

Geophysics and Drilling Collaborations Program 2021

“Resourcing the Territory”

EL32283 and EL32284 Airborne Geophysics Survey Report, Georgina Basin, NT

Report Prepared for



Knox Resources Pty Ltd



Northern Territory Geological Survey

Report Prepared by



SRK Consulting (Australasia) Pty Ltd

Tenements: EL32283, EL32284
Holder: Knox Resources Pty Ltd.
Map Sheets: 250K: Alroy, Frew River
100K: Dalmore, Favenc, Epenarra and Coolibah
Datum, Zone: GDA94, MGA Zone 53S

Date: **21 December 2021**
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Project: **KNX001**

Abstract

Knox Resources Pty Ltd (Knox or the Company) applied for and was successful in seeking exploration grants with the Northern Territory Geological Survey (NTGS) as part of the Round 14 of the 2021 Geophysics and Drilling Collaboration and the Northern Territory Government's four-year 'Resourcing the Territory' initiative. The co-funding grant was applicable to Exploration Licence (EL) 32283 and EL32284 located within the Georgina Basin, Northern Territory, to acquire an airborne magnetic survey based on a traverse line spacing of 100 m and a survey area of circa 1,100 km².

Both titles are held by Knox on a 100% basis. Knox is a wholly owned subsidiary of Greenvale Mining Limited, a publicly listed company on the Australian Securities Exchange (ASX) with ticker code GRV. EL32283 was granted on 23 September 2020 and covers an area of approximately 402 km² while the adjoining EL32284 is under application and covers an area of approximately 711 km².

Both Knox's Georgina Basin tenements cover part of the interpreted south-eastern extension of the highly prospective Warramunga Province under Georgina Basin cover sequences. Exploration is focused on IOCG style mineralisation with the Warramunga Province basement, as well sediment-hosted copper and/or zinc in palaeo-Mesoproterozoic basin successions. Pre-competitive geoscience studies in the area by Geoscience Australia and NTGS, and a recent Geoscience Australia IOCG 'Prospectivity' map (Skirrow et al., 2019) highlighted the area as being highly prospective for Tennant Creek-style IOCG mineralisation.

Knox commissioned MAGSPEC Airborne Surveys Pty Ltd. (Magspec) to undertake the geophysical survey over EL32283 and EL32284. The field acquisition commenced on 18 September 2021 until 2 October 2021 utilising a Cessna 210, a specially modified aircraft for this type of survey. The crew was based in Barkly, Northern Territory for the duration of the survey.

Field data were processed, and inversion geophysical modelling undertaken by Resource Potentials Pty Ltd (Resource Potentials) in Perth, with the geological interpretation, 3D geological modelling and drill hole targeting undertaken by SRK Consulting (Australasia) Pty Ltd (SRK). A total of 12,977 total line kms were acquired during the survey.

The airborne magnetic survey data has provided a better understanding of important structural corridors, distribution and architecture of prospective geological horizons, potential fluid sources as well as provide greater confidence for drill targeting present in EL32283 and EL32284. Several target areas have been identified as a result and represent follow-up drill ready targets for Knox.

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Appendix A: Magspec Airborne Surveys – Survey Report

Supplied Separately

Digital line data in ASCII, ASEG-GDF and Geosoft GDB formats, grids in ER Mapper format and processing report, magnetic models and section plans. All data files will be provided separately in appropriate format/s.

Disclaimer

The opinions expressed in this Report have been based on the information supplied to SRK Consulting (Australasia) Pty Ltd (SRK) by Knox Resources Pty Ltd (Knox). The document has been written by Carl D'Silva for submission to the Northern Territory Geological Survey as part of the co-funding requirements.

SRK has exercised all due care in reviewing the supplied information. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information and does not accept any consequential liability arising from commercial decisions or actions resulting from them. Opinions presented in this Report apply to the site conditions and features as they existed at the time of SRK's investigations, and those reasonably foreseeable. These opinions do not necessarily apply to conditions and features that may arise after the date of this Report, about which SRK had no prior knowledge nor had the opportunity to evaluate. Any information included in the report that originates from historical reports or other sources is listed in the "References" section. All relevant authorisations and consents have been obtained. Carl D'Silva authorised the NTGS to copy and distribute the report and associated data.

Useful definitions

This list contains definitions of symbols, units, abbreviations, and terminology that may be unfamiliar to the reader.

%	percent
ca.	circa; approximately
DEM	digital elevation model
EL	Exploration Licence
IOCG	iron oxide copper gold
k	thousand
km	kilometres
km ²	kilometres squared
m	metres
Ma	million years ago
NDI	National Drilling Initiative
NTGS	Northern Territory Geological Survey
SRK	SRK Consulting (Australasia) Pty Ltd
Magspec	MAGSPEC Airborne Surveys Pty Ltd

1 Introduction

As part of the Northern Territory Government's Geophysics and Drilling Collaborations Program (Round 14), Knox was successful in seeking co-funding to conduct a high resolution airborne geophysical surveying over its leases EL32283 and EL32284 including airborne magnetic, radiometric and digital elevation model (DEM).

The acquired survey will enable Knox to improve the current publicly available airborne magnetic data over EL32283 and EL32284 from 400 m line spacing to 100 m line spacing and in turn results in a greatly enhanced dataset to enable a detailed geological analysis and target identification for IOCG mineralisation in this frontier region.

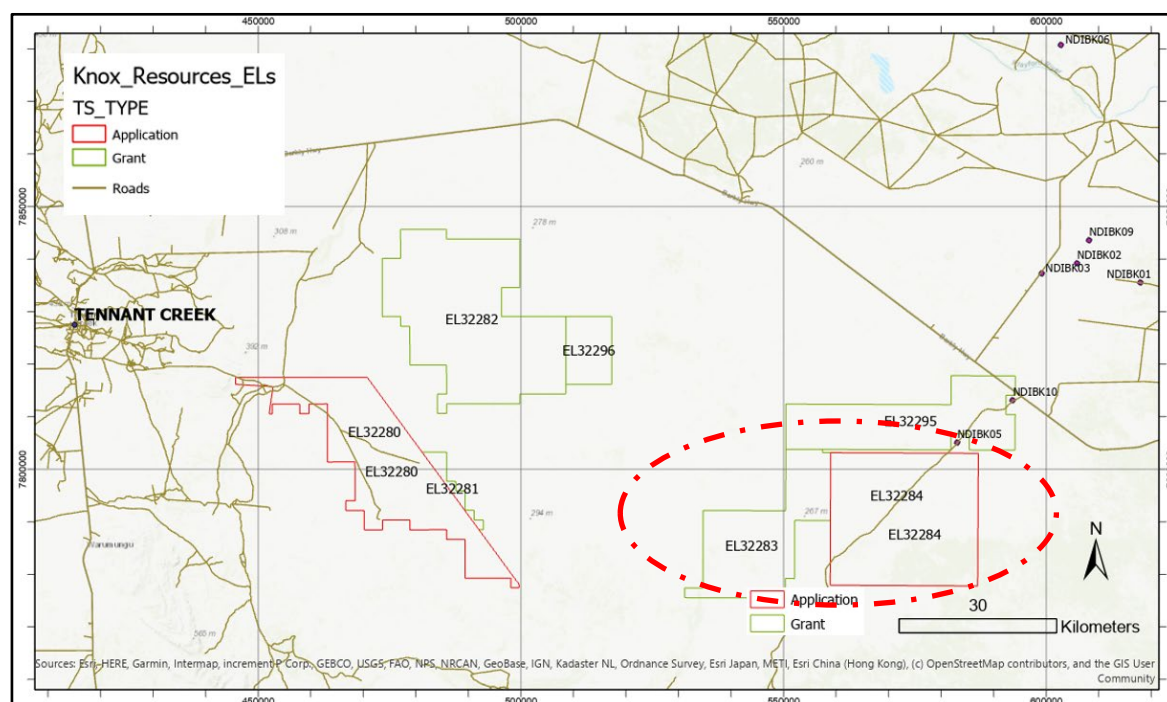
1.1 Background

Knox holds seven granted exploration licences over four distinct locations covering some 4,523 km². The licences are situated between the historical Tennant Creek and Mount Isa IOCG provinces. EL32283 and EL32284 are 150 kilometres east of the Tennant Creek township and are accessible by 4WD vehicle by road and tracks (Figure 1-1) from the Barkly Homestead Roadhouse.

EL32283 was granted on 23 September 2020 and covers an area of approximately 402 km² whilst the adjoining EL32284 is under application and covers an area of approximately 711 km². Knox is a wholly owned subsidiary of Greenvale Mining Limited, a publicly listed company on the Australian Securities Exchange (ASX) with ticker code GRV.

Knox has a 100% ownership in both permits which form part of the Company's Georgina Basin project. Recent data released from the ten deep diamond drill holes drilled under the MinEx CRC National Drilling Initiative (NDI) across the Barkly Tableland, east of Tennant Creek, provided new insights into the mineral potential of this area. The drilling was designed to test the potential of basement rocks in the East Tennant area which are known to host gold- and copper-rich deposits similar to those in the world-class Tennant Creek mineral field.

Figure 1-1: Knox's Georgina Basin project tenements and MinEx CRC NDI drill hole locations



Source: SRK Consulting

2 Regional context

2.1 Regional geology

The Barkly Tableland area east of Tennant Creek is a focus of substantial exploration interest with the commencement of exploration by a number of companies following up encouraging results from the collaborative pre-competitive geoscience studies in the area by Geoscience Australia and NTGS (Skirrow et al., 2019). Exploration in the area is targeting mineralisation in Proterozoic basement underlying Cambrian cover of the Georgina Basin, with key targets being IOCG in Warramunga Province rocks, and sediment-hosted copper and/or zinc in Palaeo-Mesoproterozoic basin successions.

High-grade deposits of copper and gold mineralisation associated with magnetite and/or hematite bearing ironstones hosted within the Warramunga Formation have been mined in the Tennant Creek Inlier since the 1930s. The Warramunga Formation is characterised by turbiditic felsic volcanic derived sediments and felsic tuffs (deposited about 1862 Ma) that have been deformed during a major north–south directed compression, basin inversion and bedding parallel thrusting about east–west axial planes. Basin dewatering during early orogenesis leached the sediments of iron and redeposited it as hematite and or magnetite within planar shears or by selective replacement of bedding parallel thrusts in the hinge zones of folds. Syn-tectonic intrusive rocks of the Tennant Creek Suite comprise granites and quartz porphyries and lesser mafic to intermediate intrusions focused along pre-existing structures (1851–1847 Ma).

Knox's Georgina Basin project covers part of the interpreted southeast extension of the highly prospective Warramunga Province under Georgina Basin cover sequences (Figure 2-1). The area comprises metasediments and metavolcanics interpreted to be probable equivalents of the Warramunga Formation and Ooradidgee Group, intruded by felsic intrusions. Major east–west shear zones divide the area into several structural blocks of tightly folded strata.

Exploration is primarily focused on targeting IOCG style mineralisation within the Warramunga Province basement, as well sediment-hosted copper and/or zinc in Palaeo-Mesoproterozoic basin successions. Due to extensive cover sequences within the region, detailed geophysical methods are required to better understand the distribution and architecture of the prospective Warramunga sequences.

2.2 Local geology of EL32283 and EL32284

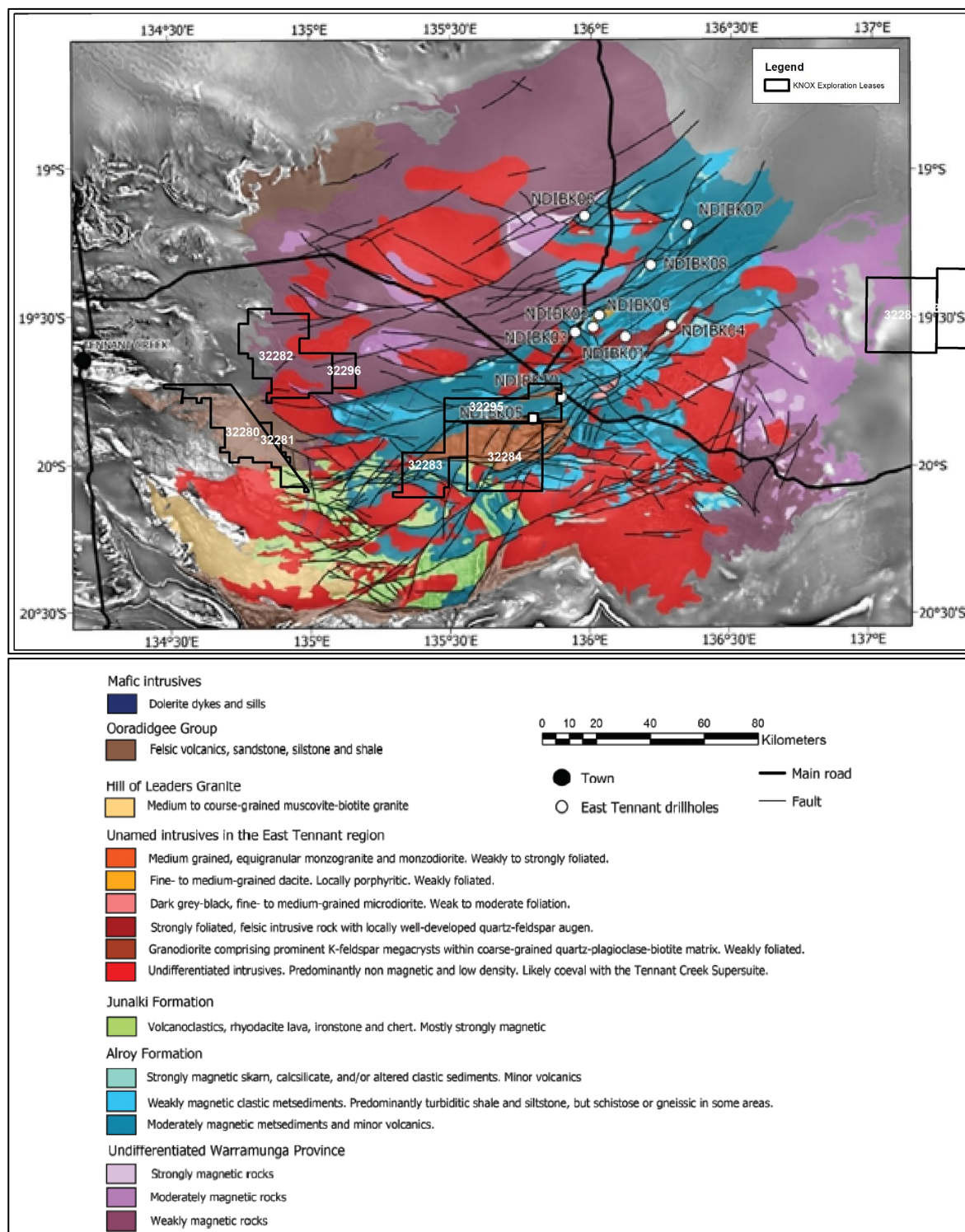
2.2.1 Warramunga Formation

The Warramunga Formation and correlative Junalki Formation and Woodenjerrie Beds represent the oldest rocks in the Warramunga Province, deposited ca. 1,860 Ma (Ahmad and Munson, 2013; Donnellan, 2013; Maidment et al., 2013). The Warramunga Formation has no exposed base and is mostly composed of weakly metamorphosed turbiditic greywacke, locally tuffaceous, with lesser siltstone, shale and argillaceous ironstone, referred to in the literature as 'haematitic ironstone' (Donnellan, 2013; Huston et al., 2020 and references therein).

The Warramunga Formation and its equivalent sequences were affected by the tectono-magmatic ca. 1,860–1,850 Ma Tennant Event (Donnellan and Johnstone, 2004). This event resulted in extensive syn- to post-tectonic magmatism (Tennant Creek Supersuite) and regional D₁ shortening of the crust, expressed as the east or east–northeast-trending upright F₁ folds and low-grade metamorphism (Donnellan, 2013). The ca. 1,850–1,840 Ma Tennant Creek Supersuite (Wyborn et al., 1998) comprises mainly granitic intrusions with lesser granodiorite, tonalite, felsic porphyry and dolerite, as well as extrusive felsic volcanic rocks (Donnellan, 2013). The Tennant Event folded and thrustled the

sedimentary sequences and ultimately exhumed the entire package. This resulted in an erosional angular unconformity between the pre-Tennant Event rocks (Warramunga Formation, Junalki Formation and Woodenjerrie Beds) and the overlying volcano-sedimentary successions of the Ooradidgee Group (Donnellan, 2013).

Figure 2-1: Paleoproterozoic bedrock geology, Knox Exploration Leases and location of NDI drill holes in the East Tennant region



Source: Stewart et al., (2020)

Notes: Interpreted Paleoproterozoic bedrock geology, location of NDI drill holes and Knox Exploration Leases in the East Tennant region overlain onto an image of the first vertical derivative of total magnetic intensity.

2.2.2 Tennant Creek Suite

Deposition of the Warramunga Formation was closely followed by intrusive and extrusive felsic magmatism of the Tennant Supersuite, as well as deformation and Tennant Creek-style IOCG mineralisation associated with the 1,860–1,845 Ma Tennant Event. This event is defined as D₁ across the Tennant Creek region (Donnellan, 2013; Maidment et al., 2013). The syn-tectonic intrusive rocks of the Tennant Creek Suite comprise granites and quartz porphyries as well as lesser mafic to intermediate intrusions. Intrusion of this suite is interpreted to have exploited pre-existing structures between 1,860 and 1,840 Ma.

2.2.3 Ooradidgee Group

Unconformably overlying the Warramunga Formation are volcano-sedimentary rocks of the ca. 1,845–1,840 Ma Ooradidgee Group (Maidment et al., 2013). Early sequences of the Ooradidgee Group (such as the Monument and Yungkulungu formations) are interpreted to overlap in time with the intrusion of the Tennant Creek Suite and the main sulfide mineralisation event within Tennant Creek (Houston et al., 2020).

The Ooradidgee Group comprises dominantly extrusive volcanic (and volcanoclastic) rocks intercalated with sedimentary sequences that vary upward from deep-water to sublittoral/littoral and finally fluvial facies. Donnellan (2013) recognised three volcanic episodes in the Ooradidgee Group. The oldest, at ca. 1,850 Ma, is represented by the Monument Formation and Yungkulungu Formation, and the mafic Edmirringee Volcanics; a second event, bimodal, at ca. 1,840 Ma, is represented by the Epenarra Volcanics and the Bernborough Formation; and a third event, at ca. 1,814 Ma, is represented by the Treasure Volcanics.

The Davenport Event resulted in the folding of the Ooradidgee Group and most likely overprinted the Tennant Event deformation in the Warramunga Formation (Donnellan, 2013). This phase of deformation is interpreted to be broadly coeval with emplacement of the ca. 1,710 Ma Devils Suite and correlative with tectonism and magmatism of similar age in the Aileron Province (McGloin et al., 2020). The Devils Suite granites are associated with tungsten-tin-tantalum-molybdenum and gold mineralisation in the Davenport Province, which lies to the south of the Warramunga Province (Skirrow et al., 2019).

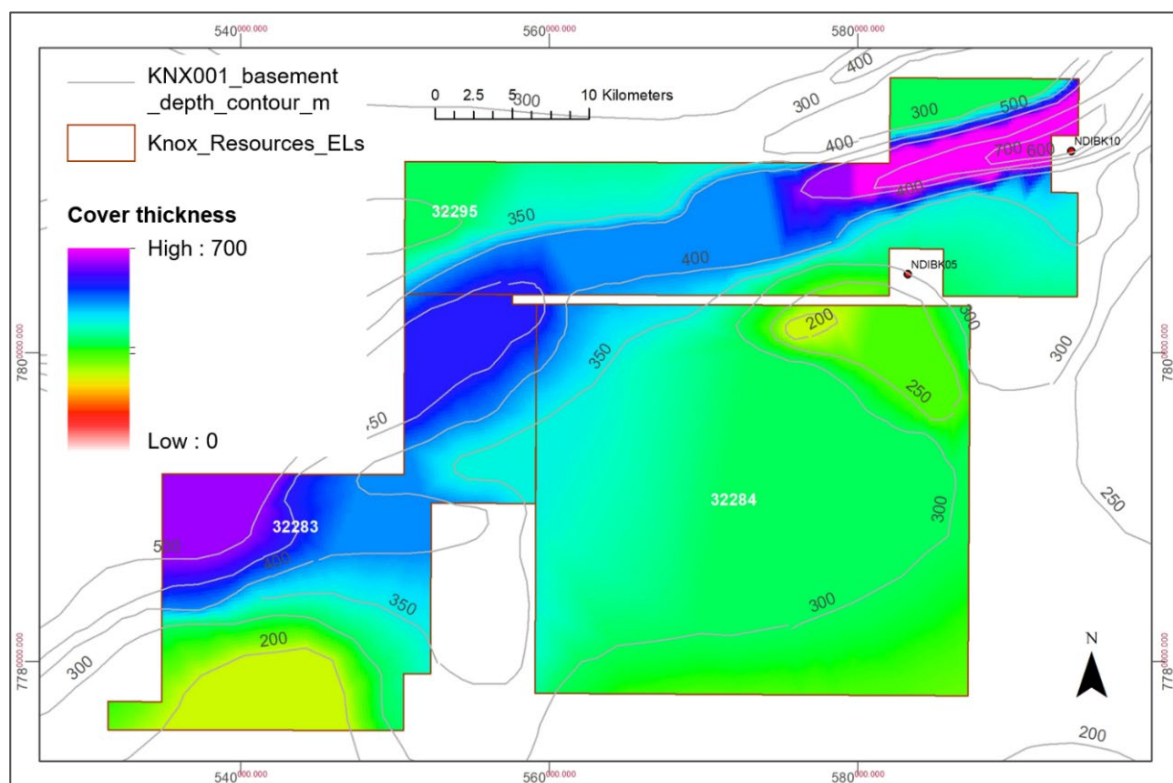
Two phases of concentric folding overprint the Ooradidgee Group (Blake et al., 1987): a first folding event that resulted in northwest trending folds, which were superimposed by a second event with northeast trending folds.

2.2.4 Georgina Basin sediments

The Georgina Basin is a widespread intra-cratonic basin covering over 325,000 km² within Australia and includes rocks of Cryogenian to Devonian age (Khan et al., 2007). Rocks of the Georgina Basin vary compositionally from east to west with a gradual shift from predominantly siliciclastic to more carbonate-rich components. These compositional changes reflect a palaeo-geographic setting shift, which varied from a marine slope, ramp-dominated facies to sabka-type, supratidal depositional settings.

The interpolation of gridded contours by Euler deconvolution indicate that Cambrian sedimentary cover thickness ranges from 0 m to ~350 m across Knox's ELs. In addition, a narrow ~5 km fault-bounded trough of up to 400 m of younger Proterozoic sediment (possibly Alroy Formation) overlies basement throughout the length of EL32295 and into EL32283 (Figure 2-2).

Figure 2-2: Interpreted thickness of cover over Paleoproterozoic basement EL 32283, EL32284 and EL32295



Source: SRK, 2021

3 Previous exploration

3.1 Program objectives

The regional area has previously been explored for phosphate and IOCG style mineralisation, however a review of open file historical data and exploration reports suggests no previous mineral occurrences have been identified in the area including EL32283 and EL32284, largely reflecting the extensive cover within this area. Pre-competitive geoscience studies in the area by Geoscience Australia and NTGS, and a recent Geoscience Australia IOCG 'Prospectivity' map (Skirrow et al., 2019) highlighted the area as being highly prospective for IOCG style mineralisation. This is reinforced by the surface copper discovery reported in late 2020 by Middle Island Resources (ASX: MDI) at their Crosswinds Prospect, which borders Knox's EL32295.

In December 2020, Knox completed a high resolution airborne geophysical survey using a fixed wing platform (airborne magnetic, radiometric and DEM) across its western and southeastern tenements, namely EL32282, EL32296 and EL32295. The survey data have proven invaluable in the Company's updated interpretation of potential basement sequences across the ELs.

3.2 Historical data sets

Historical airborne geophysical survey data over EL32283 and EL32284 is limited to the Geoscience Australia (GA) Bonney Well (GA survey 1008; acquired in 1999) and Georgina (GA survey 1022; acquired in 2002) surveys. These airborne geophysical surveys were carried out using a 400 m flight line spacing (with some 200 m infill in the Bonney Well survey area).

The survey flight line orientation for the recent survey was determined following an open-file historical airborne geophysical data compilation, processing and imaging study carried out by Knox over EL32283 and EL32284. A filtered magnetic anomaly is shown in Figure 3-1 and highlights a predominate east–west orientation of stratigraphy within the western part of EL32283.

The acquisition of airborne magnetic survey data in EL32283 and EL32284 would complement the existing datasets in order to refine the current interpretations, to better understand the structural and geological architecture of the region and assist with target generation for ongoing exploration.

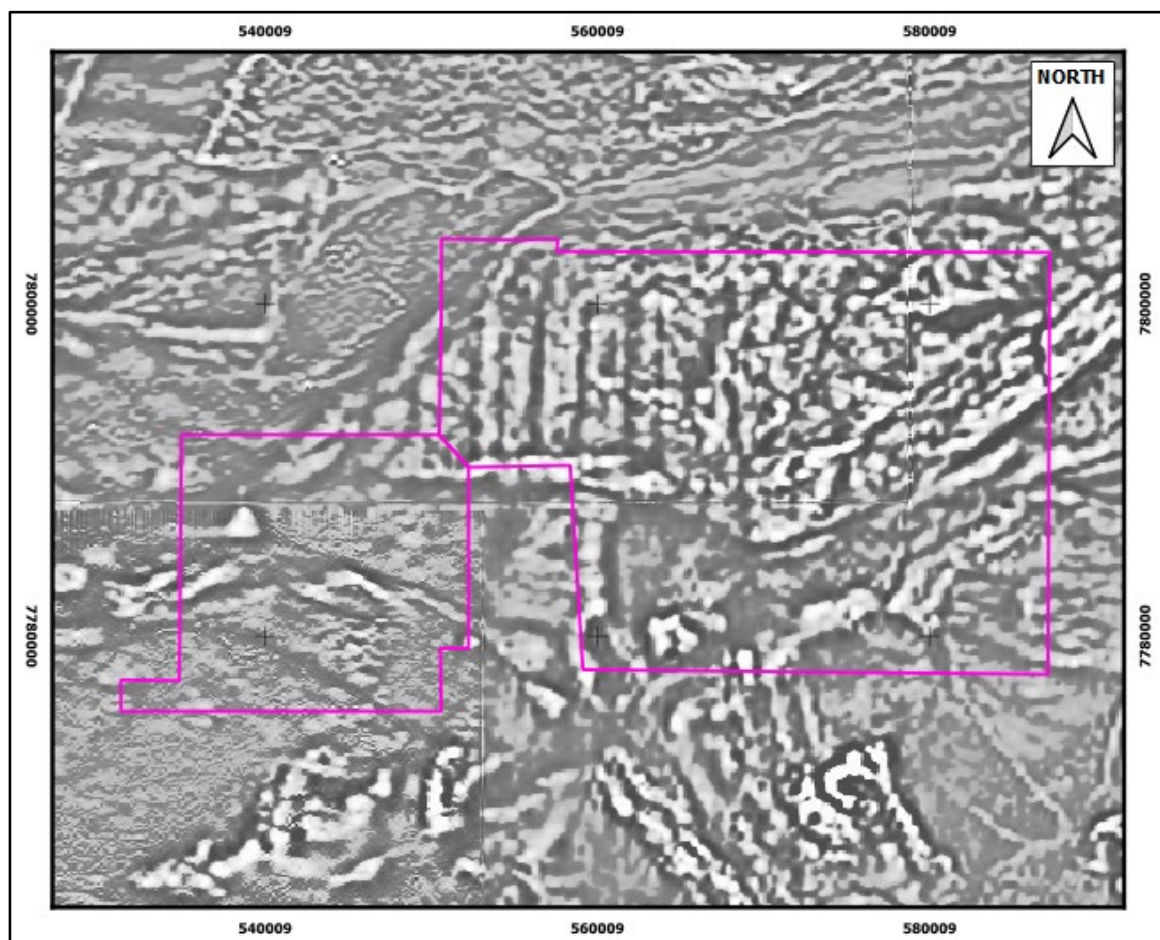
3.3 Exploration model – IOCG deposits

The Barkly Tableland area east of Tennant Creek is a focus of substantial exploration interest with the commencement of exploration by a number of companies following up encouraging results from the collaborative pre-competitive geoscience studies in the area by Geoscience Australia and NTGS. Knox is primarily targeting mineralisation in Proterozoic basement underlying Cambrian cover of the Georgina Basin, with key targets being IOCG in Warramunga Province, and sediment-hosted copper and/or zinc in Palaeo-Mesoproterozoic basin successions.

IOCG deposits are an important and highly valuable global source of copper, gold and uranium, as well as having the potential to host other minerals including silver, bismuth, molybdenum, cobalt and rare earth elements.

IOCG deposits generally show a strong magnetic and/or gravity response with a strong association noted with iron rich host sequences in the Tennant Creek region lending to this geophysical character. In addition, major structures are recognised to act as important fluid flow conduits for tapping fertile fluid sources at depth. Granites additionally play a key role in fluid and heat source dynamics for IOCG mineral systems in this region and are an important element for targeting in the region. Due to the extensive cover in Knox's project area geophysical tools such as magnetics and gravity remain critical tools for understanding of the key mineral systems elements and target vectoring.

Figure 3-1: Historical airborne geophysical survey areas overlain on compiled and filtered magnetic image over EL32283 and EL32284



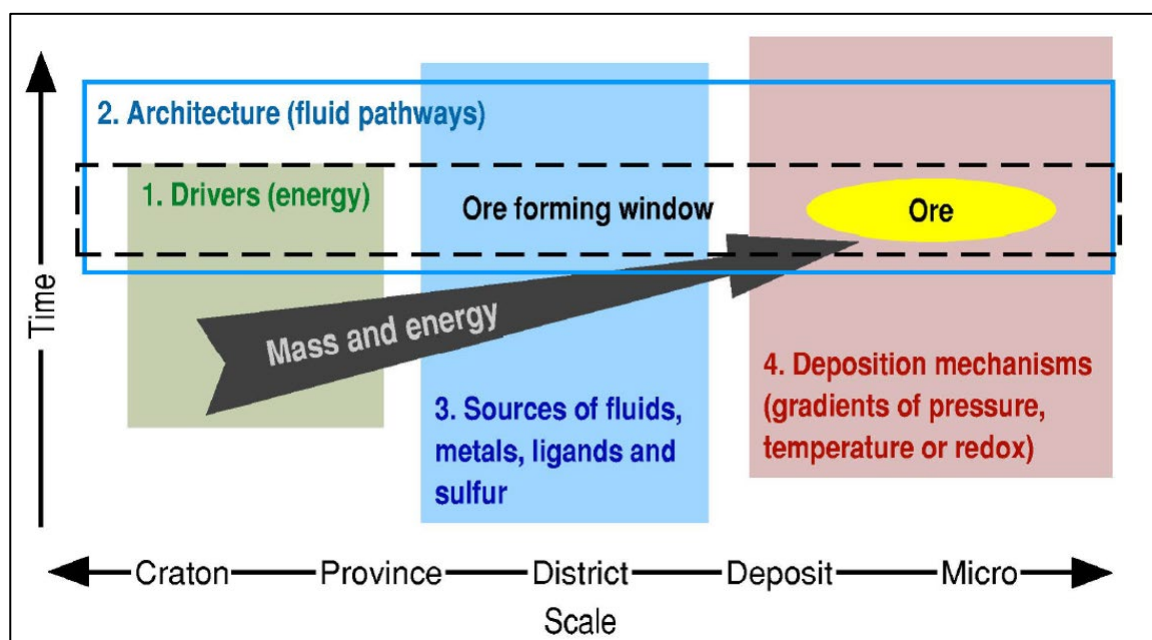
Source: Resource Potentials Pty Ltd

3.4 Main targets

Knox is primarily targeting mineralisation in Proterozoic basement underlying Cambrian cover of the Georgina Basin, with key targets being IOCG in Warramunga Province, and sediment-hosted copper and/or zinc in Palaeo-Mesoproterozoic basin successions.

A review of the mineral systems of Tennant Creek was conducted by SRK to better understand the local IOCG systems and broader IOCG mineralisation model (Figure 3-2). This work sought to break the underlying mineralisation model into mappable components inclusive of the fluid source, fluid pathway and fluid traps. The system elements of the project were broken down as follows:

- Fluid source: favourable intrusives (such as the Tennant Creek suite granites)
- Fluid pathway: major faults and minor faults
- Fluid trap: host rocks (such as the Warramunga Formation and potentially early Ooradidgee Group sequences), ironstones (indicated by presence of favourable alteration/gravity highs).

Figure 3-2: Mineral systems concept

Source: After Wyborn et al., (1994) and Skirrow et al., (2019)

Notes: When the four core components are spatially connected (x axis) and temporally coincident (y axis), they facilitate mineral deposit formation (ore window).

(1) Drivers: energy that facilitates fluid flow and transfer of mass and energy.

(2) Architecture: faults and structures that allow propagation of energy and fluids.

(3) Sources: of metals, fluids and ligands.

(4) Deposition mechanisms: a boundary of chemical, physical, barometric and/or thermal change that denatures ligands and facilitates mineral precipitation.

3.5 Exploration rationale

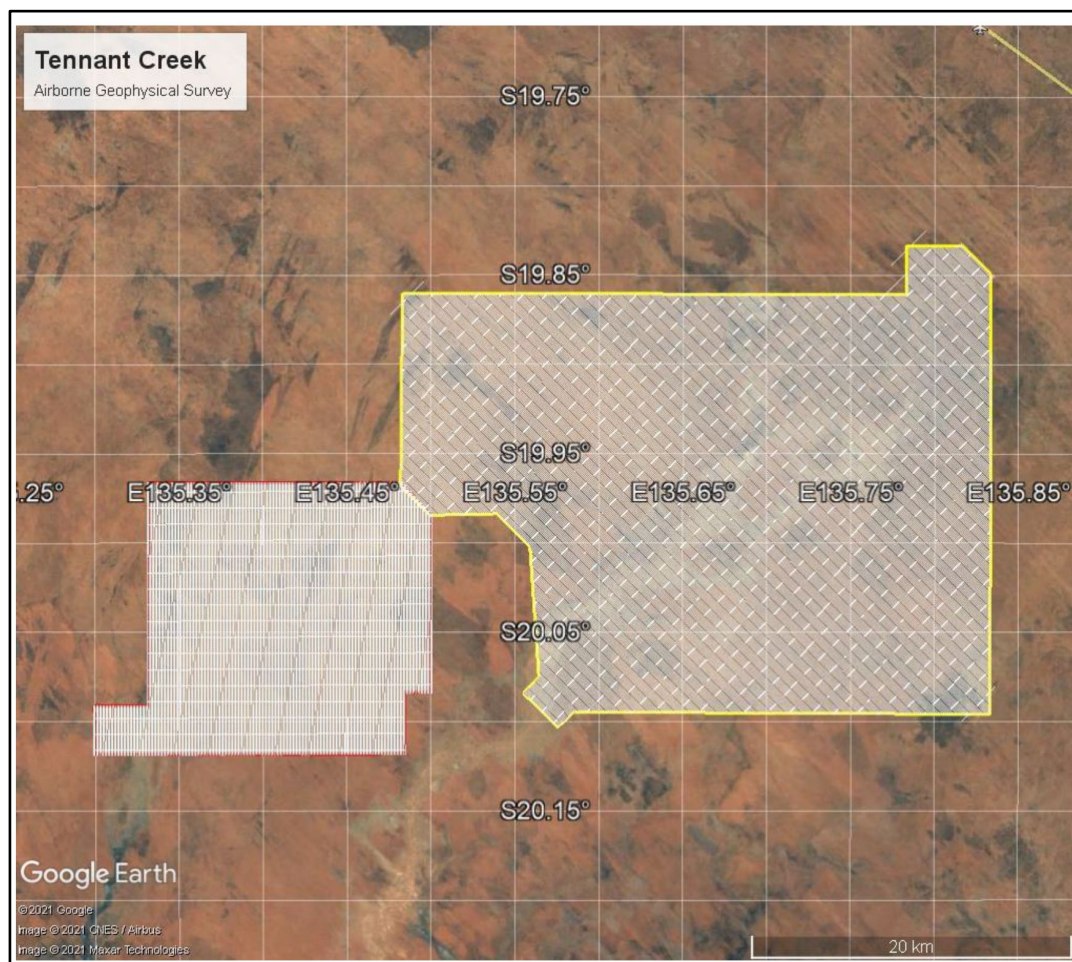
Given the extensive cover over the East Tennant region, detailed magnetic and gravity datasets are required to define the key mappable IOCG targeting elements within the project area. The addition of detailed magnetic data, across EL32283 and EL32284 area will assist in understanding important structural corridors, distribution and architecture of prospective geological horizons, potential fluid sources as well as provide greater confidence for drill targeting across the project area.

4 Airborne Geophysics survey details

Knox applied for and was successful in seeking exploration grants with the NTGS as part of Round 14 of the 2021 Geophysics and Drilling Collaboration and the NT Government's four-year 'Resourcing the Territory' initiative. The co-funding grant was applicable to EL32283 and EL32284 in the Georgina Basin, NT, to acquire a high resolution airborne magnetic, radiometric and DEM geophysical surveying using a fixed wing aircraft.

The magnetic airborne survey completed of a total of 12,977 survey line kilometres, covering an area of more than 1,100 km² (Figure 4-1).

Figure 4-1: Flight line and spacing design over EL32283 and EL32284



Source: MAGSPEC Pty Ltd, 2021

4.1 Survey details

Knox commissioned MAGSPEC Airborne Surveys Pty Ltd (MAGSPEC) to undertake the geophysical survey over EL32283 and EL32284. Field acquisition for the airborne magnetic survey commenced on 18 September 2021 to 2 October 2021 utilising a Cessna 210, a specially modified aircraft for this type of survey.

The crew was based in Barkly, Northern Territory for the duration of the survey. Full survey details of the program are summarised in the acquisition report in Appendix A with survey parameters briefly summarised below and Table 4-1:

- Survey area: ~1,100 km²
- Line spacing: 100 m

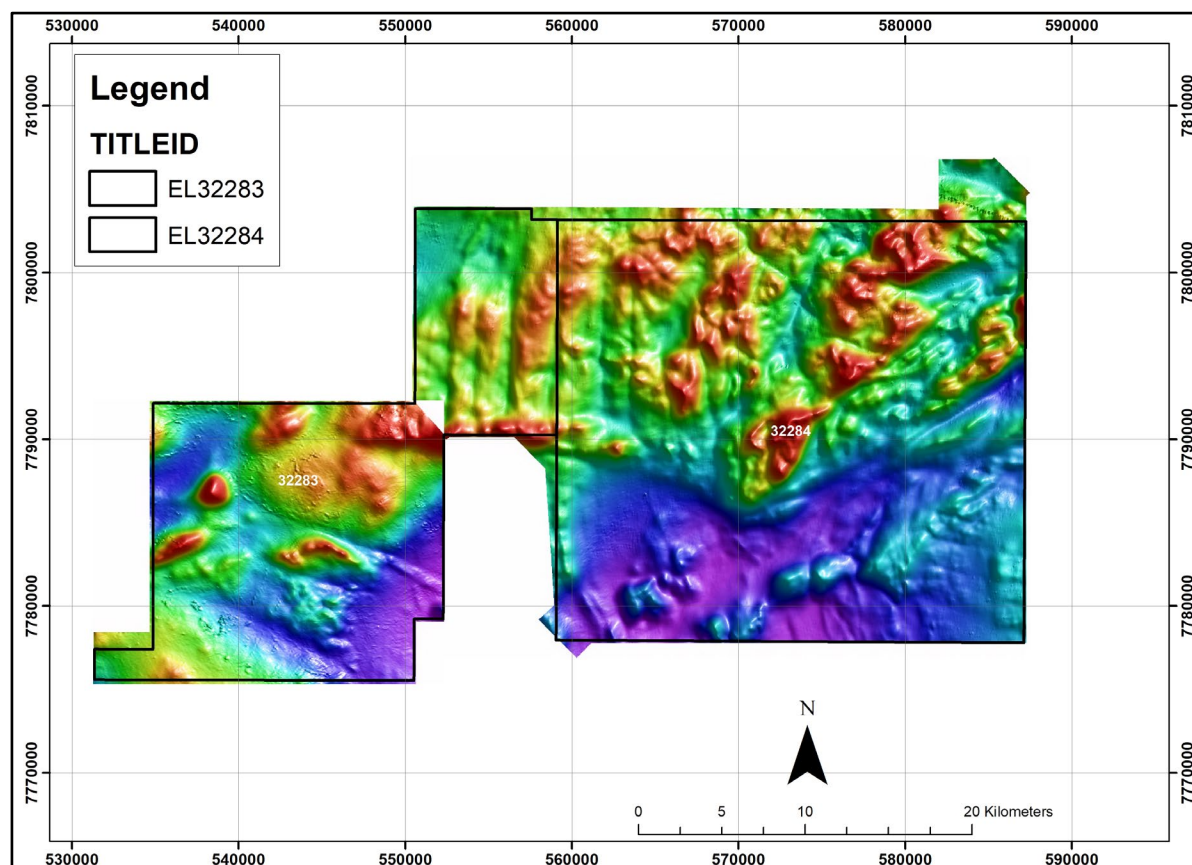
- Tie-line spacing: 1,000 m
- Bearing: 0/180 for EL32283 and 135/315 for EL32284
- Flying height: 30 m
- Total line km: 12,977 km.

Table 4-1: Summary of flight specifications of 2021 airborne geophysical survey

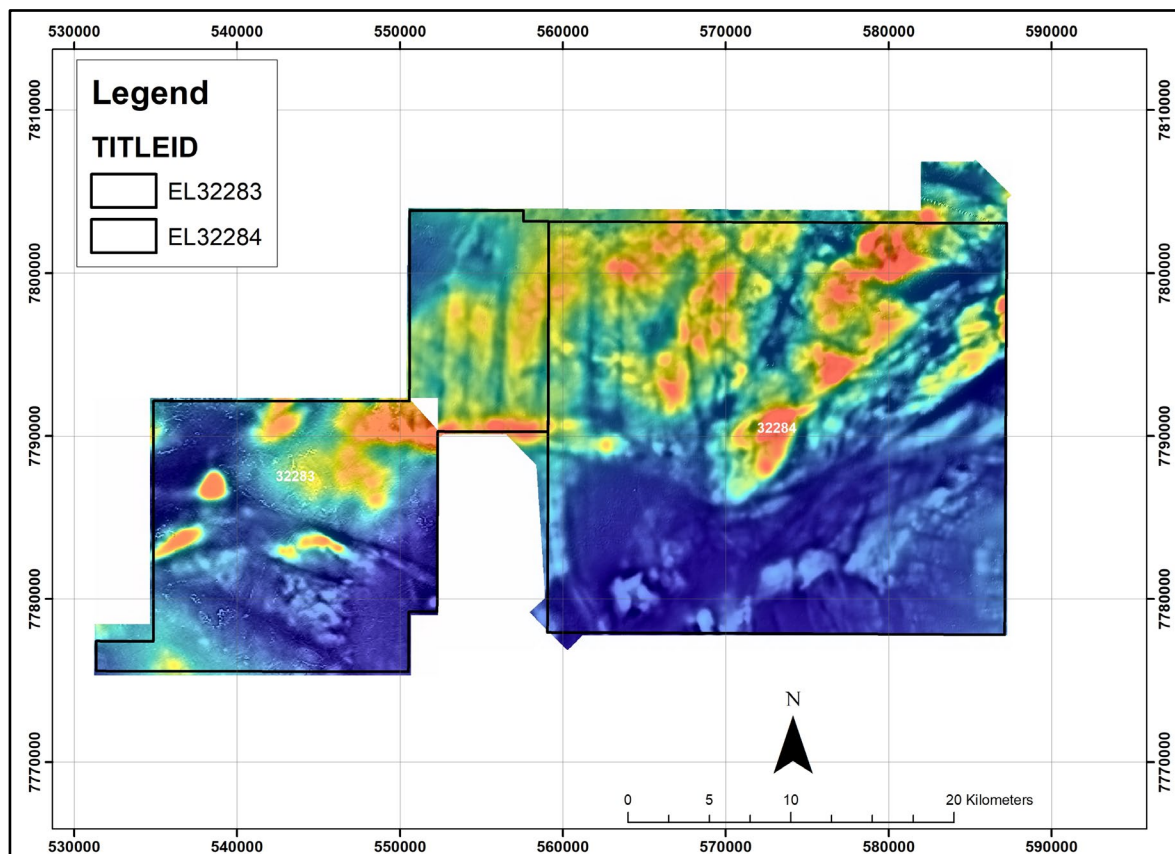
Area Name	Traverse line spacing (m)	Traverse line direction (degrees)	Tie-line spacing (m)	Tie-line direction (degree)	Sensor height (m)	Total line (km)
EL32283	100	000–180	1,000	090–270	30	3,336
EL32284	100	135–315	1,000	045–225	30	9,641
Total						12,977

Source: MAGSPEC Pty Ltd, 2021

On completion of the survey, Resource Potentials undertook a phase of gridding of the data to prepare a series of products for interpretation by Knox's exploration team. Example images are presented in Figure 4-2 and Figure 4-3.

Figure 4-2: Reduced to pole total magnetic intensity (RTP-TMI) image

Source: Resource Potentials, 2021

Figure 4-3: First vertical derivative (1VD) image

Source: Resource Potentials, 2021

5 Results and interpretation

Preliminary interpretations of Knox's exploration leases were conducted by SRK to define the geology and structure of the prospective Paleoproterozoic, below younger Proterozoic strata, Cambrian sedimentary and volcanic rocks of the Georgina Basin and unconsolidated Cainozoic sedimentary cover. Within EL32283 and EL32284, this work was conducted using available geology datasets, magnetic and gravity datasets namely:

- high-resolution aeromagnetic and regional gravity data
- outcrop data from the 100 K NT geology maps
- Northern Territory, Tennant Creek and Frew River solid geology maps
- drilling data where available.

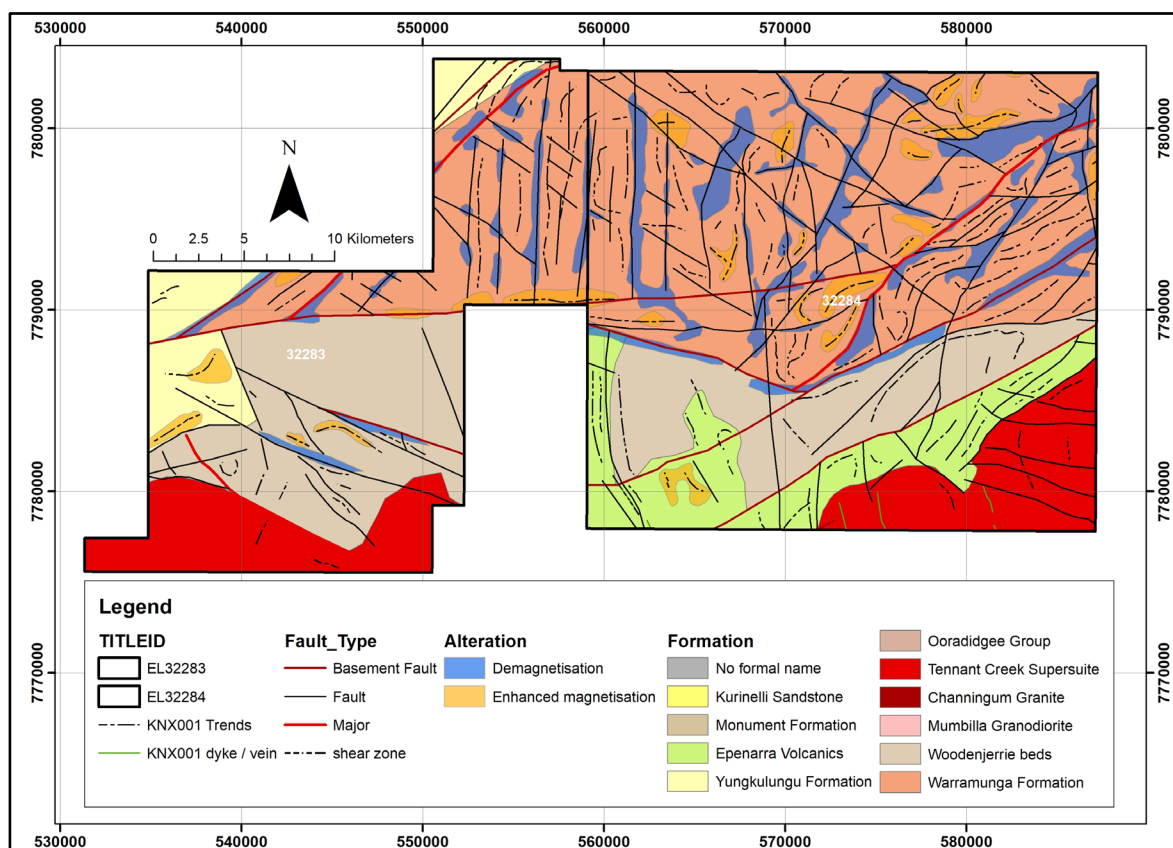
The interpretation of the solid geology and structure was undertaken at a scale ranging between 1:25,000 and 1:50,000. Structures interpreted included faults, bedding trends, dykes and fold axes. The faults were subdivided into either major or minor where the former could be distinguished by displacements of several kilometres and expression in the regional gravity data.

The acquisition of detailed aeromagnetic, digital elevation and radiometric data across EL32283 and EL32284 was subsequently conducted to assist in further refining the subsurface interpretations and definition of target areas for follow up investigations. The final geological and structural interpretations of EL32283 and EL32284 as presented in Figure 5-1 with updated interpretations relying heavily on the aeromagnetic datasets.

Both EL32283 and EL32284 are interpreted to largely consist of undifferentiated sediments and felsic intrusives of Warramunga Group equivalents, forming as a lensoidal shaped domain through the centre of EL32284 and north of EL32283. This basement inlier is bound by crustal-scale shear zones of several kilometres of displacement and zones of extensive magnetite destruction evident (hematite alteration). To the south of this inlier is a magnetically quieter zone interpreted to reflect sediments of the Woodenjerrie Beds. To the southeast and southwest of the leases undifferentiated felsic intrusives of unknown age have been interpreted, potentially belonging to the Tennant or Devils Suite intrusives. A zone of Epenarra Volcanics have been interpreted in EL32284 between the felsic intrusives and Woodenjerrie Beds, showing a moderately elevated magnetic character relative to the surrounding Woodenjerrie Bed sediments. On the western edge of the leases a zone of fault bound Yungkulungu Formation has additionally been interpreted.

In addition to the geology, numerous structurally controlled zones of both magnetic enhancement and magnetite destruction have been interpreted within both leases (Figure 5-1). Several of these alteration zones have been noted as coincident with elevated gravity signatures within the regional gravity datasets.

From the overall interpretations of these leases several areas have been identified to show favourable structure, geology and geophysical character consistent with Tennant Creek style IOCG systems and have been interpreted to warrant follow-up investigations. Additional detailed gravity surveys, site surveys and drill planning are aimed to be conducted within the next phases of the exploration program to assist with drill targeting.

Figure 5-1: Geological interpretation of project area covering EL32283 and EL32284

Source: SRK, 2021

6 Conclusions

The acquisition of the high-resolution airborne magnetic survey data over EL32283 and EL32284 was co-funded through the 'Resourcing the Territory Initiative' and will greatly add to the Northern Territory regional aeromagnetic dataset.

The geophysical and geological mapping work to date highlights the prospectivity of the East Tennant Region. This data has provided a better understanding of important structural corridors, distribution and architecture of prospective geological horizons, potential fluid sources as well as provide greater confidence for drill targeting across EL32283 and EL32284.

Several target areas have been identified from this data and represent follow up targets for additional exploration work going forward. The co-funding initiative has proven an invaluable contribution to Knox's exploration program with aims for a successful discovery early in the new year.

7 References

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Appendices

Appendix A: Magspec Airborne Surveys – Survey Report



**Ultra low level and
regional survey
specialists.**



Airborne Geophysical Survey

Survey Report

Tennant Creek Project

Survey carried out on behalf of

Knox Resources Limited

(Reference Number: 1253)

18 October 2021

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1. SURVEY EQUIPMENT

1.1 Aircraft

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

Registration - VH-HHJ



Survey Aircraft

1.2 Data Acquisition System

High speed digital data acquisition system.

- Sample rates up to 20 Hz
- Integrated Novatel OEM DGPS receiver providing positional information, 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

1.3 Magnetometers

Tail sensor mounted in a stinger housing.

- | | | |
|----------------|---|------------------------------------|
| • Model / Type | - | G-823A caesium vapour magnetometer |
| • Resolution | - | 0.001 nT resolution |
| • Sensitivity | - | 0.01 nT sensitivity |
| • Sample Rate | - | 20 Hz (approximately 3.5 m) |
| • Compensation | - | 3-axis fluxgate magnetometer |

1.4 Gamma-Ray Spectrometer

RSI RS-500 gamma-ray spectrometer incorporating 2x RSX-4 detector packs.

- | | | |
|------------------------|---|---------------------------|
| • Total Crystal Volume | - | 32 L |
| • Channels | - | 1024 |
| • Sample Rate | - | 2 Hz (approximately 35 m) |
| • Stabilisation | | Multi-peak automatic gain |

1.5 Altimeters

Bendix/King KRA 405 radar altimeter.

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

Renishaw ILM-500R laser altimeter.

- | | | |
|---------------|---|-------------|
| • Resolution | - | 0.01 m |
| • Sample Rate | - | up to 20 Hz |
| • Range | - | 0-500 m |

Barometric pressure sensor.

- Accuracy - RSS $\pm 0.25\%$ FS (at constant temp)
- Range - 600-1100 hPa

1.6 Magnetic Base Stations

GEM GSM-19 Overhauser & Scintrex Envi-Mag proton precession base station magnetometers.

- Resolution - 0.01 / 0.1 nT
- Accuracy - 0.1 / 0.5 nT
- Sample Rate - 1.0 / 0.5 Hz

The GEM GSM-19 sampling at 1 second was used for all corrections.

2. NAVIGATION AND FLIGHT PATH RECOVERY

Integrated Novatel OEM719 DGPS receiver:

- L1/L2 + GLONASS Multi Frequency
- 555-channel

Navigation information supplied to the pilot via an LCD steering indicator. All data were synchronised to a one pulse per second triggered by the GPS time.

3. CALIBRATIONS AND CHECKS

3.1 Magnetometers

A compensation box was flown prior to 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.

3.2 GPS

GPS accuracy tests were performed by accumulating GPS readings for approximately 5 minutes whilst the aircraft was static. All readings (X, Y, Z) were within 2 meters.

3.3 Altimeters

Prior to commencement of survey production, the radar altimeter was checked for linearity by way of a swoop test over flat terrain.

4. QUALITY CONTROL

4.1 During Flight

During survey, the pilot monitored system health from prompts on the navigation screen.

The diurnal base stations were monitored by 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 Magnetism

The following steps were performed during the magnetism 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 2020 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 MAGSPEC 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.

5.2 Radiometrics

Radiometric processing consisted of the following steps:

- 256-channel spectral noise reduction using the NASVD method
- 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 where 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.

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.

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);

β - 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 , β 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:

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

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

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

Where:

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

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

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

where: -

N_{corr}	=	the count rate normalized to the nominal Survey altitude, h_0 ;
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 was 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 MAGSPEC 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 altimeter
- Subtraction of radar altimeter from GPS height
- Tie line and micro levelling

The laser, radar altimeter and GPS 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.

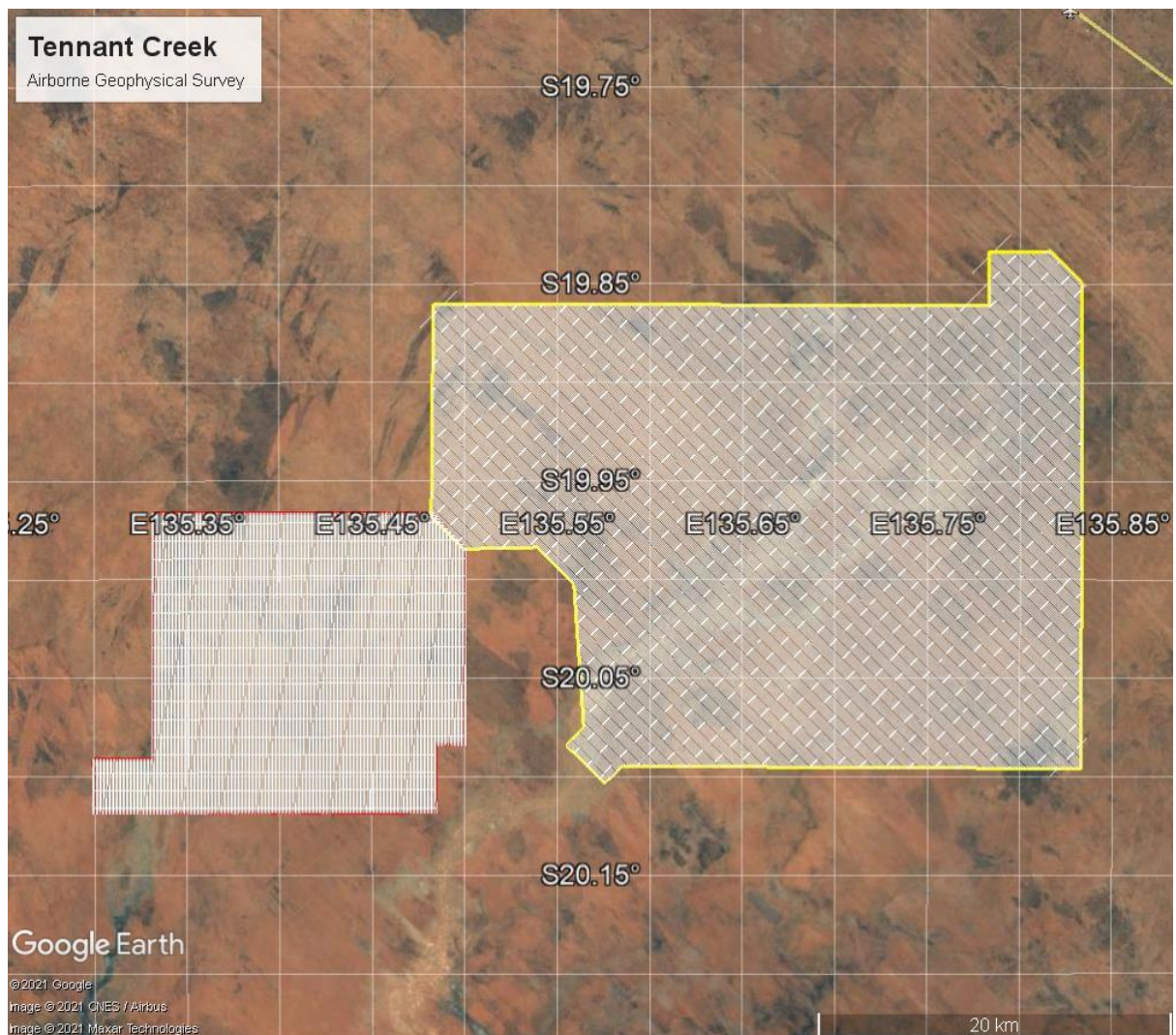
Tie line levelling was applied by way of a least squares minimisation procedure using a polynomial fit of order 0 over the cross over errors calculated between the traverse and tie line intersections.

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 - SURVEY AREA

Survey Area Diagram



Survey Area (Google Earth)

Survey Area Coordinates and Flight Specifications

WGS84

SUTM Zone 53

West		East	
EASTING	NORTHING	EASTING	NORTHING
534700	7792200	550583	7803910
550500	7792200	582016	7803740
552300	7790200	582009	7806778
552300	7779200	585518	7806760
550600	7779200	587282	7805000
550600	7775400	587115	7777697
531300	7775400	561174	7777948
531300	7778400	560166	7776976
534700	7778400	557991	7779126
		559004	7780118
		558474	7788144
		556381	7790237
		552207	7790160
		550434	7791941

Area Name	Traverse Line spacing (m)	Traverse Line Direction (deg)	Tie Line Spacing (m)	Tie Line Direction (deg)	Sensor Height (m)	Total Line Kilometres
Tennant Ck West	100	000-180	1,000	090-270	30	3,336
Tennant Ck East	100	135-315	1,000	045-225	30	9,641
Total						12,977

APPENDIX 2 - FIELD OPERATION AND PROJECT MANAGEMENT

Operational Base

The aircraft and crew were based in Barkly, Northern Territory for the duration of the survey. Production of the survey started on 18th September 2021 and ended on 2nd October 2021.

Personnel

Client Contacts	-	Matthew Healy
	-	Alex Costall
Pilots	-	Henrique Oliveira
	-	Hugh Sterle
	-	Liam Corcoran
Operations	-	Bailey Johnston
QC/QA	-	Andrew Taylor
Project Management	-	Peter Spencer
Data Processing	-	Cameron Johnston

Base Station Magnetometer Positions

The base station magnetometers were located near the Barkly Station Airstrip.

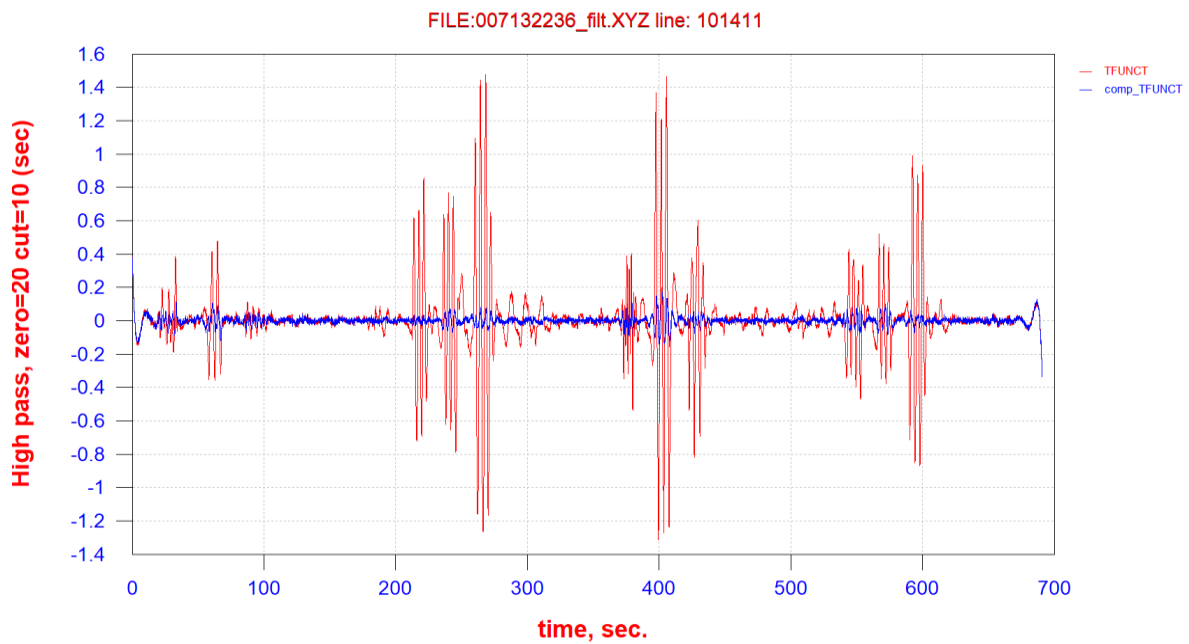
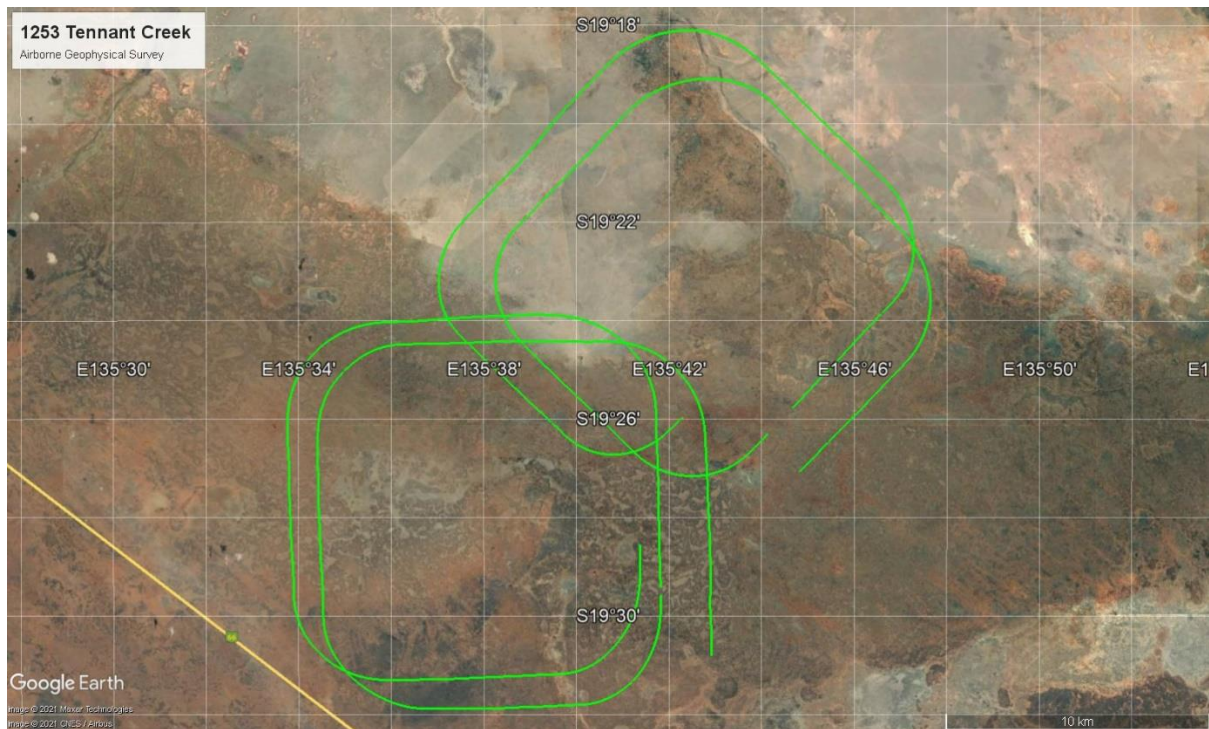


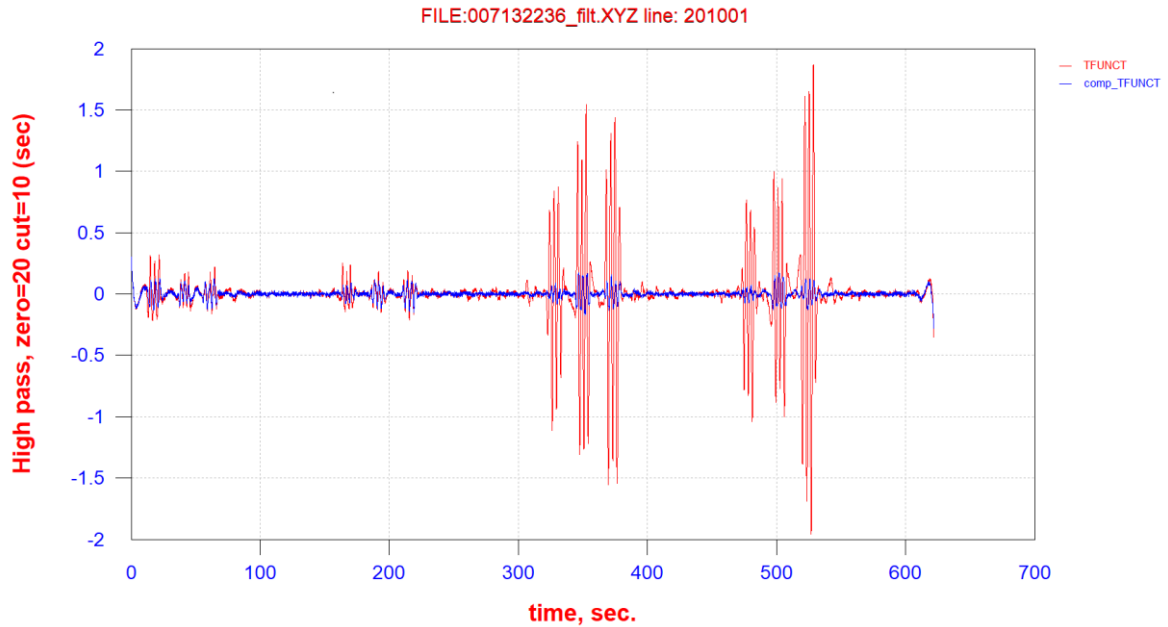
Base station 1 location co-ordinates (WGS84): 19.709894° S; 135.824608° E

Base station 2 location co-ordinates (WGS84): 19.710020° S; 135.824908° E

APPENDIX 3 – CALIBRATIONS

Magnetometer Compensation

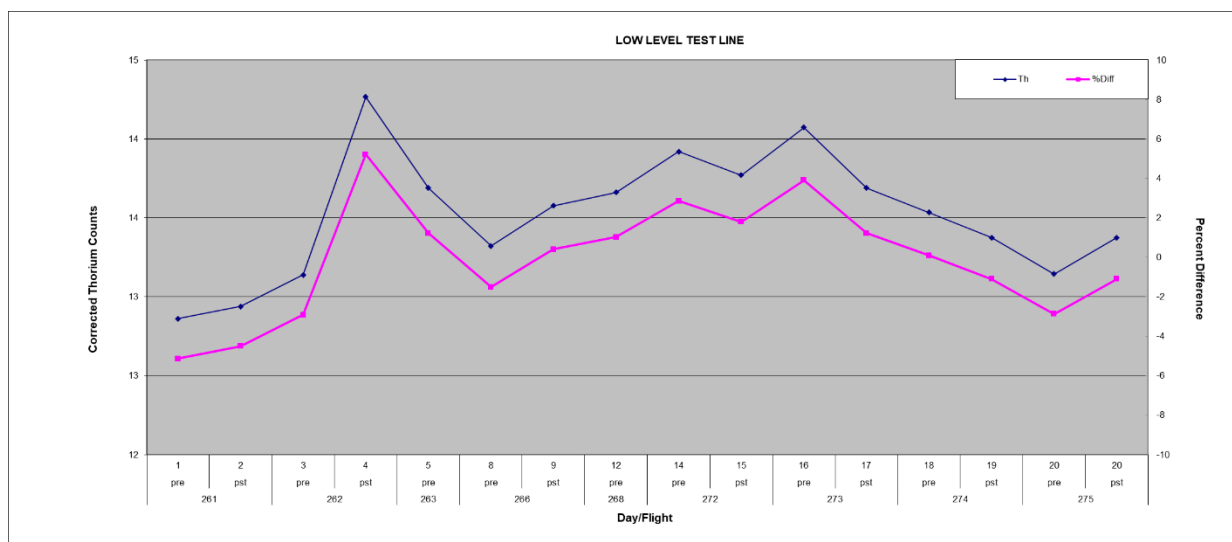
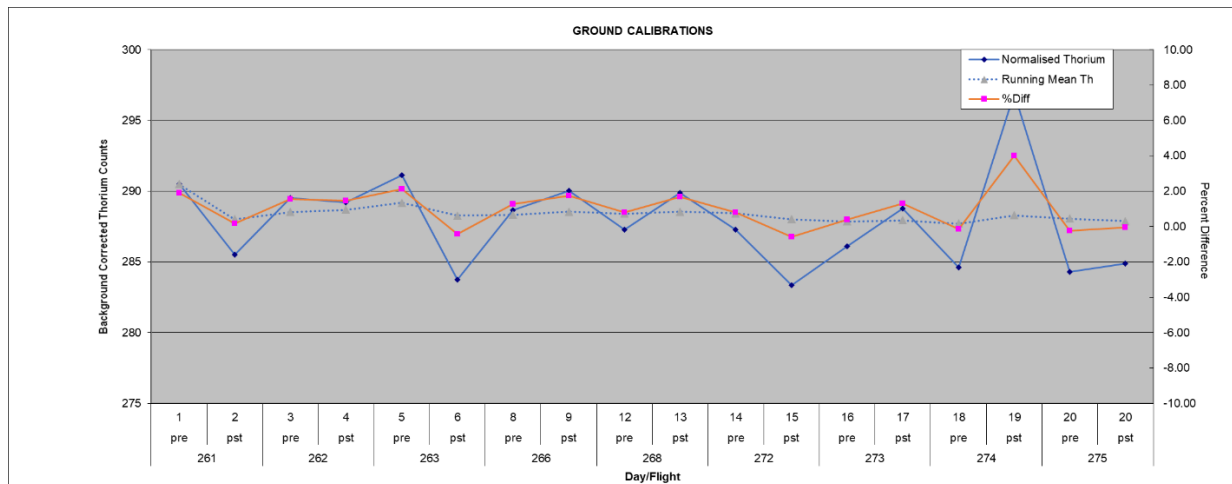




Processed Compensation Box

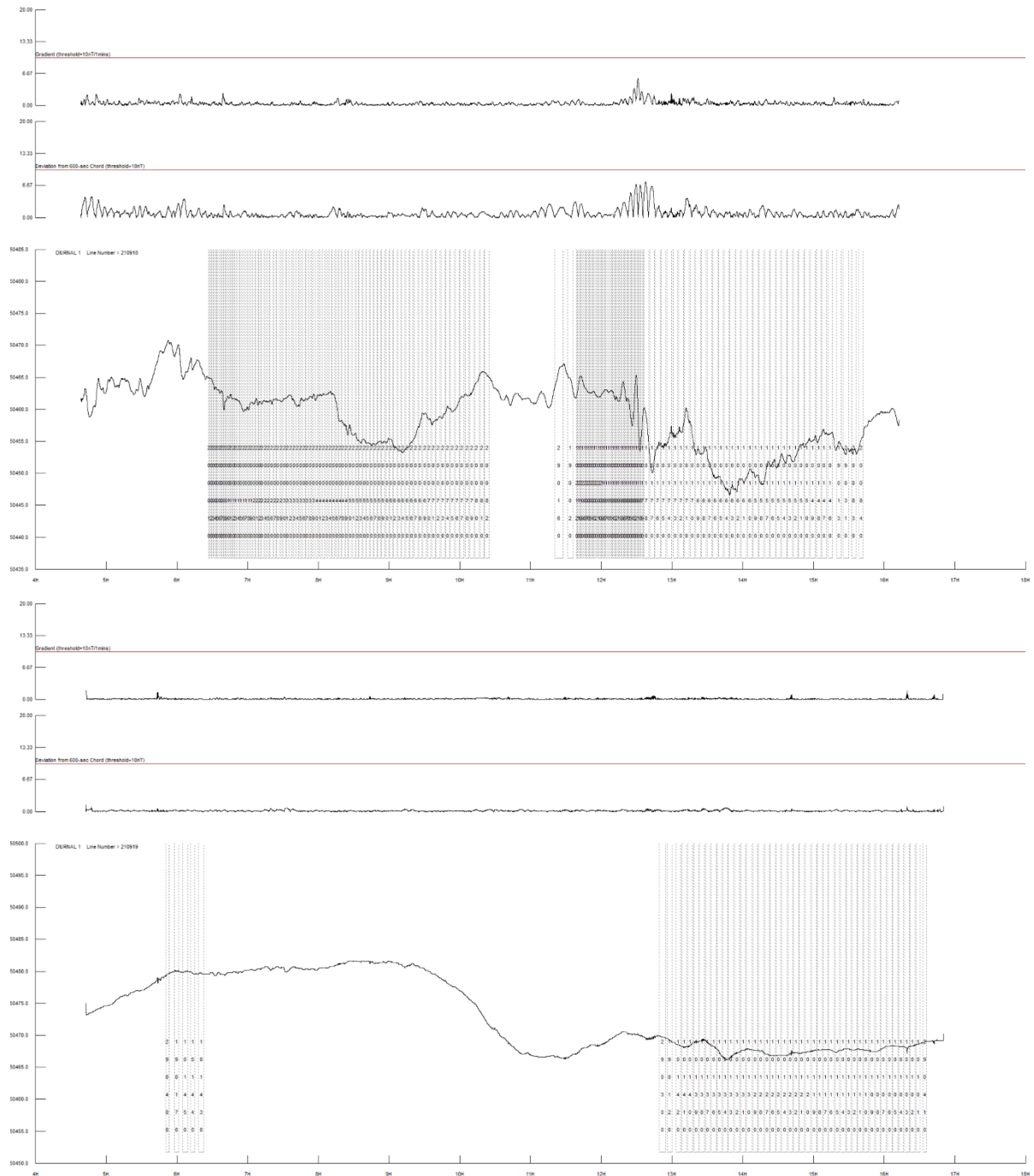
Sensor	Line	Original RMS	Compensated RMS	Improvement Ratio
Tail	101411	0.223	0.025	9.084
Tail	201001	0.269	0.035	7.652

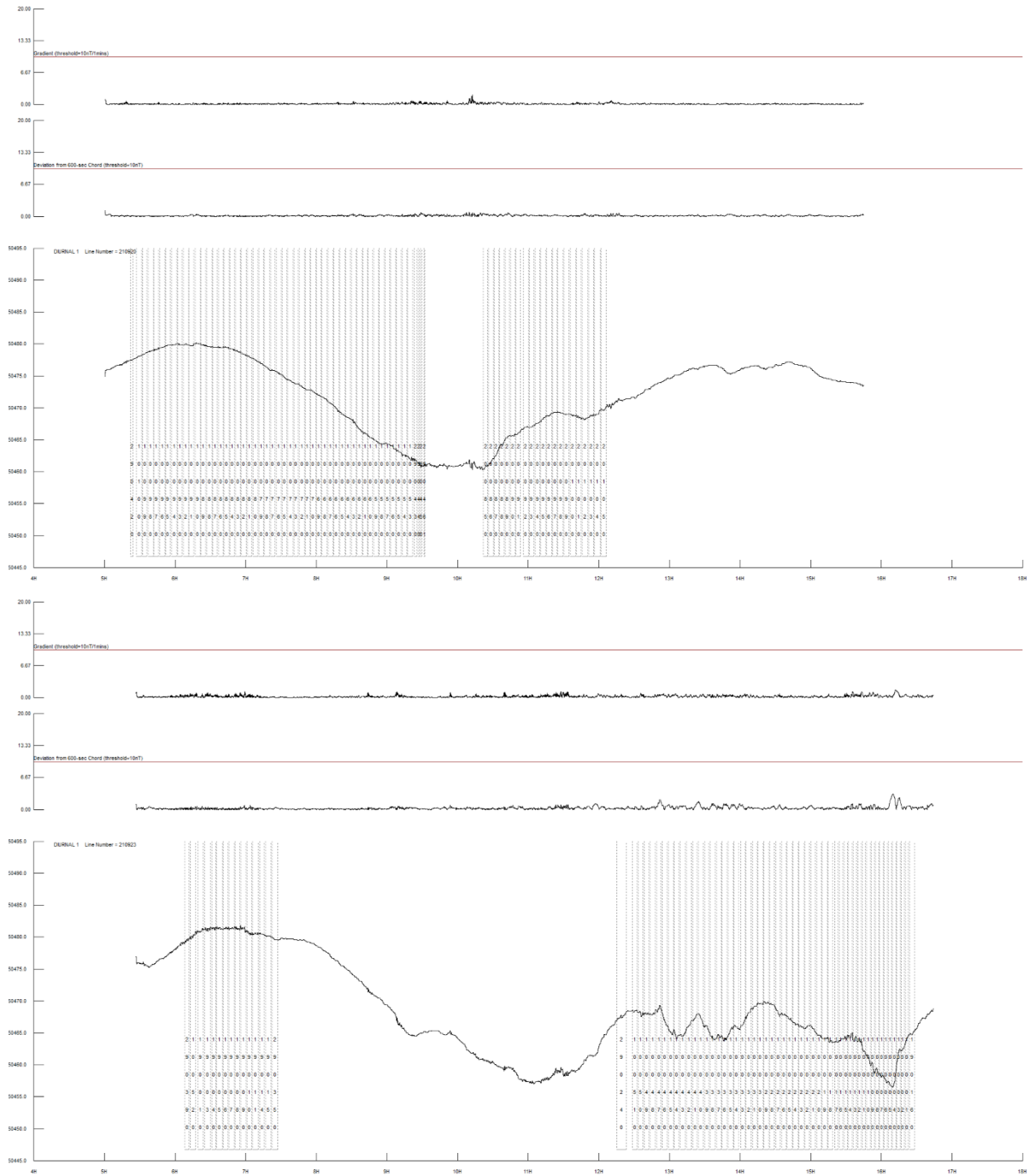
Ground Calibration Checks and Test Lines

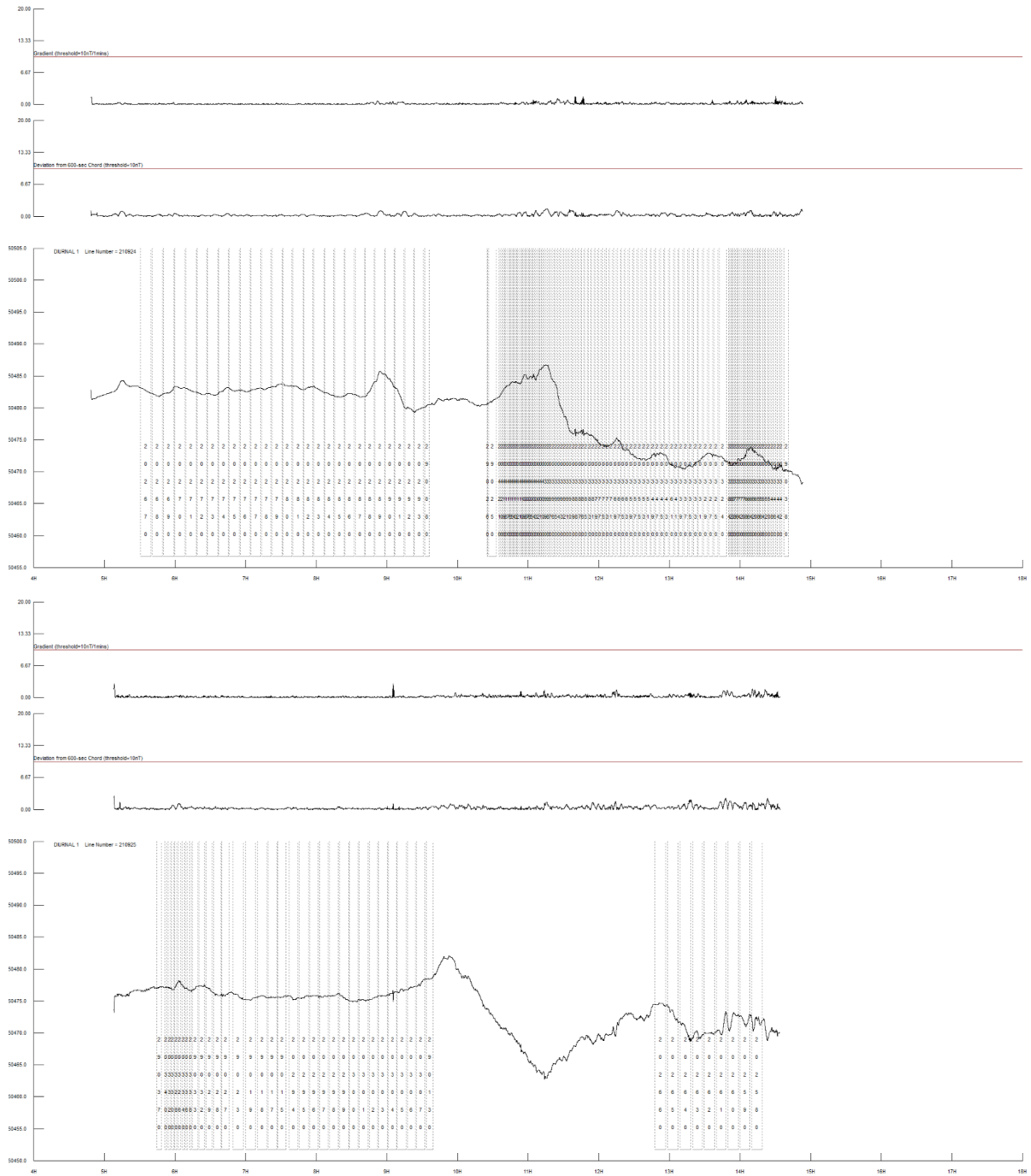


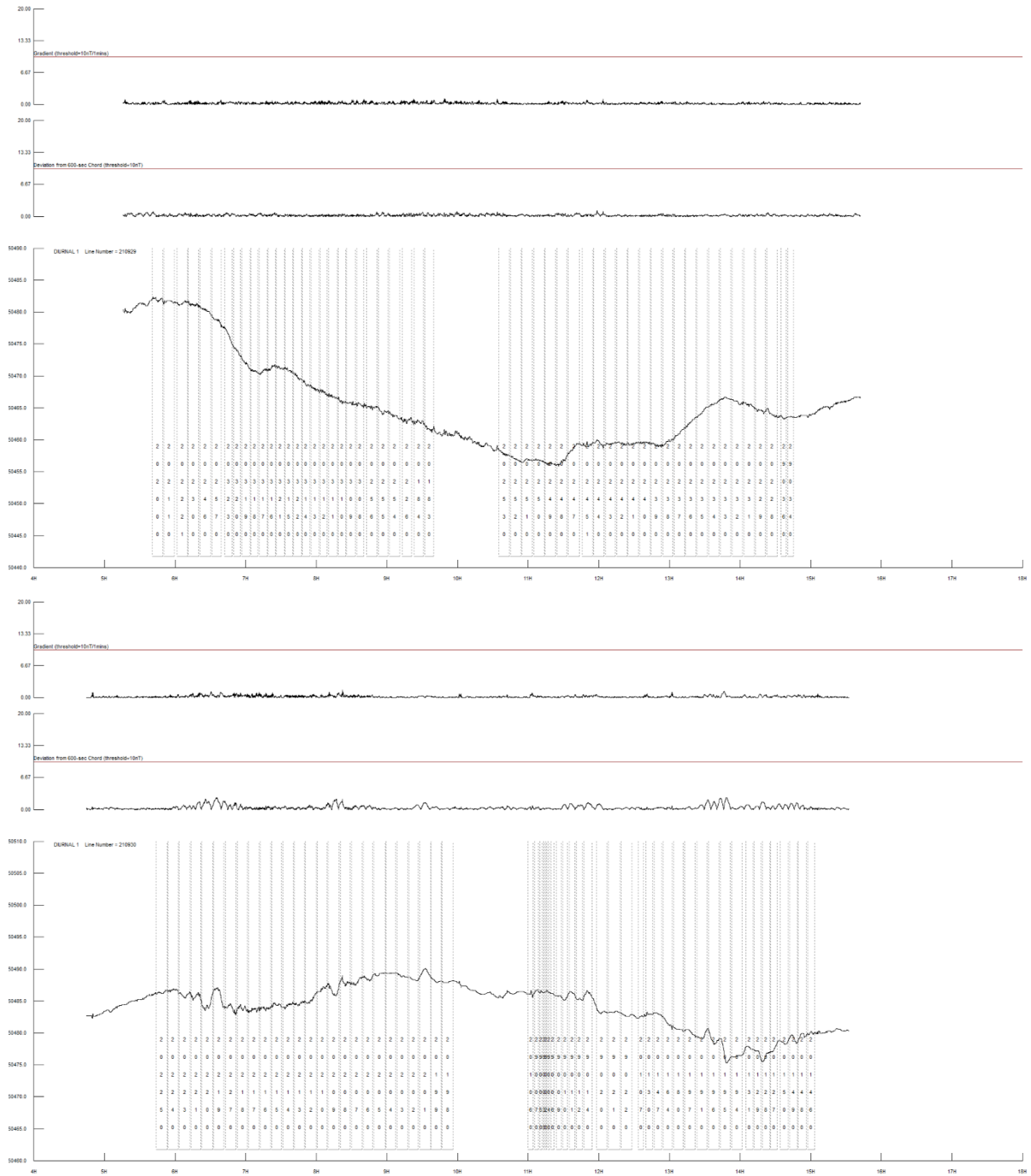
APPENDIX 4 – DIURNAL BASE STATION PLOTS

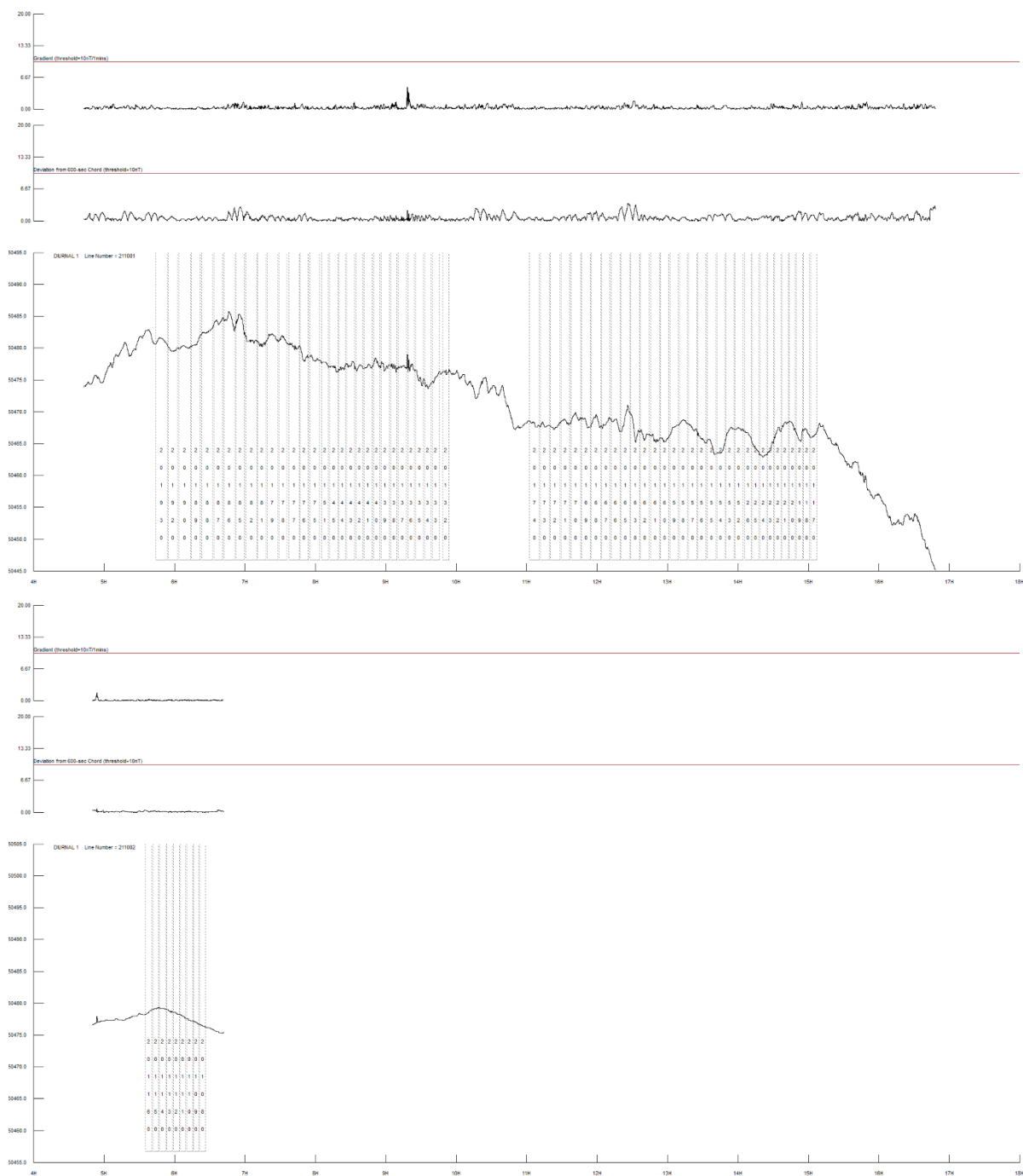
Diurnal 1 Line Number = YYMMDD











APPENDIX 5 – PROCESSING PARAMETERS AND DELIVERABLES

Magnetics

Average Diurnal 50,470 nT

IGRF Correction Parameters

	West	East
Year:	2021.72	2021.73
Height:	300	280
Zone:	53	53
Latitude:	-20.0436255 °	-19.9682542 °
Longitude:	135.4101928 °	135.6766090 °
Total Field:	50692.56 nT	50622.32 nT
Declination:	4.3993 °	4.4567 °
Inclination:	-50.5800 °	-50.4626 °

Radiometrics

Radiometric Correction Parameters

Radiometric Stripping Coefficients

Alpha:	0.2875
Beta:	0.4483
Gamma:	0.7943
a:	0.0523

	<i>Height Attenuation</i>	<i>Aircraft Background</i>	<i>Cosmic Corrections</i>	<i>Concentration Coefficients</i>
Total Count	-0.0074	23.35	1.1482	37.50
Potassium	-0.0094	5.3757	0.0659	125.52
Uranium	-0.0084	0.1493	0.054	14.12
Thorium	-0.0074	0.000	0.064	6.91

Located and Gridded Data

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

ASCII Located Data File Formats and Channels

MAGNETICS

Line:I8:NULL=9999999:NAME=Line number
 Flight:I4:NULL=999:NAME=Flight number
 Date:I9:NULL=99999999:UNIT=YYYYMMDD:NAME=Date
 Time:F11.2:NULL=9999999.99:UNIT=seconds:NAME=Time
 Fid:I9:NULL=99999999:NAME=Fiducial number
 Zone:I4:NULL=999:NAME=WGS84 Zone
 Latitude:F12.6:NULL=9999.999999:UNIT=degrees:NAME=WGS84 Latitude
 Longitude:F12.6:NULL=9999.999999:UNIT=degrees:NAME=WGS84 Longitude
 Easting:F12.2:NULL=99999999.99:UNIT=metres:NAME=SUTM53 Easting
 Northing:F12.2:NULL=99999999.99:UNIT=metres:NAME=SUTM53 Northing
 Radalt:F8.2:NULL=99999.9:UNIT=metres:NAME=Radar altimeter
 Laseralt:F8.2:NULL=99999.9:UNIT=metres:NAME=Laser altimeter
 Gpsht:F8.2:NULL=99999.9:UNIT=metres:NAME=GPS Height
 DTM:F8.2:NULL=99999.9:UNIT=metres:NAME=Digital terrain model
 Diurnal:F10.3:NULL=999999.999:UNIT=nT:NAME=Diurnal
 IGRF:F9.2:NULL=99999.99:UNIT=nT:NAME=IGRF
 Raw_TMI:F10.3:NULL=99999.999:UNIT=nT:NAME=Raw total magnetic intensity
 Mag_Dnl:F10.3:NULL=99999.999:UNIT=nT:NAME=Diurnal corrected TMI
 Mag_Dnl_IGRF:F10.3:NULL=99999.999:UNIT=nT:NAME=Diurnal and IGRF corrected TMI
 Tlev_TMI:F10.3:NULL=99999.999:UNIT=nT:NAME=Tie Line Levelled Total Magnetic Intensity
 Mlev_Final_TMI:F10.3:NULL=99999.999:UNIT=nT:NAME=Mlev Final Total Magnetic Intensity

RADIOMETRICS

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 Flight:I4:NULL=999:NAME=Flight number
 Date:I9:NULL=99999999:UNIT=YYYYMMDD:NAME=Date
 Time:F11.2:NULL=9999999.99:UNIT=seconds:NAME=Time
 Fid:I10:NULL=9999999:NAME=Fiducial number
 Zone:I4:NULL=999:NAME=WGS84 Zone
 Latitude:F12.6:NULL=9999.999999:UNIT=degrees:NAME=WGS84 Latitude
 Longitude:F12.6:NULL=9999.999999:UNIT=degrees:NAME=WGS84 Longitude
 Easting:F12.2:NULL=99999999.99:UNIT=metres:NAME=SUTM53 Easting
 Northing:F12.2:NULL=99999999.99:UNIT=metres:NAME=SUTM53 Northing
 RAD_ALT:F8.2:NULL=99999.9:UNIT=metres:NAME=Altitude
 GPS_height:F8.2:NULL=99999.9:UNIT=metres:NAME=GPS Height
 Live_Time:I5:NULL=9999:NAME=Live time
 Baro_pres:F8.1:NULL=99999.9:UNIT=hPa:NAME=Baro pressure
 Temp:F6.1:NULL=999.9:UNIT=degrees C:NAME=Temperature
 Humid:F6.1:NULL=999.9:UNIT=percent:NAME=Humidity
 RAW_TOT:I6:NULL=99999:UNIT=CPS:NAME=Raw Total count
 RAW_POT:I6:NULL=99999:UNIT=CPS:NAME=Raw K40
 RAW_URA:I6:NULL=99999:UNIT=CPS:NAME=Raw Bi214
 RAW_THO:I6:NULL=99999:UNIT=CPS:NAME=Raw TI208
 Cosmic:I6:NULL=99999:UNIT=CPS:NAME=Cosmic
 TOTAL_COUNT:F9.2:NULL=99999.99:UNIT=CPS:NAME=Corrected Total Count
 POTASSIUM:F9.2:NULL=99999.99:UNIT=CPS:NAME=Corrected Potassium
 URANIUM:F9.2:NULL=99999.99:UNIT=CPS:NAME=Corrected Uranium
 THORIUM:F9.2:NULL=99999.99:UNIT=CPS:NAME=Corrected Thorium
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 URANIUM_PPM:F9.4:NULL=999.9999:UNIT=PPM:NAME=Uranium PPM
 THORIUM_PPM:F9.4:NULL=999.9999:UNIT=PPM:NAME=Thorium PPM
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Data Contents

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- | 125301_Tennant_Creek_West_TMI-Grey.tif
- | 125301_Tennant_Creek_West_TMI.tif
- | 125301_Tennant_Creek_West_Total_Count.tif
- | 125302_Tennant_Creek_East_DEM.tif
- | 125302_Tennant_Creek_East_Ternary.tif
- | 125302_Tennant_Creek_East_TMI-1VD.tif
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- | 125302_Tennant_Creek_East_Total_Count.tif
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- | +---DATA
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| \---GRIDS

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- | 125301_Tennant_Creek_West_TMI
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\---SPEC

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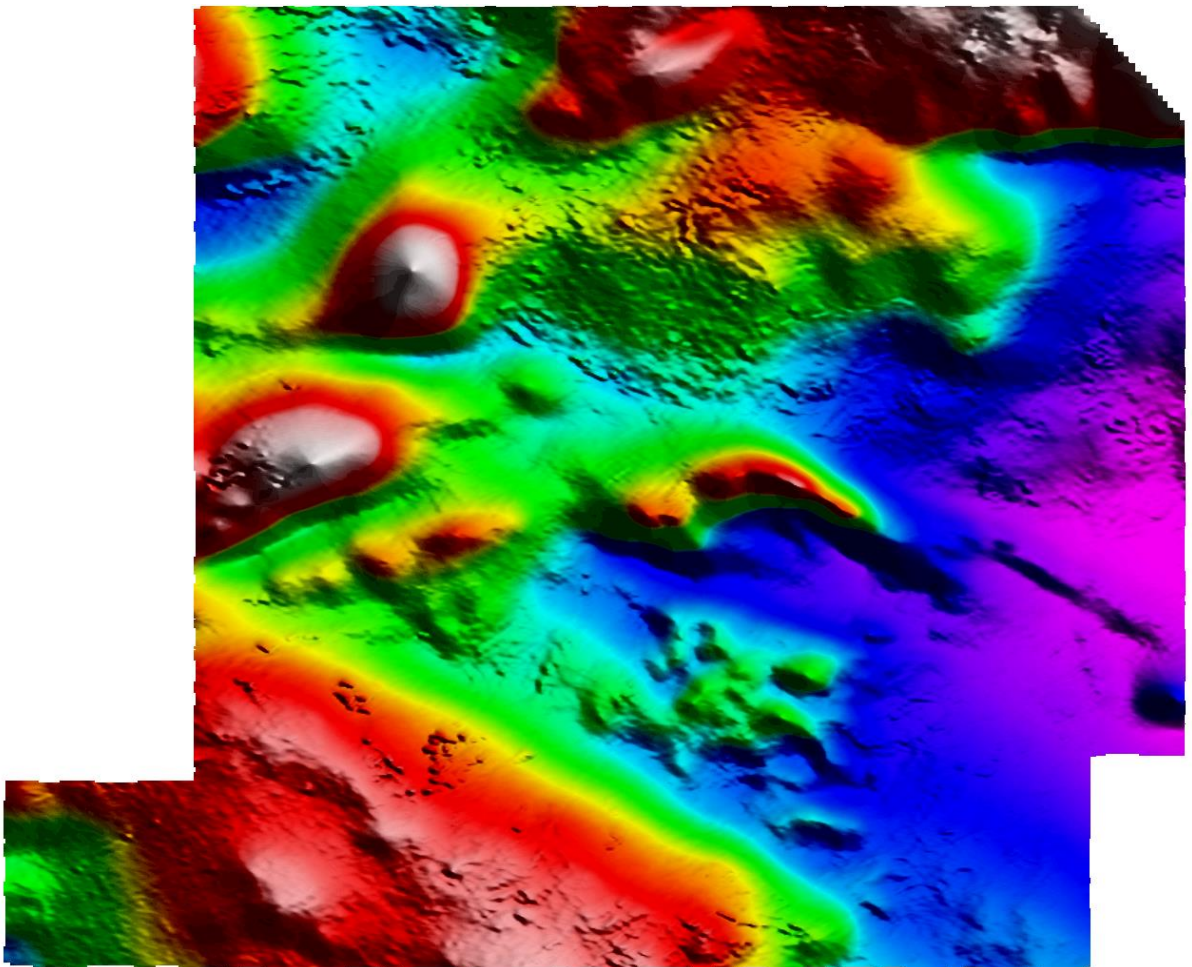
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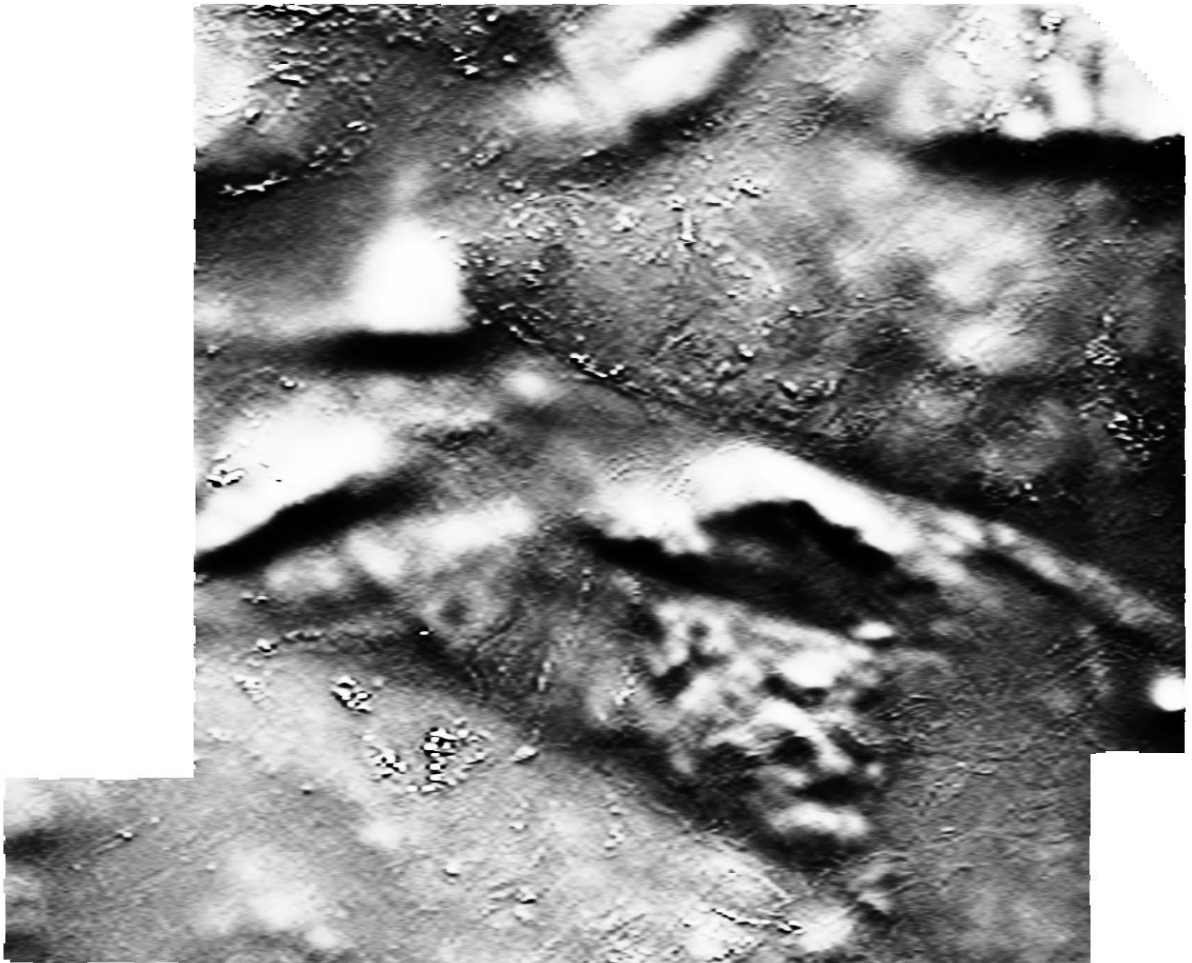
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    125301_Tennant_Creek_West_Dose_Rate
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    125301_Tennant_Creek_West_Potassium
    125301_Tennant_Creek_West_Potassium.ers
    125301_Tennant_Creek_West_Potassium_Percent
    125301_Tennant_Creek_West_Potassium_Percent.ers
    125301_Tennant_Creek_West_Thorium
    125301_Tennant_Creek_West_Thorium.ers
    125301_Tennant_Creek_West_Thorium_PPM
    125301_Tennant_Creek_West_Thorium_PPM.ers
    125301_Tennant_Creek_West_Total_Count
    125301_Tennant_Creek_West_Total_Count.ers
    125301_Tennant_Creek_West_Uranium
    125301_Tennant_Creek_West_Uranium.ers
    125301_Tennant_Creek_West_Uranium_PPM
    125301_Tennant_Creek_West_Uranium_PPM.ers
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    125302_Tennant_Creek_East_Potassium
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    125302_Tennant_Creek_East_Potassium_Percent
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    125302_Tennant_Creek_East_Thorium_PPM.ers
    125302_Tennant_Creek_East_Total_Count
    125302_Tennant_Creek_East_Total_Count.ers
    125302_Tennant_Creek_East_Uranium
    125302_Tennant_Creek_East_Uranium.ers
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    125302_Tennant_Creek_East_Uranium_PPM.ers
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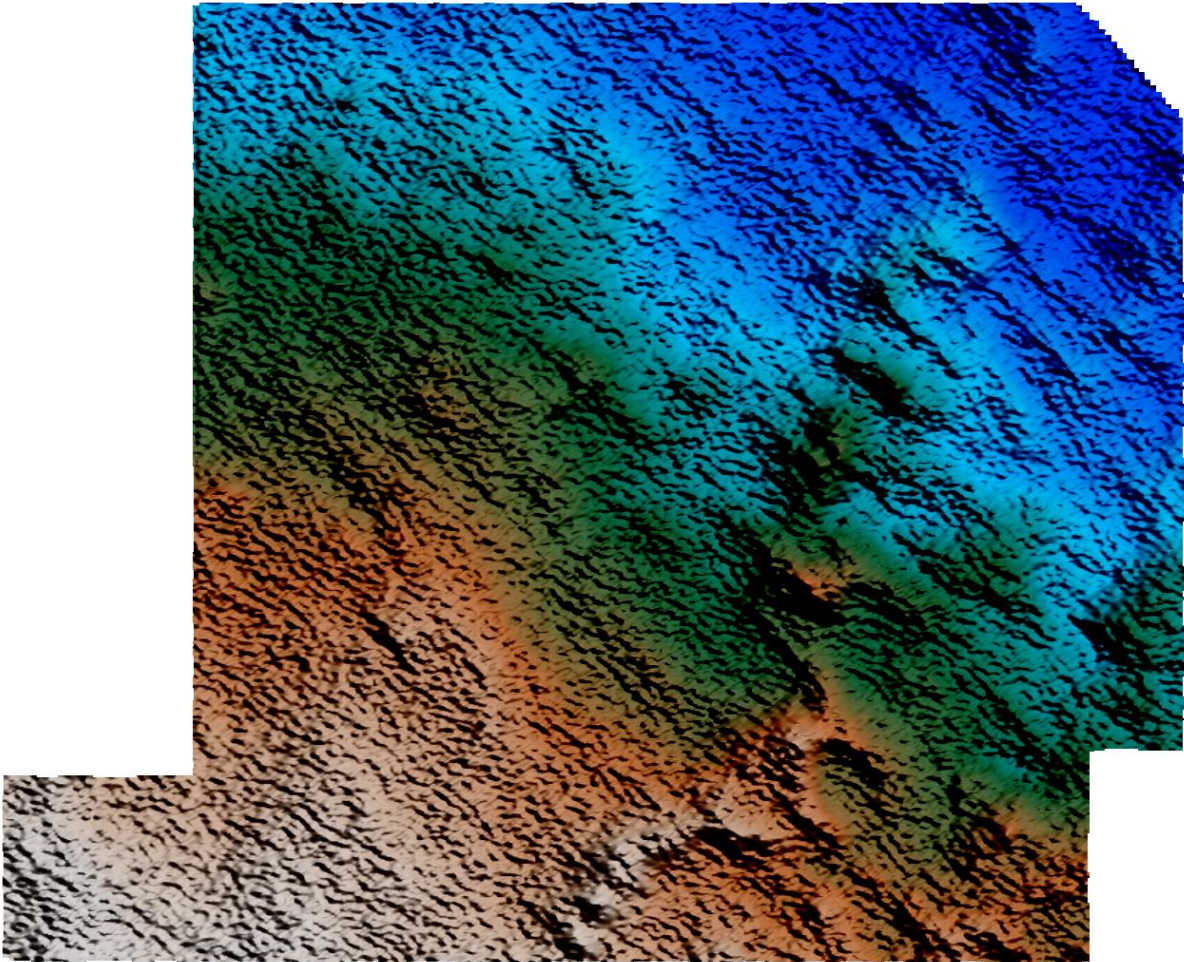

APPENDIX 6 – VERIFICATION IMAGES



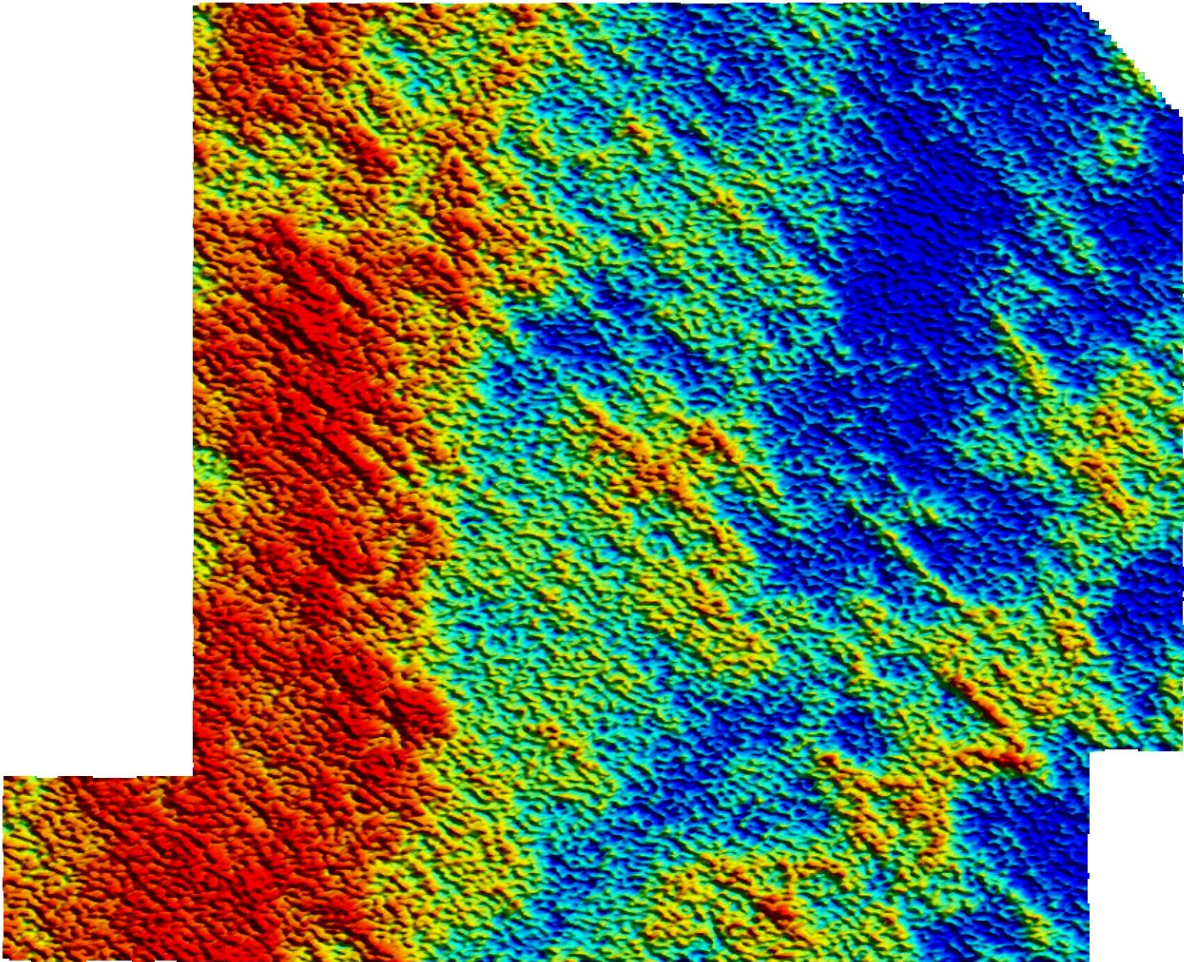
Tennant Creek West - Total Magnetic Intensity



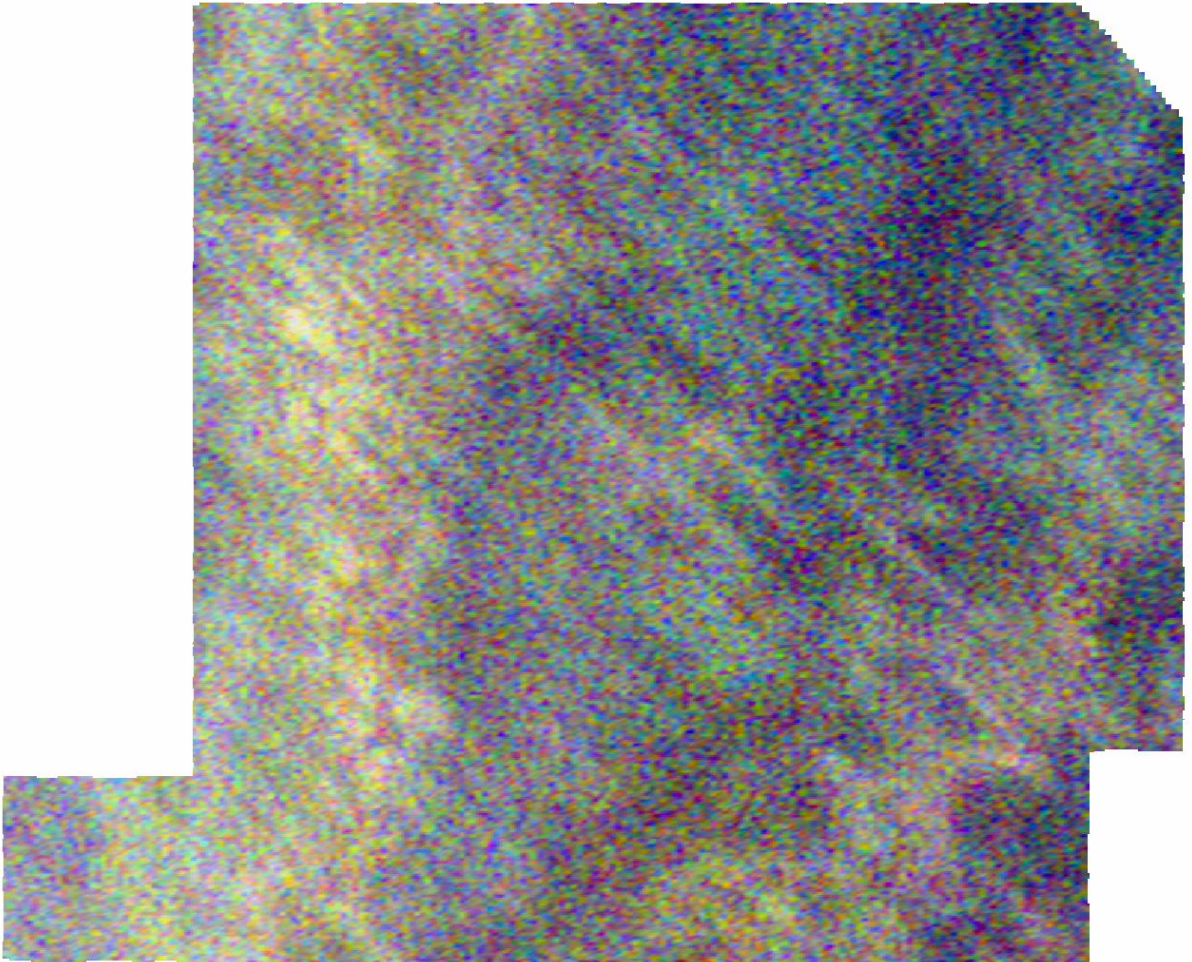
Tennant Creek West - Total Magnetic Intensity - First Vertical Derivative



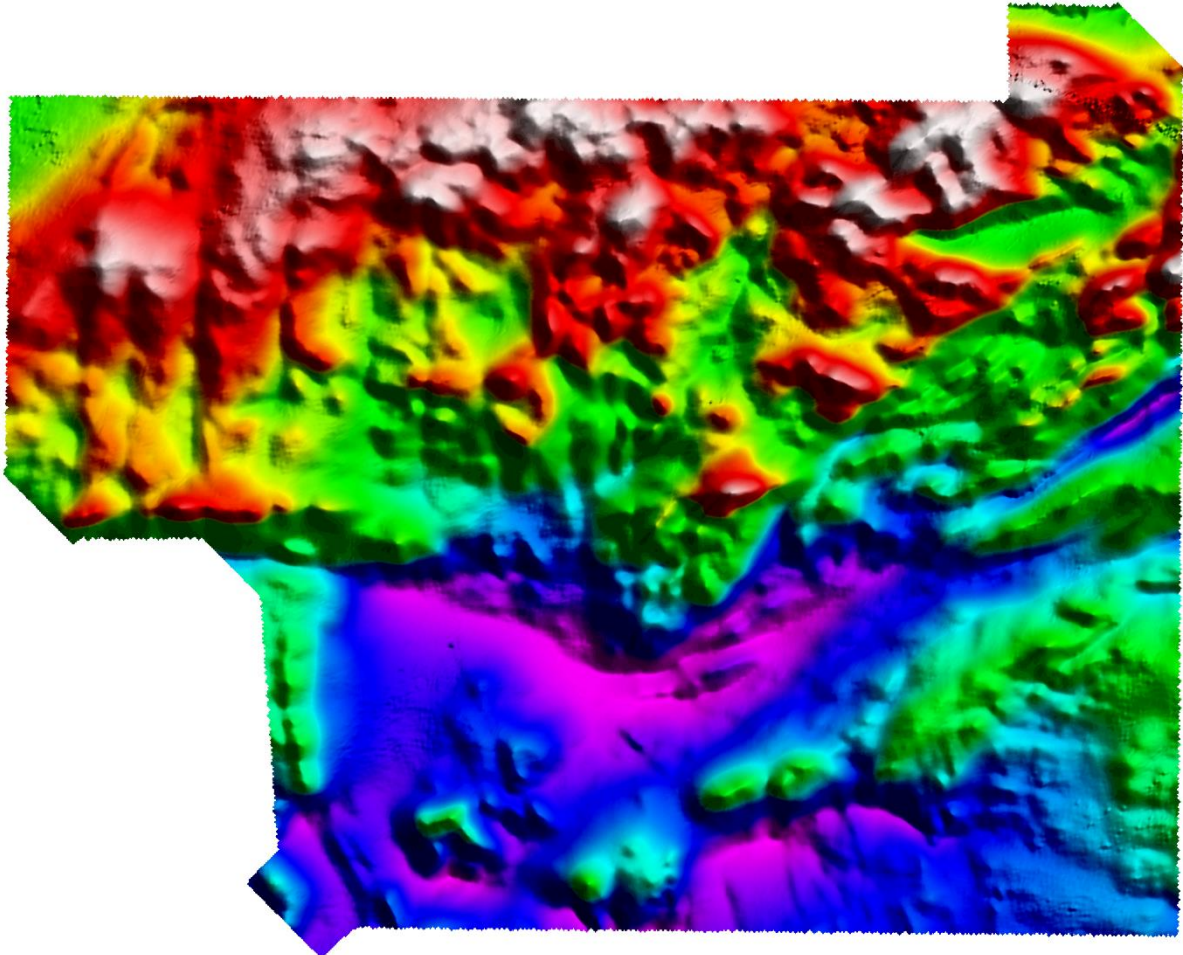
Tennant Creek West - Digital Elevation Model



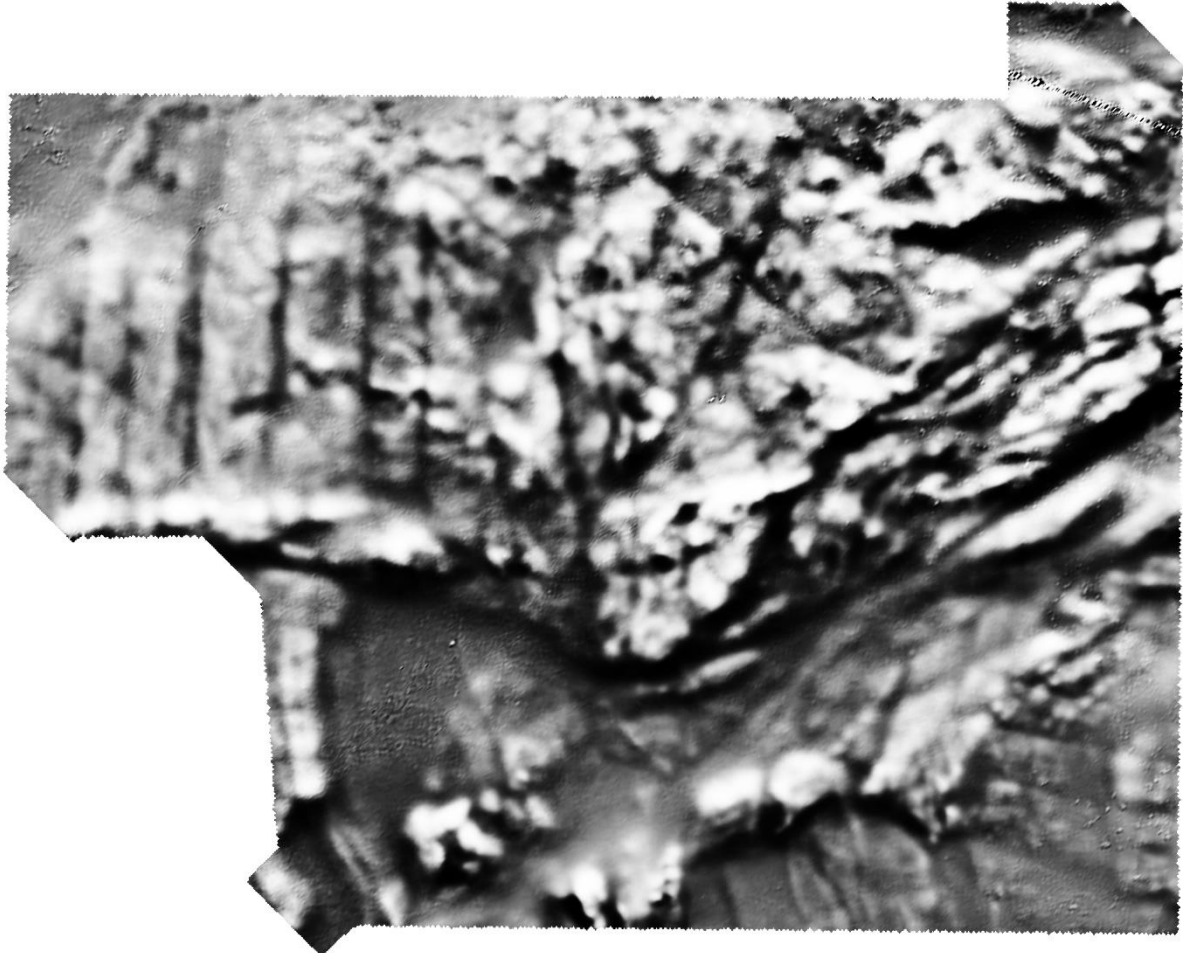
Tennant Creek West - Total Count Radiometrics



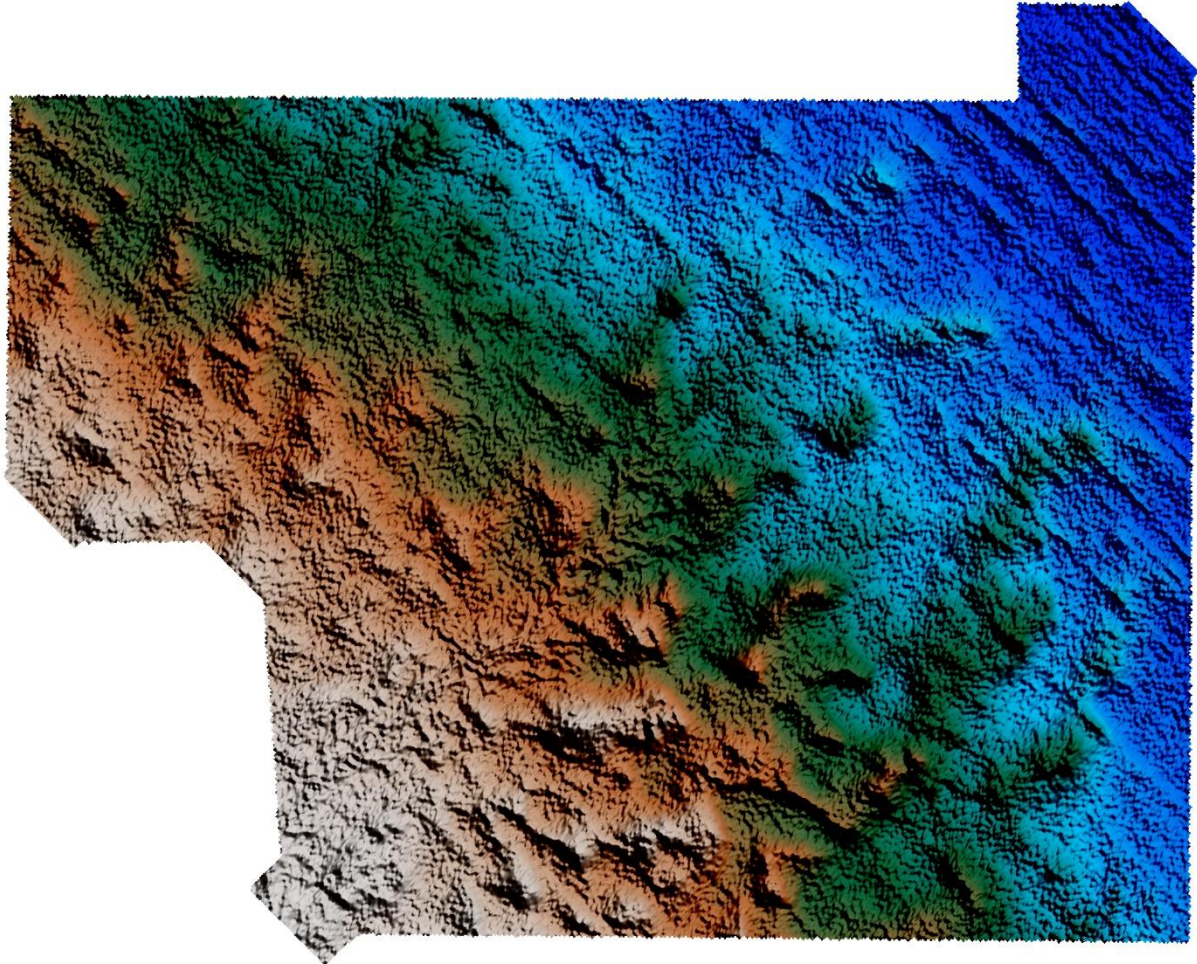
Tennant Creek West - Ternary Radiometrics



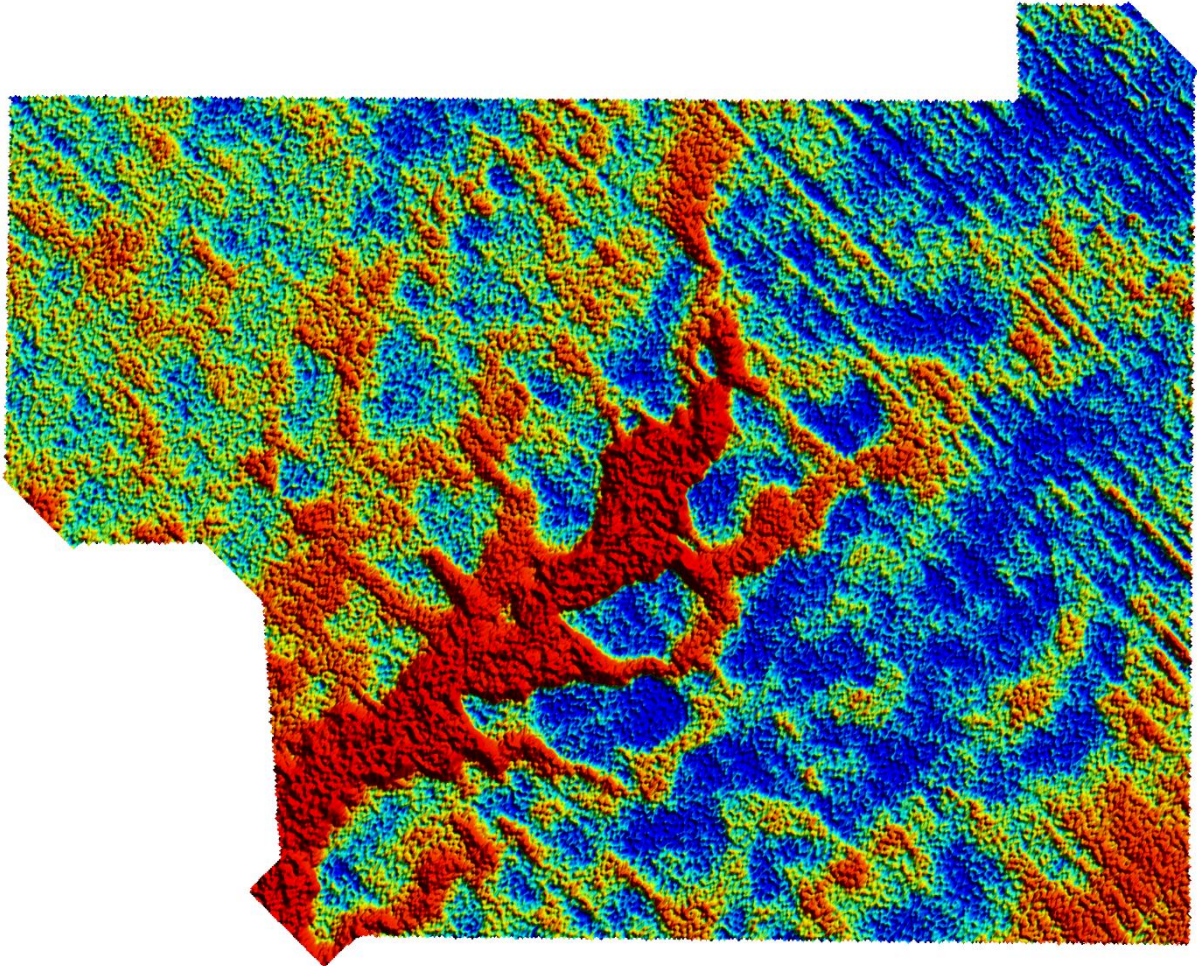
Tennant Creek East - Total Magnetic Intensity



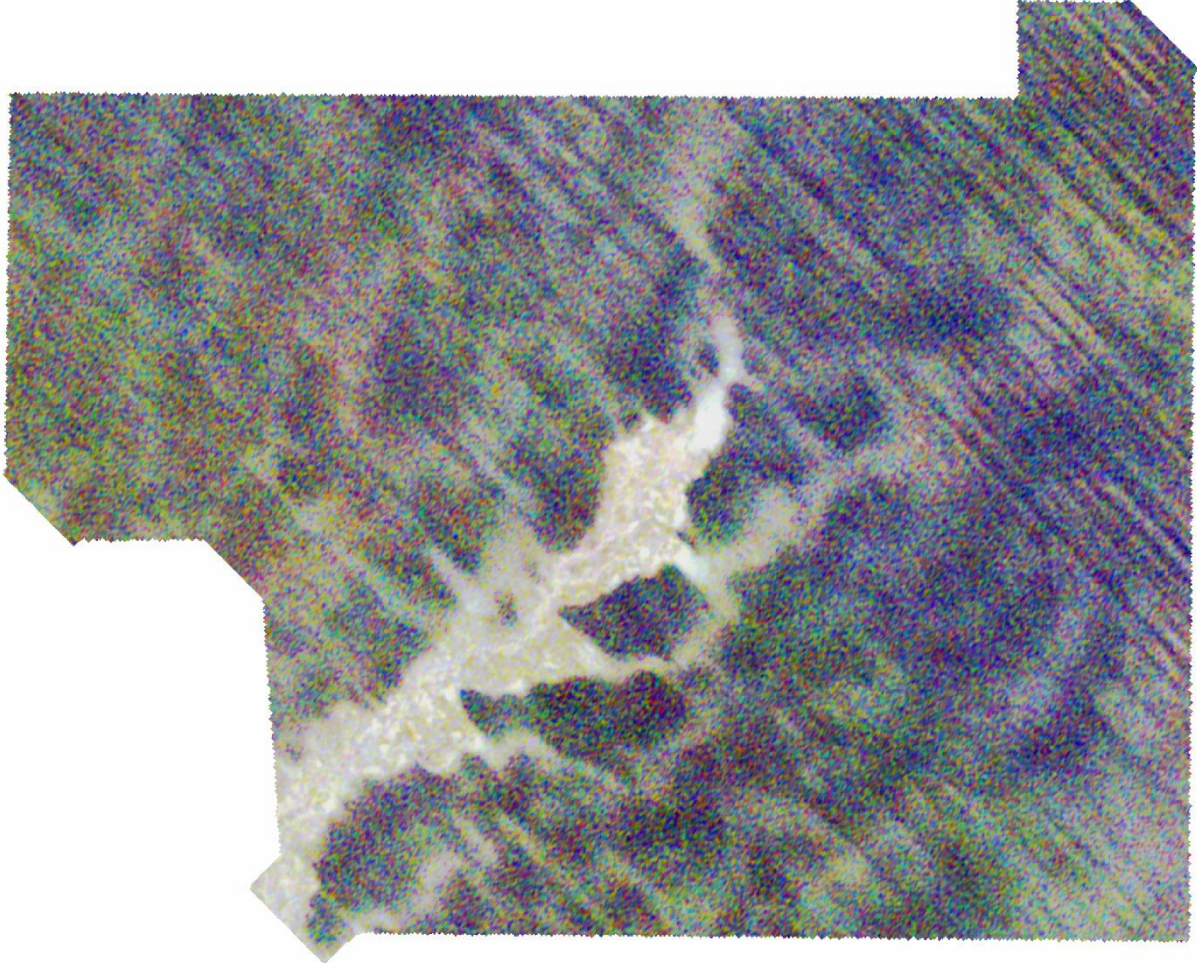
Tennant Creek East - Total Magnetic Intensity - First Vertical Derivative



Tennant Creek East - Digital Elevation Model



Tennant Creek East - Total Count Radiometrics



Tennant Creek East - Ternary Radiometrics