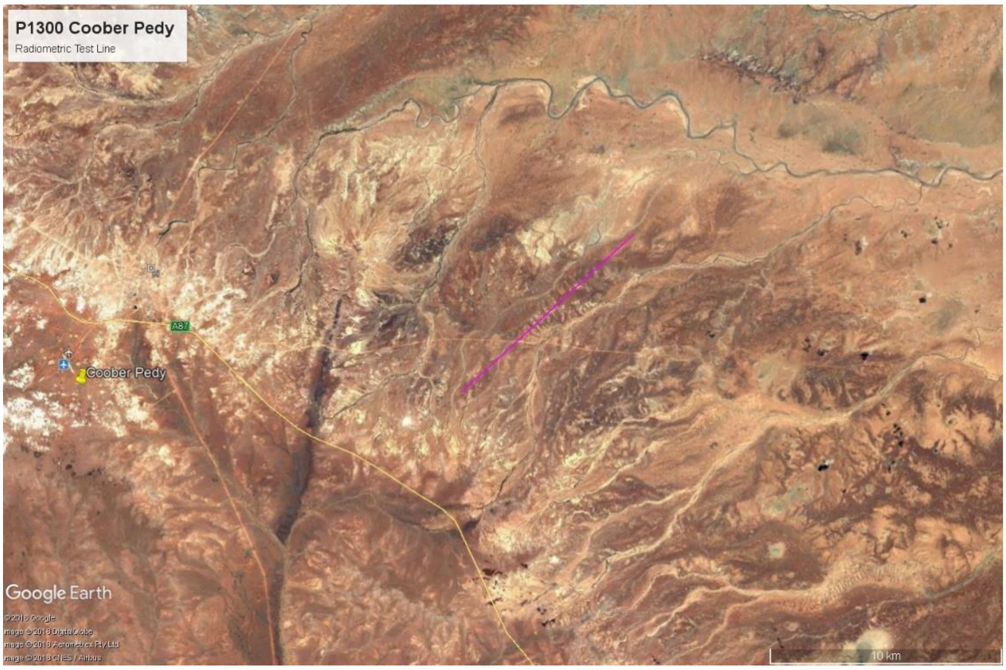


Low Level Test Line

A suitable radiometric low-level test line was established near each base of operation, as shown in the images below. The pre- and post-survey data were collected to monitor the effects of soil moisture: -



William Creek low-level test line (Start: 624332E 6803154N; End: 616927E 6795974N – MGA Zone 53)



Coober Pedy low-level test line (Start: 489949E 6786362N; End: 497345E 6793110N – MGA Zone 53)

Low Level Test Lines (William Creek)

Date	Flight #	Background and height corrected thorium (cps)	% change from mean
10/10/2017	1	26.53	0.92
	1	26.05	-0.93
13/10/2017	2	27.25	3.51
	2	27.61	4.79
14/10/2017	3	25.88	-1.57
	5	25.98	-1.19
15/10/2017	6	27.15	3.16
	7	25.91	-1.48
16/10/2017	8	27.35	3.87
	9	27.15	3.16
17/10/2017	10	26.62	1.25
	11	26.28	-0.05
18/10/2017	12	26.68	1.46
	13	27.31	3.72
20/10/2017	14	26.92	2.34
	14	26.25	-0.17
21/10/2017	15	25.94	-1.36
	17	26.63	1.28
22/10/2017	18	26.48	0.73
	20	27.39	4.03
23/10/2017	21	26.90	2.27
	22	26.08	-0.82
24/10/2017	23	26.71	1.57
		No post flight due wx	
25/10/2017	24	26.95	2.45
	25	27.13	3.11
26/10/2017	26	25.78	-1.99
		No post flight due wx	
27/10/2017	28	27.05	2.82
	28	27.77	5.33
28/10/2017	29	25.84	-1.73
	31	27.42	4.13
29/10/2017	32	26.11	-0.71
	32	28.05	6.27
30/10/2017	33	25.70	-2.30
	34	26.18	-0.42
31/10/2017	35	26.30	0.02
	36	26.81	1.93
3/11/2017	37	26.20	-0.33
	38	27.10	2.98
4/11/2017	39	26.37	0.31
	40	27.33	3.80

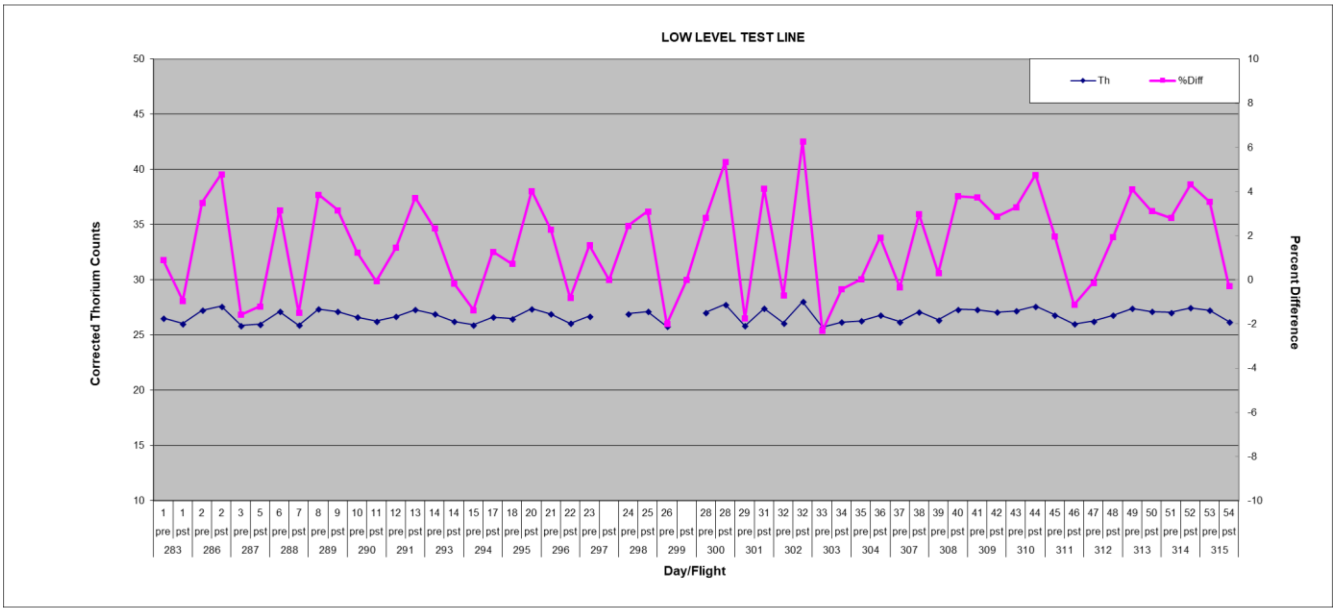
5/11/2017	41	27.31	3.74
	42	27.07	2.87
6/11/2017	43	27.18	3.29
	44	27.61	4.77
7/11/2017	45	26.82	1.98
	46	26.00	-1.12
8/11/2017	47	26.26	-0.12
	48	26.81	1.94
9/11/2017	49	27.42	4.11
	50	27.14	3.12
10/11/2017	51	27.05	2.81
	52	27.48	4.34
11/11/2017	53	27.26	3.55
	54	26.22	-0.28
10/10/2017	1	26.53	0.92
	1	26.05	-0.93
13/10/2017	2	27.25	3.51
	2	27.61	4.79
14/10/2017	3	25.88	-1.57
	5	25.98	-1.19
15/10/2017	6	27.15	3.16
	7	25.91	-1.48
16/10/2017	8	27.35	3.87
	9	27.15	3.16

Low Level Test Lines (Coober Pedy)

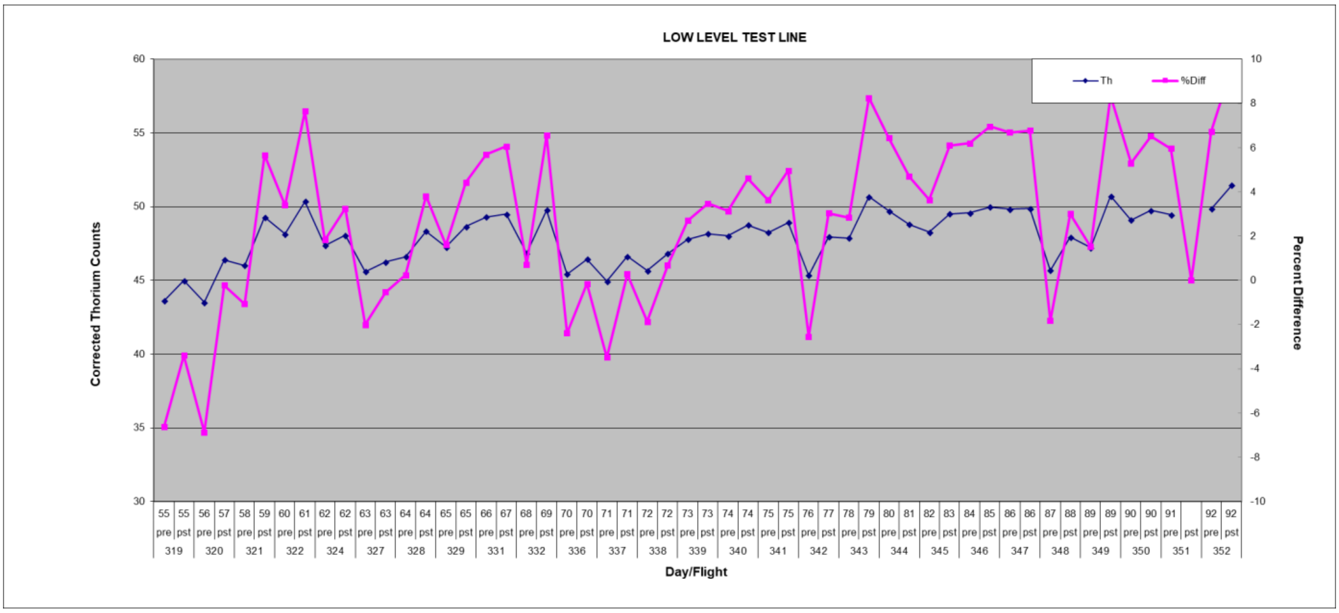
Date	Flight #	Background and height corrected thorium (cps)	% change from mean
15/11/2017	55	43.61	-6.62
	55	44.97	-3.40
16/11/2017	56	43.51	-6.87
	57	46.39	-0.23
17/11/2017	58	46.01	-1.07
	59	49.29	5.66
18/11/2017	60	48.13	3.40
	61	50.35	7.65
20/11/2017	62	47.36	1.82
	62	48.06	3.25
23/11/2017	63	45.59	-2.01
	63	46.25	-0.53
24/11/2017	64	46.61	0.24
	64	48.34	3.81
25/11/2017	65	47.25	1.60
	65	48.66	4.43
27/11/2017	66	49.30	5.69

	67	49.50	6.06
28/11/2017	68	46.83	0.71
	69	49.76	6.54
2/12/2017	70	45.42	-2.38
	70	46.43	-0.15
3/12/2017	71	44.93	-3.48
	71	46.63	0.28
4/12/2017	72	45.65	-1.87
	72	46.81	0.67
5/12/2017	73	47.79	2.70
	73	48.17	3.47
6/12/2017	74	48.01	3.14
	74	48.74	4.60
7/12/2017	75	48.25	3.62
	75	48.93	4.96
8/12/2017	76	45.35	-2.54
	77	47.95	3.03
9/12/2017	78	47.86	2.85
	79	50.68	8.24
10/12/2017	80	49.70	6.43
	81	48.79	4.70
11/12/2017	82	48.26	3.65
	83	49.52	6.10
12/12/2017	84	49.57	6.20
	85	49.98	6.95
13/12/2017	86	49.83	6.69
	86	49.88	6.77
14/12/2017	87	45.67	-1.82
	88	47.94	3.01
15/12/2017	89	47.22	1.52
	89	50.72	8.33
16/12/2017	90	49.10	5.29
	90	49.74	6.52
17/12/2017	91	49.45	5.96
		No post flight due wx	
18/12/2017	92	49.86	6.74
	92	51.46	9.64

Summary plots of the test lines for the duration of the project are shown below: -



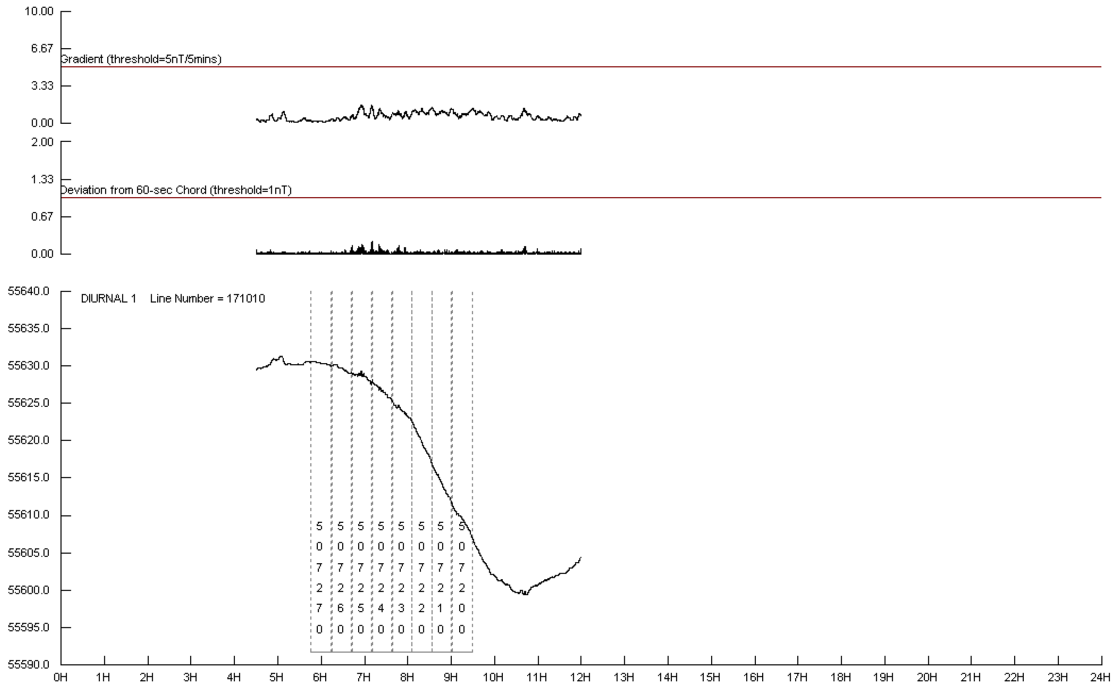
Low level test line William Creek

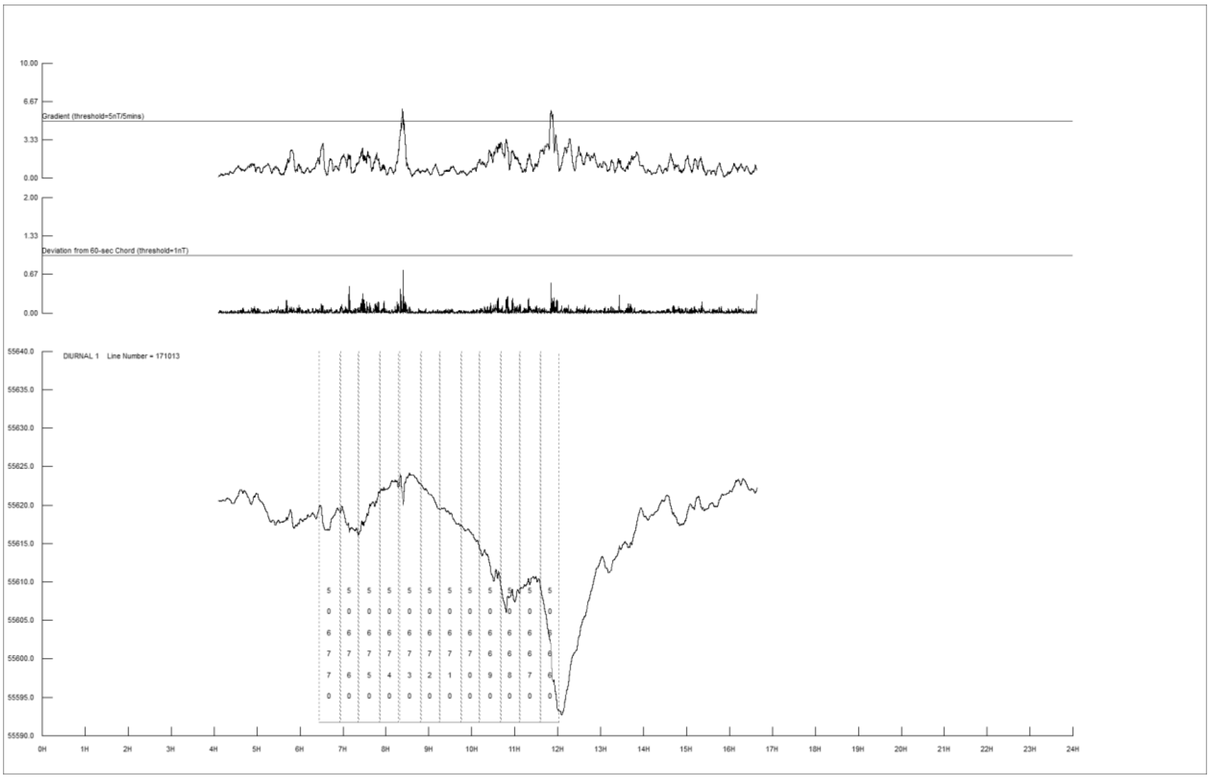


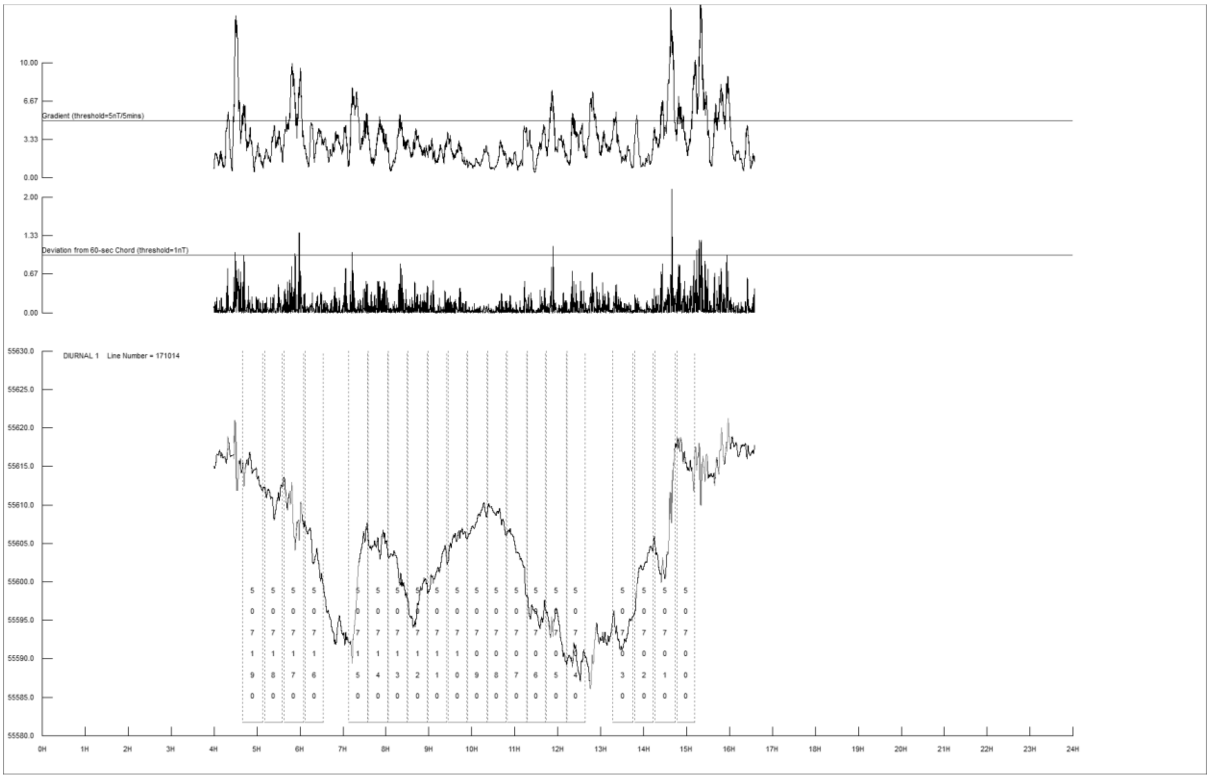
Low level test line – Coober Pedy

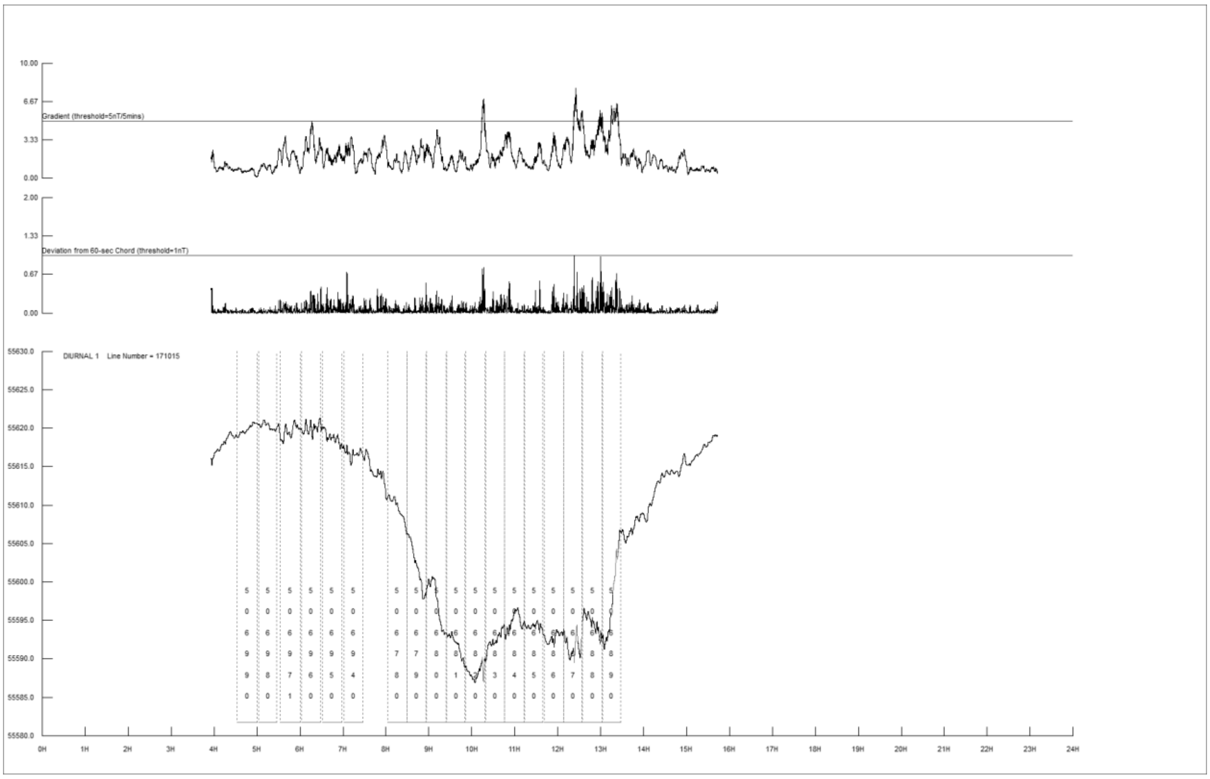
APPENDIX 3 DIURNAL BASE STATION PLOTS

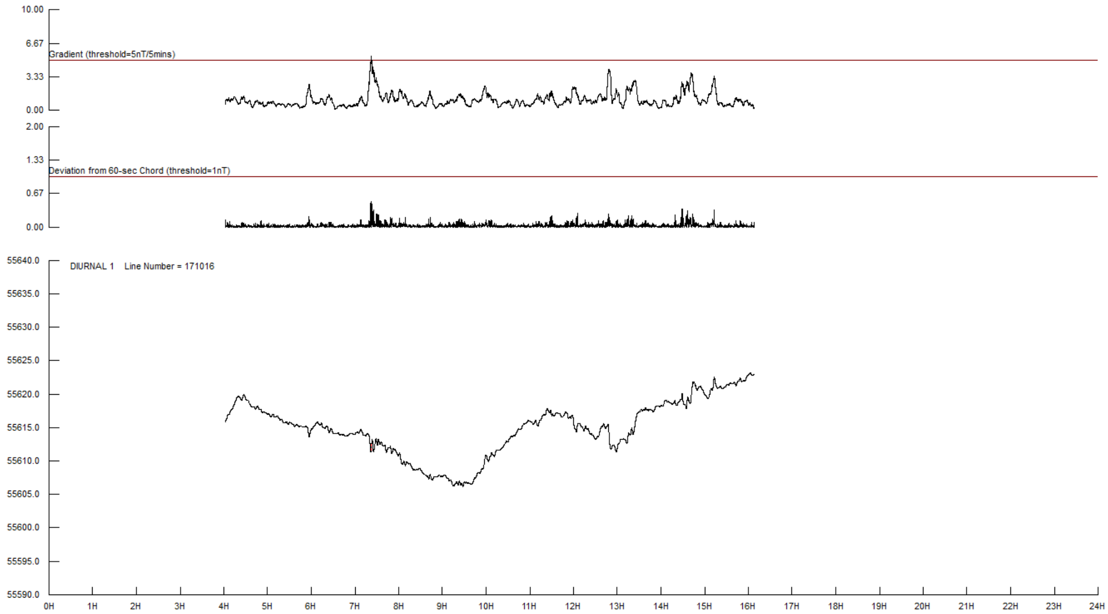
Diurnal 1 Line Number = YYMMDD

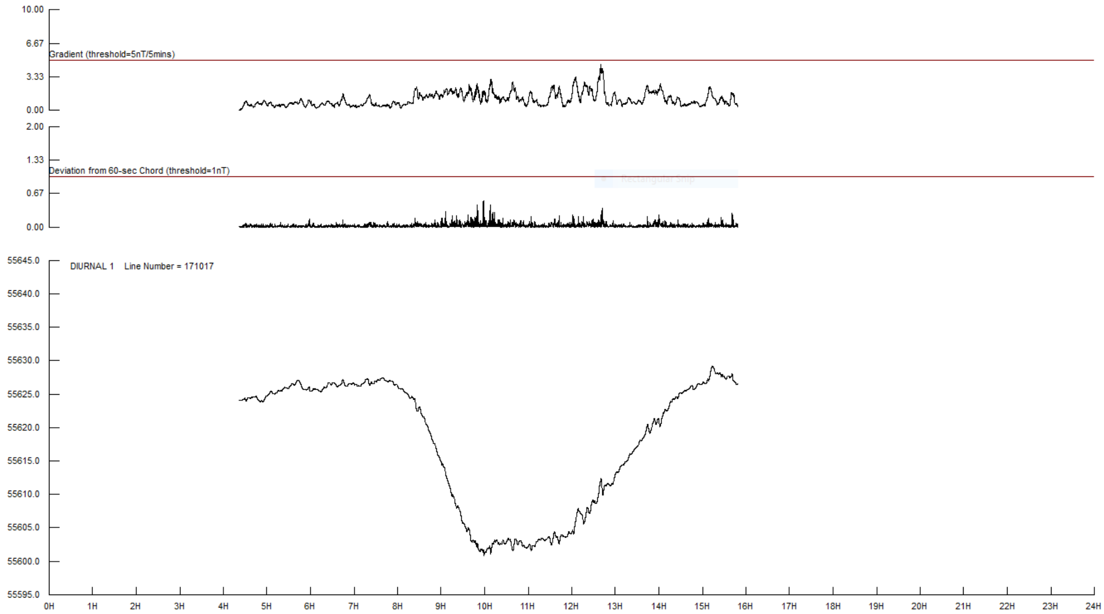


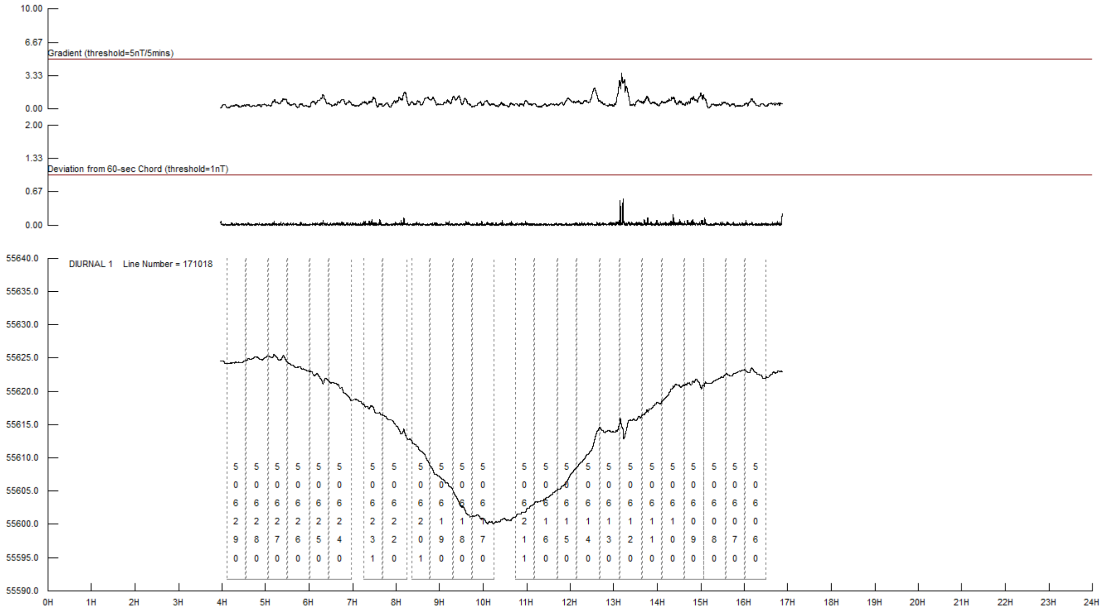


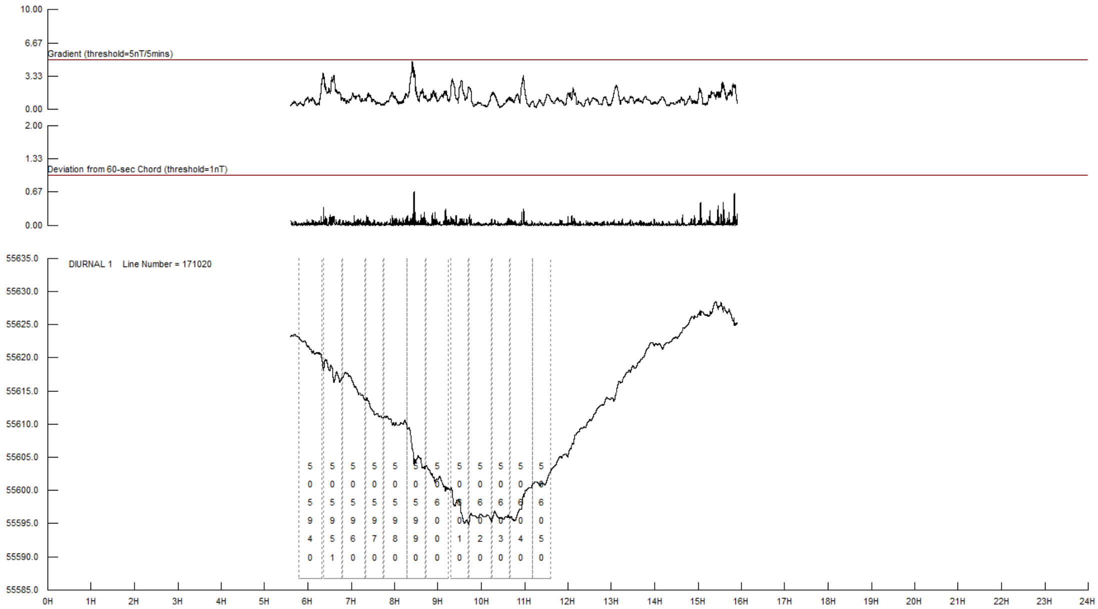

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171014
10.00
6.67
3.33
0.00
2.00
1.33
0.67
0.00
55630.0
55625.0
55620.0
55615.0
55610.0
55605.0
55600.0
55595.0
55590.0
55585.0
55580.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

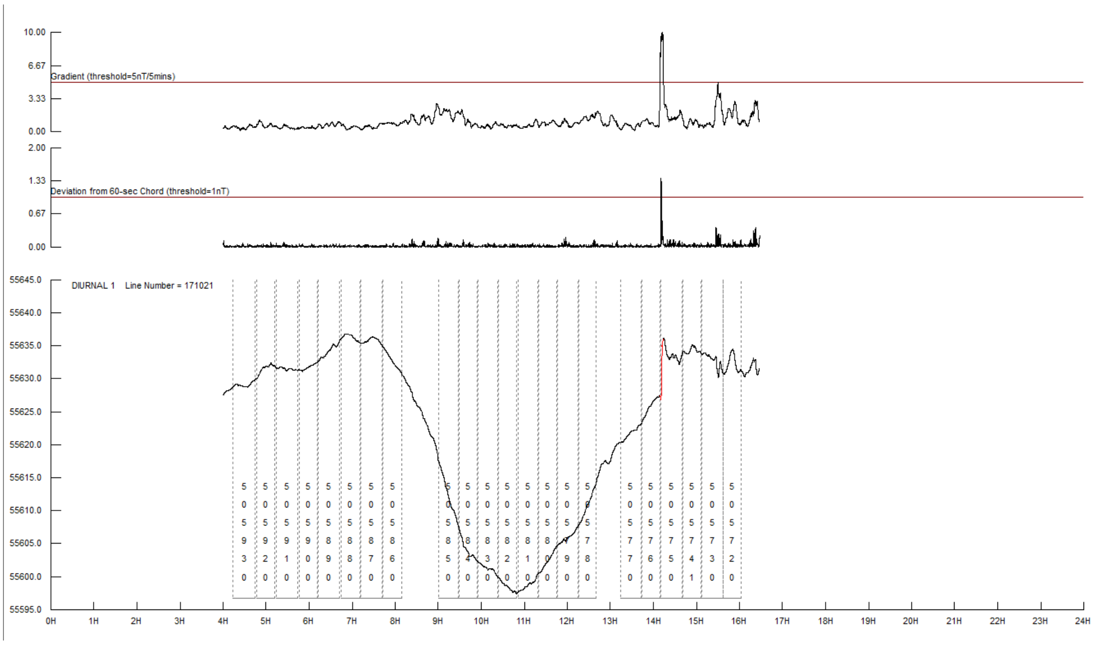

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171015
10.00
6.67
3.33
0.00
2.00
1.33
0.67
0.00
55630.0
55625.0
55620.0
55615.0
55610.0
55605.0
55600.0
55595.0
55590.0
55585.0
55580.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

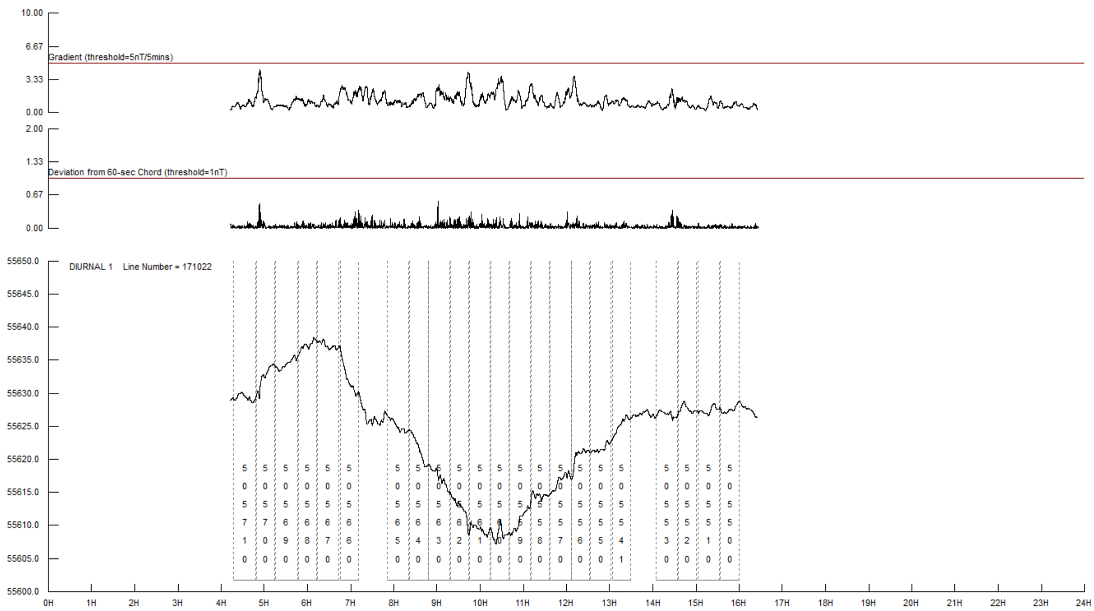

Gradient (threshold=5nT/5mins)
10.00
6.67
3.33
0.00
Deviation from 60-sec Chord (threshold=1nT)
2.00
1.33
0.67
0.00
DIURNAL 1 Line Number = 171016
55640.0
55635.0
55630.0
55625.0
55620.0
55615.0
55610.0
55605.0
55600.0
55595.0
55590.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

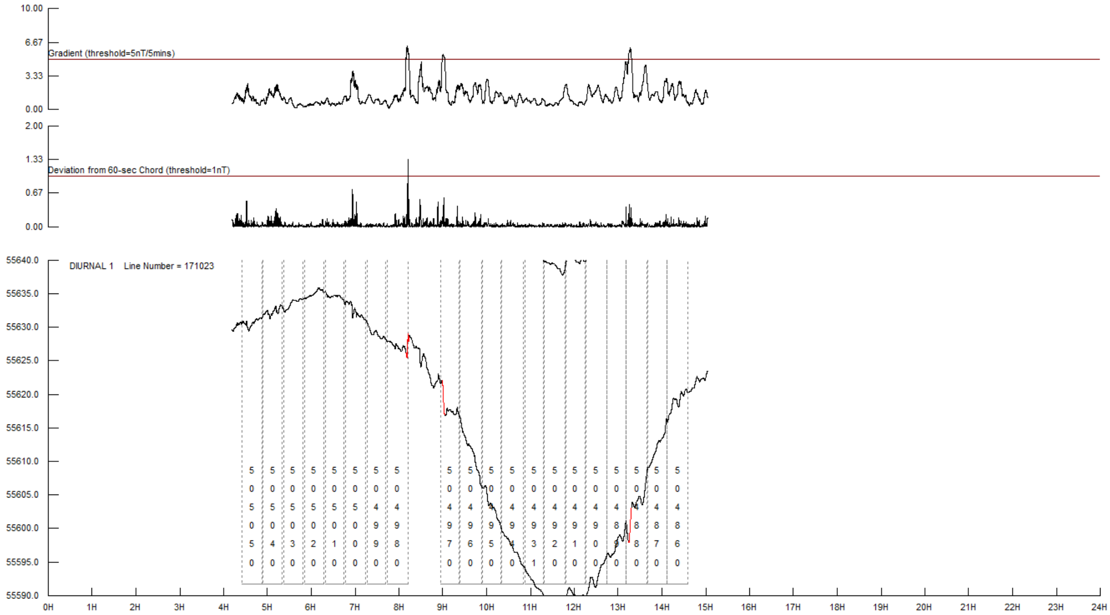

Gradient (threshold=5nT/5mins)
10.00
6.67
3.33
0.00
Deviation from 60-sec Chord (threshold=1nT)
2.00
1.33
0.67
0.00
DIURNAL 1 Line Number = 171017
55645.0
55640.0
55635.0
55630.0
55625.0
55620.0
55615.0
55610.0
55605.0
55600.0
55595.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

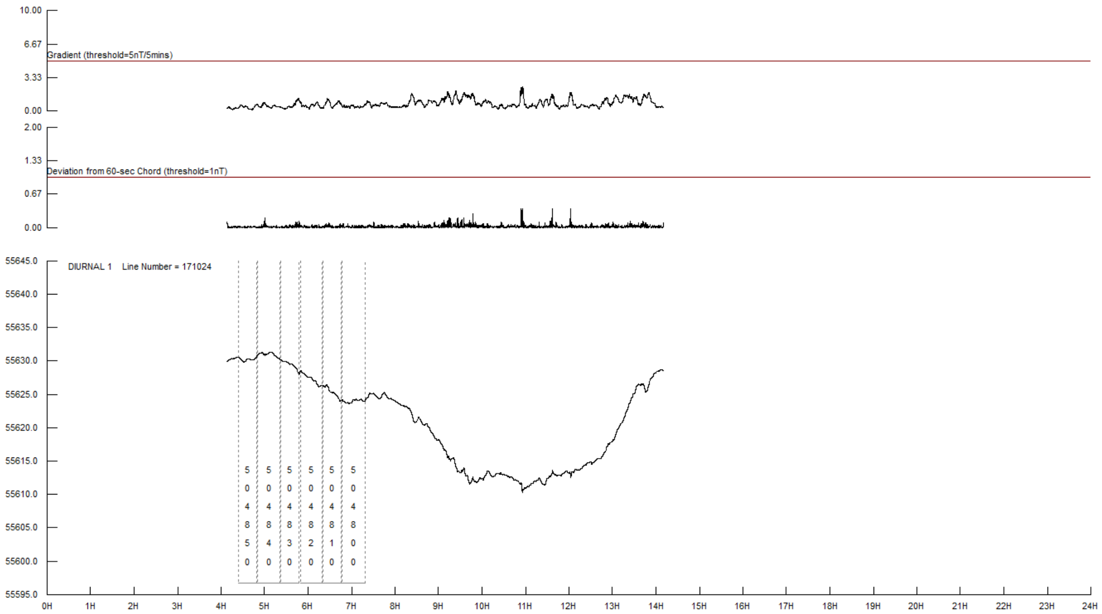

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171018

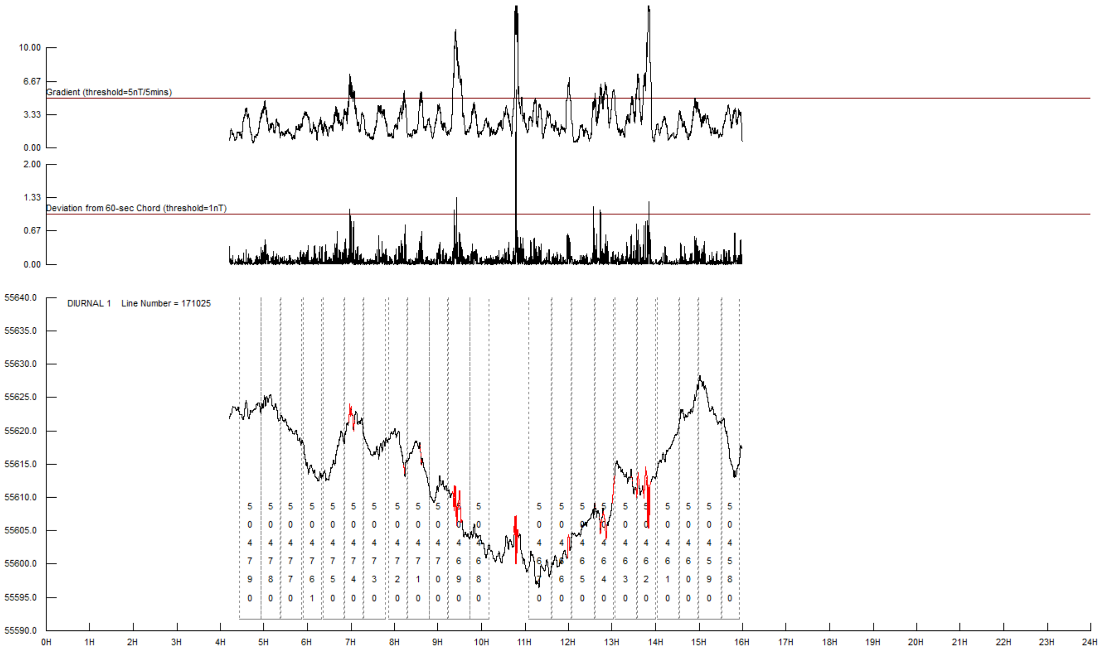

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171020

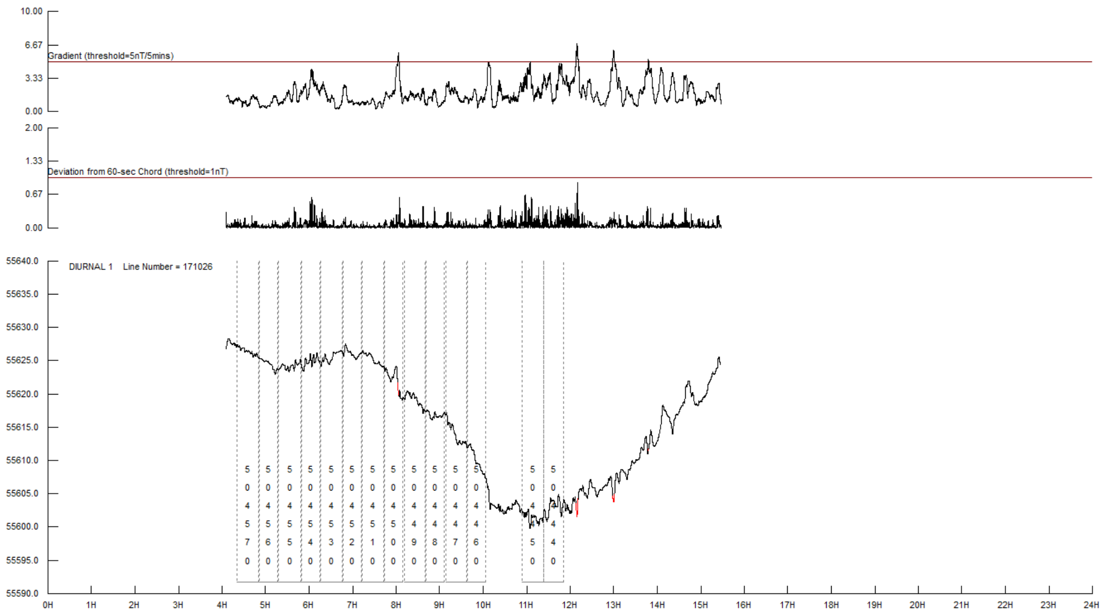

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171021

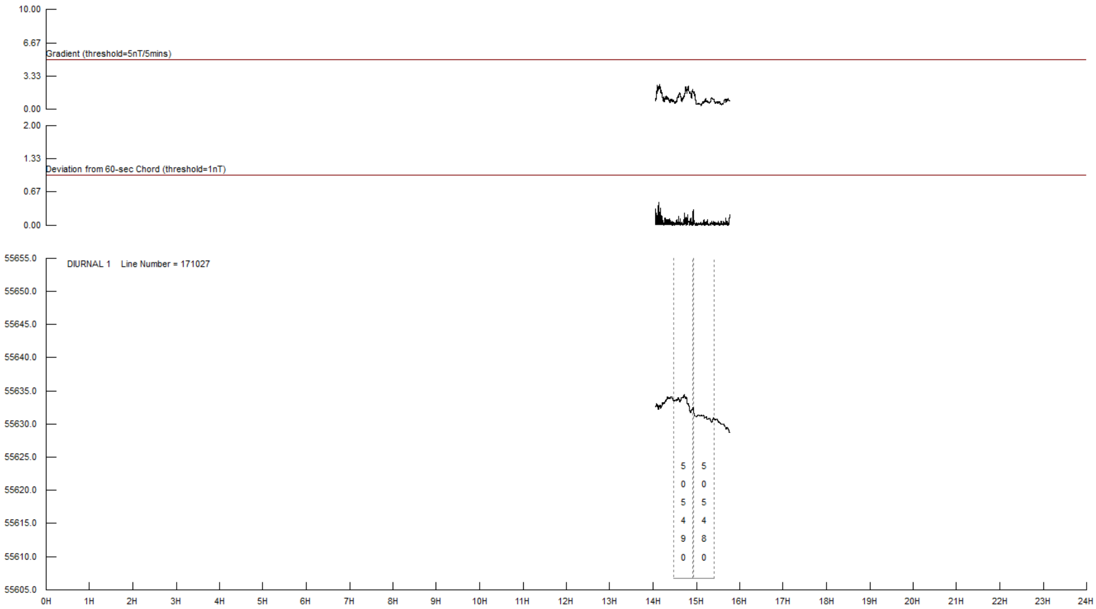

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171022

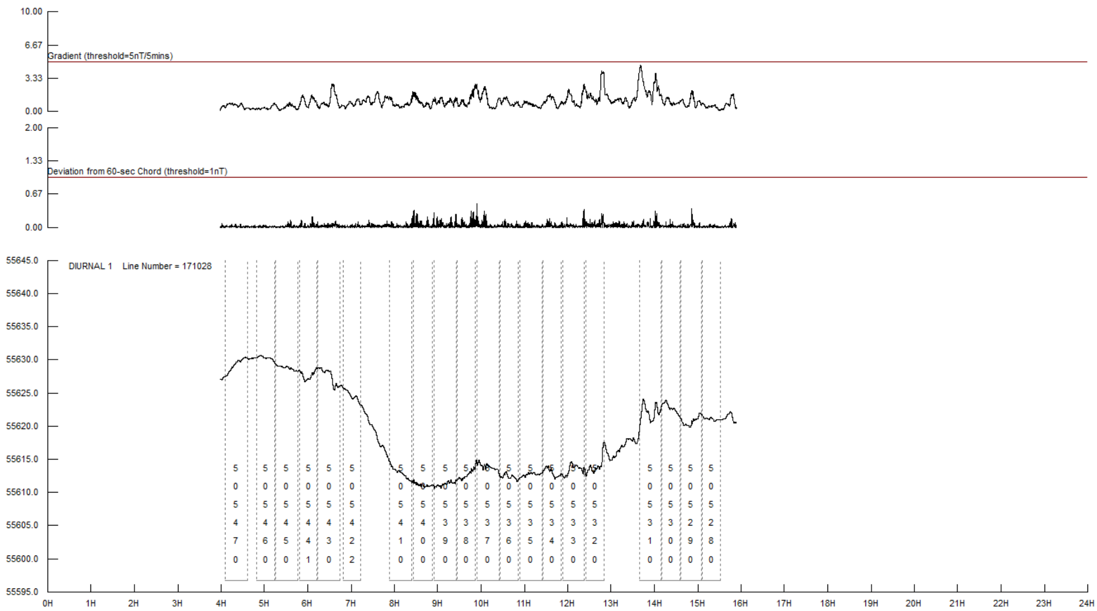

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171023

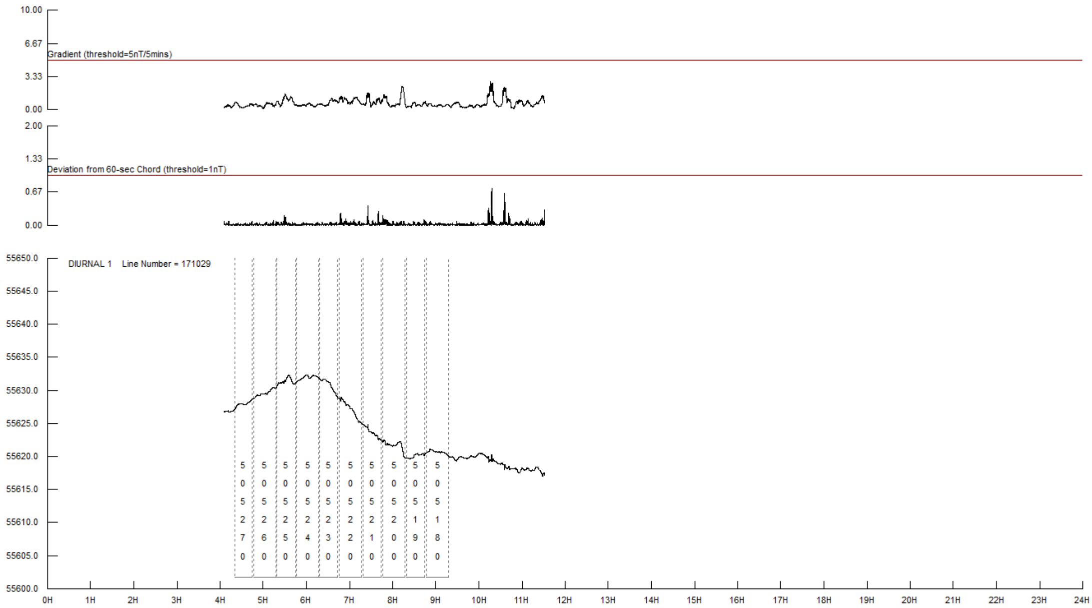

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171024


10.00
6.67
Gradient (threshold=5nT/5mins)
3.33
0.00
2.00
1.33
Deviation from 60-sec Chord (threshold=1nT)
0.67
0.00
DIURNAL 1 Line Number = 171025
55640.0
55635.0
55630.0
55625.0
55620.0
55615.0
55610.0
55605.0
55600.0
55595.0
55590.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

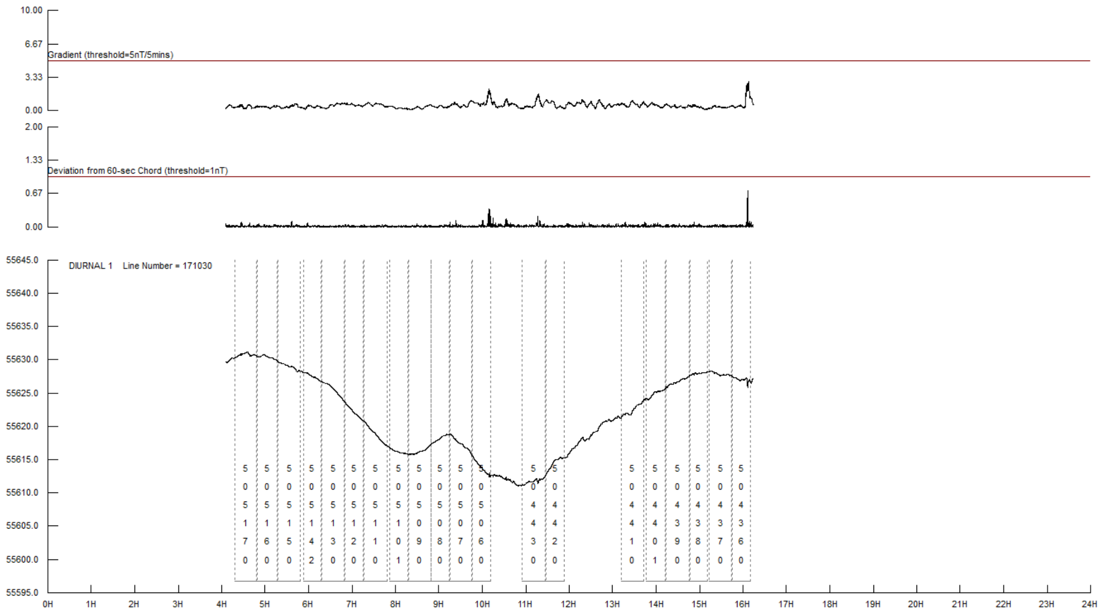

10.00
6.67
Gradient (threshold=5nT/5mins)
3.33
0.00
2.00
1.33
Deviation from 60-sec Chord (threshold=1nT)
0.67
0.00
DIURNAL 1 Line Number = 171026
55640.0
55635.0
55630.0
55625.0
55620.0
55615.0
55610.0
55605.0
55600.0
55595.0
55590.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171027
505490
505480
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

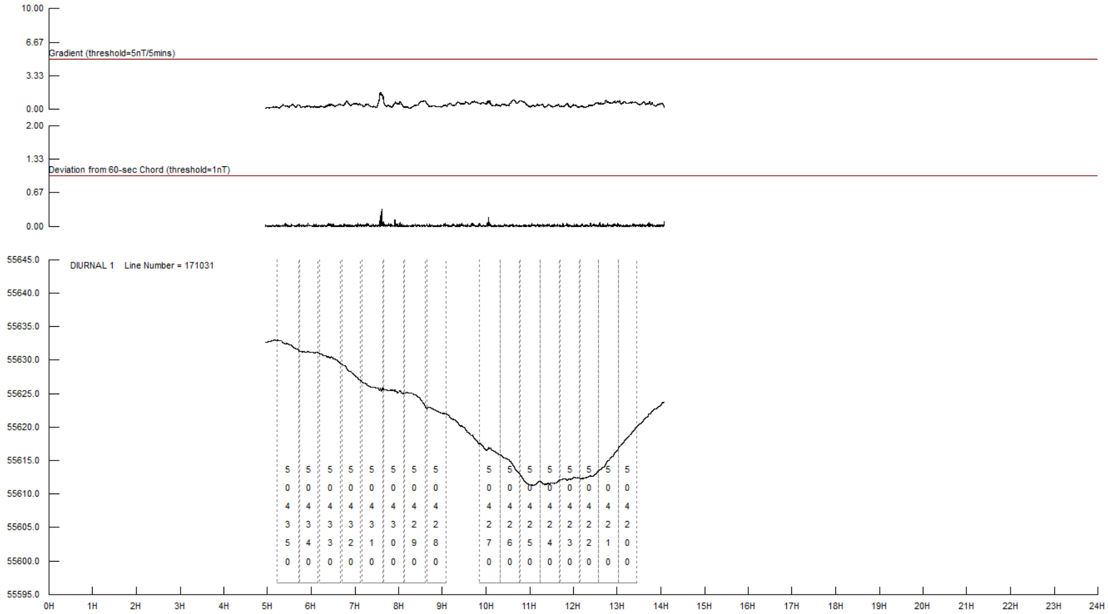

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171028
505470
505460
505450
505441
505430
505422
505410
505400
505390
505380
505370
505360
505350
505340
505330
505320
505310
505300
505290
505280
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

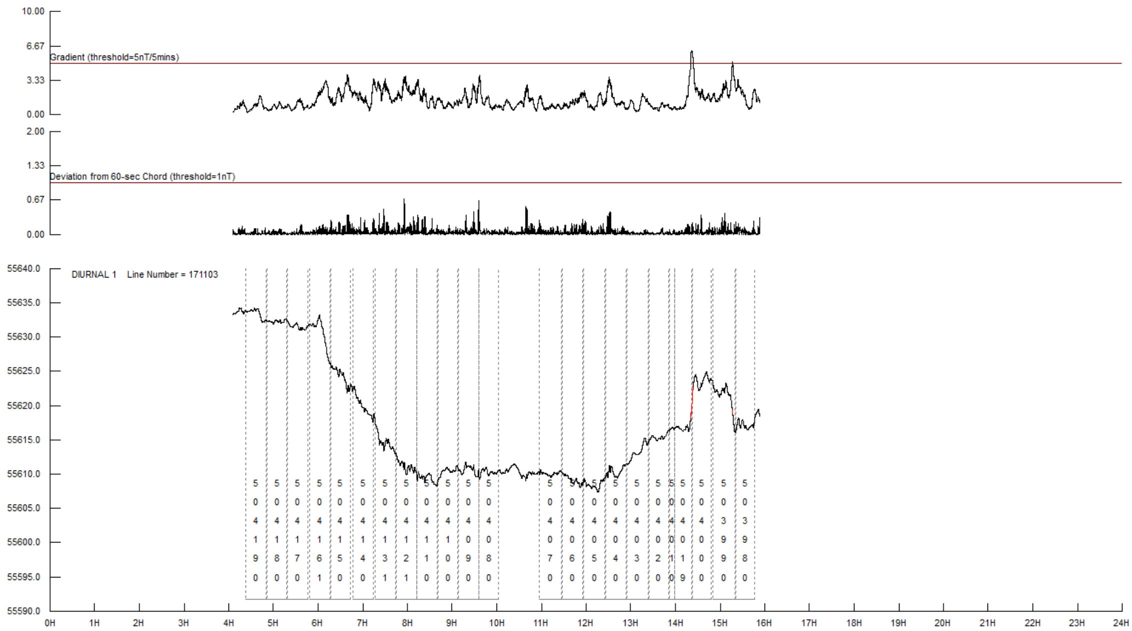


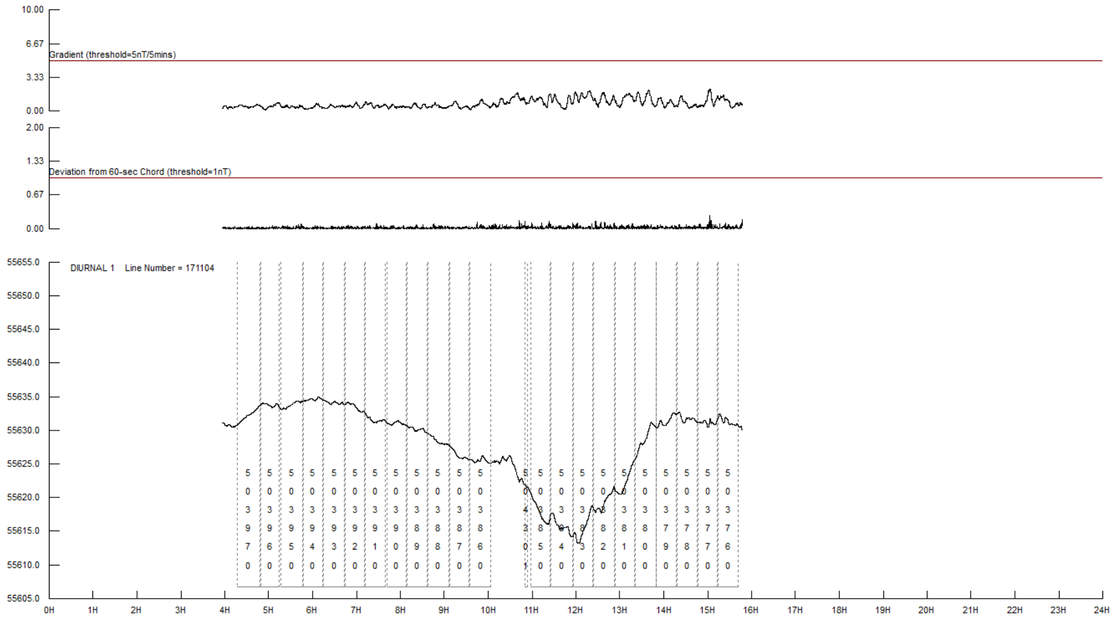
Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171029
10.00
6.67
3.33
0.00
2.00
1.33
0.67
0.00
55650.0
55645.0
55640.0
55635.0
55630.0
55625.0
55620.0
55615.0
55610.0
55605.0
55600.0
505270
505260
505250
505240
505230
505220
505210
505200
505190
505180
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

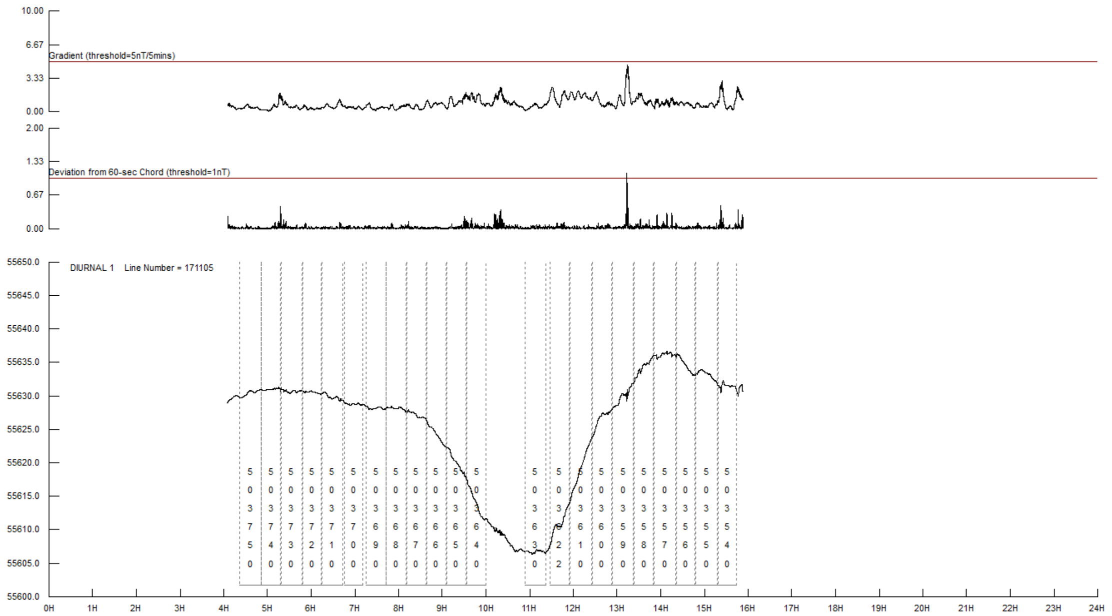


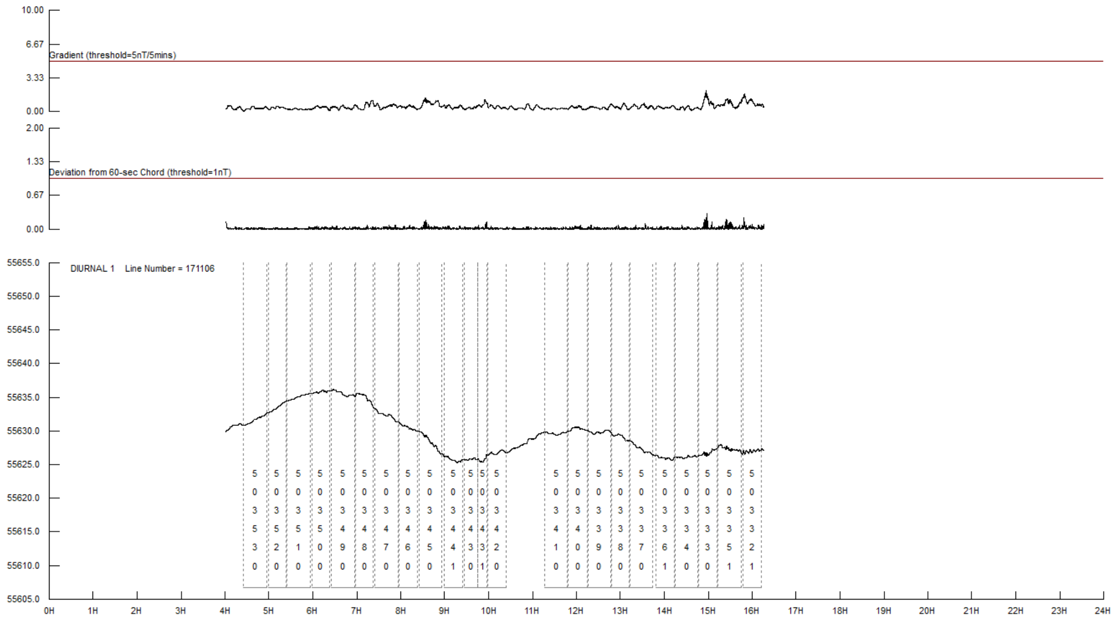
Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171030
10.00
6.67
3.33
0.00
2.00
1.33
0.67
0.00
55645.0
55640.0
55635.0
55630.0
55625.0
55620.0
55615.0
55610.0
55605.0
55600.0
55595.0
505170
505160
505150
505142
505130
505120
505110
505101
505090
505080
505070
505060
504430
504420
504410
504401
504390
504380
504370
504360
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

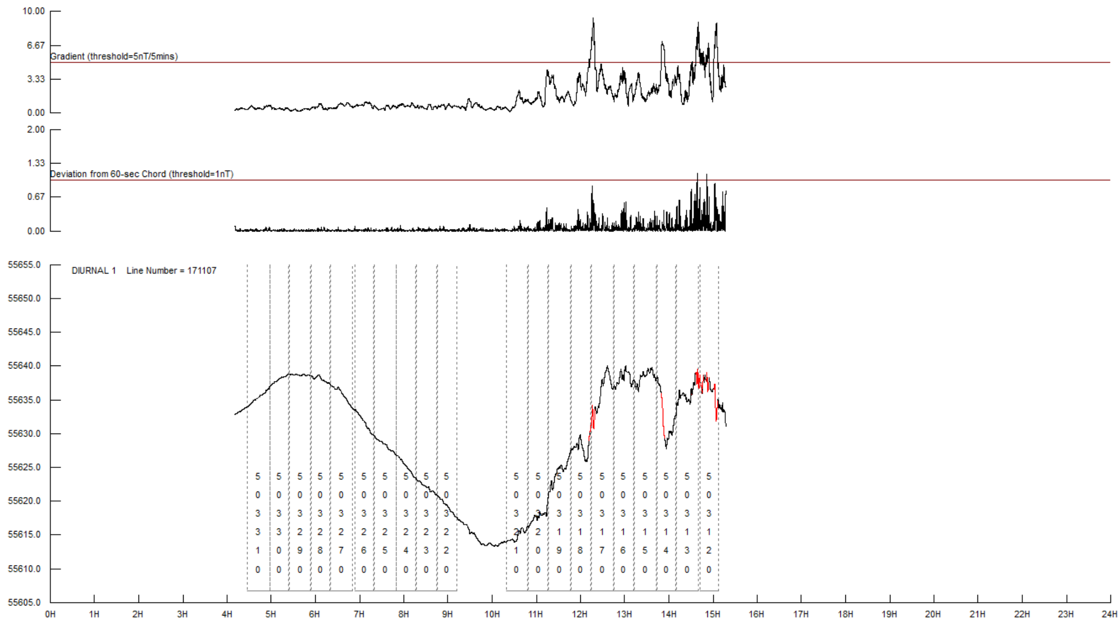

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171031

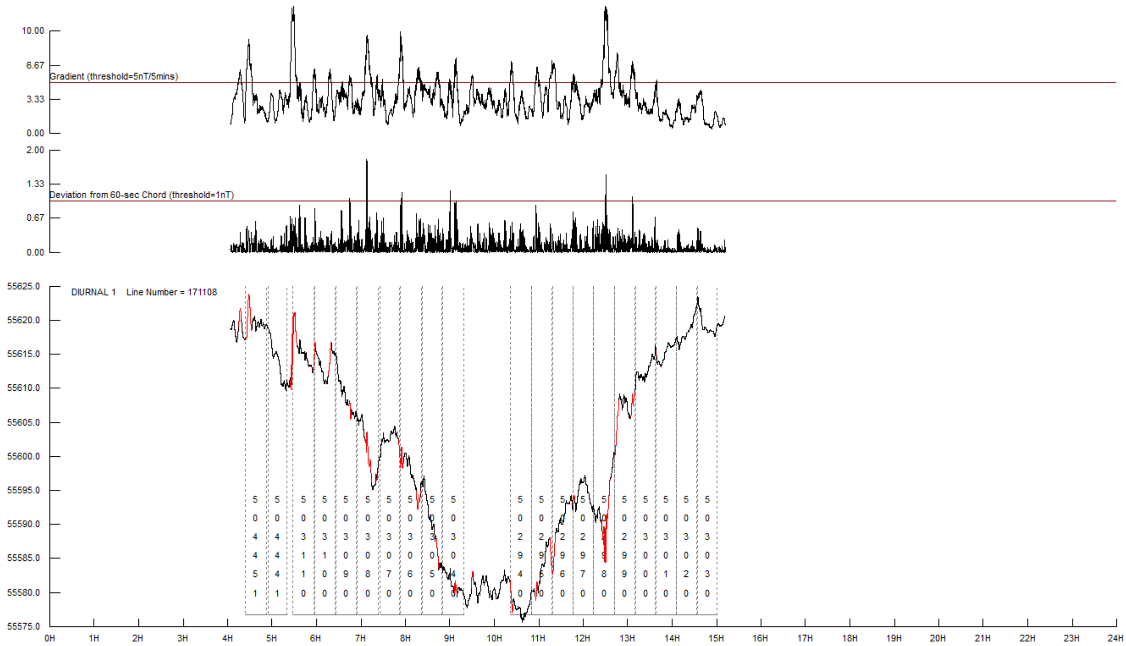

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171103

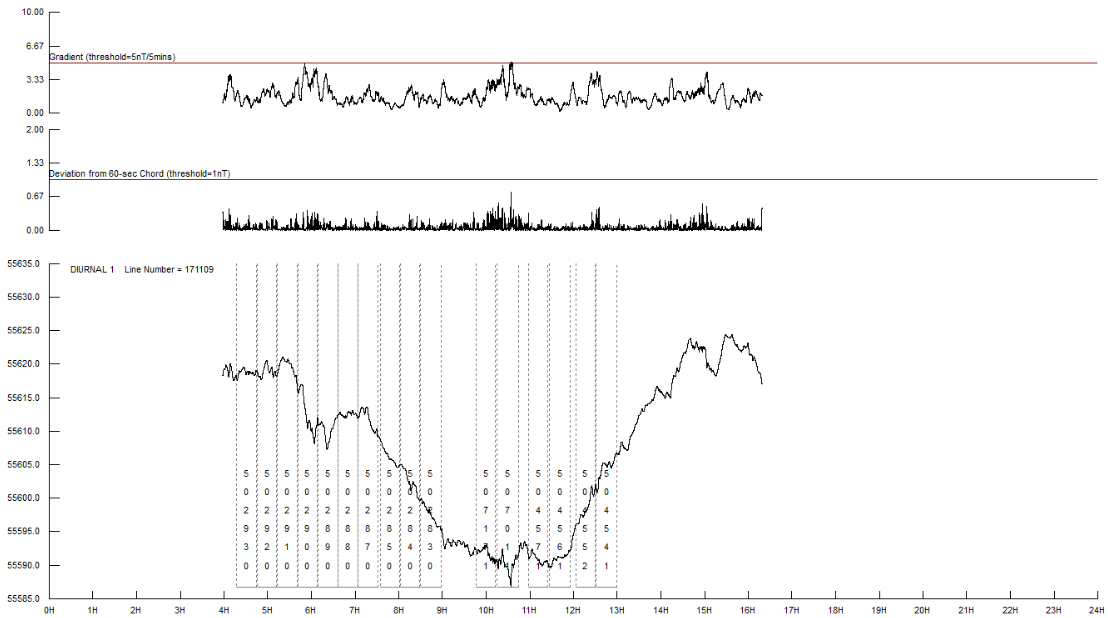

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171104

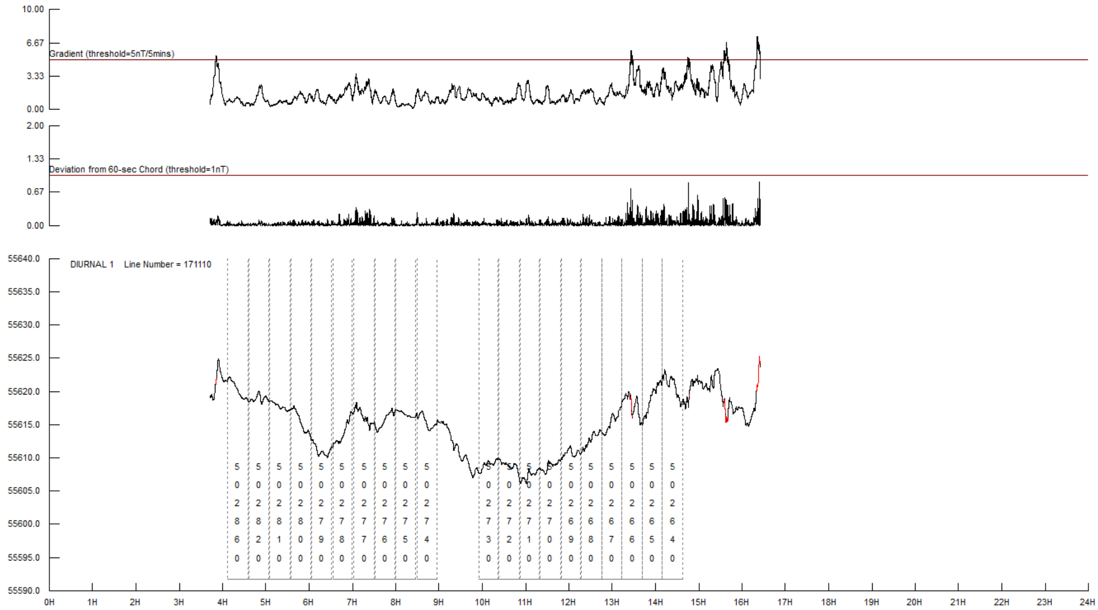

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171105

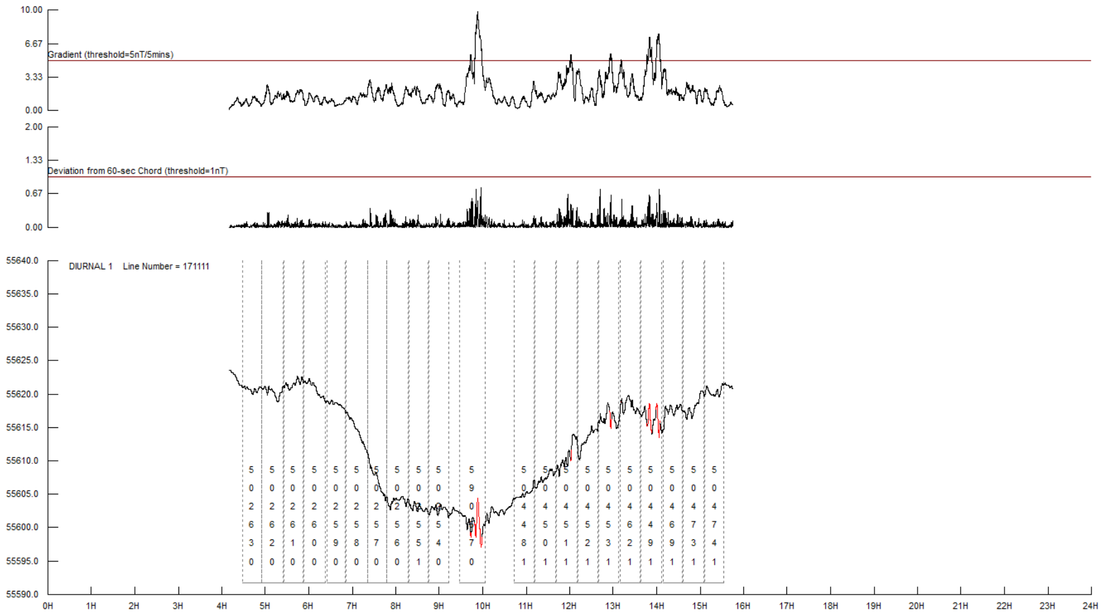

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171106

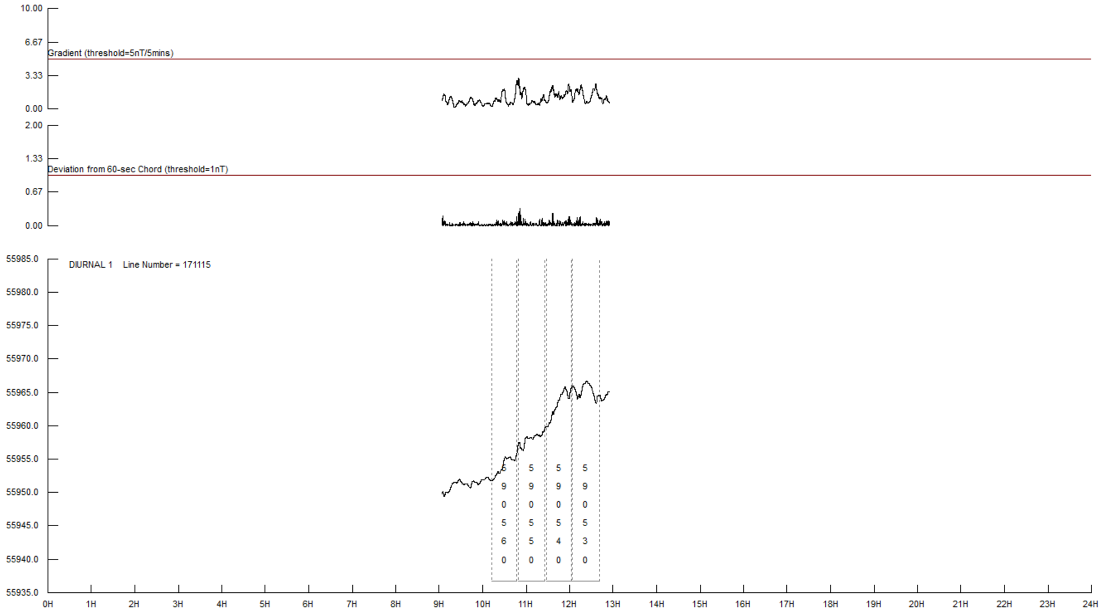

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171107

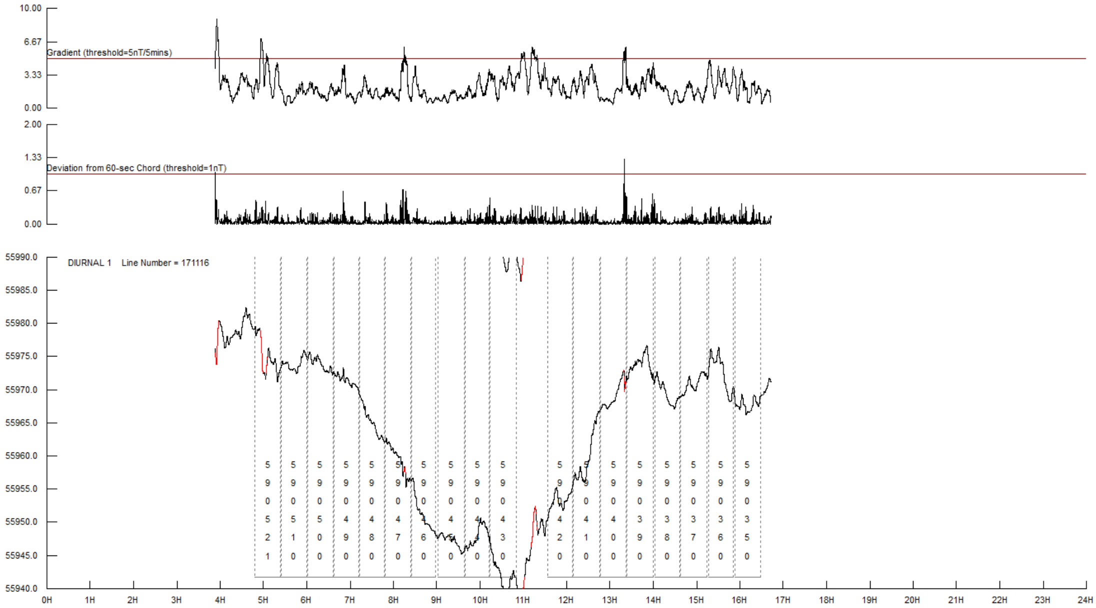

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171108

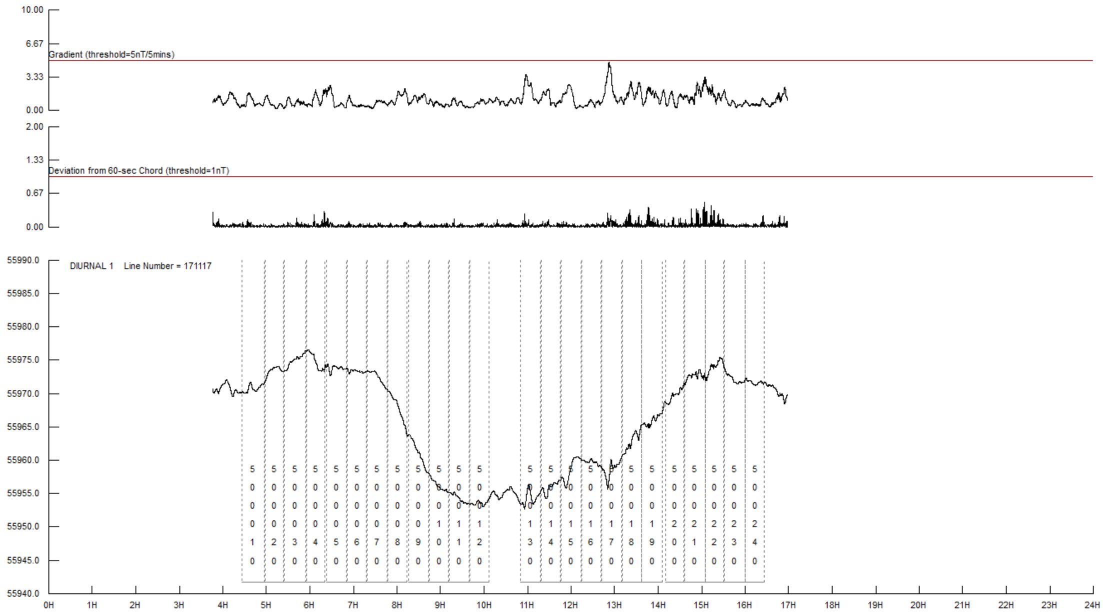

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171109


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171110


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171111


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171115


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171116


10.00
6.67
Gradient (threshold=5nT/5mins)
3.33
0.00
2.00
1.33
Deviation from 60-sec Chord (threshold=1nT)
0.67
0.00
DIURNAL 1 Line Number = 171117
55990.0
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
55945.0
55940.0
500010
500020
500030
500040
500050
500060
500070
500080
500090
500100
500110
500120
500130
500140
500150
500160
500170
500180
500190
500200
500210
500220
500230
500240
0H
1H
2H
3H
4H
5H
6H
7H
8H
9H
10H
11H
12H
13H
14H
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17H
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19H
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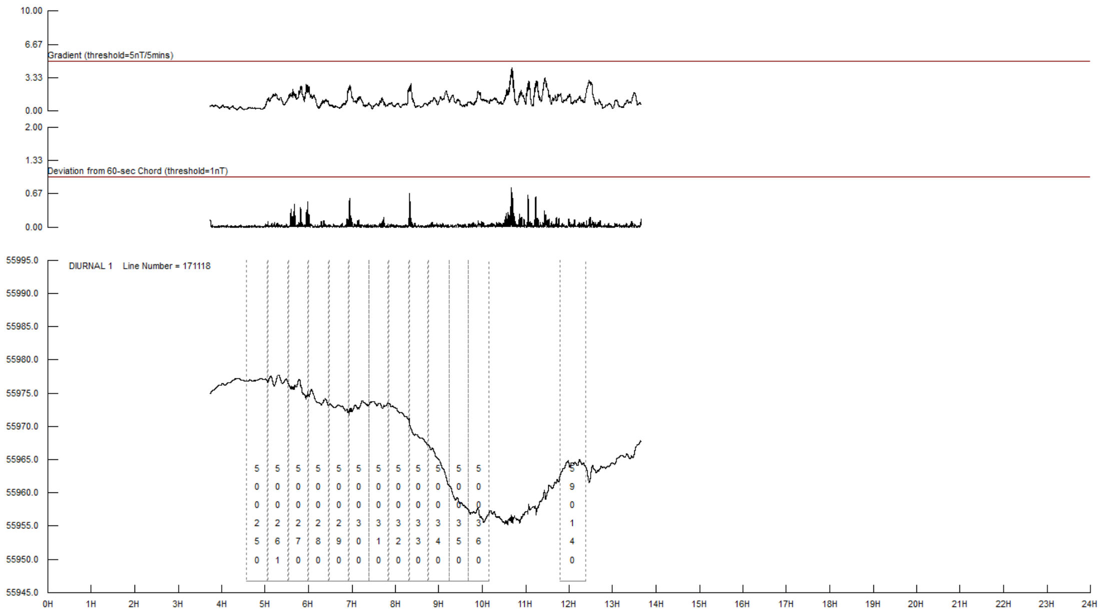
21H
22H
23H
24H


10.00
6.67
Gradient (threshold=5nT/5mins)
3.33
0.00
2.00
1.33
Deviation from 60-sec Chord (threshold=1nT)
0.67
0.00
DIURNAL 1 Line Number = 171118
55995.0
55990.0
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
55945.0
500250
500261
500270
500280
500290
500300
500310
500320
500330
500340
500350
500360
590140
0H
1H
2H
3H
4H
5H
6H
7H
8H
9H
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14H
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17H
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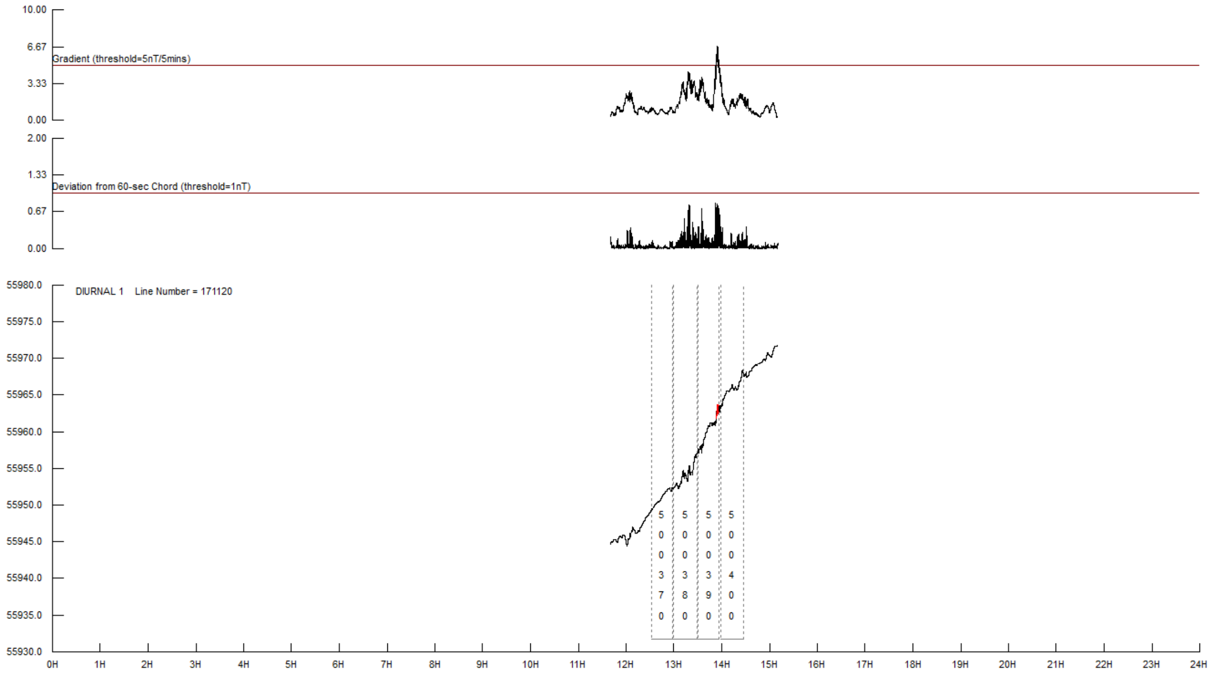
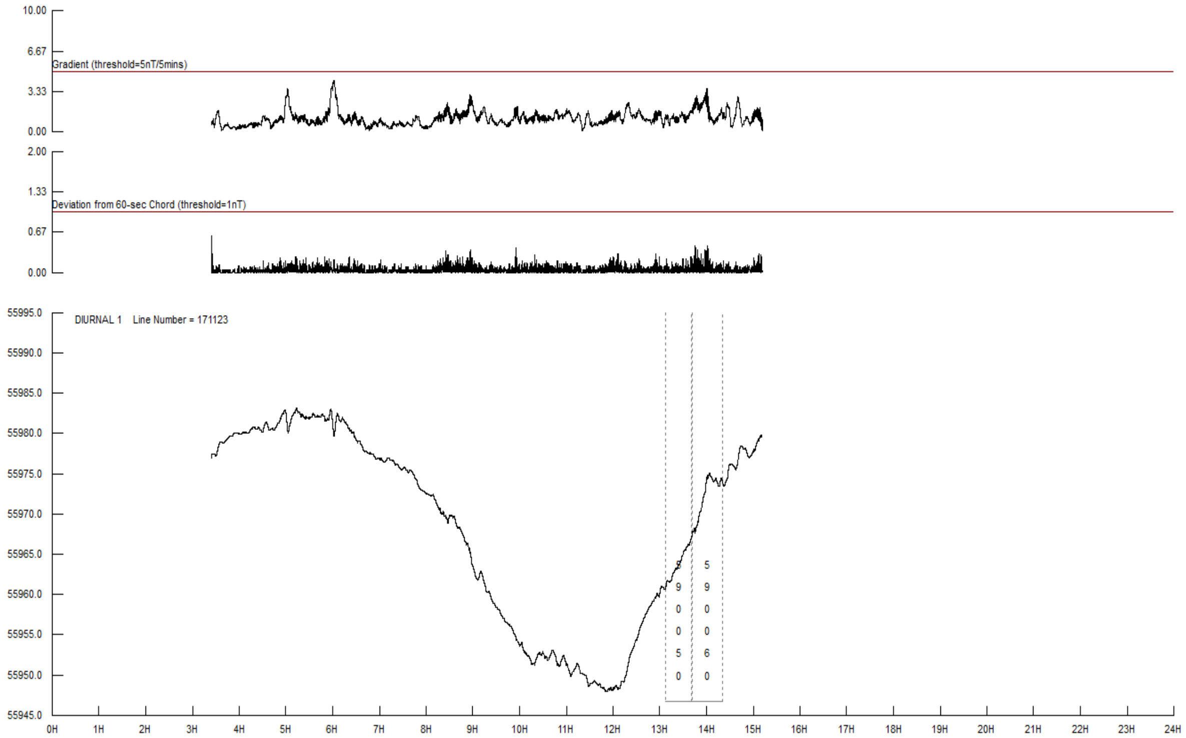
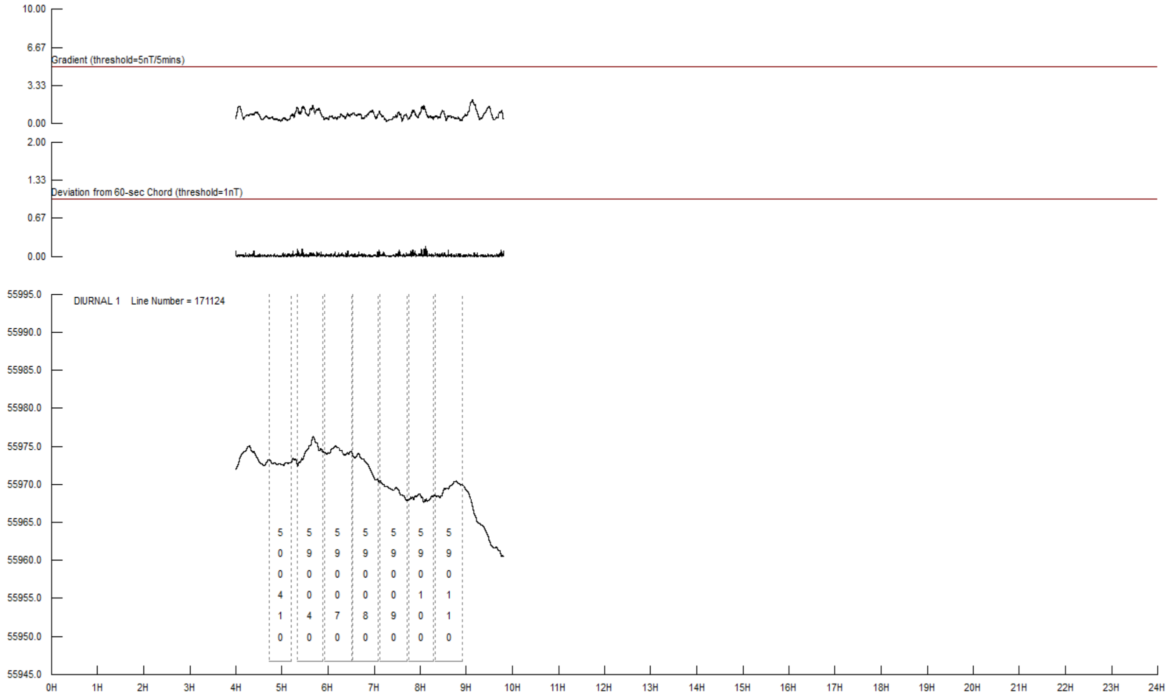
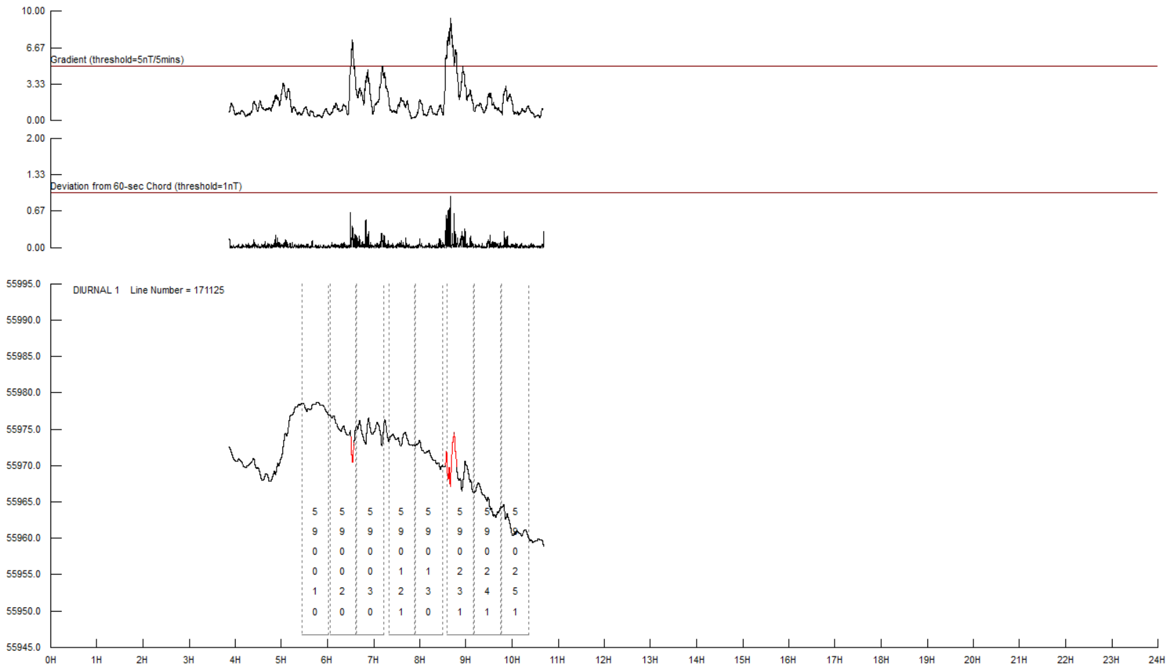
19H
20H
21H
22H
23H
24H

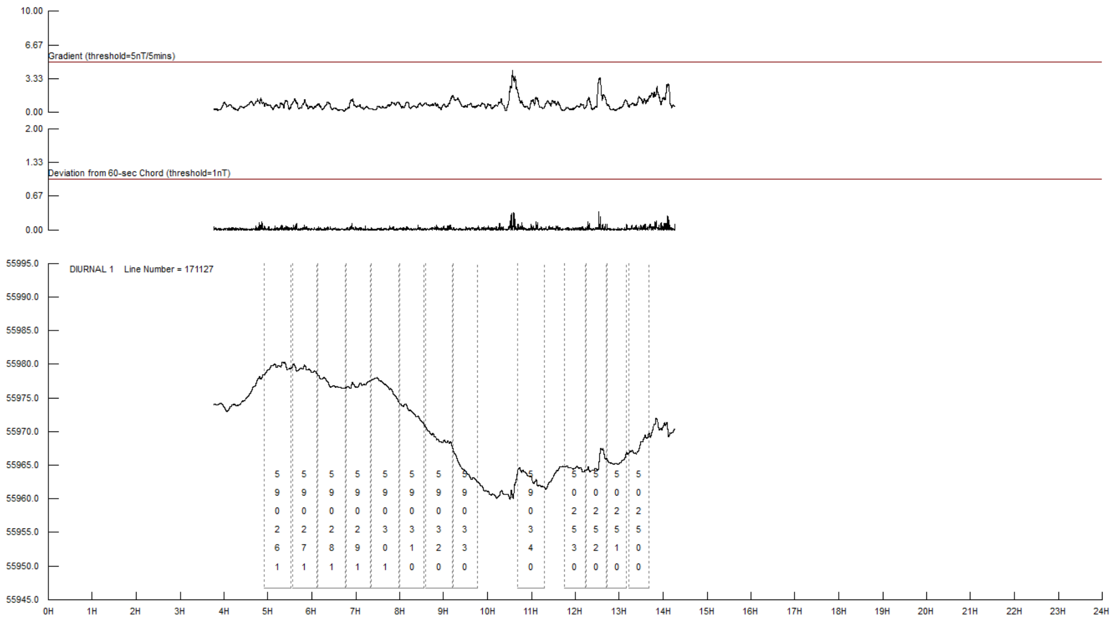

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171120

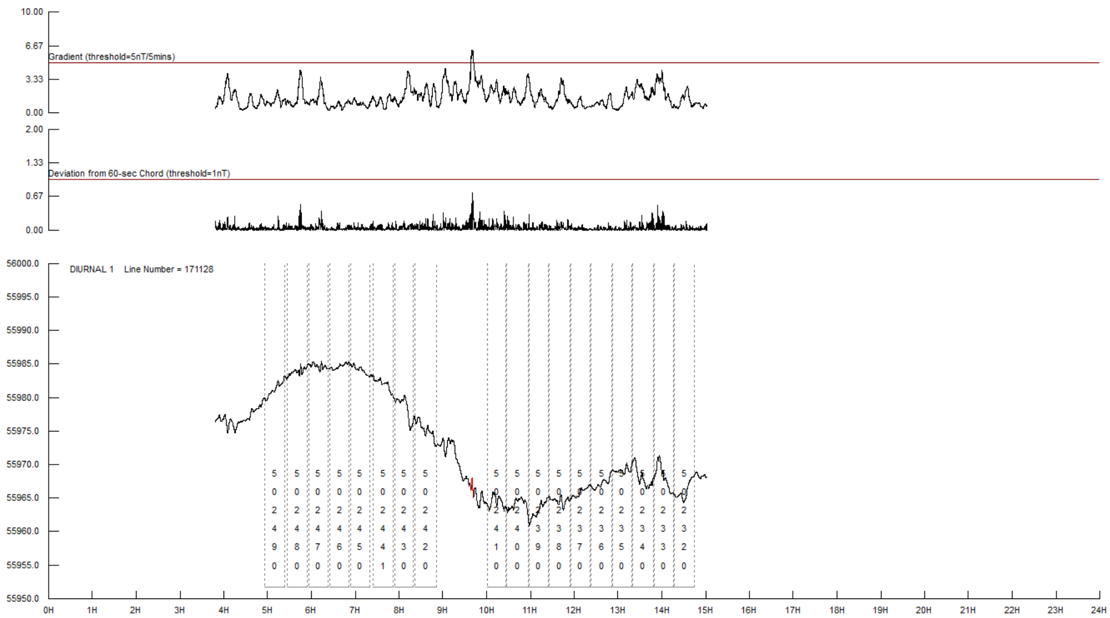

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171123

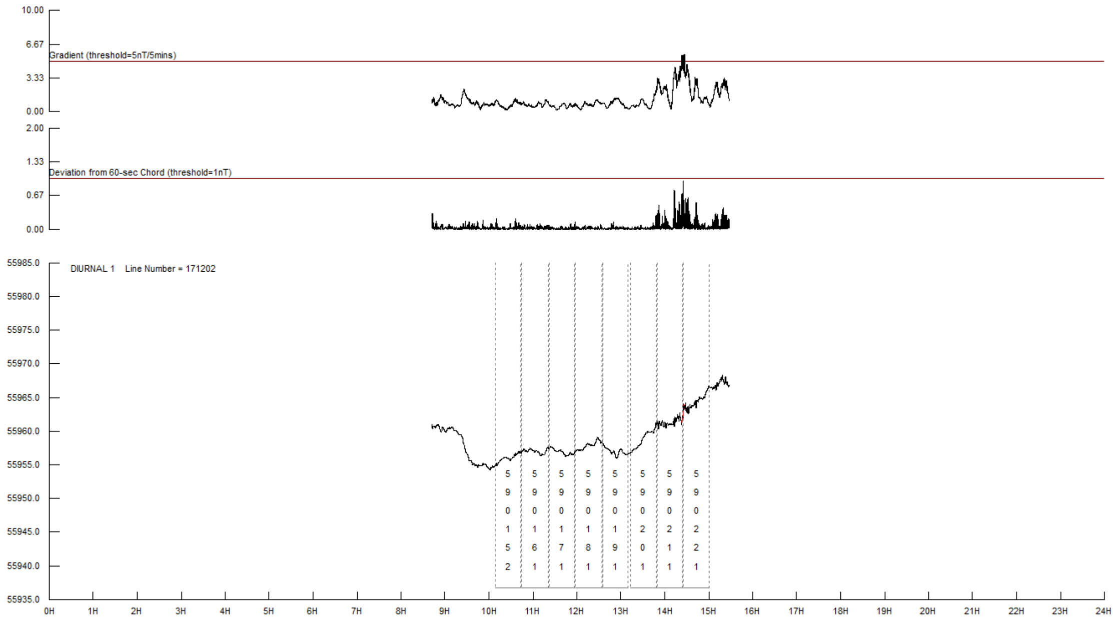
MAGSPEC AIRBORNE SURVEYS

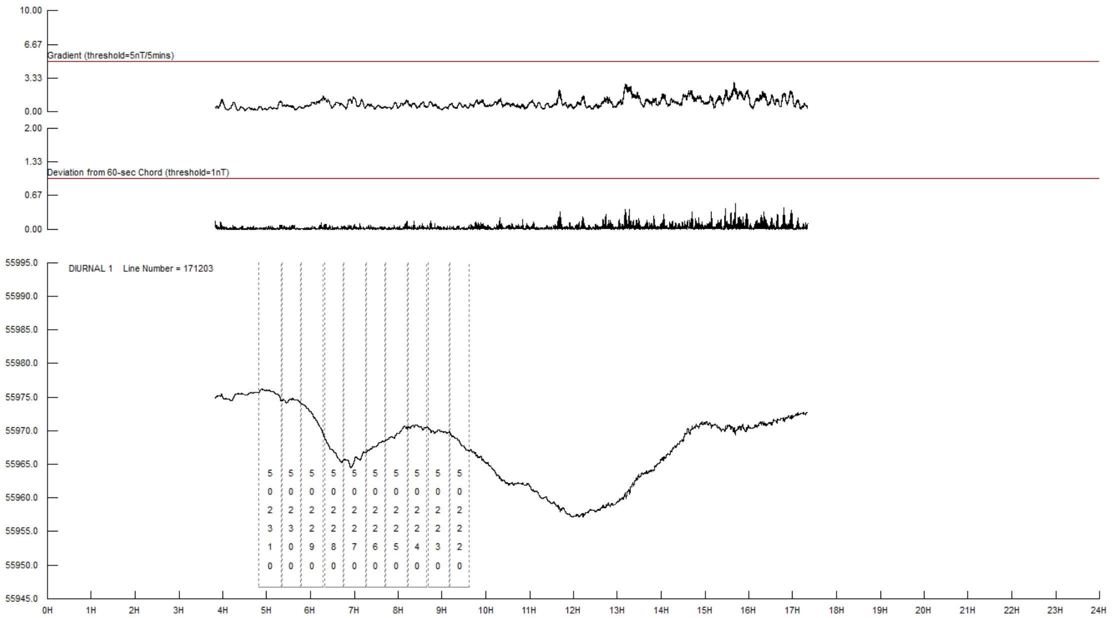


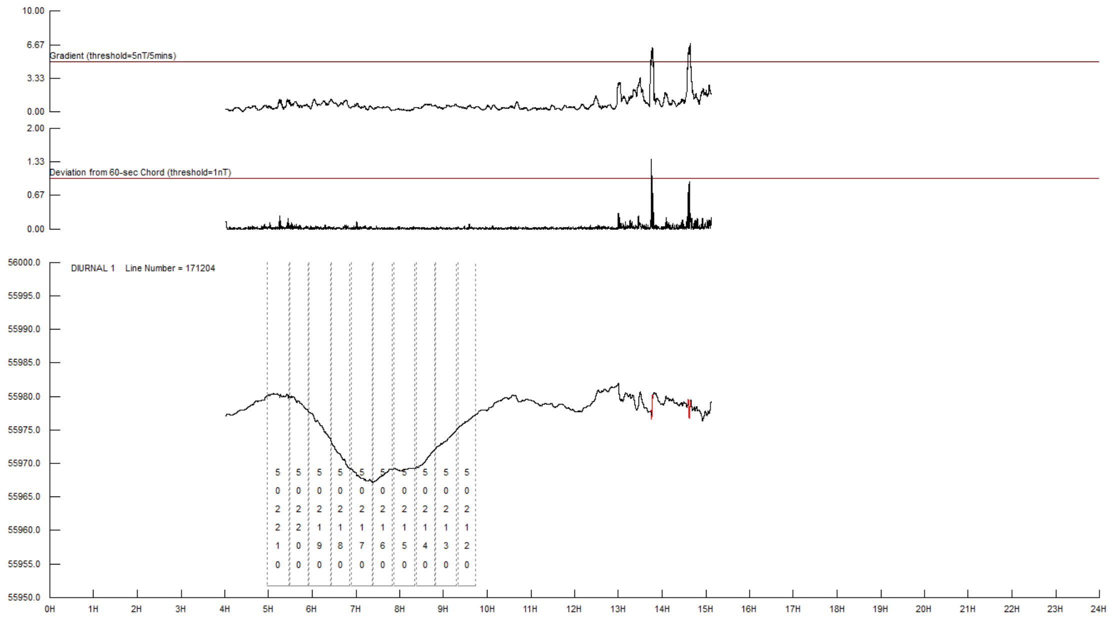


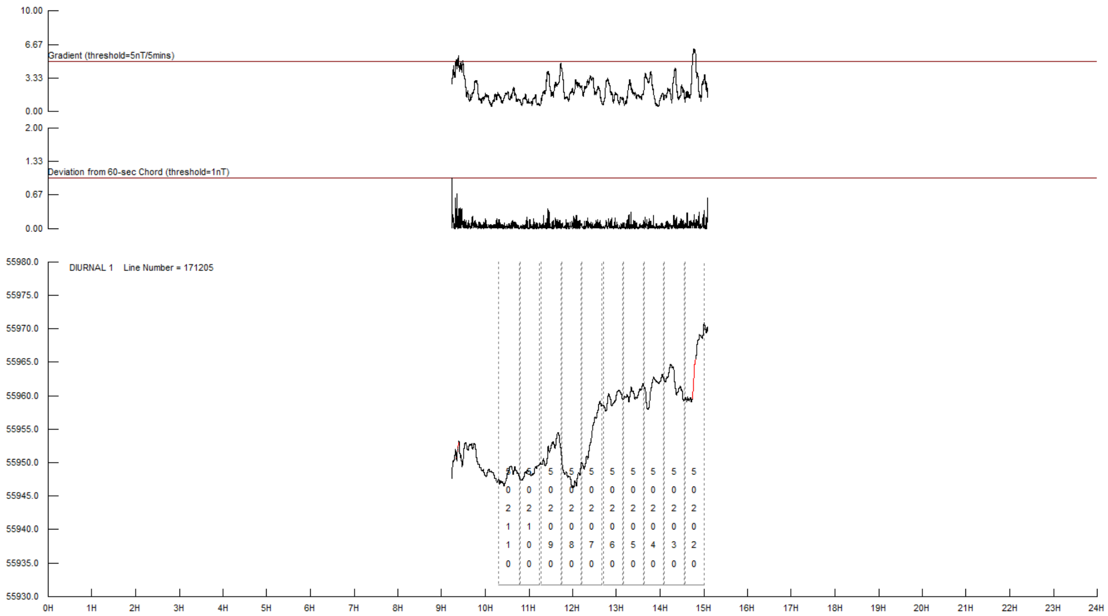

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171127
10.00
6.67
3.33
0.00
2.00
1.33
0.67
0.00
55995.0
55990.0
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
55945.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

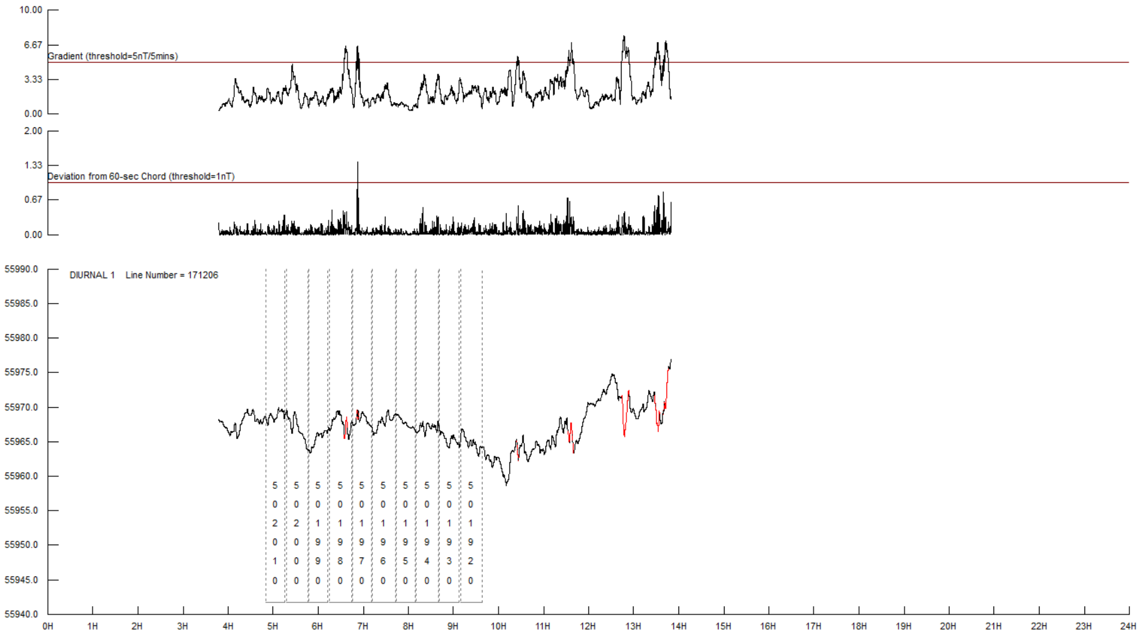

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171128
10.00
6.67
3.33
0.00
2.00
1.33
0.67
0.00
56000.0
55995.0
55990.0
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

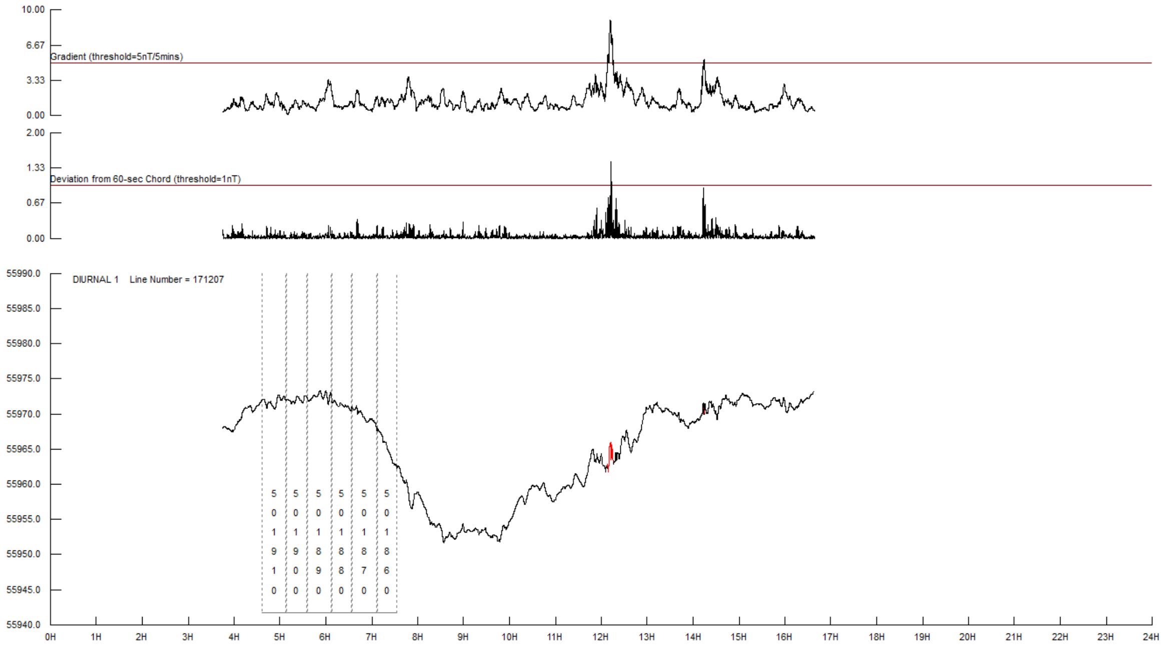

10.00
6.67
Gradient (threshold=5nT/5mins)
3.33
0.00
2.00
1.33
Deviation from 60-sec Chord (threshold=1nT)
0.67
0.00
DIURNAL 1 Line Number = 171202
590152
590161
590171
590181
590191
590201
590211
590221
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
55945.0
55940.0
55935.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

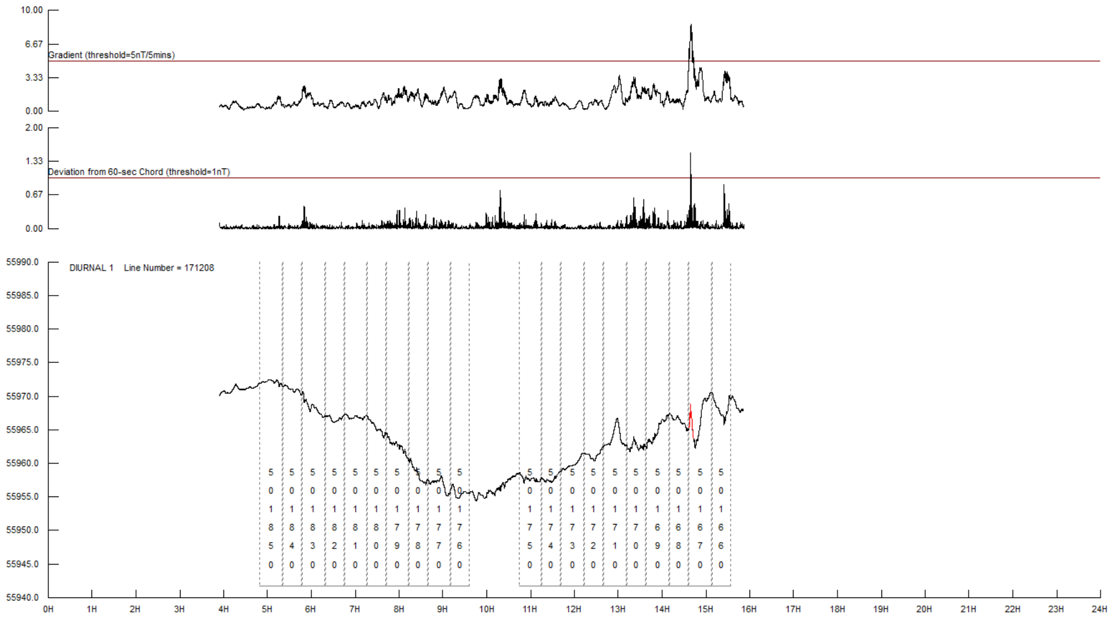

10.00
6.67
Gradient (threshold=5nT/5mins)
3.33
0.00
2.00
1.33
Deviation from 60-sec Chord (threshold=1nT)
0.67
0.00
DIURNAL 1 Line Number = 171203
502310
502300
502290
502280
502270
502260
502250
502240
502230
502220
55995.0
55990.0
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
55945.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

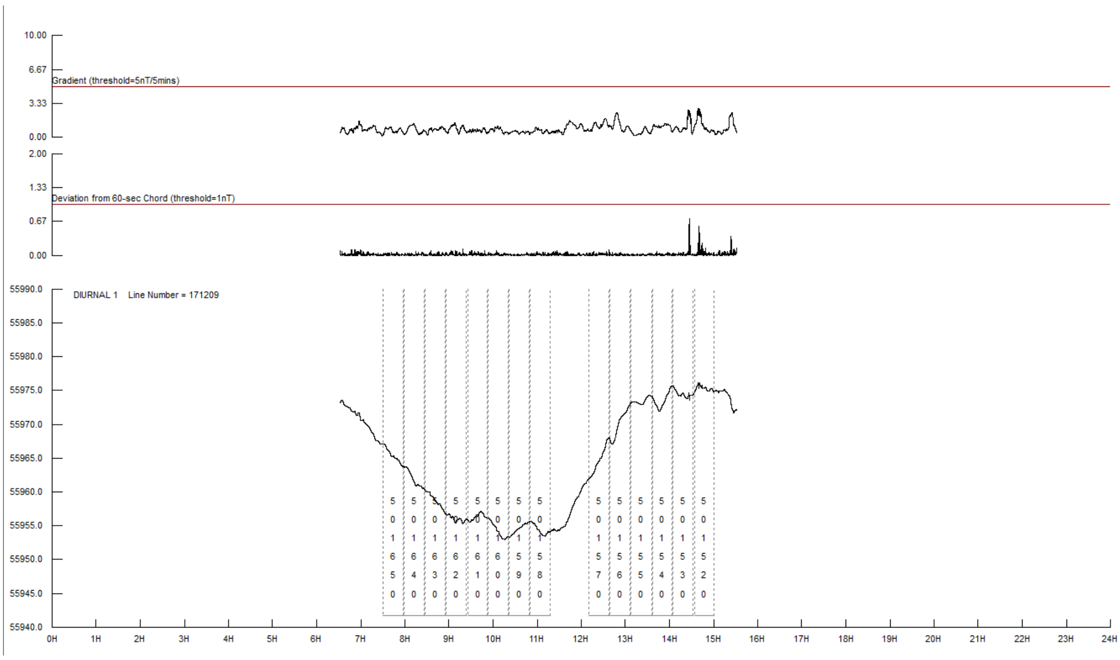

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171204

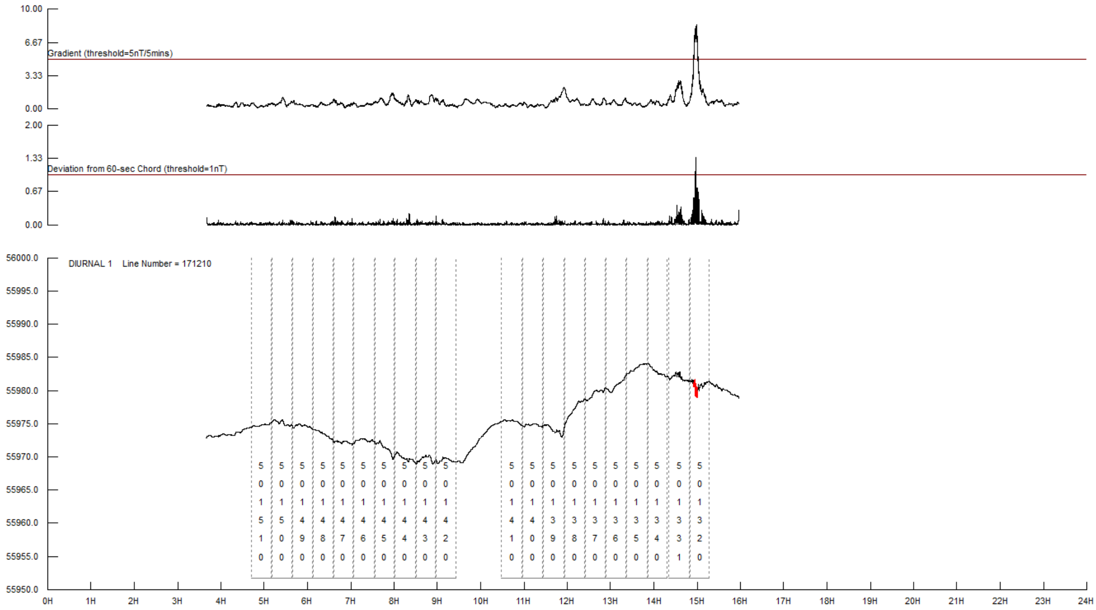

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171205

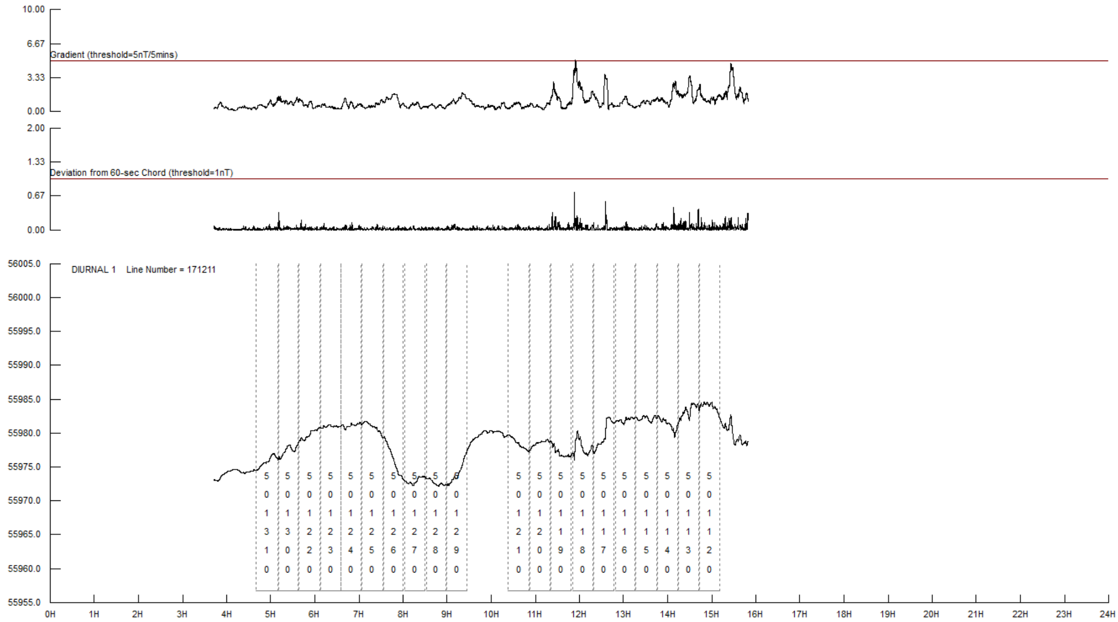

10.00
6.67
Gradient (threshold=5nT/5mins)
3.33
0.00
2.00
1.33
Deviation from 60-sec Chord (threshold=1nT)
0.67
0.00
55990.0
DIURNAL 1 Line Number = 171206
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
55945.0
55940.0
502010
502000
501990
501980
501970
501960
501950
501940
501930
501920
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

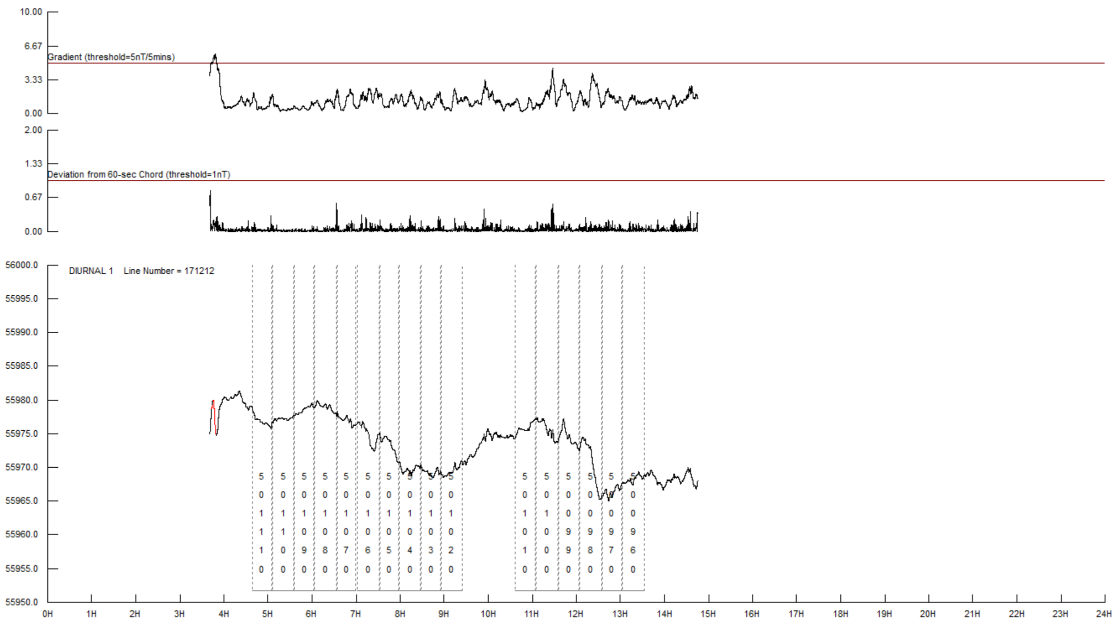

10.00
6.67
Gradient (threshold=5nT/5mins)
3.33
0.00
2.00
1.33
Deviation from 60-sec Chord (threshold=1nT)
0.67
0.00
55990.0
DIURNAL 1 Line Number = 171207
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
55945.0
55940.0
501910
501900
501890
501880
501870
501860
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

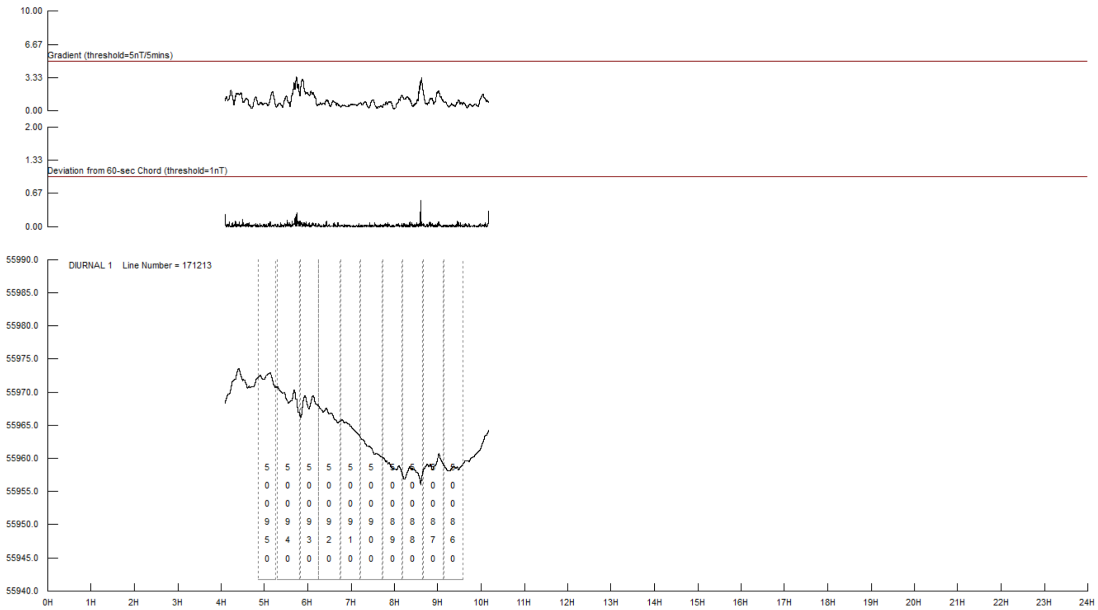

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171208

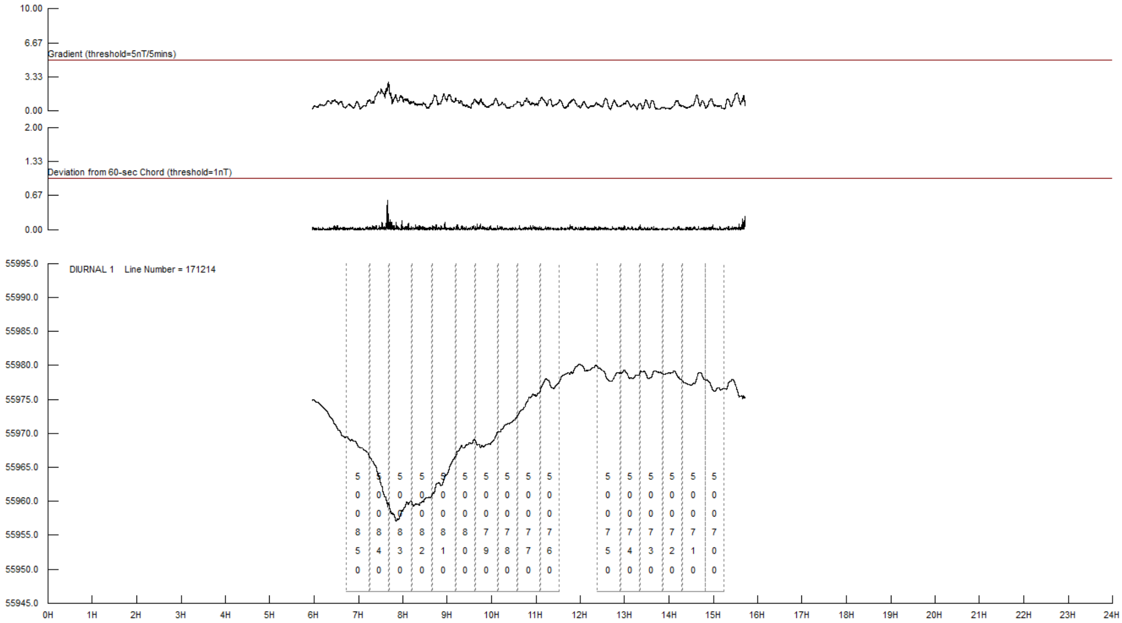

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171209

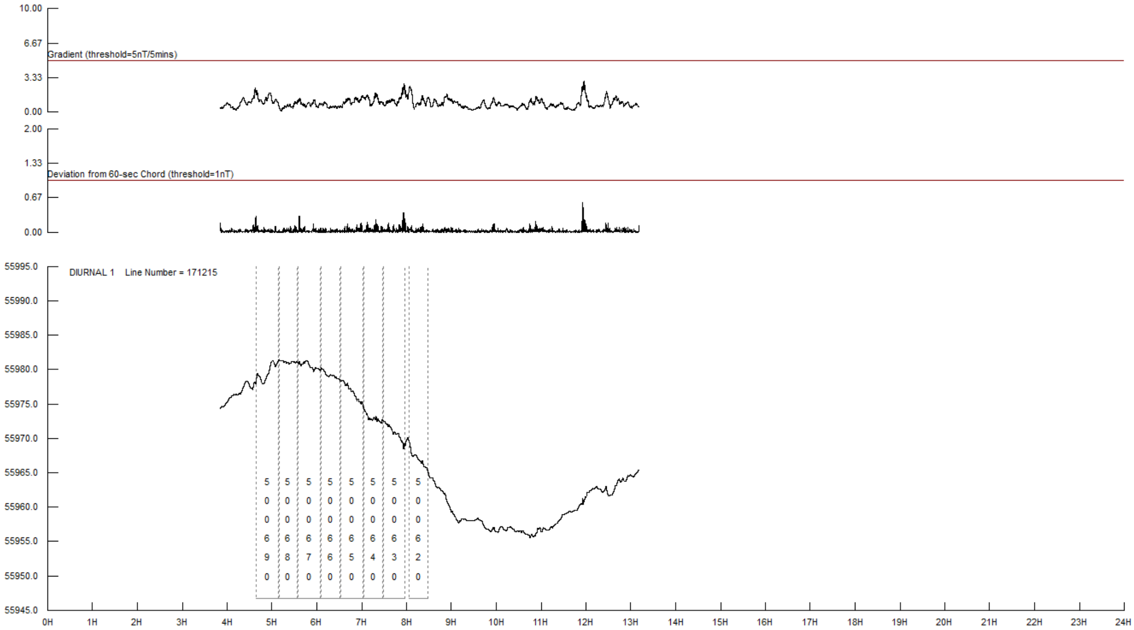

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171210
10.00
6.67
3.33
0.00
2.00
1.33
0.67
0.00
56000.0
55995.0
55990.0
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H
501510 501500 501490 501480 501470 501460 501450 501440 501430 501420
501410 501400 501390 501380 501370 501360 501350 501340 501331 501320

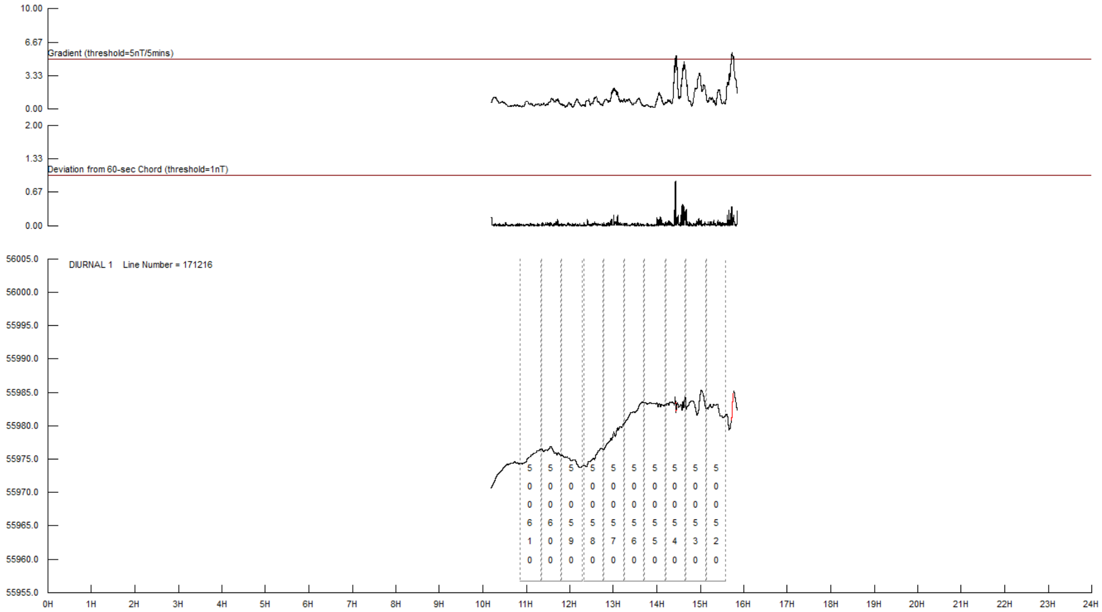

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171211
10.00
6.67
3.33
0.00
2.00
1.33
0.67
0.00
56005.0
56000.0
55995.0
55990.0
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H
501310 501300 501220 501230 501240 501250 501260 501270 501280 501290
501210 501200 501190 501180 501170 501160 501150 501140 501130 501120

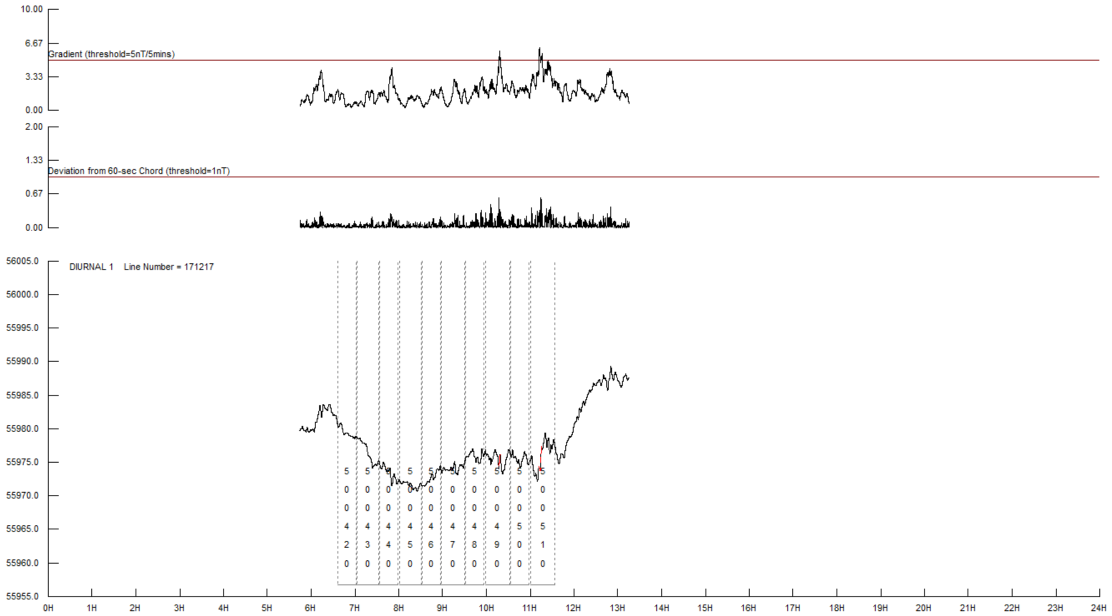

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171212

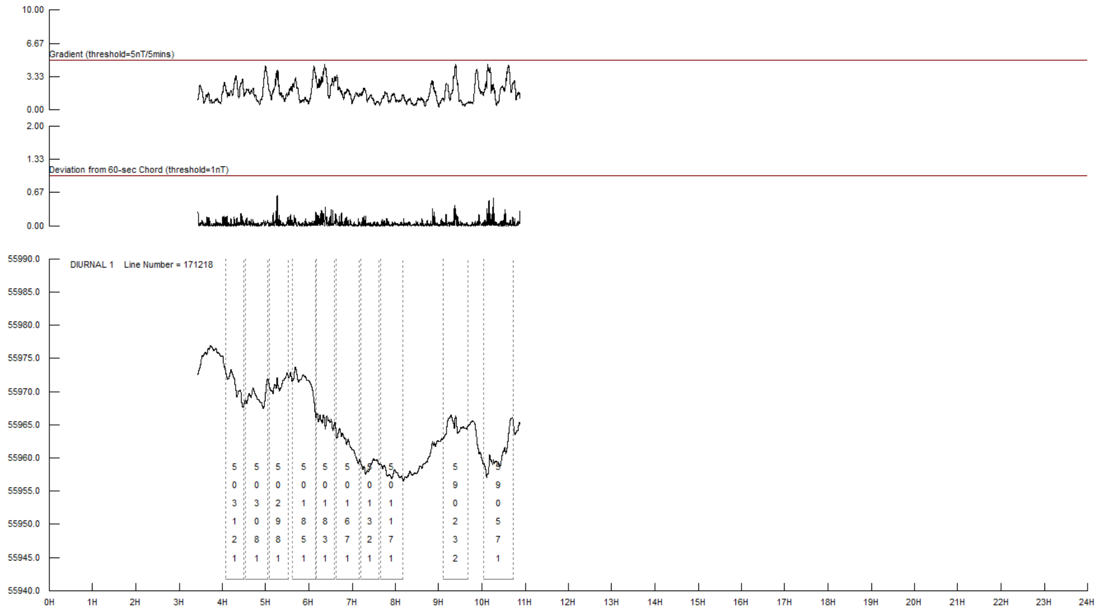

Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171213


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171214
500850
500840
500830
500820
500810
500790
500780
500770
500760
500750
500740
500730
500720
500710
500700


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171215
500690
500680
500670
500660
500650
500640
500630
500620


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171216


Gradient (threshold=5nT/5mins)
Deviation from 60-sec Chord (threshold=1nT)
DIURNAL 1 Line Number = 171217


10.00
6.67
3.33
0.00
Gradient (threshold=5nT/5mins)
2.00
1.33
0.67
0.00
Deviation from 60-sec Chord (threshold=1nT)
55990.0
55985.0
55980.0
55975.0
55970.0
55965.0
55960.0
55955.0
55950.0
55945.0
55940.0
DIURNAL 1 Line Number = 171218
503121
503081
502981
501851
501831
501671
501321
501171
590232
590571
0H 1H 2H 3H 4H 5H 6H 7H 8H 9H 10H 11H 12H 13H 14H 15H 16H 17H 18H 19H 20H 21H 22H 23H 24H

APPENDIX 4 PROCESSING PARAMETERS AND DELIVERABLES

Magnetics

Average Diurnal 55,968 nT

IGRF Correction Parameters

Year:	2017.87
Zone:	53
Hemisphere:	South
Latitude:	-29.4992514 °
Longitude:	135.7485815 °
Total Field:	56475.88 nT
Declination:	5.8936 °
Inclination:	-61.7839 °

Radiometrics

Radiometric Correction Parameters

Height Attenuation Coefficients

Total Count:	-0.0074
Potassium:	-0.0094
Uranium:	-0.0084
Thorium:	-0.0074

Aircraft Background Coefficients

Total Count:	51.287
Potassium:	11.921
Uranium:	0.2479
Thorium:	0.000

Cosmic Correction Coefficients

Total Count:	1.0989
Potassium:	0.0634
Uranium:	0.0518
Thorium:	0.0649

Radiometric Stripping Coefficients

Alpha:	0.2845
Beta:	0.4517
Gamma:	0.7986
a:	0.0470

Radiometric Concentration Coefficients

Total Count:	34.6
Potassium:	110.4
Uranium:	11.3
Thorium:	6.5

Located and Gridded Data

ASCII Located data were supplied in ASEG-GDF format. Gridded data were supplied in ERMapper format.

ASCII Located Data File Formats and Channels

Magnetics

survey:I6:NULL=-9999
flight:I5:NULL=-999
LINE:I9:NULL=-9999999
FID:I9:NULL=-9999999
dateCode:I10:NULL=-99999999
Bearing:I5:NULL=-999:UNIT=deg
longitude_gda94:F13.7:NULL=-999.9999999:UNIT=deg
latitude_gda94:F13.7:NULL=-999.9999999:UNIT=deg
easting_gda94:F11.2:NULL=-999999.99:UNIT=m
northing_gda94:F12.2:NULL=-9999999.99:UNIT=m
gps_height:F8.2:NULL=-999.99:UNIT=m
Zone:I4:NULL=-99
radar_alt:F8.2:NULL=-999.99:UNIT=metres
laser_alt:F8.2:NULL=-999.99:UNIT=metres
dem_laser:F8.2:NULL=-999.99:UNIT=metres
dem_radar:F8.2:NULL=-999.99:UNIT=metres
magnetics_final_tielevelled:F11.3:NULL=-99999.999:UNIT=nT
magnetics_final_microlevelled:F11.3:NULL=-99999.999:UNIT=nT
magnetics_final_microlevelled_1vd:F11.6:NULL=-99.999999:UNIT=nT/m
magnetic_diurnal:F11.3:NULL=-99999.999:UNIT=nT
magnetic_igrf:F11.3:NULL=-99999.999:UNIT=nT

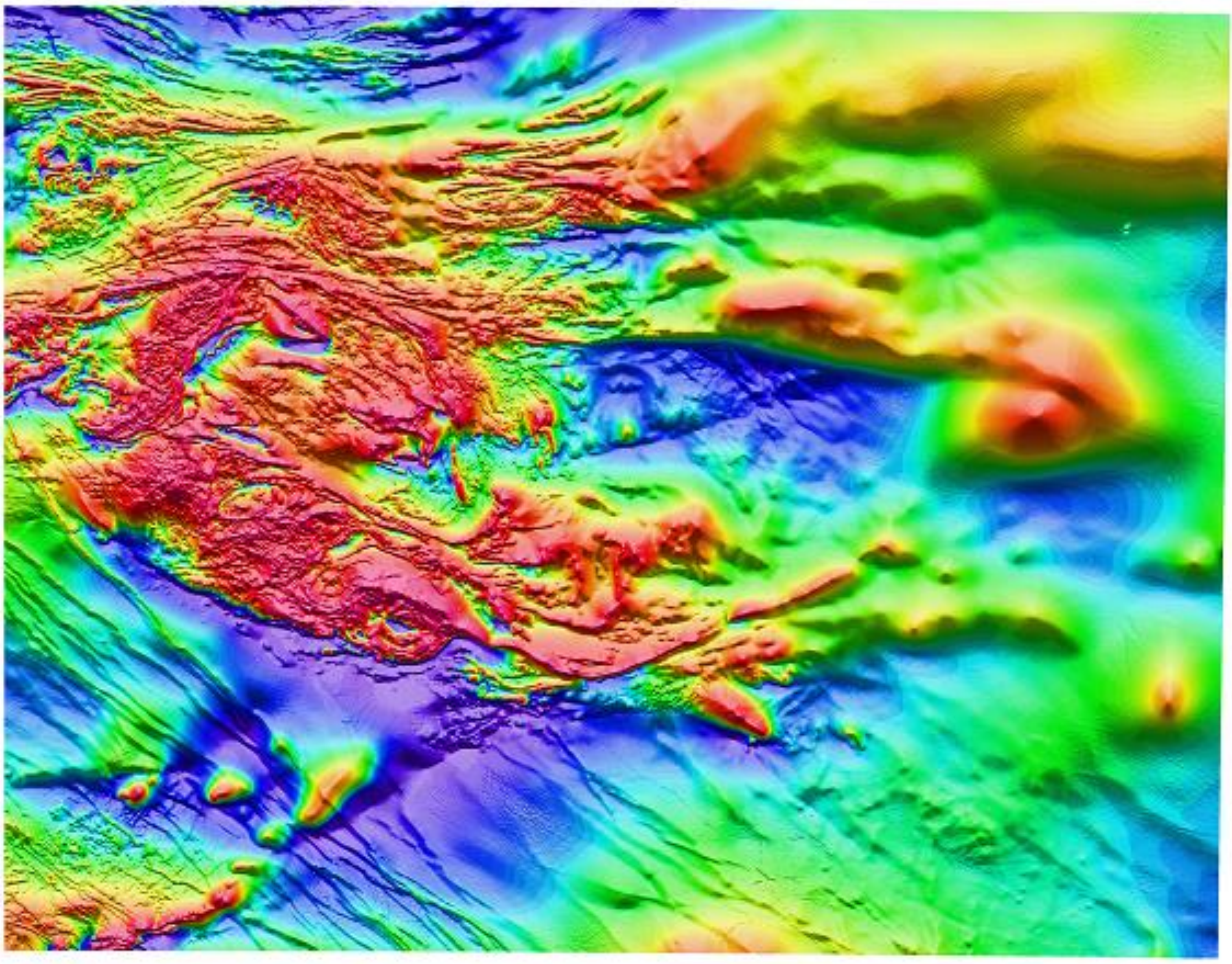
Radiometrics

survey:I6:NULL=-9999
flight:I5:NULL=-999
LINE:I9:NULL=-9999999
FID:I9:NULL=-9999999
dateCode:I10:NULL=-99999999
bearing:I5:NULL=-999:NAME=Bearing
longitude_gda94:F13.7:NULL=-999.9999999:UNIT=deg
latitude_gda94:F13.7:NULL=-999.9999999:UNIT=deg
easting_gda94:F11.2:NULL=-999999.99:UNIT=m
northing_gda94:F12.2:NULL=-9999999.99:UNIT=m
gps_height:F8.2:NULL=-999.99:UNIT=m
zone:I4:NULL=-99
radar_alt:F8.2:NULL=-999.99:UNIT=m
laser_alt:F8.2:NULL=-999.99:UNIT=m
dem_laser:F8.2:NULL=-999.99:UNIT=m
dem_radar:F8.2:NULL=-999.99:UNIT=m
pressure:F8.2:NULL=-999.99:UNIT=mbar
temperature:F7.2:NULL=-99.99:UNIT=degrees C
doserate_no_nasvd:F10.2:NULL=-9999.99:UNIT=nGy/hr
k_percent_no_nasvd:F9.2:NULL=-999.99:UNIT=percent
u_ppm_no_nasvd:F9.2:NULL=-999.99:UNIT=ppm
th_ppm_no_nasvd:F9.2:NULL=-999.99:UNIT=ppm
dose_nasvd:F10.2:NULL=-9999.99:UNIT=nGy/hr
k_percent_nasvd:F9.2:NULL=-999.999:UNIT=percent
u_ppm_nasvd:F9.2:NULL=-999.99:UNIT=ppm
th_ppm_nasvd:F9.2:NULL=-999.99:UNIT=ppm

Elevation

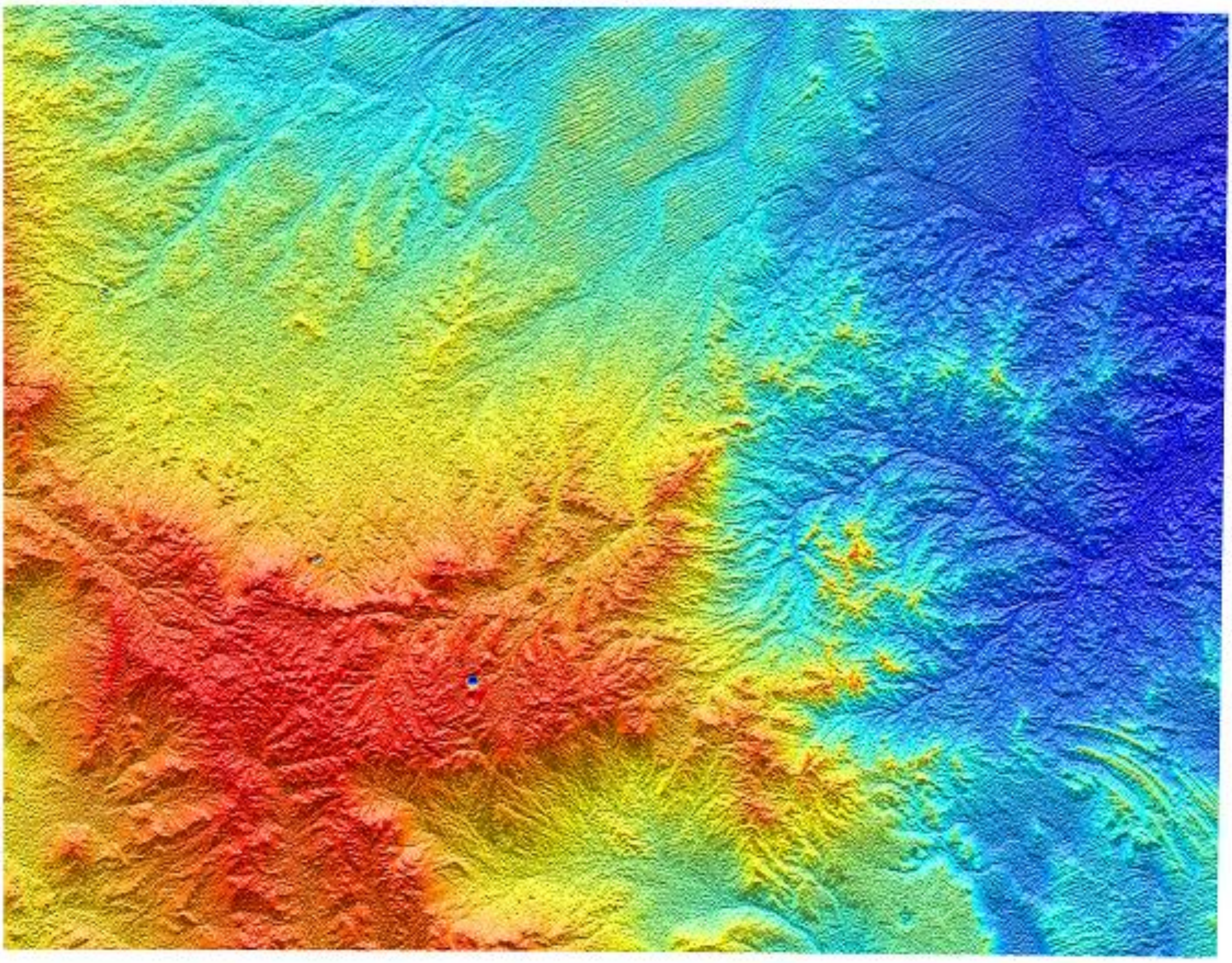
survey:I6:NULL=-9999
flight:I5:NULL=-999
LINE:I9:NULL=-9999999
FID:I9:NULL=-9999999
dateCode:I10:NULL=-99999999
bearing:I5:NULL=-999
longitude_gda94:F13.7:NULL=-999.9999999:UNIT=deg
latitude_gda94:F13.7:NULL=-999.9999999:UNIT=deg
easting_gda94:F11.2:NULL=-999999.99:UNIT=m
northing_gda94:F12.2:NULL=-9999999.99:UNIT=m
GeoidN:F7.2:NULL=-99.99:UNIT=m
gps_height:F8.2:NULL=-999.99:UNIT=m
zone:I4:NULL=-99
radar_alt:F8.2:NULL=-999.99:UNIT=m
laser_alt:F8.2:NULL=-999.99:UNIT=m
laser_height:F8.2:NULL=-999.99:UNIT=m
dem_laser:F8.2:NULL=-999.99:UNIT=m
dem_radar:F8.2:NULL=-999.99:UNIT=m

APPENDIX 5 VERIFICATION IMAGES

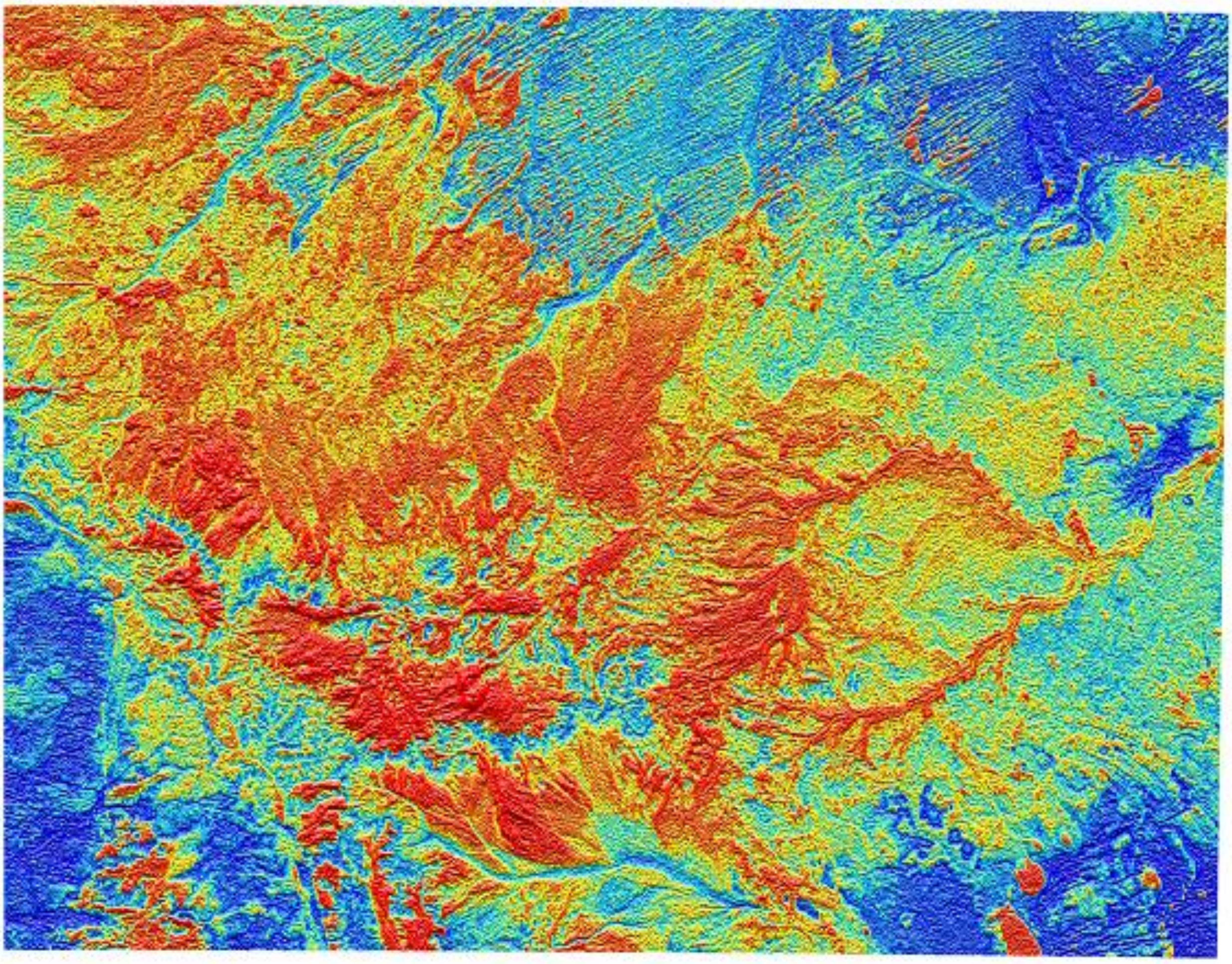


Colour Total Magnetic Intensity

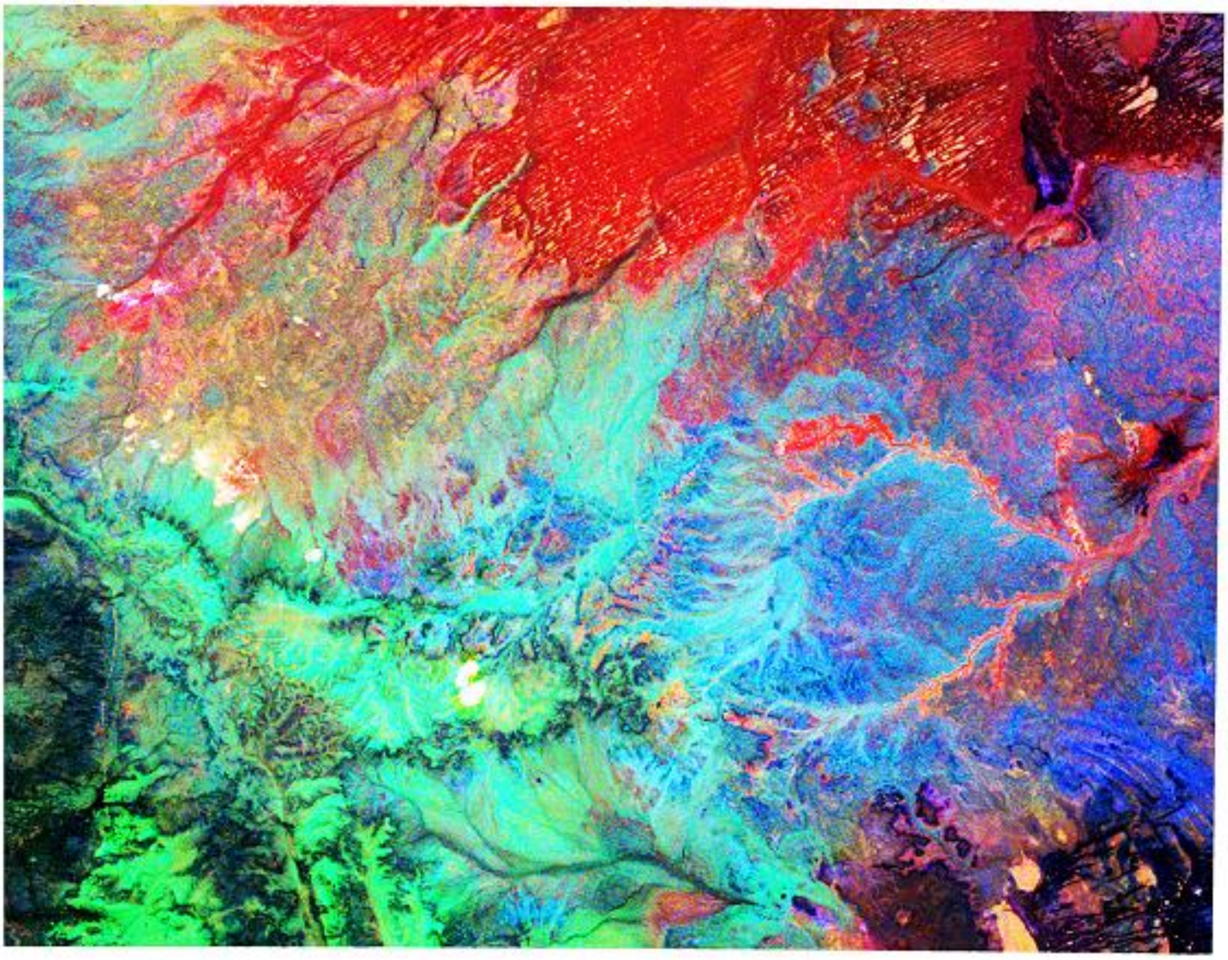
Grey Reduced to Pole TMI First Vertical Derivative



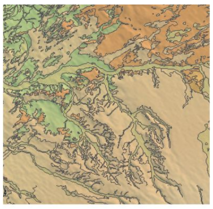
Colour Digital Elevation Model

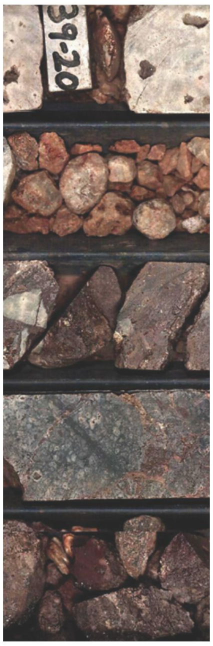


Colour Dose Rate



Radiometric Ternary

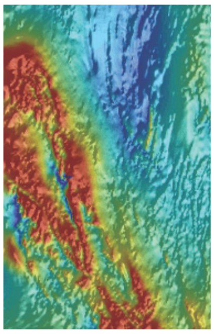




Department of State Development

Metadata: PACE Copper Gawler Craton Airborne Survey, Region 8B, P1300, Billa Kalina, 2018SA001

Date Printed: 20/09/2018



SOUTH AUSTRALIA

Government of South Australia
Department for Energy and Mining

Dataset

Title: PACE Copper Gawler Craton Airborne Survey, Region 8B, P1300, Billa Kalina, 2018SA001

Custodian: Department of the Premier and Cabinet

Jurisdiction: SA

Description

Abstract:

The Gawler Craton Airborne Survey will capture approximately 1,670,000 line kilometres of new geophysical data (magnetic, radiometric and digital elevation data) over an area of approximately 294,000 square kilometres. Magnetic data includes TMI, TMI reduced to pole and 1VD of RTP TMI; elevation data includes models derived from radar altimeter and laser altimeter subtracted from differential GPS heights; spectrometer data includes dose rate, uranium, thorium, potassium and ternary (RGB) radiometrics. Radiometric data have been processed using the Noise Adjusted Singular Value Decomposition (NASVD) method. Radiometric data with no NASVD processing is also included.

ANZLIC Search Terms:
GEOSCIENCES Geophysics BOUNDARIES Surveys

GEN Category: GAWLER PROVINCE

GEN Custodial Jurisdiction: South Australia

GEN Name: Billa Kalina Map Sheet, Gawler Craton

Geographic Extent Polygon: -28.99, 136.503, -30.01, 134.996

North bounding latitude: -28.99

South bounding latitude: -30.01

East bounding longitude: 136.503

West bounding longitude: 134.996

Data Currency

Beginning Date: 01/02/2017

End Date: 18/10/2017

Dataset Status

Progress: Complete

Maintenance: As required

Version Number: 1

Access

Stored format: DIGITAL data are stored as located data (ascii), ERMapper grids, tif images.

Available format(s): DIGITAL

SARIG Layer(s): Gawler Craton Airborne Survey\Region 8B

Data Quality

Lineage: The data was originally collected by government, released as located data and processed into grid and image products.

Positional accuracy: Original data were located using GPS. GPS units are accurate to less than 10 metres.

Attribute accuracy: Not Known

Logical consistency: All data have been quality controlled by the Geological Survey of South Australia.

Completeness: This survey is complete

Contact Information

Contact organisation: Department of the Premier and Cabinet

Contact position: Customer Service Centre

Contact mail address: GPO box 320 Adelaide SA 5001

Contact telephone: 08 8463 3000

Contact email: Resources.CustomerServices@sa.gov.au

Metadata Dates

Add date: 2018-08-21

Change date: 2018-09-20

Responsible Party

Responsible party: Director, Geological Survey of South Australia

Responsible party function: Custodian/Steward

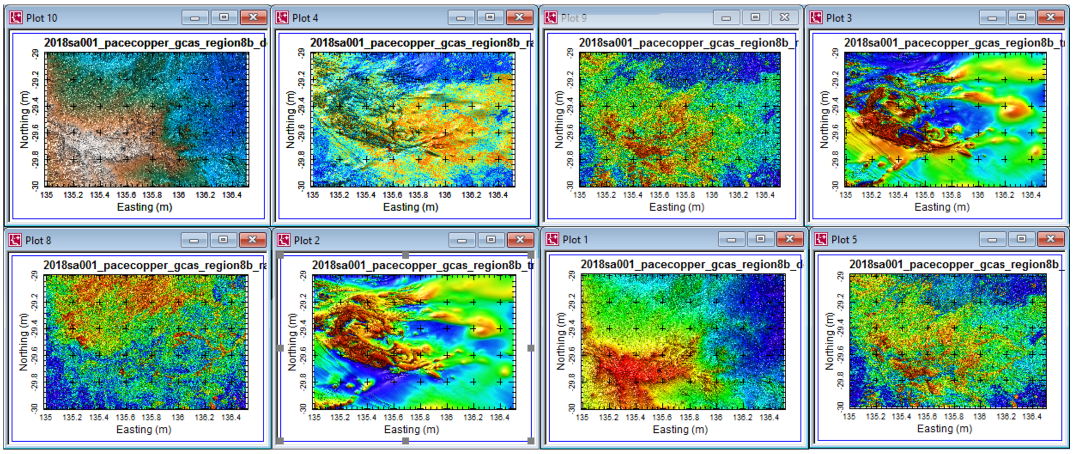
Description

Dataset classification: Principal version

Spatial representation type: Matrix

Dimension: Other

Sample Graphic(s)



Usage

Purpose: This set of data is designed as an aid to geological exploration.

Use: Used to supply industry, government and the general public with geophysical information, primarily used for mineral exploration.

Usage limitations: Grid data has been gridded at one fifth of line spacing and interpretations should not be made at scales less than this.

Dataset Associations

Dependant datasets: Airborne Magnetic Surveys of South Australia.

Origin

Dataset size: 10.5Gb

Projection: Geographical

Datum: GDA94

Dataset Management

Authorised by: Director, Geological Survey of South Australia

Attributes
