Geophysics and Drilling Collaborations Program 2022

Round 15

EL32285 and EL32286 Ground Gravity and Passive Seismic Survey (Ranken Project) South Nicholson Basin, NT

Knox Resources Pty Ltd

Northern Territory Geological Survey

Report prepared by

SRK Consulting (Australasia) Pty Ltd

Tenements:	EL32285, EL32286
Holder:	Knox Resources Pty Ltd
Operator:	Astro Resources NL
Map Sheets:	250K: Ranken SE5316
	100K: Alexandria 6259, Lulu 6539, Ranken 6258 & Lignum 6358
Datum, Zone:	GDA94, Zone 53S

Date:	22 June 2023
Authors:	Carl D'Silva and Ben Jupp
Email:	cdsilva@srk.com.au
Project:	KNX004

Executive summary

Knox Resources Pty Ltd (Knox or the Company) was a successful applicant and awarded a co-funding grant under the Northern Territory (NT) Government's Round 15 Geophysics and Drilling Collaborations (GDC) program. The co-funding grant was applicable to Exploration Licences (EL) 32285 and 32286 within the South Nicholson Basin of the NT to acquire a ground-gravity survey. The survey was based on a spacing grid of 1 km × 1 km station spacing to complement the existing datasets along with a passive seismic horizontal to vertical spectral ratio (HVSR) survey totalling 220 km at station intervals of 400 m.

Knox's Ranken Project encompasses two exploration permits (EL32285 and EL32286) that lie approximately 320 km east of Tennant Creek in the NT. Unlike the East Tennant Project, the Ranken Project is hosted within the central west of the Mesoproterozoic South Nicholson Basin. This region is largely obscured by younger Cambrian Georgina Basin and Cenozoic cover sequences and has therefore undergone only very limited mineral exploration activities including any drill hole data.

Knox's exploration targeting has interpreted that the Ranken Project is host to McNamara Group sequences below shallow (<300 m) Georgina Basin sediments. Both Isa style copper and sedimentary hosted style deposits are hosted within several stratigraphic levels of the McNamara Group and Isa Superbasin equivalents highlighting the Project area is a prospective base metal target area.

The original survey was proposed for August 2022. However, the survey was delayed due to corporate transactions involving the sale of assets from Greenvale Mining NL to Astro Resources. Further significant delays were encountered in early 2023 due to heavy rainfall resulting in flooding in the Ranken Project area and preventing the crews from accessing the site.

Atlas Geophysics Pty Ltd (Atlas) undertook the ground-based gravity survey over EL32285 and EL32286 from 20 May 2023 to 7 June 2023 using utility terrain vehicles (UTVs). A total of 1,047 new gravity stations were acquired using 1 km × 1 km grid configurations. Field data were processed and modelled by Resource Potentials Pty Ltd (Resource Potentials) in Perth, with the geological interpretation undertaken by SRK Consulting (Australasia) Pty Ltd (SRK).

The passive seismic HVSR program was acquired by Atlas between 21 May and 8 June 2023 using Tromino® seismometers. A total of 282 passive seismic HVSR recording stations were acquired using a nominal station spacing of 400 m with nine survey lines of variable length and orientations collected. The data were acquired using a 20-minute recording period and a sampling frequency of 128 Hz. Resource Potentials conducted quality assurance and quality control (QA/QC), data processing and preliminary data interpretations.

The acquisition of the detailed gravity and passive seismic over EL32285 and EL32286 has greatly added to the NT regional gravity datasets, with the work already completed from these datasets further highlighting the greenfields prospectivity of the South Nicholson Basin. The new data will provide a better understanding of important structural corridors, distribution and architecture of prospective geological horizons and potential fluid sources and has provided greater confidence for proposing a stratigraphic hole, Ranken-01, within the permit area. Knox is currently evaluating the new geological and geophysical data to position the stratigraphic hole in an optimal location.

Table of Contents

List of Figures

List of Appendices

Supplied separately

The Gravity Survey and Passive Seismic digital dataset 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 (NTGS) as part of the co-funding requirements.

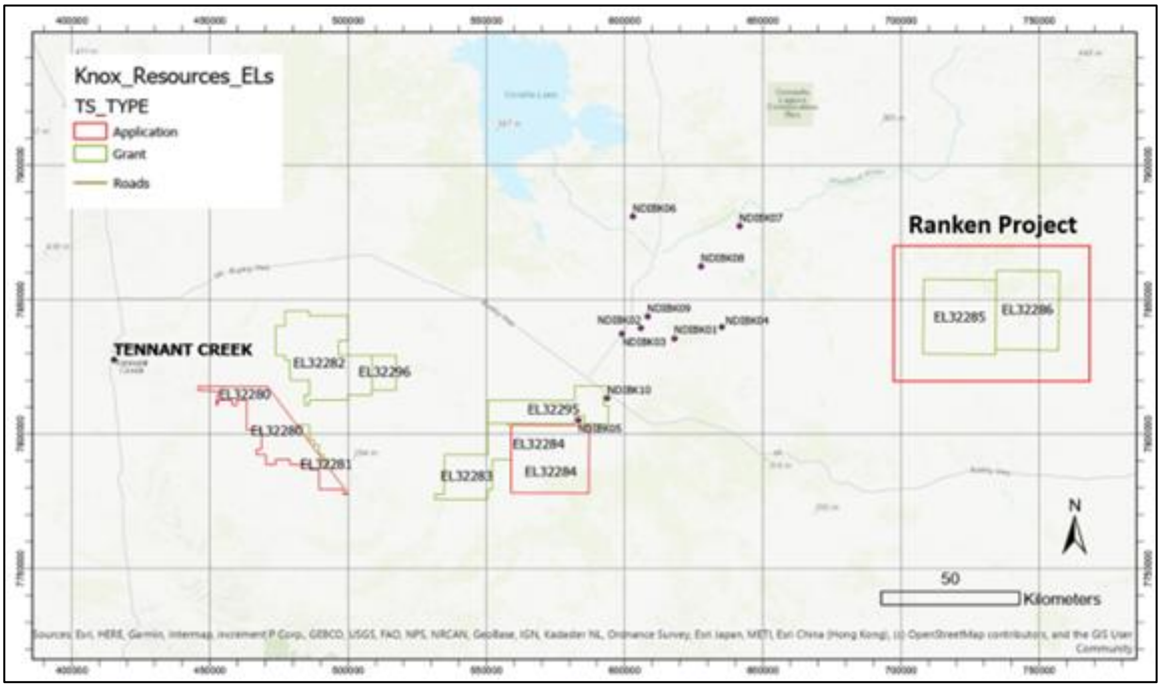
SRK has exercised all due care in reviewing the supplied information. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility 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.

1 Introduction

Knox Resources Pty Ltd (Knox) is a subsidiary of Astro Resources NL (Astro), 80%, and Greenvale Mining Limited (Greenvale), which holds a 20% share. Knox holds significant tenure in the prospective East Tennant region of the Northern Territory (NT). Knox's exploration activities are focused on Tennant Creek–style ironstone associated gold-copper-bismuth mineralisation, part of the iron oxide-copper-gold (IOCG) group of deposits.

Knox holds ten exploration licences (ELs) in the NT with seven granted ELs and three exploration licence application (ELA) areas. EL32285 and EL32286 cover an area of 1,402 km^2 across the Ranken Project area at 1:250,000 scale NTGS geological map sheet. The Ranken Project area is located approximately 320 km east of Tennant Creek, NT (Figure 1-1).

Figure 1-1: Location of EL32285 and EL32286 (Ranken Project)



Source: SRK

1.1 Regional context

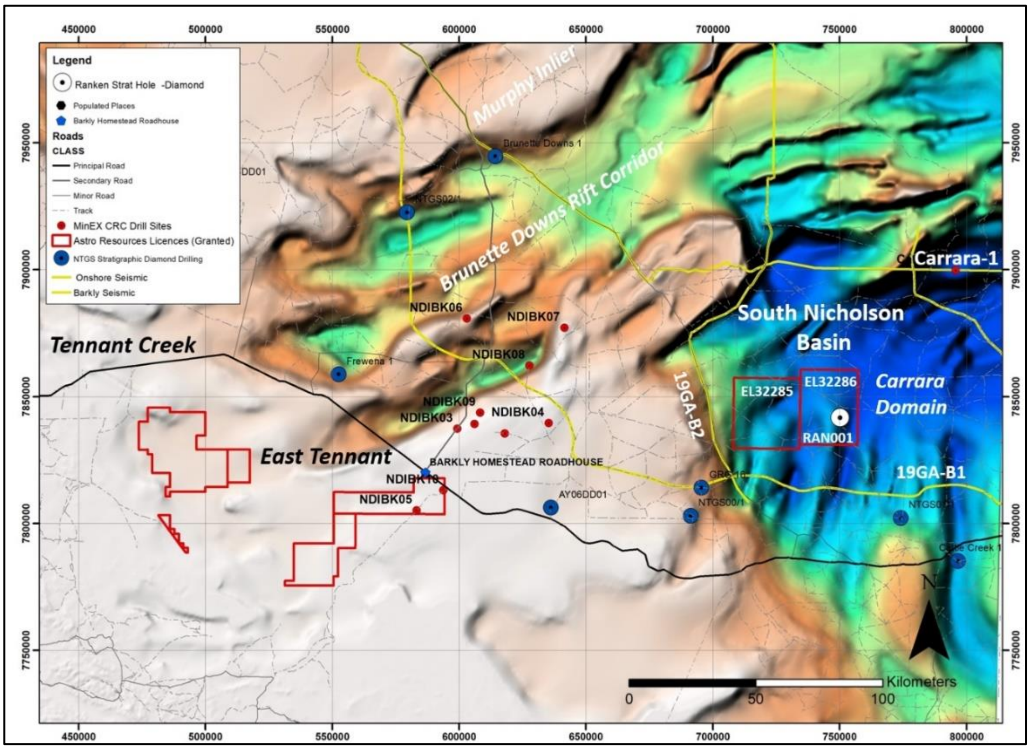
The Mesoproterozoic South Nicholson Basin was deposited from 1,500 Ma to 1,400 Ma and consists of units of the South Nicholson Group. The South Nicholson Group represents a separate basin cycle from the underlying Proterozoic Superbasin sequences (Isa c. 1,670–1,575 Ma, Calvert c. 1,735–1,690 Ma and Leichhardt c. 1,790–1,750 Ma), which extend westward from the Mount Isa Province in northwest Queensland (Figure 1-2). The South Nicholson Group is a temporal equivalent to the Roper Group sedimentary sequences to the north, separated by the Murphy Inlier, an east–west trending feature consisting of pre-Barramundi aged (1,870–1,850 Ma) metamorphic rocks (Murphy Metamorphics). Together the South Nicholson Group and Roper Group are recognised as the Roper Superbasin, which are regionally unconformable to the Isa Superbasin and Tennant region representing a widespread basin sequence. There is only limited outcrop of the South Nicholson Group within the NT which flanks the southern margin of the Murphy Inlier to the north of the basin (Figure 1-3).

There are conflicting interpretations for the origin of the South Nicholson Basin, which has been interpreted by McConachie and Dunster (1998) to have formed in a foreland basin setting as a result of a late-stage orogenic deformation. This was later revised by Southgate et al. (1999) due to the extensive depositional hiatus between the end of the Isa Superbasin and the initiation of the South Nicholson Group, suggesting this group represented a separate cycle of basin formation with sediments sourced from the Mount Isa Inlier (De Vries et al, 2008).

The South Nicholson Group is separated into two subgroups with a disconformable relationship marking the boundary (Rawlings et al., 2008) (Figure 1-4). The upper Accident Subgroup is composed of the Constance Range Sandstone, Mittiebah Sandstone and overlying Mullera Formation, which overlie units of the Wild Cow Subgroup and the lowermost Playford Sandstone. The Accident Subgroup has been described by Sweet et al. (1981) as dominated by finer-grained lithologies including very fine-grained glauconitic sandstone, siltstone and shale, which were deposited in mostly deeper marine environs. The Mittiebah and Constance sandstones are defined as lateral equivalent units and have been grouped within the subsequent solid geology interpretations. The uppermost sequence is the Mullera Formation and is comprised of locally ferruginous siltstone, organic-rich shale and lithic fine-grained sandstone. Deposition of this unit is interpreted to have occurred in a shallow marine shelf environment, partially above the storm wave base and partially below where shale and organic rich facies have deposited (Kruse et al., 2008).

The Wild Cow Subgroup consists of the Crow Formation, minor Bowgan Sandstone and Playford Sandstone at the base (Figure 1-4). These units are dominated by cross-stratified, medium to coarse grained lithologies typical of marine environments (Sweet et al., 1981). The Crow Formation is the dominant unit of the subgroup and consists of recessive siltstone, sandstone and conglomerate. Several facies are evident in this unit including deep shelf facies, storm shelf facies, debris flow facies, shallow water sandstone facies and saprolite facies. Each of the facies illustrate changes in character from siltstone to sandstone dominant. The Playford Sandstone is also the lowermost unit of the basin sequence and consists predominantly of siltstones and sandstone with minor ironstone and stromatolites (Kruse et al., 2008).

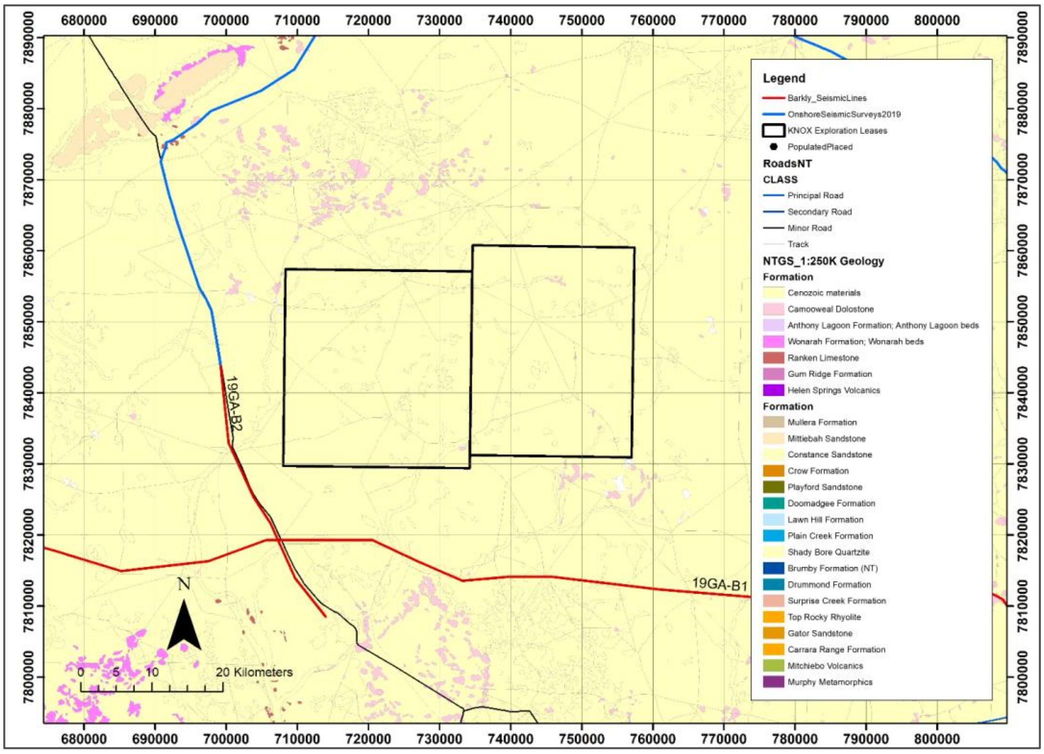
Figure 1-2: SEEBASE image illustrating South Nicholson Basin seismic sub-domains



Source: SRK

Notes: RAN001 is the location of Knox's proposed stratigraphic drill hole within EL32286. Coordinate system GDA94 MGA Zone 53.

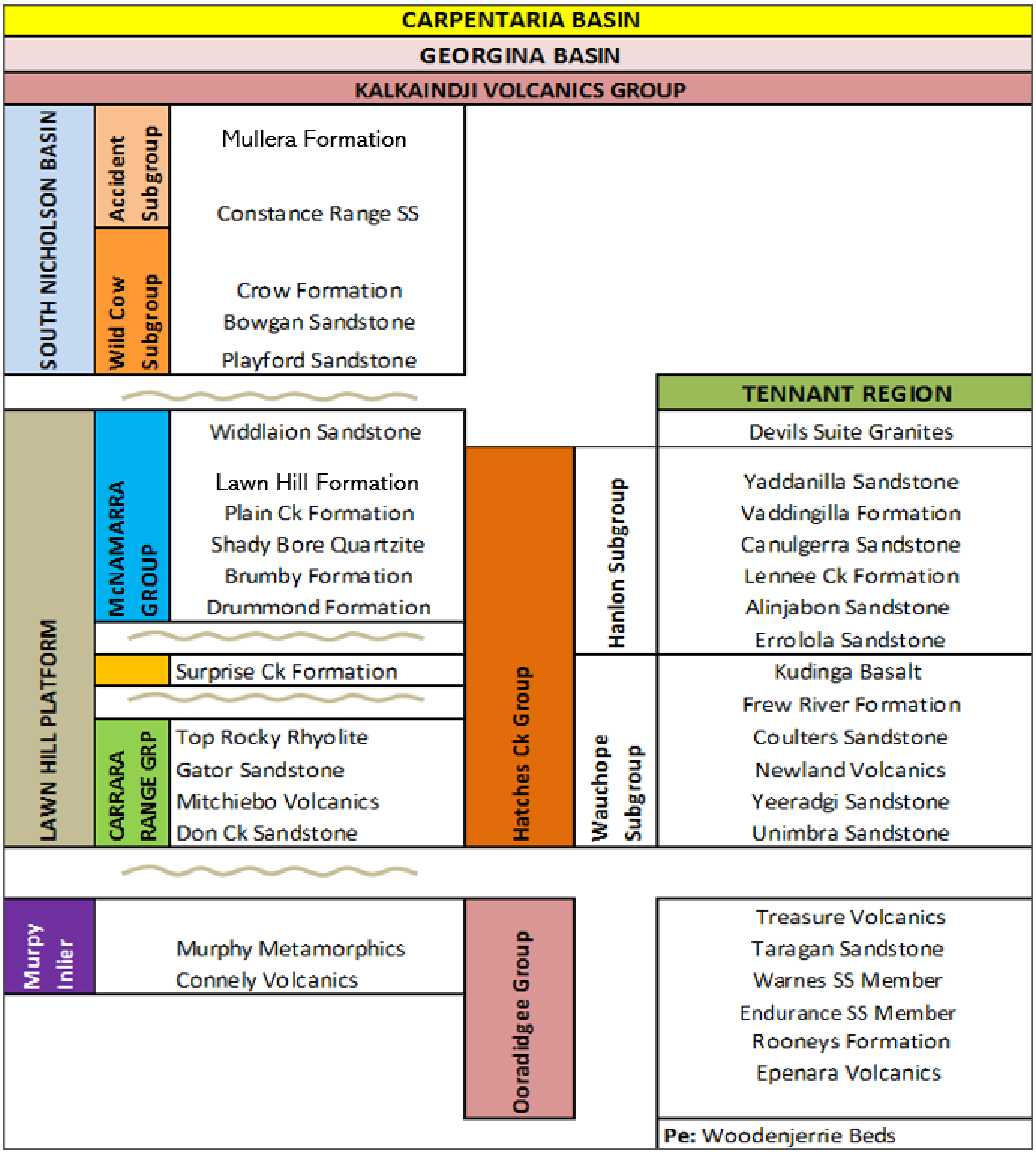
Figure 1-3: Outcropping South Nicholson Basin and McNamara Group units within the South Nicholson Basin region



Source: SRK

Notes: Deep crustal seismic lines 19GAB1 and 19GA-B2 illustrated as red lines. Coordinate system GDA94 MGA Zone 53.

Figure 1-4: Major tectonostratigraphic sequences in South Nicholson Basin



Source: SRK, adapted from Kruse et al. (2008)

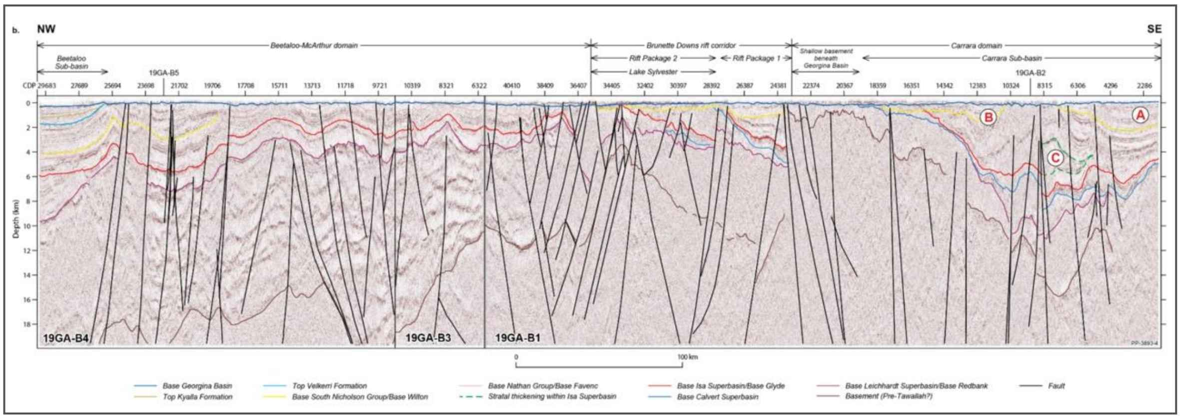
1.2 Geoscience Australia Interpretation

Recent deep crustal seismic (2017 and 2019) conducted as part of the Exploring for the Future Program (EFTF) stratigraphic drilling conducted by Mineral Exploration Cooperative Research Centre (MinEx CRC) and SEEBASE modelling commissioned by the NTGS, have greatly improved the understanding of the South Nicholson Basin region. This work has included revised basin extents, which now cover approximately 91,449 km^2 (Figure 1-2). Based on the seismic data, the South Nicholson Basin region has been divided into two informal domains, namely the Carrara domain and Brunette-Downs Rift Corridor with the Beetaloo-McArthur domain of the McArthur Basin defined to the north (Southby et al., 2021). The Carrara domain corresponds with the position of the Ranken Project area.

Carrara domain

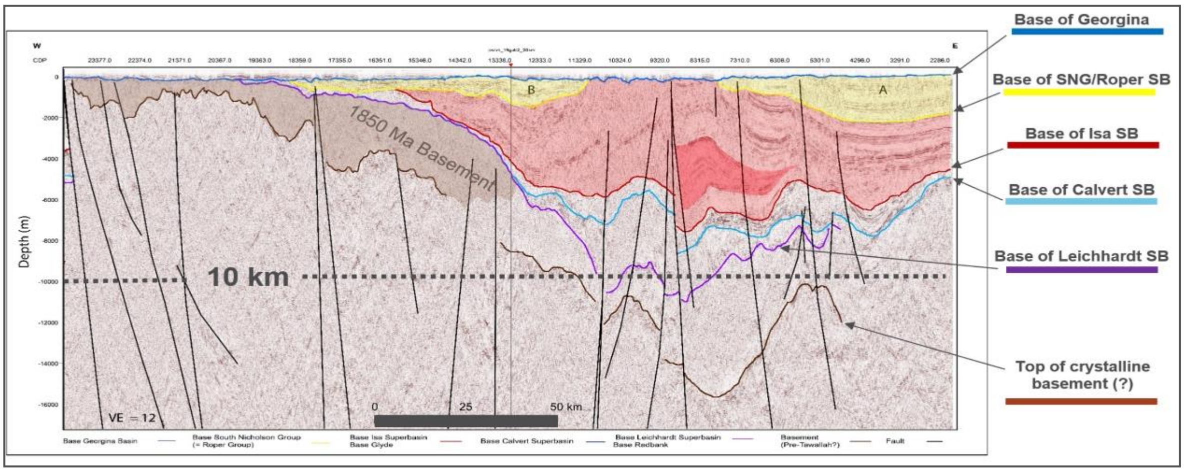
Knox's Ranken Project (EL32285 and EL32286) lies within the Carrara domain, extending westward from the Queensland–NT border. This domain is up to 16 km deep and encompasses sequences of the Paleoproterozoic Leichhardt, Calvert and Isa superbasins. These Paleoproterozoic superbasins are overlain by the Mesoproterozoic Roper Superbasin, represented here by the South Nicholson Basin. The underlying 1,850 Ma crystalline basement has been interpreted to be composed of a metamorphic basement, belonging to continuation of the rocks of the Murphy Inlier from the north or Warramunga Province (East Tennant) from the west, consisting of metasedimentary sequences and 1,850 Ma felsic intrusives. The Leichhardt Superbasin overlies this basement and is up to 4,000 m thick at its thickest point, thinning and onlapping onto shallowing basement to the west of the basin toward Tennant Creek. The Calvert Superbasin is relatively uniform in thickness across the domain, showing similar onlap geometries onto the shallowing basement in the west. Compositionally this sequence is interpreted to consist of shallow marine sandstone packages. The Isa Superbasin sequences represent the thickest package within the Carrara domain, up to 7.4 km thick (Figure 1-5). The Isa Superbasin sequences thin and onlap onto the Calvert Superbasin in the west of the basin as the underlying basement shallows (Figure 1-5; Figure 1-7). The Roper Superbasin unconformably overlies all the underlying sequences (Figure 1-6; Figure 1-7) (Southby et al., 2021).

Figure 1-5: Composite seismic lines 19GA-B1-B3-B4 and informal domains



Source: Southby et al. (2021)

Figure 1-6: Seismic line 19GA-B1 illustrating Carrara domain



Source: Southby et al. (2021)

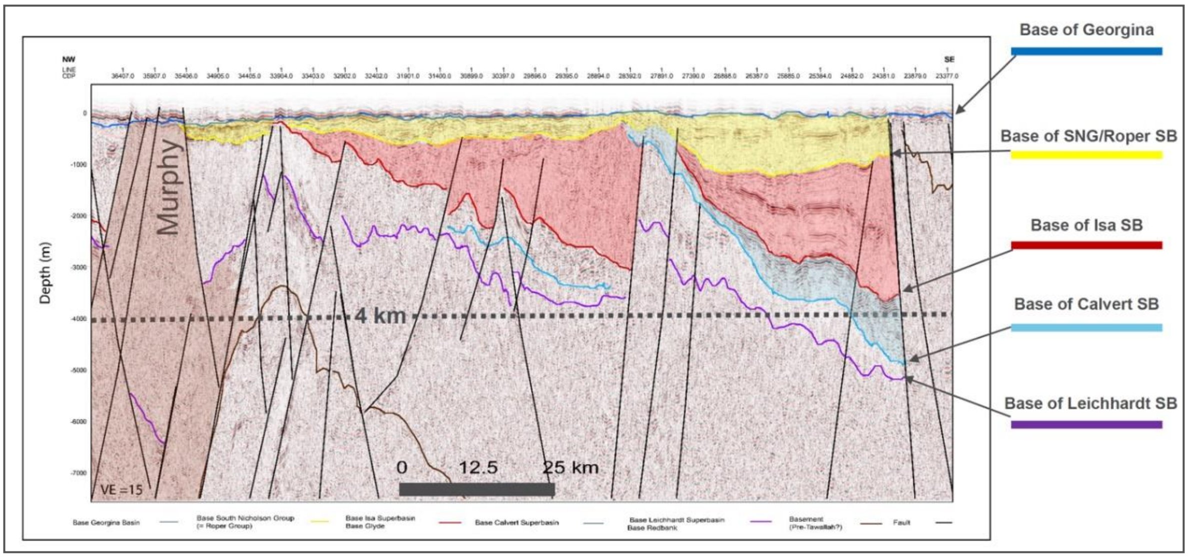
Notes: Reddest zone within the Isa Superbasin package is interpreted by Southby et al. (2021) as a fault-controlled growth package.

Brunette Downs Rift Corridor

The Brunette Downs Rift Corridor lies to the north of the Carrara domain and is bound to the north by the Murphy Inlier and to the south by a major steeply south-dipping basement fault (Figure 1-7). The domain has been interpreted to form as two southeasterly deepening half-graben structures controlled by steeply north-dipping extensional faults and sub-parallel secondary faults (Figure 1-7). The southernmost graben structure is bound to the south by a major structure that juxtaposes 4 km of sediments against near-exposed basement to the south, underlying shallow (<400 m) Georgina Basin cover.

As with the Carrara domain, sequences of the Isa, Calvert and Leichhardt superbasins are interpreted to occur at depth below sequences of South Nicholson Basin. Significant southward sedimentary thickening/growth has been interpreted within the half-grabens, best observed within the Isa Superbasin package, with growth of up to 3 km interpreted by Southby et al. (2021) (Figure 1-6).

Figure 1-7: Seismic line 19GA-B1 illustrating Brunette Downs Rift Corridor



Source: Southby et al. (2021)

2 Previous exploration

Historical exploration has primarily focused on phosphate mineralisation within the Georgina Basin cover sequence, as well as diamonds and limited base metals.

IMC Development Corporation (IMC) completed an extensive phosphate exploration program between 1968 and 1971. Work completed included aerial photography interpretation, geological mapping, and interpretation of radiometric and magnetic geophysics surveys . IMC completed an extensive drilling program, which led to the discovery of the Wonarah and Alexandria phosphate deposits to the southwest and northwest of Knox's ELs.

EL3077 was granted to BHP Minerals Limited in December 1981 for 12 months. The exploration objective was lead-zinc deposits of the Mississippi Valley Type. Exploration work included desktop and photo-geological studies for lead-zinc deposits of the Mississippi Valley Type. No exploration drilling was undertaken, and the tenements were relinquished in 1982.

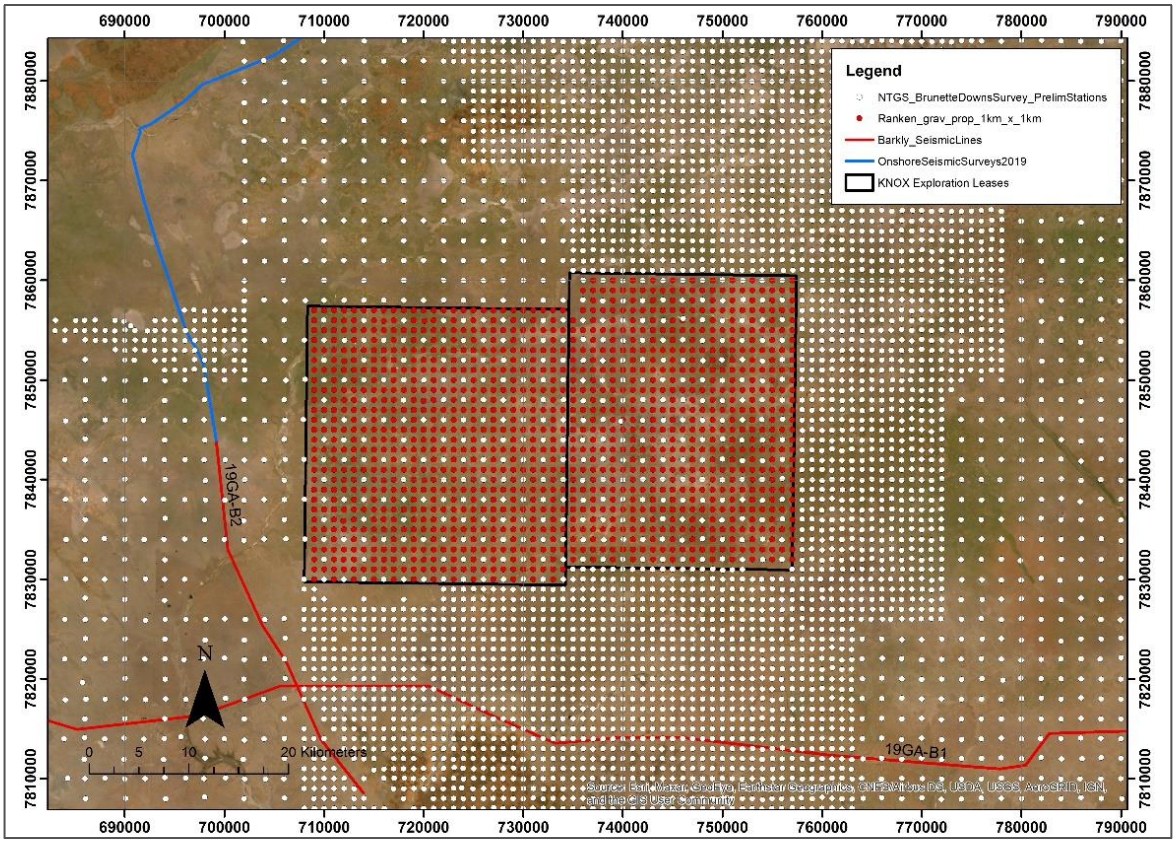
During 1985–86, the area was explored by the ADE Joint Venture (ADE) including Ashton Mining Limited acting as manager, AOG Minerals Limited, Aberfoyle Exploration Pty Ltd and Australian Diamond Exploration NL. Work completed included a regional gravel sampling program and an airborne thematic mapper survey (spectral scanner). While a small number of gravel samples were found to contain micro-diamonds, the exploration program failed to locate the presence of a kimberlite pipe within EL4532 and EL4535.

In 1989, CRA Exploration Pty Ltd (CRAE) flew a detailed airborne aeromagnetic and radiometric survey over EL6578. Anomalous features whose heliborne magnetic profiles were considered to represent possible target diatremes were sampled. Seventeen anomalies were traversed by ground magnetics. Following field sampling and interpretation of magnetics data, fifteen targets were selected for drill testing (including three drill holes in Knox's EL32286).

Between 2002 and 2003, De Beers Australia Exploration Ltd (De Beers) held several ELs overlapping Knox's current project area (EL22976/77/79). De Beers reviewed the existing data and available previous exploration results to assess the prospectivity for diamond mineralisation.

Recent deep crustal seismic (2017 and 2019) conducted as part of the EFTF, stratigraphic drilling conducted by MinEx CRC and SEEBASE modelling commissioned by the NTGS, have greatly improved the understanding of the South Nicholson Basin region. The Ranken gravity survey was designed to infill the regional gravity survey data that was acquired on a 2 km by 2 km grid pattern also known as the Brunette Downs Survey (Figure 2-1). The gravity survey was commissioned by NTGS and completed by Atlas Geophysics Pty Ltd from 2017 to 2022.

Figure 2-1: Location of the 2023 Ranken gravity survey stations (red) and existing gravity survey stations (white)



Source: SRK

Notes: Coordinate system GDA94 MGA Zone 53.

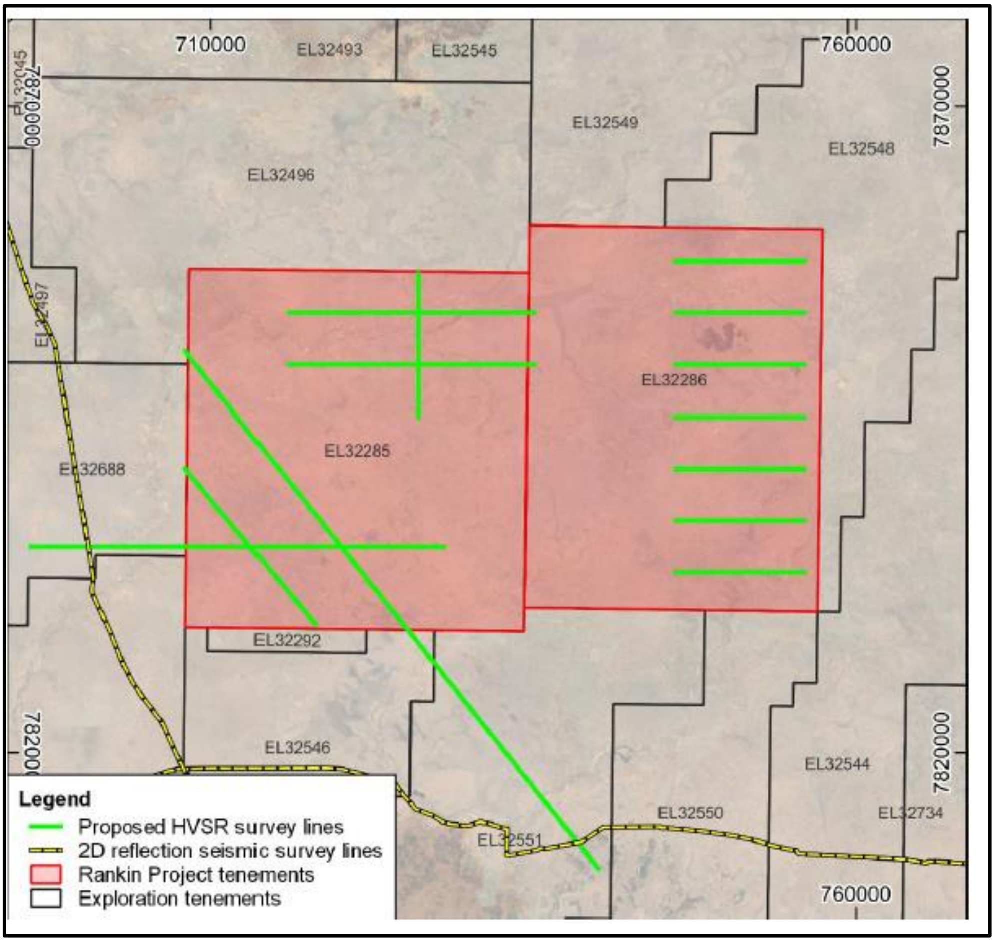
3 Exploration rationale

The Ranken Project is interpreted to occur within a series of stacked Paleoproterozoic to Mesoproterozoic superbasin sequences interpreted as the western extension of the Mount Isa Province underlying the South Nicholson Basin. Closest geological affinities are interpreted to include the Lawn Hill Platform and Western Fold Belt which is host to sediment hosted Zn-Pb-Ag and Cu±Co±Au such as the Century Mine (Zn-Pb-Ag) and Mount Isa Cu±Co±Au and Pb-Zn mines. While no significant base or precious metals mineralisation has been recorded within the NT portion of the South Nicholson Basin this is largely a result of the extensive younger sedimentary cover (e.g. Georgina Basin and Cenozoic cover) which has limited exploration interest in this region.

Recent seismic and stratigraphic drilling within the South Nicholson Basin has highlighted the potential of the Ranken Project area with McNamara equivalents interpreted to occur at relatively shallow depths (<300 m). The basin architecture based on seismic data (GA19-B1) underlying the Ranken Project additionally indicates the presence of a deep stacked volcano-sedimentary sequence of several superbasins with potential to host suitable fluid sources for both the copper (Eastern Creek Volcanics) and zinc-lead-silver systems. This is supported/highlighted by the dense nature of the thick sedimentary package apparent in the gravity imagery. Several major faults are also apparent, cross-cutting through the Project, possibly providing suitable fluid conduits tapping older, deeper basin elements. In addition, a possible major growth structure has been interpreted by Southby et al. (2021), potentially providing favourable tilt block architecture for sedimentation and sedimentary hosted style fluid system development.

Exploration aims to assist with refining the structural and lithological architecture of the Project. Given the strong lithological and structural control on these deposit types, detailed gravity data are fundamental in refining current interpretations and to assist with defining the regional basin architecture and its resource potential. The passive seismic will additionally provide valuable constraint on basement composition and depths below younger cover to assist with drill targeting (Figure 3-1).

Figure 3-1: Proposed passive seismic HVSR survey lines across Ranken Project



Source: Resource Potentials (2023)

Note: Proposed passive seismic lines in green. Coordinate system GDA94 MGA Zone 53.

4 Ground based gravity program details

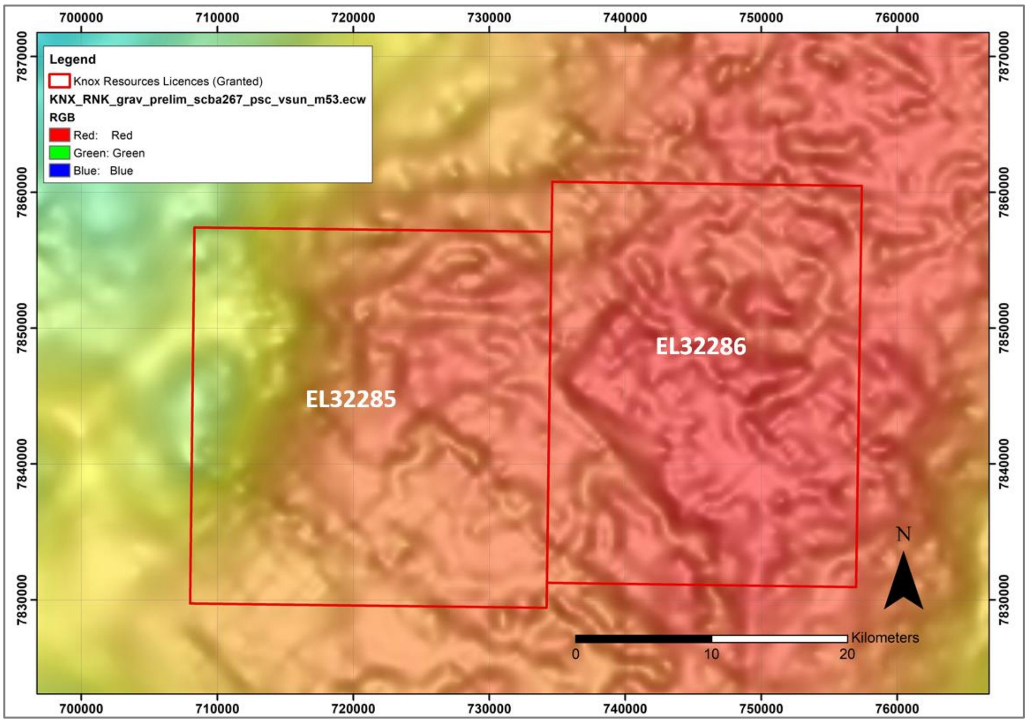
The gravity survey in EL32285 and EL32286 was designed to infill the regional NTGS Brunette Downs survey which was collected on a 2 km by 2 km grid pattern between 2017 and 2022 by Atlas Geophysics Pty Ltd (Atlas).

The infill program was designed to complement the NTGS Brunette Downs survey with the Ranken gravity survey designed on a 1 km by 1 km infill across the tenements, excluding the NTGS survey stations and encompassing 1,047 stations. The collected gravity stations are shown overlain in Figure 2-1. Atlas was commissioned to undertake the survey which was conducted between 20 May 2023 and 7 June 2023. Significant delays were experienced between survey commission and acquisition due to heavy rainfall and flooding of the area, preventing access to site.

Field data were processed and modelled by Resource Potentials with additional unconstrained inversion modelling work conducted using Geosoft VOXI to generate a 3D gravity density anomaly block model. The model was generated on a 500 × 500 × 100 m grid using the gravity SCBA 2.76 data. Details of Resource Potential's modelling are summarised in Appendix A.1 with the raw/processed data included in Appendix A.2.

Products developed by Resource Potentials include merged gravity anomaly images and contours, digital data products and unconstrained 3D inversion modelling provided in GDA94, MGA Zone 53. Derived grid images and 3D inversion iso-shells are presented in Figure 4-1, Figure 4-2, Figure 4-3 and Figure 4-4.

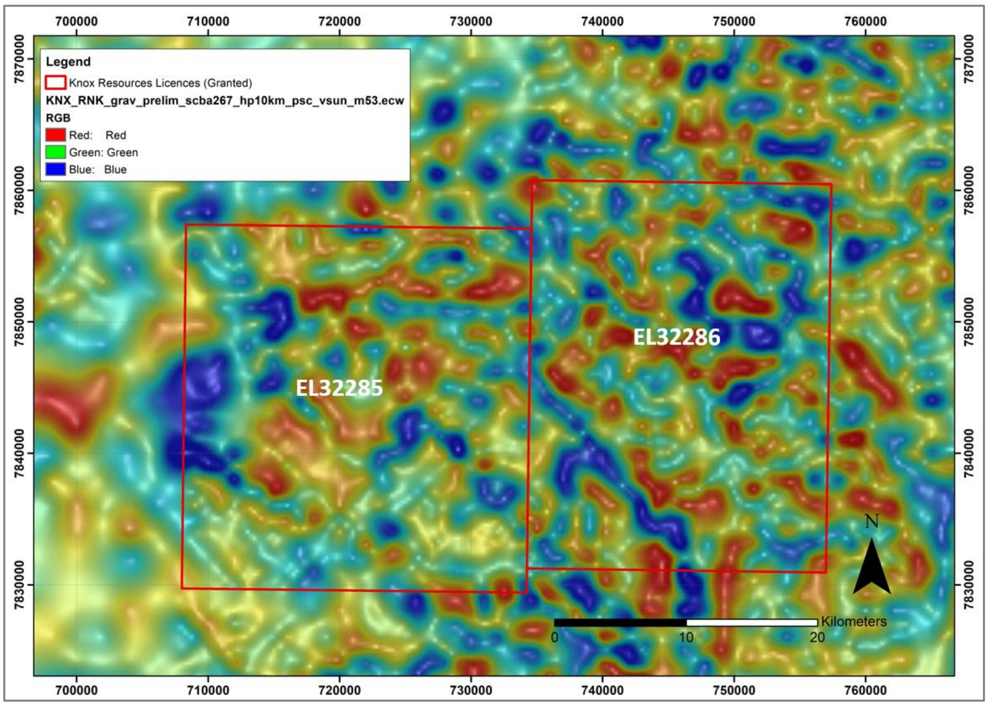
Figure 4-1: Ranken gravity survey, Bouguer gravity image



Source: Resource Potentials (2023)

Note: Ranken gravity data merged with regional NTGS gravity datasets. Vertical sun shading applied. Coordinate system GDA94 MGA Zone 53.

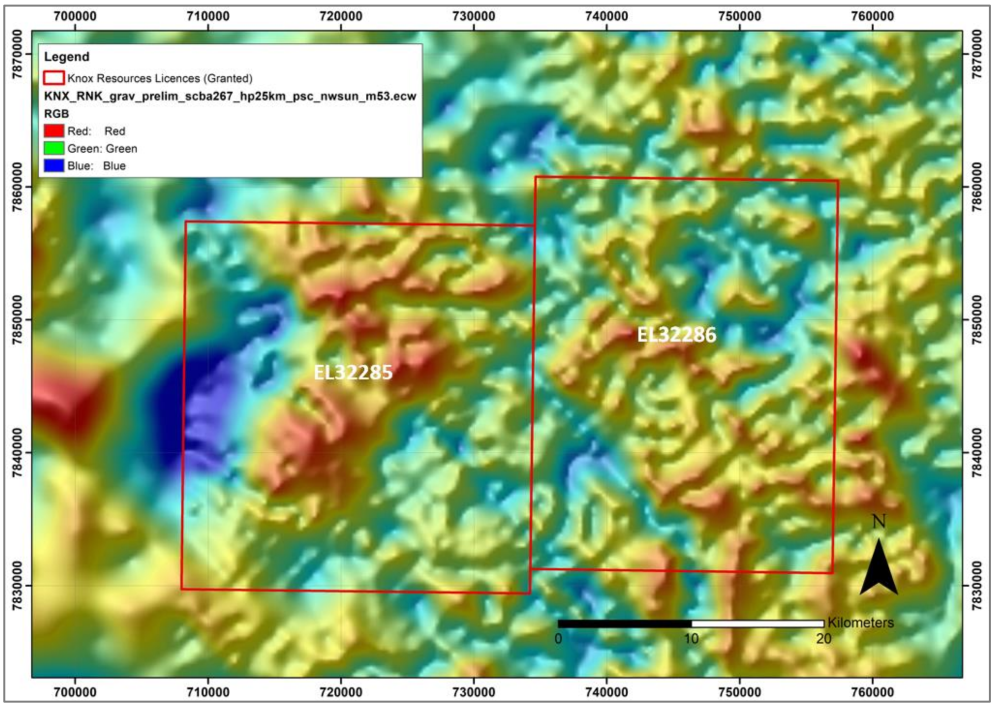
Figure 4-2: Ranken gravity survey, high pass filter 10 km



Source: Resource Potentials (2023)

Note: Ranken gravity data merged with regional NTGS gravity datasets. Vertical sun shading applied. Coordinate system GDA94 MGA Zone 53.

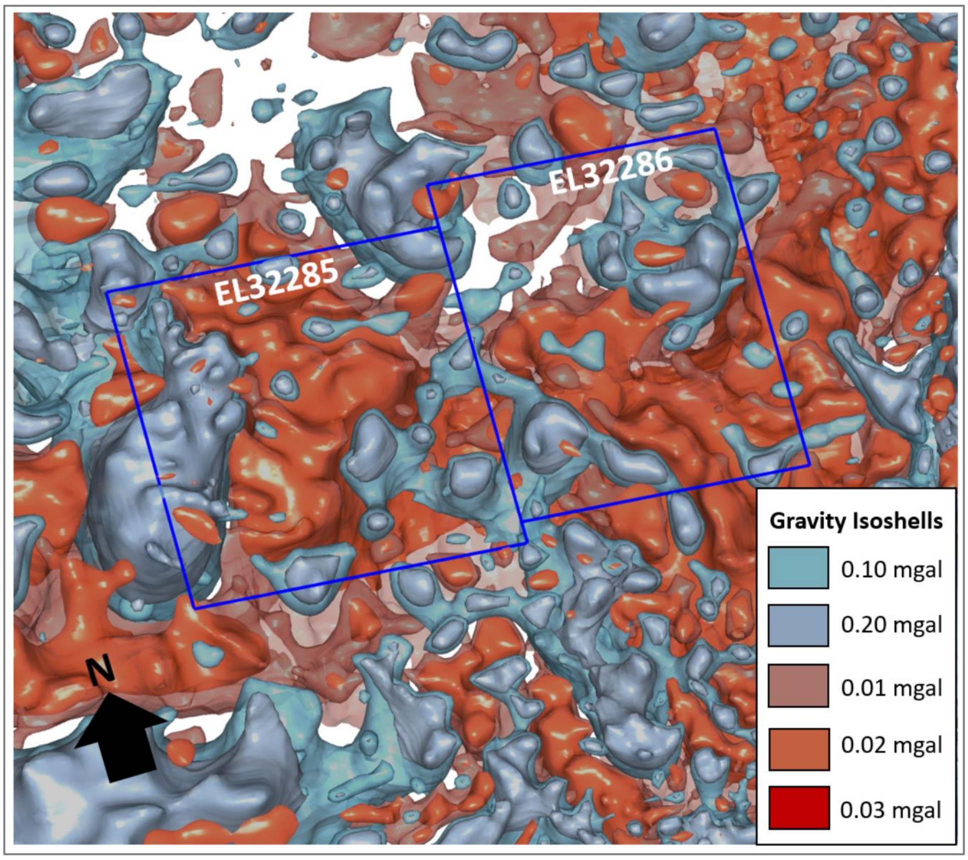
Figure 4-3: Ranken gravity survey, high pass filter 25 km



Source: Resource Potentials (2023)

Note: Ranken gravity data merged with regional NTGS gravity datasets. Vertical sun shading applied. Coordinate system GDA94 MGA Zone 53.

Figure 4-4: Unconstrained gravity inversion iso-shells



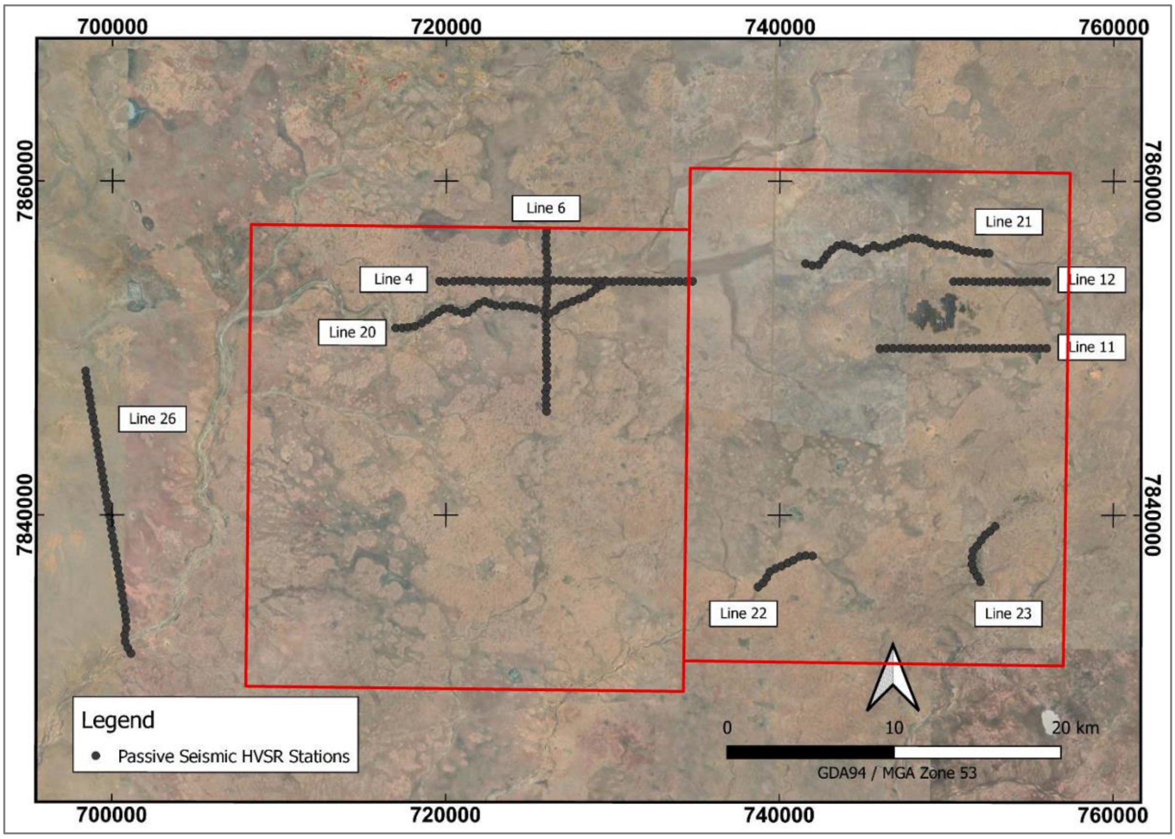
Source: Resource Potentials (2023)

5 Passive seismic program details

A trial passive seismic horizontal to vertical spectral ratio (HVSR) survey was undertaken within the Ranken Project area. This survey was designed to assist Knox to map the interface between the Lower Palaeozoic Georgina Basin and the underlying Paleoproterozoic to Mesoproterozoic South Nicholson Basin for the purpose of assisting drill targeting. A full memorandum of the results and an outline of the methodologies are provided by Resource Potentials in Appendix A.1 with the raw and processed data included in Appendix A.2.

Passive seismic HVSR data were acquired by Atlas between 21 May 2023 and 8 June 2023 using Tromino® seismometers. HVSR survey data were uploaded for Resource Potentials geophysicists on a regular basis during the survey for survey monitoring, data quality assurance and quality control (QA/QC) and preliminary data processing and ongoing survey recommendations.

Figure 5-1: Final passive seismic HVSR stations (black dots) over satellite image



Source: Resource Potentials (2023)
Note: Coordinate system GDA94 MGA Zone 53.

A total of 282 passive seismic HVSR recording stations were acquired by Atlas using a nominal station spacing of 400 m along nine survey lines of variable lengths and orientations (Figure 5-1). The passive seismic HVSR data were acquired using a 20-minute recording period and a sampling frequency of 128 Hz.

During ongoing data QA/QC throughout the survey period, Resource Potentials observed that a number of the HVSR station recordings along passive seismic HVSR survey lines 4, 6, 11 and 12 contained a broad low frequency (<10 Hz) response. This response was initially interpreted to be caused by higher levels of wind noise during acquisition, as well as suboptimal ground surface conditions caused by porous topsoil in the floodplains resulting in poor coupling of the seismometer with the ground. Therefore, a single test survey line along a creek bed was conducted with the

Tromino® seismometer positioned in areas with more suitable ground conditions, such as sand, to attempt to reduce noise associated with poor ground coupling. Passive seismic HVSR data acquired along this test survey line showed cleaner data recordings with notable reduction in noise at lower frequencies (Line 20 – Figure 5-1). As a result, several lines were planned and acquired (Lines 21, 22 and 23) along other creek beds identified in the satellite imagery.

A single passive seismic HVSR survey transect (Line 26 – Figure 5-1) was acquired along Ranken Road located to the west of the survey area and coincident to the existing regional 2D seismic reflection survey line 19GA-B2, to compare the results of the passive seismic HVSR survey with the processed and depth converted reflection seismic survey section.

Digital datasets developed by Resource Potentials include HVSR amplitude-depth cross sections as 2D maps and as 3D georeferenced images.

6 Results and initial interpretation

Several products were developed by Resource Potentials from both the gravity and HVSR datasets for interpretations. These included gravity image derivatives for Bouguer and high pass filters (10 km and 25 km), 3D unconstrained gravity inversions as well as HVSR modelled depth slice images and station depth points. These datasets were integrated with available regional magnetics, gravity, deep crustal seismic (19GAB1 and 19GAB2) and previous interpretations completed by SRK (SRK, 2023) from which updated interpretations were conducted. The following sections provide a high-level summary of the preliminary interpretations made from these datasets.

6.1 Gravity interpretations

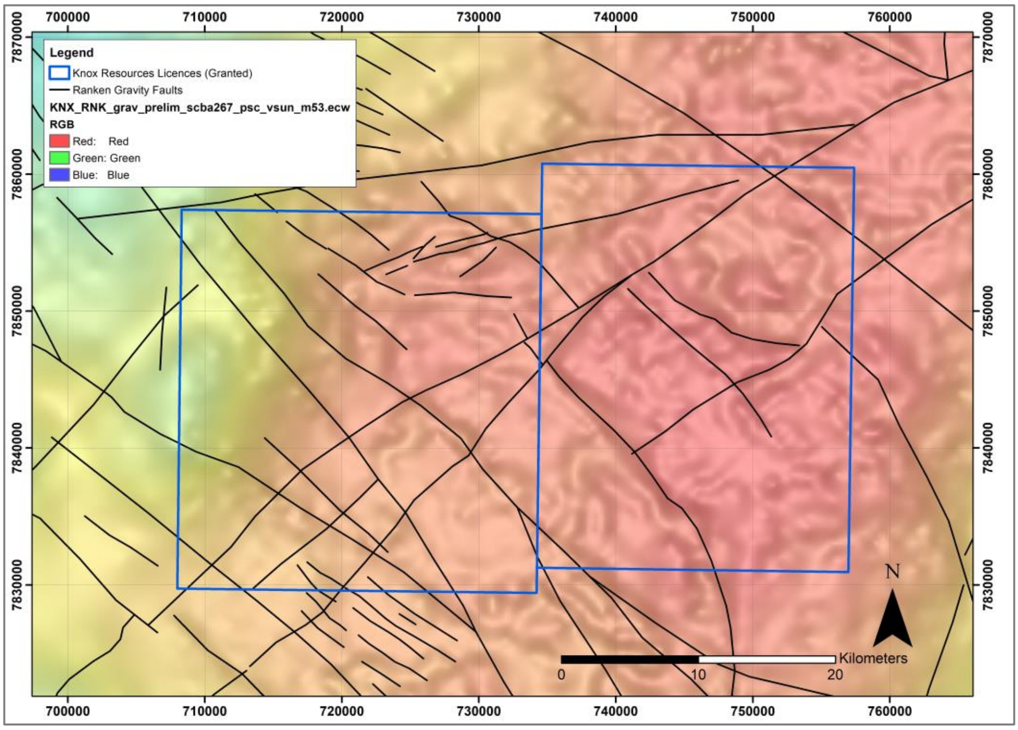
The purpose of the detailed ground-based gravity survey was to assist with the interpretation of the Proterozoic basement units and structures within EL32285 and EL32286 (Ranken Project) which underlie extensive Cambrian Georgina Basin and Cenozoic cover sediments. Previous to the detailed gravity acquisition, the datasets available included moderate resolution magnetics and regional gravity data (4 km spaced stations) with no outcrop and drill hole data available in the licence areas and immediate surrounds, therefore limiting confidence in any interpretations. The detailed gravity data has provided valuable insight into understanding the basement architecture and structure, helping to narrow the focus areas for mineral targeting. Interpretations are ongoing however preliminary interpretations are presented below.

Structure

Fault structures were interpreted across the Ranken Project integrating the detailed gravity data with the regional magnetics and deep crustal seismic data. Two dominant orientations were interpreted – northwest and northeast – and with lesser north trends evident (Figure 6-1). These trends are interpreted to reflect structural patterns consistent with the broader Carrara Domain region as well as the broader Mount Isa region. Two major northeast trending faults have additionally been interpreted and a small structure in the northwest, with this orientation interpreted to be consistent with major northeast trending faults connected to the East Tennant geology to the west.

Several faults were interpreted to intercept the deep crustal seismic (19GA-B1 and 19GA-B2). The major north and northwest trending structures are interpreted to link with steep to moderate dipping faults interpreted in the seismic data, and in some areas appearing to control the observed growth packages interpreted by Soutby et al. (2021) within 19GA-B1 (Figure 6-2 and Figure 1-7).

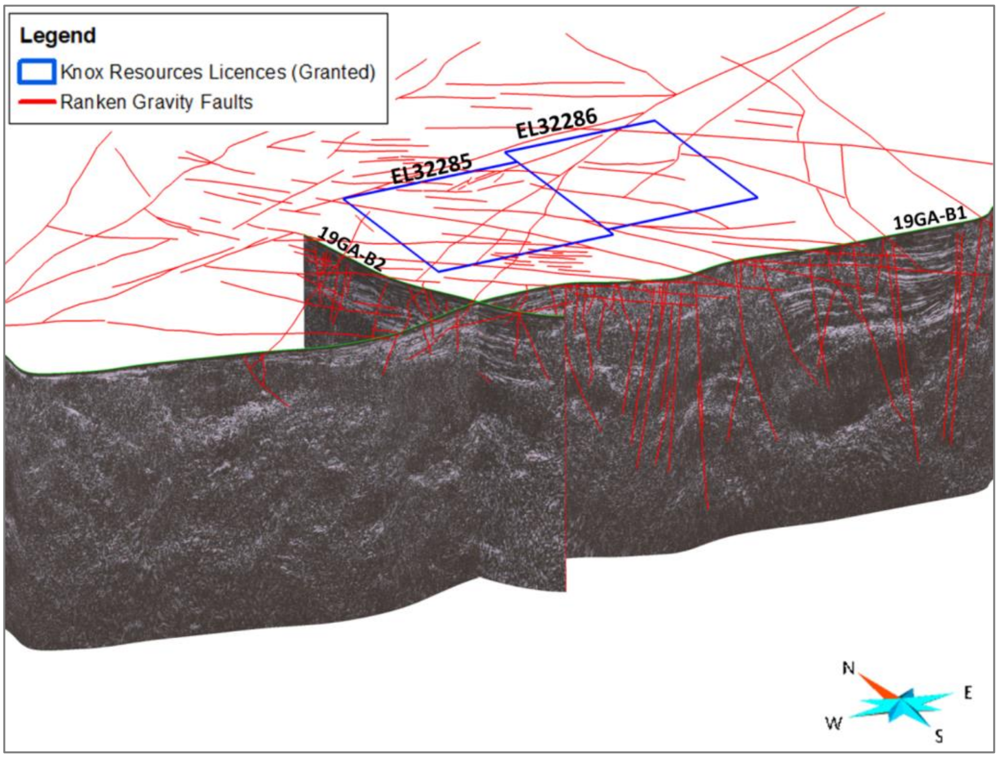
Figure 6-1: Interpreted faults overlain on preliminary gravity Bouguer imagery



Source: Gravity imagery Resource potentials (2023)

Note: Bouguer gravity imagery, vertical sunshade applied. Coordinate system GDA94 MGA Zone 53.

Figure 6-2: Seismic line 19GA-B1 and interpretive linework from Southby et al. (2021)



Source: Seismic data: Geoscience Australia (2019)

Note: 5x vertical exaggeration applied. Red lines are SRK interpreted faults from gravity and sub-surface faults from seismic.

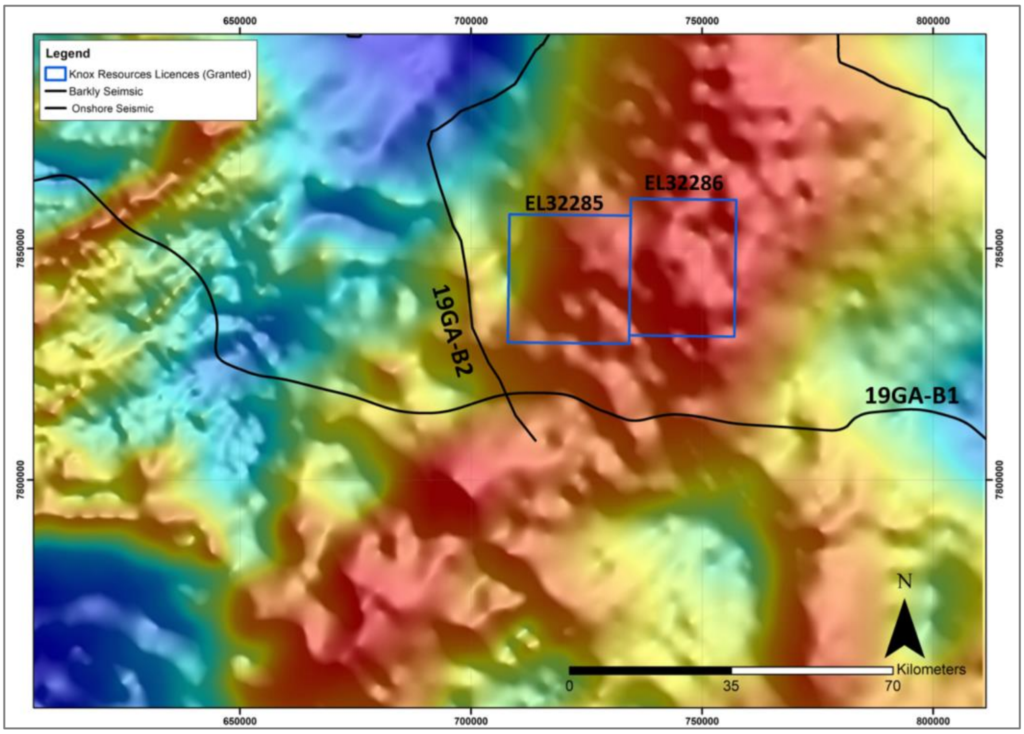
Geology

The Ranken Project is overlain by sediments of the Georgina Basin which obscure the underlying Mesoproterozoic and Paleoproterozoic basement sequences. Interpretations of the Proterozoic sequences within the Project have therefore relied on available geophysical data. Interpretations have been greatly assisted by the recently acquired 1 km by 1 km infill gravity data.

As illustrated in Figure 6-3, the Ranken Project and surrounding region is dominated by a major (~70 km wide) north-northeast trending gravity high domain, extending northwards to outcropping McNamara Group units within the Carrara Range. Based on deep crustal seismic (19GA-B1) the Georgina Basin rocks in this region are underlain by inverted basin sequences interpreted to form part of the Mesoproterozoic South Nicholson Basin and the Paleoproterozoic Isa, Calvert and Leichardt superbasins (Figure 1-6) (Southby et al., 2021). Based on the seismic interpretations this gravity domain corresponds with a thick sedimentary sequence forming an inverted north-trending trough with total maximum sediment thickness greater than 10 km (Southby et al., 2021). The McNamara Group has been interpreted to core this zone before thinning to the west and onlapping older Paleoproterozoic sedimentary and basement metamorphic and igneous rocks (Figure 1-7) (Southby et al., 2021). The dense rocks observed throughout the gravity high domain are interpreted to possibly indicate metamorphic basement highs and/or the presence of mafic volcanics and possibly dense dolostone either within the base of the McNamara Group or the underlying sequences of the Calvert and Leichardt superbasins.

Solid geology interpretations were conducted for the Precambrian sequences (sub-Georgina Basin) including the South Nicholson Basin and the underlying Isa Superbasin sequences (McNamara Group) (Figure 6-4). EL32285 has been interpreted to consist of Wildcow Subgroup whereas the McNamara Group sedimentary units make-up much of the sub-Georgina Basin geology in EL32286. The South Nicholson Basin units are interpreted as a broadly sub-horizontal sequence occurring in a broad north trending antiform which is cored by the Paleoproterozoic McNamara Group (EL32286). To the west of the EL, where the McNamara Group sedimentary sequence is less than a few kilometres thick in the seismic data (i.e. west of EL32285), observed gravity anomalies have been interpreted to reflect sources within the underlying Paleoproterozoic basement and granite intrusions.

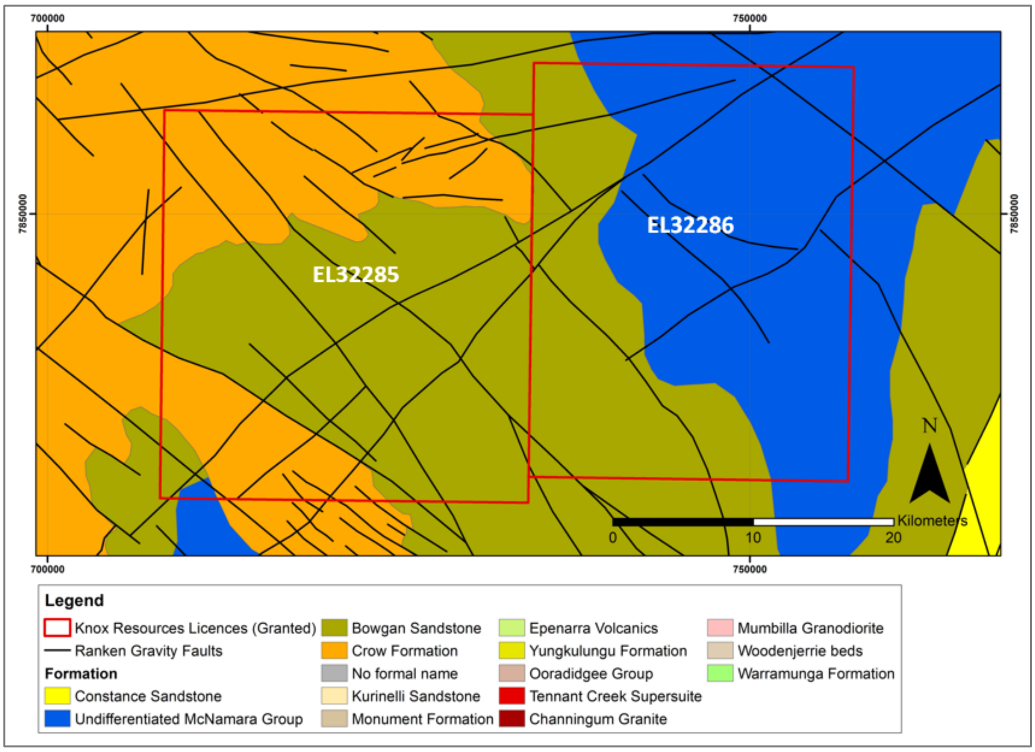
Figure 6-3: Regional merged Bouguer gravity imagery



Source: Gravity imagery Resource Potentials (2021)

Note: Regional merged Bouguer gravity imagery. Coordinate system GDA94 MGA Zone 53.

Figure 6-4: SRK Precambrian solid geology interpretations



Source: SRK

Note: Updated Precambrian basement from SRK (2022). Coordinate system GDA94 MGA Zone 53.

6.2 Passive seismic interpretations

The following summary is an extract from Resource Potentials' memorandum of the results as provided in Appendix A.1. At the time of reporting, interpretation work was ongoing.

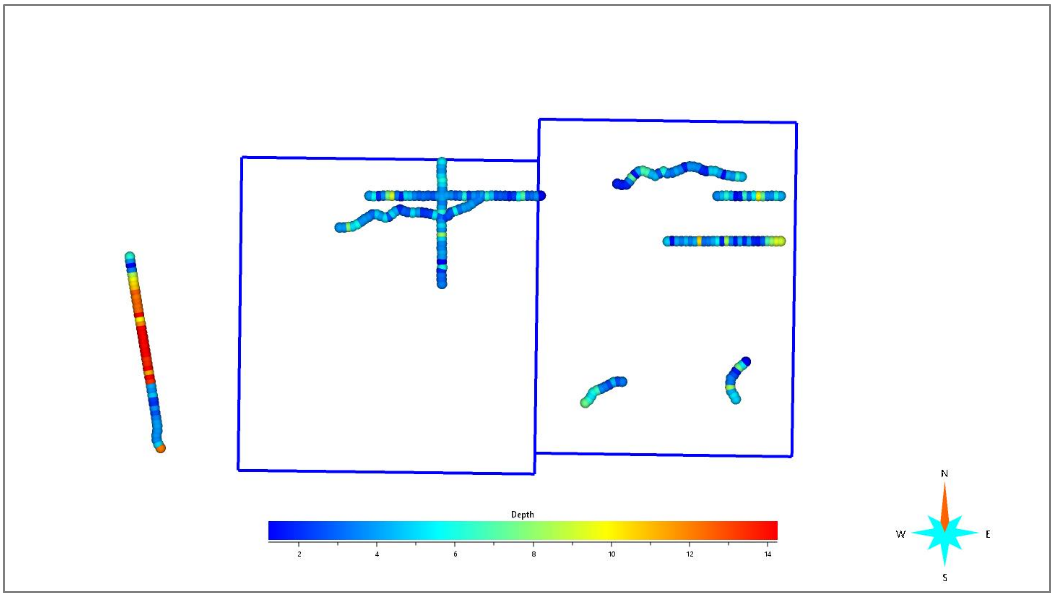
As noted in Section 5, a number of the HVSR station recordings (lines 4, 6, 11 and 12) contained a broad low frequency (<10 Hz) response which was initially interpreted to be caused by higher levels of noise during acquisition. Improved results were obtained from creek beds with notable reduction in noise at lower frequencies (lines 20, 21, 22 and 23).

In general, the majority of HVSR station recordings were determined by Resource Potentials to resolve a high frequency and mid-to-high amplitude HVSR resonant frequency response interpreted to be caused by an undulating shallow and strong acoustic impedance contrast. This HVSR response is interpreted to potentially reflect a shallow acoustic impedance contrast interface from within the soft cover and regolith deposits, or to potentially represent the top of the weathered or fresh Georgina Basin sediments. Depths of this interface ranged between 1.2 m and 19.3 m depth, with an average depth of 5.3 m (Figure 6-5).

Within Line 20 a subtle, low frequency HVSR response was evident, which has been interpreted to relate to an acoustic impedance contrast between the Georgina Basin sediments and the underlying South Nicholson Basin, or alternatively it may be related to noise and poor ground conditions. The depth of this signal was recorded between 638 m and 800 m (Figure 6-2). Given the depth range this signal may alternatively represent the contact between the South Nicholson Basin and underlying Paleoproterozoic basement such as McNamara Group sediments. These results were only resolved on Line 20.

Preliminary results from the HVSR have been interpreted to have been unsuccessful in identifying the lower contact of the Georgina Basin sediments with the underlying Proterozoic sequences. This is interpreted to have been a result of high levels of noise during acquisition, as well as suboptimal ground surface conditions caused by porous topsoil in the floodplains and poor coupling of the seismometer. Results were improved during acquisition within the creeks, where more competent ground material was present (e.g. calcrete within the creeks).

Figure 6-5: Ranken HVSR calculated depths



Source: Data from Resource Potentials (2023)

7 Conclusions

The acquisition of the detailed gravity and passive seismic over the Ranken Project (EL32285 and EL32286) has greatly added to the NT regional gravity datasets, with the work already completed from these datasets assisting in further highlighting the greenfields prospectivity of the South Nicholson Basin.

Based on the acquired gravity datasets over the Ranken Project, a better understanding of the architecture and stratigraphy of the licences has been achieved. The Proterozoic solid geology underlying the Georgina Basin in the Ranken project had previously interpreted South Nicholson Basin units as a broadly sub-horizontal sequence occurring in a broad north trending anti-form which is cored by the Paleoproterozoic McNamara Group in EL32286. Structurally the licence shows several major cross-cutting structures dominantly on a northwest and lesser northeast orientation. Deep crustal seismic data located <12 km to the south (19GAB1) indicates major growth faults potentially linking with the northwest trending structures interpreted within the gravity data.

Several challenges were met with the passive seismic HVSR data within the Project area with poor acquisition over the black soil plain areas resulting from excess noise due to wind and poor ground coupling with the loose soil. Improved results were acquired within creek zones where more competent ground material was present. Results were capable of differentiating the cover contact between the Georgina Basin and overlying sediments, however the contact between the Georgina Basin and underlying Proterozoic sequences was not able to be resolved from preliminary interpretations. Additional insights have also been obtained as to potential depth ranges to prospective Proterozoic sequences from passive seismic data.

The new data acquired as part of this co-funding grant is continuing to be evaluated by Knox. From preliminary interpretations these data are greatly assisting in understanding the structural and basin architecture of the Ranken Project and provide greater confidence for targeting the stratigraphic hole, Ranken-01, within the licence area. Ranken-01 is planned for drilling later this year.

8 References

De Vries, S T, Pryer, L and Fry, N, 2008. Evolution of Neoarchaean and Proterozoic basins of Australia, *Precambrian Research*, 166:39–53.

Kruse, P D, Maier, R C, Khan, M and Dunster, J N, 2008. 1:250 000 Geological map series explanatory notes, SE 53-07, SE 53-11, SE 53-15, SE 53-03, Northern Territory Geological Survey, Darwin.

McConachie, B A and Dunster, J N, 1998. Regional stratigraphic correlations and stratiform sediment-hosted base-metal mineralisation in the northern Mt Isa Basin, *Australian Journal of Earth Sciences*, 45(1):83–88.

Rawlings, D J, Sweet, I P and Kruse, P D, 2008. Mount Drummond, Northern Territory, 1:250 000 geological map series explanatory notes, SE 53-12, Northern Territory Geological Survey, Darwin.

Southby, C, Rollet, N, Carson, C, Car, L, Henson, P, Fomin, T, Costelloe, R, Doublier, M and Close, D, 2021. The Exploring for the Future 2019 Barkly 2D Deep Crustal Reflection Seismic Survey: Key discoveries and implication for resources, in *AGES 2021 Proceedings*, NT Geological Survey.

Southgate, P N, Bradshaw, B E, Domalga, J, Jackson, M J, Idnurm, M, Krassay, A A, Page R W, Sami, T T, Scott, D L, Lindsay, J F, McConachie, B A and Tarlowski, C Z, 2000. Chronostratigraphic basin framework for Palaeoproterozoic rocks (1730–1575 Ma) in northern Australia and implications for base-metal mineralisation, *Australian Journal of Earth Sciences*, 47:461–483.

SRK Consulting (Australasia) Pty Ltd, 2023. Ranken Prospectivity Review, prepared for Middle Island Resources Pty Ltd: West Perth WA 6005, Project number: MIR001, issued 29 May 2023.

Sweet, I P and Hutton, L J, 1981. Lawn Hill Region, Queensland, 1:100 000 geological map commentary, Bureau of Mineral Resources, Australia, Report 167.

Appendices

Appendix A.1 Resource Potentials’ memorandum – Gravity survey data processing and passive seismic survey for Ranken Project, NT

1/46 Hasler Road, Osborne Park, WA 6017
PO Box 167 Northbridge, WA 6865
Ph: (08) 9289 9100
Website: www.respot.com.au
Email: info@respot.com.au

Memorandum

To	:	Paul Abbot and Matthew Healy – Astro Resources NL
From	:	Alexander Costall – Resource Potentials Pty Ltd
Subject	:	High Level Summary of Gravity Survey Data Processing and Unconstrained 3D Inversion Modelling for the Ranken Project, NT
Date	:	13th June 2023

Astro Resources NL's ("Astro") Ranken Project is located approximately 320 km to the east of Tennant Creek, NT (see map image shown in Figure 1), and is within an area recently identified by Geoscience Australia to be prospective for sediment-hosted Zn-Ag-Pb (Cloutier et al, 2023). Astro commissioned Resource Potentials Pty Ltd ("ResPot") during December 2022 to plan and budget a ground gravity survey within Astro's Ranken Project, which was successfully applied for and granted for co-funding during Round 15 of the Northern Territory Geological Survey (NTGS) Geophysics and Drilling Collaborations (GDC) program. ResPot have completed survey QC during survey period, and then final data processing and imaging, and unconstrained 3D inversion modelling of the final merged gravity dataset. No interpretation of the merged gravity data or 3D inversion model products are included within this memorandum.

The Ranken gravity survey was designed to infill regional gravity survey data that were acquired on 2 km by 2 km grid pattern, which was commissioned by the NTGS and completed by Atlas Geophysics Pty Ltd ("Atlas") between 2017 and 2022. ResPot proposed 1,047 new gravity survey stations on a 1 km by 1 km grid pattern which excluded the existing gravity survey stations (see map image shown in Figure 2). Atlas were contracted to undertake the planned gravity survey and completed the planned gravity survey between 20th May and 7th June 2023. A significant delay between commissioning and execution of the survey was due to heavy rainfall resulting in flooding of the area and preventing access to the survey site.

Following completion of the survey data acquisition, ResPot merged the Ranken gravity dataset with regional gravity survey data and then filtered and imaged the merged gravity data to generate sets of geophysical anomaly images and contour files (see example map images in Figures 3 and 4). A description of various geophysical filters that have been applied to the merged dataset is provided in Appendix 1 and a file naming convention is provided in Appendix 2 of this memorandum.

The merged, filtered and images gravity data show a significant improvement in resolution when compared to the recently released 2023 NTGS statewide merge (compare Figures 5 and 6), which will assist Astro to interpret lithology and structures that may be related to sediment-hosted base metal mineralisation within the Ranken Project.

The merged gravity dataset was then used as input for unconstrained 3D inversion modelling using Geosoft VOXI to generate a 3D gravity density anomaly block model. Inversion modelling parameters, including mesh size and error tolerances are provided in Table 1. The resulting 3D inversion block model was used to generate a suite of digital data products including 3D density anomaly block model, RL elevation slice images and depth slice images below ground level slicing down through the 3D density anomaly block model, and 3D isosurface shells of modelled gravity anomaly sources to assist Astro with interpretation of depth and geometry of gravity anomaly sources within the Ranken Project area (see example depth slice images shown in Figure 7 and 3D view shown in Figure 8).

Table 1: Summary of inversion modelling parameters used to generate the 3D density block model of Astro's Ranken Project area.

Parameter		Value
Input Data	Input Data	Gravity SCBA 2.67
	Data Type	Grid
	Data Unit	mGal
Mesh Size Summary	X	500 m
	Y	500 m
	Z	100 m
	No. X	260
	No. Y	240
	No. Z	45
	Top of Model	319 m
	Lin-Log Trans.	-1,000 m
Modelling Summary	Depth Extent	20,000 m
	Error Tolerance	1%
	Error Floor	0.001 mGal
	Trend Removal	Linear
	No. Iterations	24
	Data Fit	1.0424
	Convergence Time	12,770.6 s

Accompanying this memorandum in digital format, ResPot have provided the merged gravity dataset, merged gravity data grids, filtered gravity anomaly images and contours of select gravity anomaly data grids, and digital data products from the unconstrained 3D inversion modelling. All georeferenced data and images are provided in GDA94 datum and MGA Zone 53 projection, with 3D data products referenced to orthometric SRTM DEM ground surface. It is recommended that Astro complete further integration of open-file company and government available geochemical, drillhole and geophysical datasets in order to assist interpretation of the subsurface geology and generate target areas for follow-up drillhole testing.

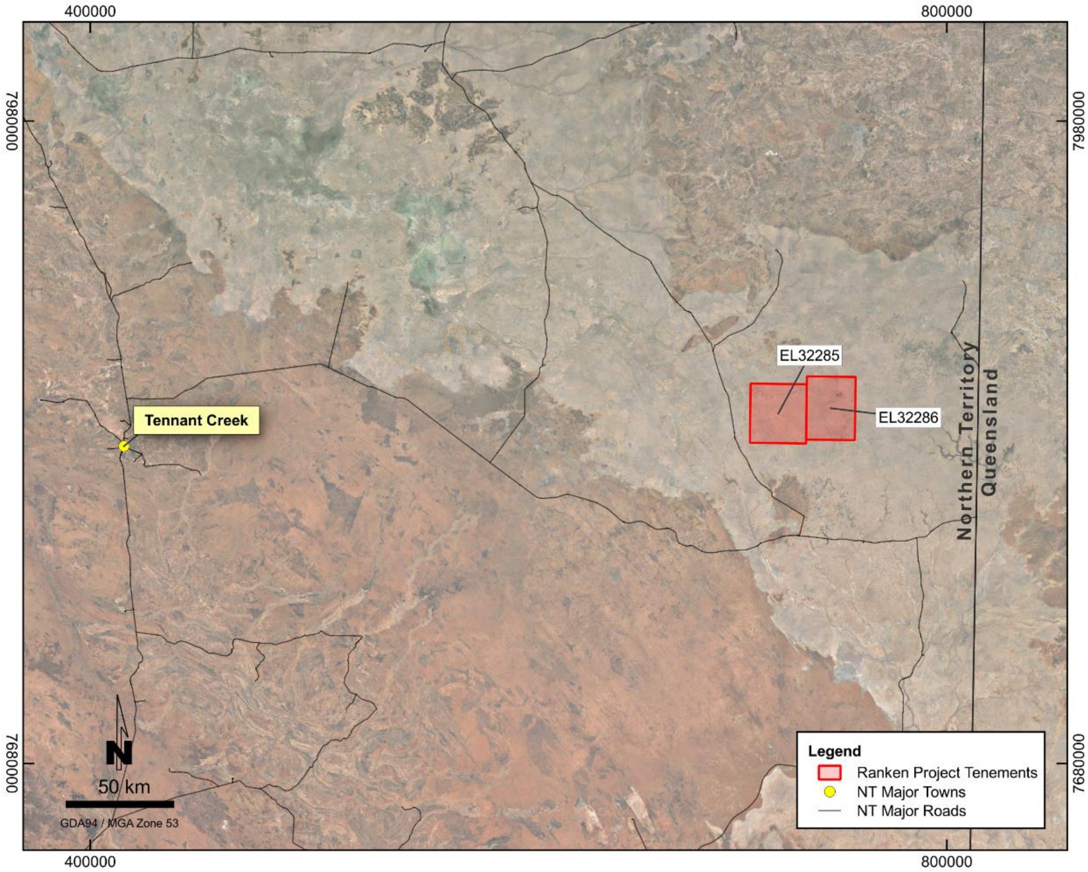


Figure 1: Location of Astro's Ranken Project tenements (shaded red polygons) located approximately 320 km to the east of Tennant Creek (yellow circle), shown over Google Earth satellite imagery.

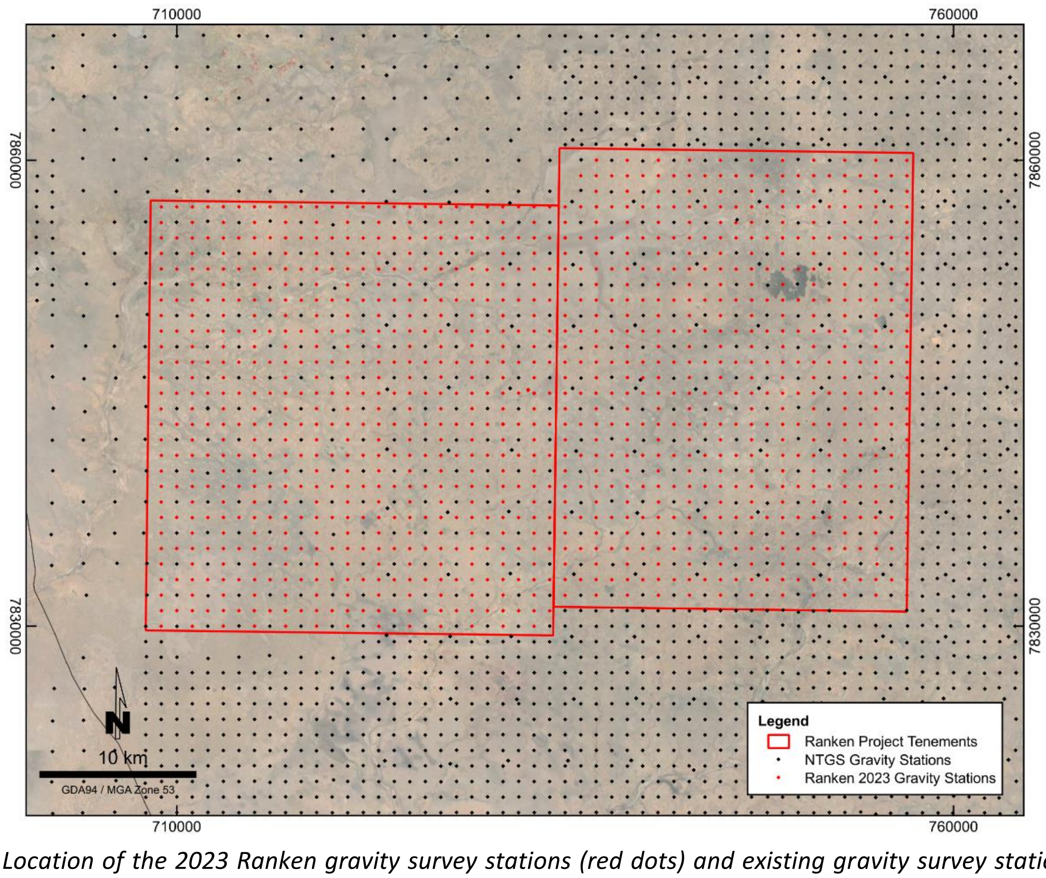


Figure 2: Location of the 2023 Ranken gravity survey stations (red dots) and existing gravity survey stations (black dots) in relation to Ranken Project tenements (red polygons) shown over Google Earth satellite imagery.

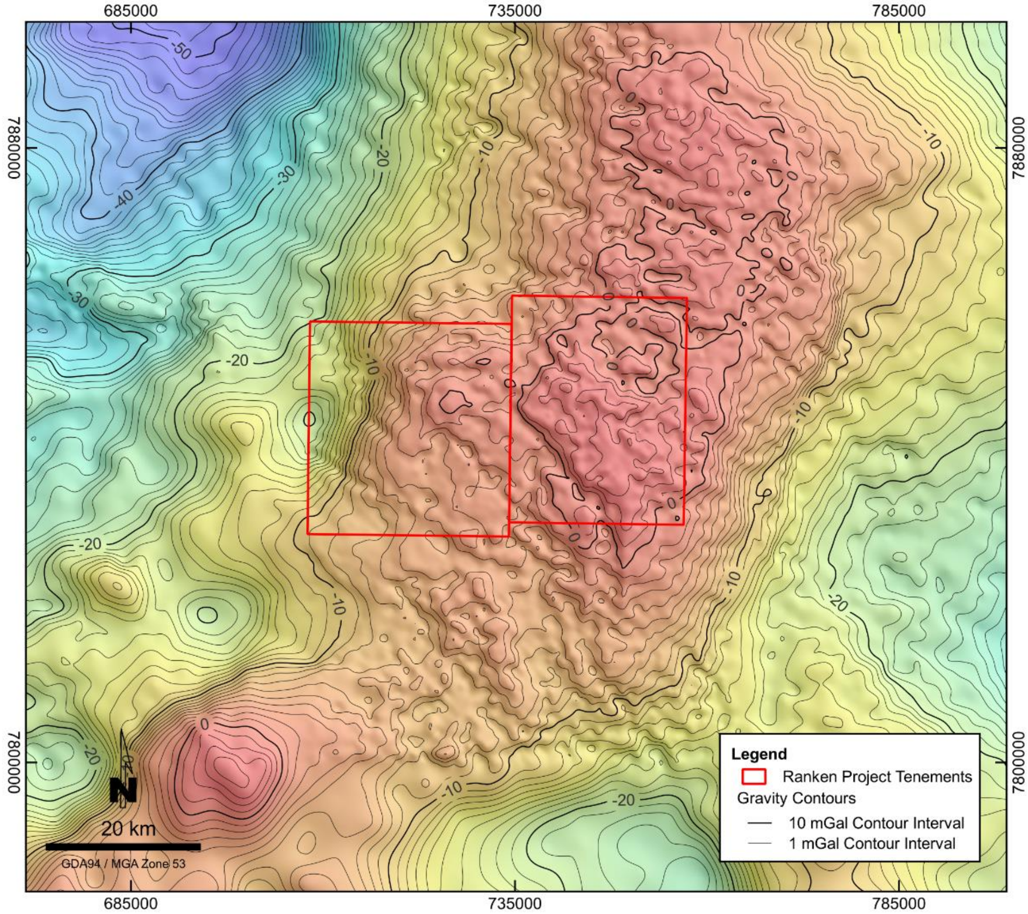


Figure 3: Example of merged gravity anomaly image showing the regional Ranken Project area of interest, shown with sun-shading from the northeast and contours at 1 mGal (thin lines) and 10 mGal (thick lines) contour intervals.

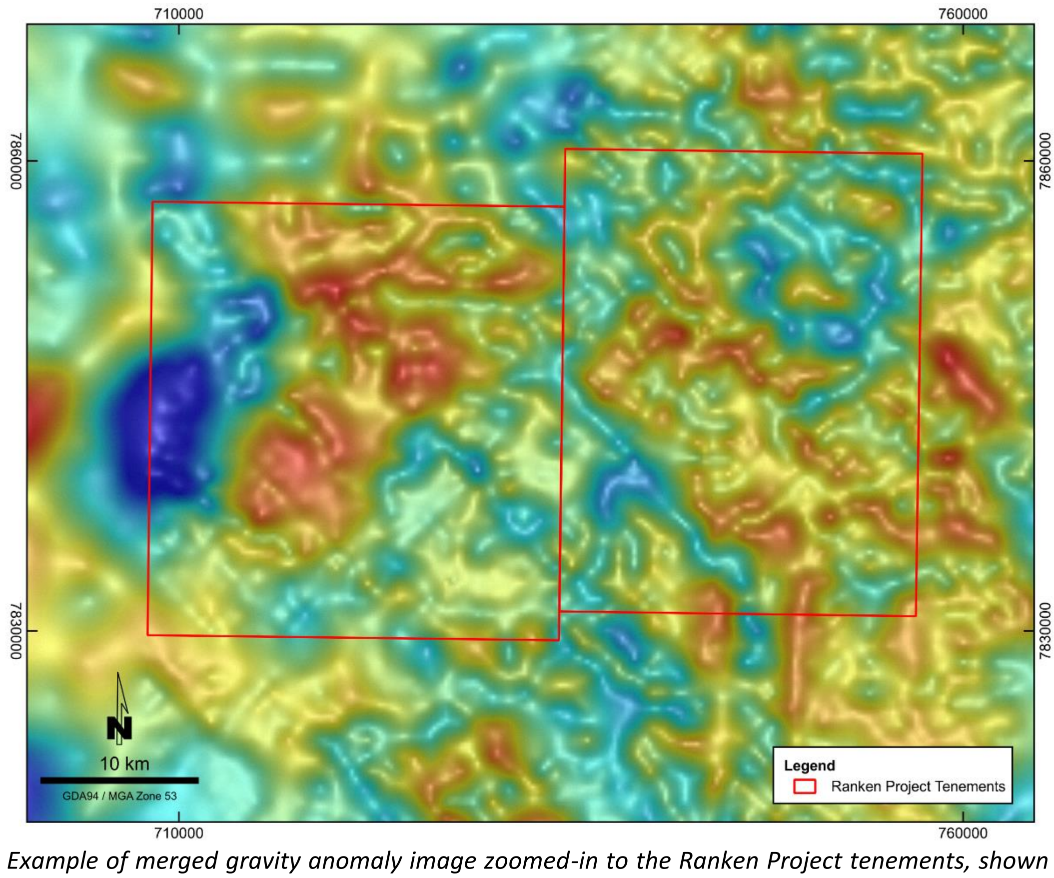


Figure 4: Example of merged gravity anomaly image zoomed-in to the Ranken Project tenements, shown with sun-shading from above.

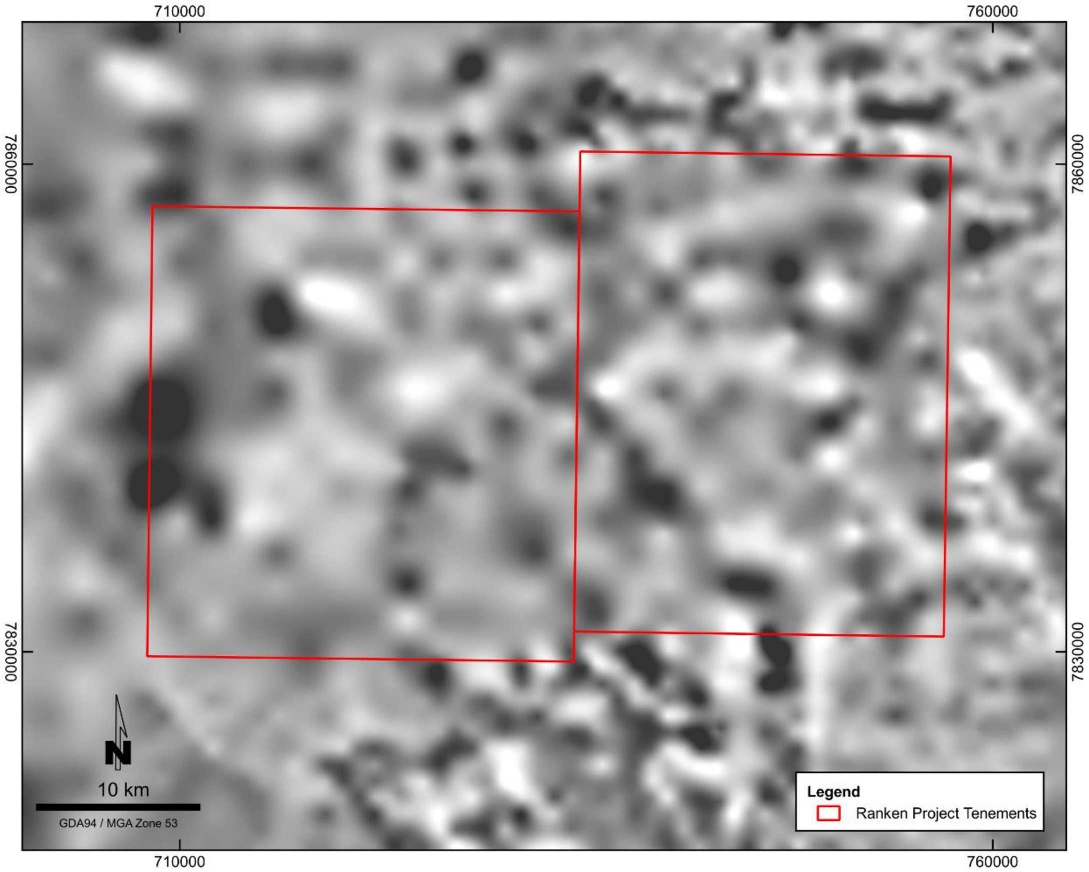


Figure 5: Example of filtered gravity anomaly image from the NTGS statewide 2023 gravity data compilation, without the Ranken 2023 gravity data. Compare this image to the merged and filtered image shown in Figure 6 (below).

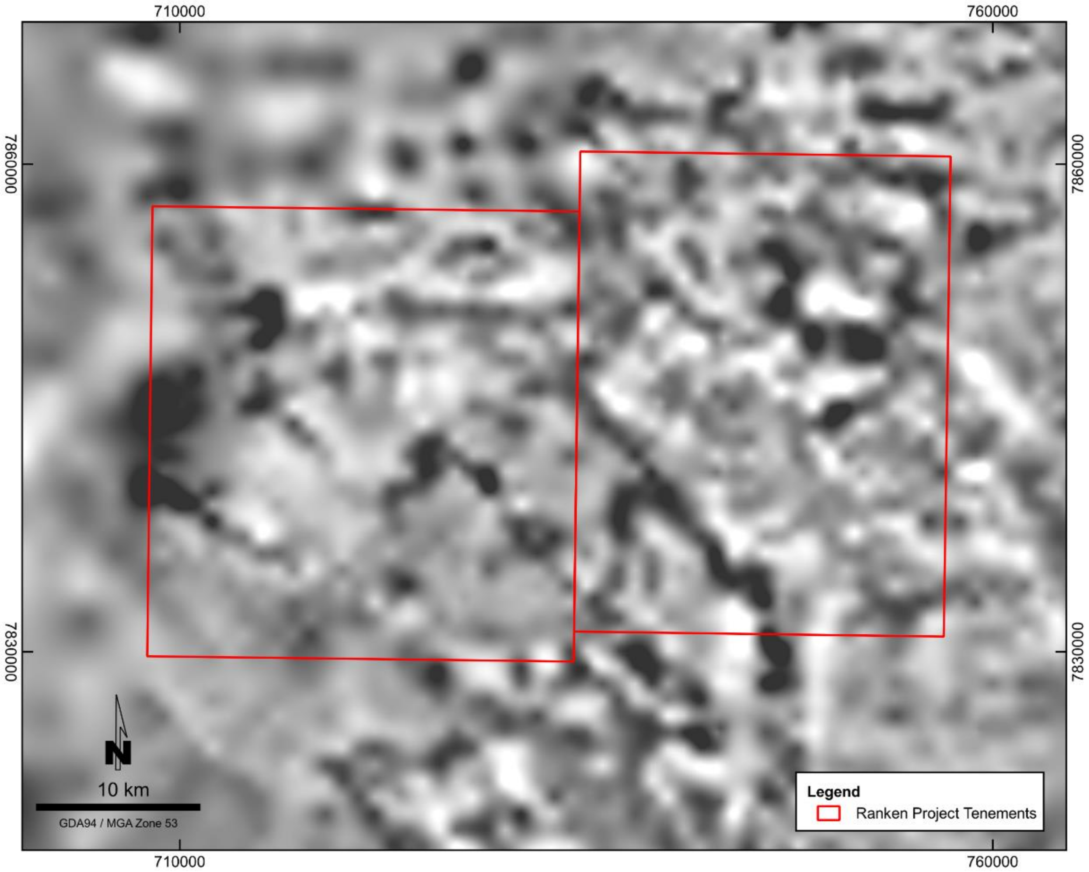


Figure 6: Example of filtered gravity anomaly image from the NTGS statewide 2023 gravity data compilation, with the Ranken 2023 gravity data. Compare this image to the filtered statewide compilation image shown in Figure 5 (above).

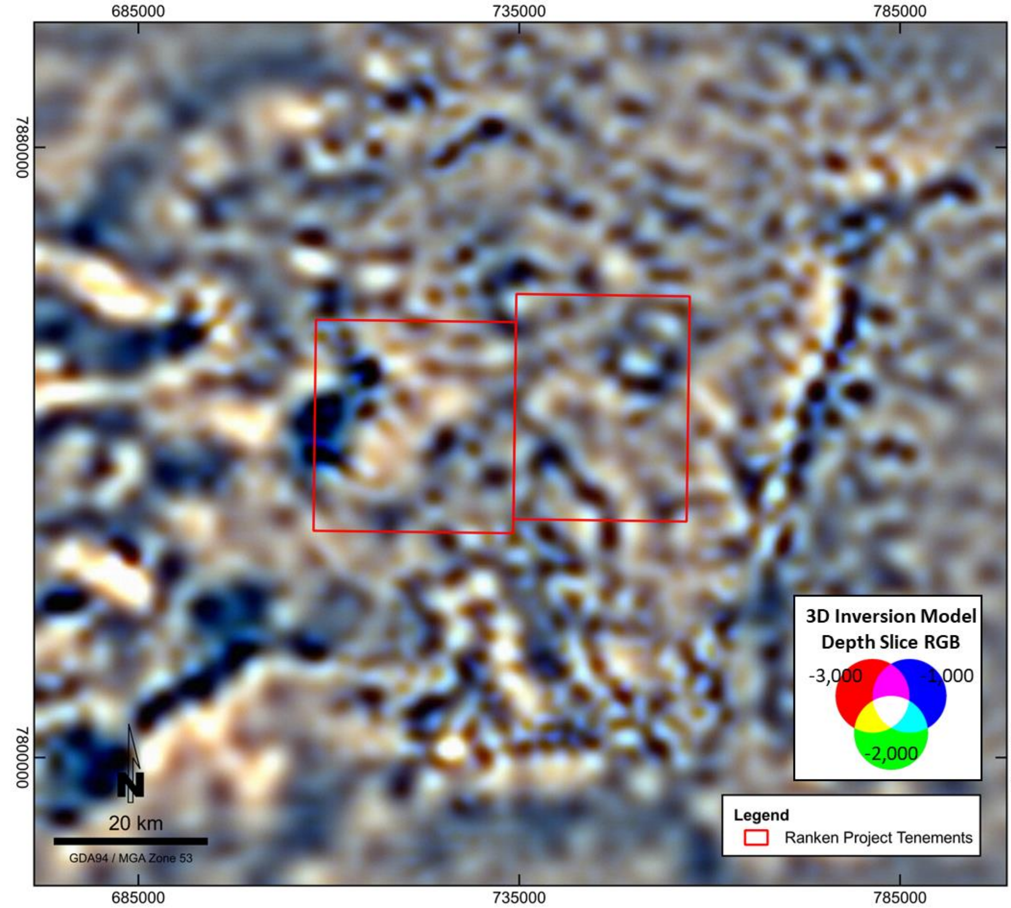


Figure 7: Example of depth slices below the SRTM DEM surface through the 3D gravity density inversion model shown as a ternary RGB image where red = -3,000 m, green = -2,000 m and blue = -1,000 m. Areas that are coloured white show high modelled source body density anomaly in all three depth slices, while areas coloured black show low modelled source body density anomaly in all three depth slices.

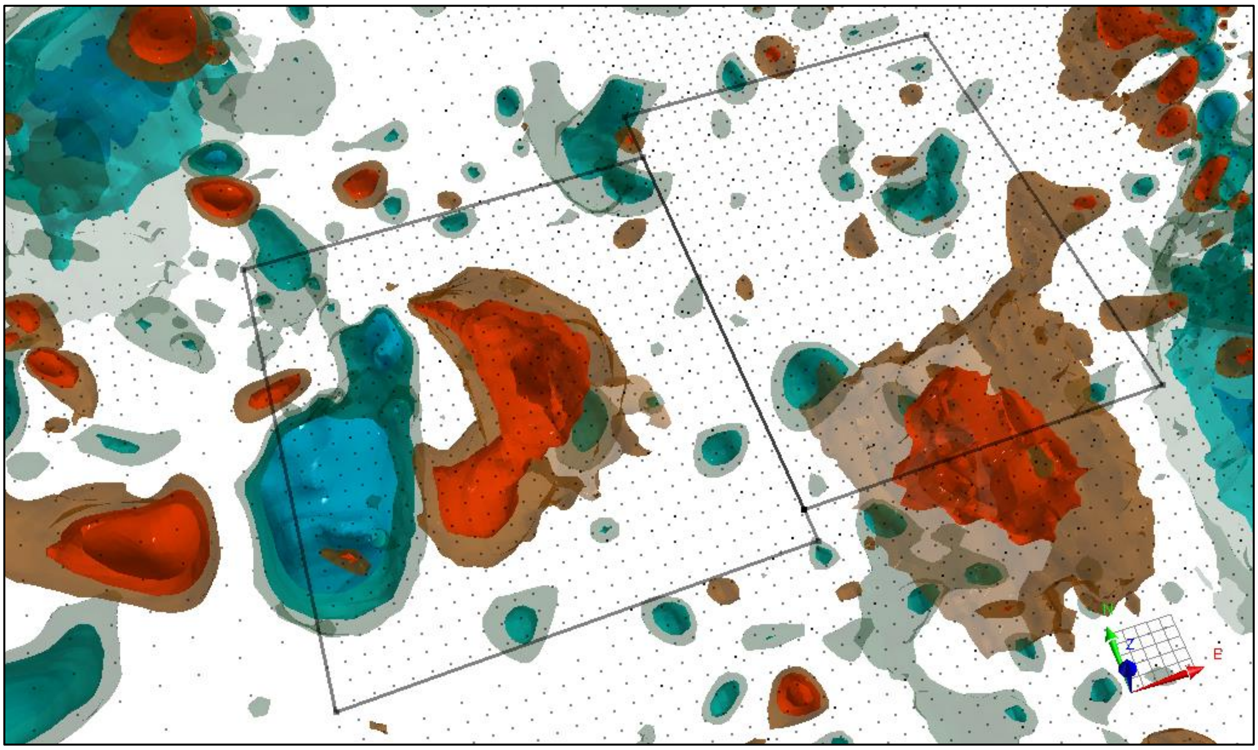


Figure 8: 3D view looking northeast and down on high (reds) and low (blues) modelled density anomaly isosurfaces generated from the 3D gravity inversion model results, shown with gravity survey stations (black dots) and Ranken Project tenement outlines (black polygons).

References:

Cloutier, J., Ford, A., Huston, D., Doublier, M., Schofield, A., Waltenberg, K., de Caritat, P., Fraser, G., Beyer, E., Bastrakov, E., Czarnota, K. 2023. *National mineral potential for sediment-hosted zinc-lead mineral systems in Australia Version 1.0*. Geoscience Australia, Canberra. https://dx.doi.org/10.26186/147540

Geophysical Acquisition & Processing Section 2018. South Nicholson Gravity Survey (P201701), gravity point data. Geoscience Australia, Canberra. https://pid.geoscience.gov.au/dataset/ga/125963

Geophysical Acquisition & Processing Section 2018. Barkly Tablelands Gravity Survey, 2009, NT (P200980), gravity point data. Geoscience Australia, Canberra. https://pid.geoscience.gov.au/dataset/ga/125901

NTGS 2022. NTGS Brunette Downs Gravity Survey, 2021, P202180. Geoscience Australia, Canberra. https://dx.doi.org/10.26186/146941

Wynne, P.E. 2019. East Tennant Gravity Survey P201901, NT, 2019. Geoscience Australia, Canberra. https://dx.doi.org/10.26186/130951

Appendix 1: Descriptions of Geophysical Filters

Reduction to Magnetic Pole (RTP): Removes the regional magnetic field from the magnetic data to remove anomaly asymmetry caused by inclination, resulting in anomalies located above the causative bodies, assuming that the remanent magnetism is small compared to the induced magnetism.

First Vertical Derivative (1vd): The 1vd filter calculates the rate of change of vertical signal component, emphasizing local anomalies and isolating them from a regional background.

Second Vertical Derivative (2vd): The 2vd filter calculates the rate of change of the 1vd, which can further sharpen and isolate anomalies, but can also increase near-surface noise and sharpen the boundaries between different surveys in a merged dataset.

Half Vertical Derivative (hvd): The hvd filter highlights gradients in data and can be considered as a 'less-harsh' 1vd filter, where it sharpens and separates anomalies without emphasising noise or widely spaced data points.

Upward Continuation (UC): An upward continuation filter shifts the data as if they were acquired using a sensor a certain distance farther away, thereby removing the shorter wavelength features associated with shallow sources and system noise.

Tilt Derivative (tilt): This filter computes the arc-tangent of the ratio of the vertical-to-horizontal derivatives. The tilt derivative filters can be useful in mapping structures in the data, however they can also highlight noise features, so care needs to be taken in interpretation of the tilt derivative images.

Bandpass Filter (HP or LP): This filter removes signal above or below certain frequencies, which are related to the distance to the respective sources. Generally, signals from deep sources have low frequencies (long wavelengths), and shallow sources have high frequencies (short wavelengths). Low pass (LP) filters are used to remove high frequency / short wavelength data related to surficial responses and noise, whereas high pass (HP) filters remove low frequency / long wavelength signals from deep and regional sources.

Appendix 2: GIS File Naming Convention

Project/Prospects

- RNK = Ranken Project
- merge = regional data merge

Data Type

- grav = gravity data
- GBA267 = gravity bouguer anomaly, calculated using a background density of 2,670 kg/m^3 (2.67 g/cm^3)
- DTM = digital terrain model elevation
- SRTM = shuttle radar topography mission

Filters

- 1vd = 1^{st} vertical derivative
- 2vd = 2^{nd} vertical derivative
- hvd = Half vertical derivative
- UC = upward continued
- DC = downward continued
- tilt = tilt derivative
- HP2km = high pass filter, passing wavelengths less than 2 km
- LP500m = low pass filter, passing wavelengths greater than 500 m

Colour Palette

- RGB = Red, Green, Blue ternary image
- psc = pseudo colour
- rbw = rainbow colour
- gsf= Geosoft colour
- elev = elevation colour
- gry = greyscale

Sun Angle Shading

- nesun = northeast sun angle shading
- nwsun = northwest sun angle shading
- vsun = vertical sun angle shading

1/46 Hasler Road, Osborne Park, WA 6017
PO Box 167 Northbridge, WA 6865
Ph: (08) 9289 9100
Website: www.respot.com.au
Email: info@respot.com.au

Memorandum

To	: Paul Abbott and Matthew Healy – Astro Resources NL
From	: Cameron Thompson– Resource Potentials Pty Ltd
Subject	: Trial Passive Seismic HVSR Surveying at the Ranken Project, Northern Territory
Date	: 18/06/2023

A trial passive seismic Horizontal to Vertical Spectral Ratio (HVSR) survey was undertaken for Knox Resources Pty Ltd ("Knox") at their Ranken Project which is located approximately 60km to the north of the town of Ranken in the Northern Territory. The passive seismic HVSR survey was designed by SRK Consulting Ltd ("SRK") and co-funded as part of the Northern Territory Geological Survey (NTGS) geophysics and drilling collaborations (GDC) program and was completed in order to assist Knox to map the interface between the Neoproterozoic to Lower Palaeozoic Georgina Basin and the underlying Paleoproterozoic to Mesoproterozoic South Nicholson Basin, which will assist Knox to plan drilling programs to test targets within the Ranken Project area.

Passive seismic HVSR data were acquired by Atlas Geophysics Pty Ltd ("Atlas") between the 21st of May 2023 and the 8th of June 2023 using innovative and sensitive Tromino® seismometers. HVSR survey data were uploaded for Resource Potentials Pty Ltd ("ResPot") geophysicists on a regular basis during the survey for survey monitoring, data QA/QC, preliminary data processing and cross section generation, ongoing client updates, and recommendations for modifications of survey line locations.

This memorandum is provided to assist Knox with interim reporting to the NTGS on work completed and preliminary results to date. Completion of a final summary and interpretation report is currently ongoing and will be provided to Knox at a later date. Digital deliverables, including HVSR amplitude-depth cross-sections as 2D maps and as 3D georeferenced images, have been provided to Knox accompanying this memorandum. All digital deliverables and maps in this memorandum reference the GDA94 datum and MGA zone 53 projection.

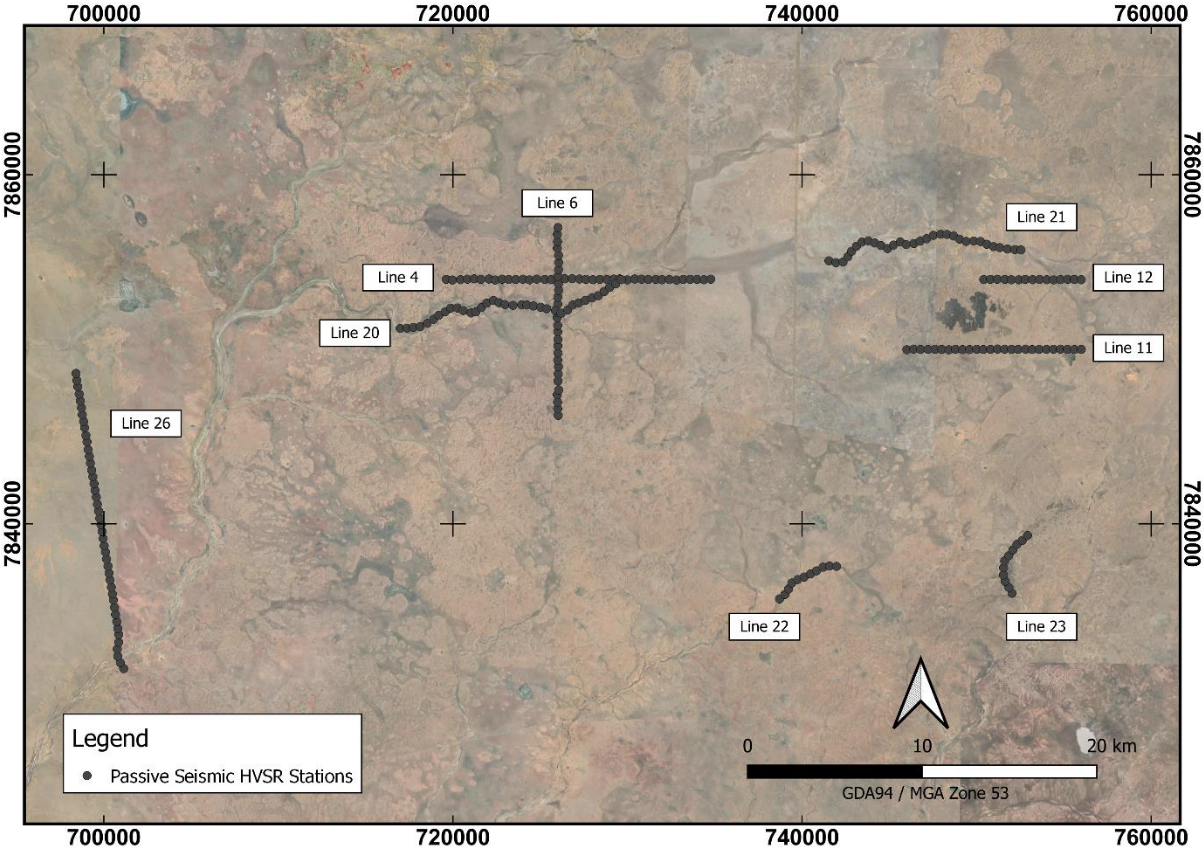


***Figure 1:** Passive seismic HVSR stations (black dots) over a Google satellite image.*

The passive seismic HVSR technique is based on horizontally and vertically travelling ambient shear waves which become trapped in softer and slower velocity regolith cover sediments and weathered bedrock, which overlies harder and higher velocity bedrock, as a form of seismic amplification at a local resonant frequency. An interface with a strong acoustic impedance contrast (ie. the difference between the density multiplied by velocity for each layer) is required to generate this seismic resonance. Passive seismic surveying involves recording ambient or naturally occurring seismic vibrations over a broad range of frequencies and a specific time period (often 10-30 minutes). The Tromino® seismometer records three axial components of vibration using velocimeters: two horizontal components (relative to the X and Y axis) and one vertical (Z axis) component. The recorded time-series vibration data are later transformed into frequency spectra by using a Fast Fourier Transform (FFT) and are then presented as a frequency-power spectrum plot for all three receiver components. Shear wave resonance developed within a low velocity layer sitting over a higher velocity layer (e.g. soft regolith or sedimentary cover over hard and fresh bedrock) produces a local minimum in the vertical component frequency power spectrum, thereby creating an ‘eyelet’ shaped separation between the horizontal and vertical vibration component frequencies. Calculating the averaged X and Y horizontal (H) to vertical (V) spectral ratio (HVSR) will produce a peak at the resonant frequency of the cover deposit layers (Figure 2).

Accurate conversion of passive seismic HVSR frequency domain data into depth is typically carried out by calibrating observed HVSR resonant frequency responses against known fresh bedrock depth (interpreted acoustic bedrock) from drilling. However, during this study there were no drillhole information available within close proximity to the survey area and therefore all passive seismic HVSR data were depth converted using a single average shear wave velocity (Vs) of 300 m/s, which is considered to be a reasonable average Vs for the shallow (≤10 m) regolith cover typically interpreted along these trial survey lines. Additionally, a second Vs of 800 m/s was also applied to passive seismic HVSR survey Line 20 as there were lower frequency HVSR responses observed below the higher frequency (shallower) HVSR responses that could potentially represent another acoustic impedance contrast interface at depth. A higher Vs was applied in order to reflect an increase in seismic velocity with depth often encountered due to compaction. Due to the lack of project calibration, there will most likely be depth discrepancies between drillhole intercepted acoustic bedrock and calculated acoustic bedrock.

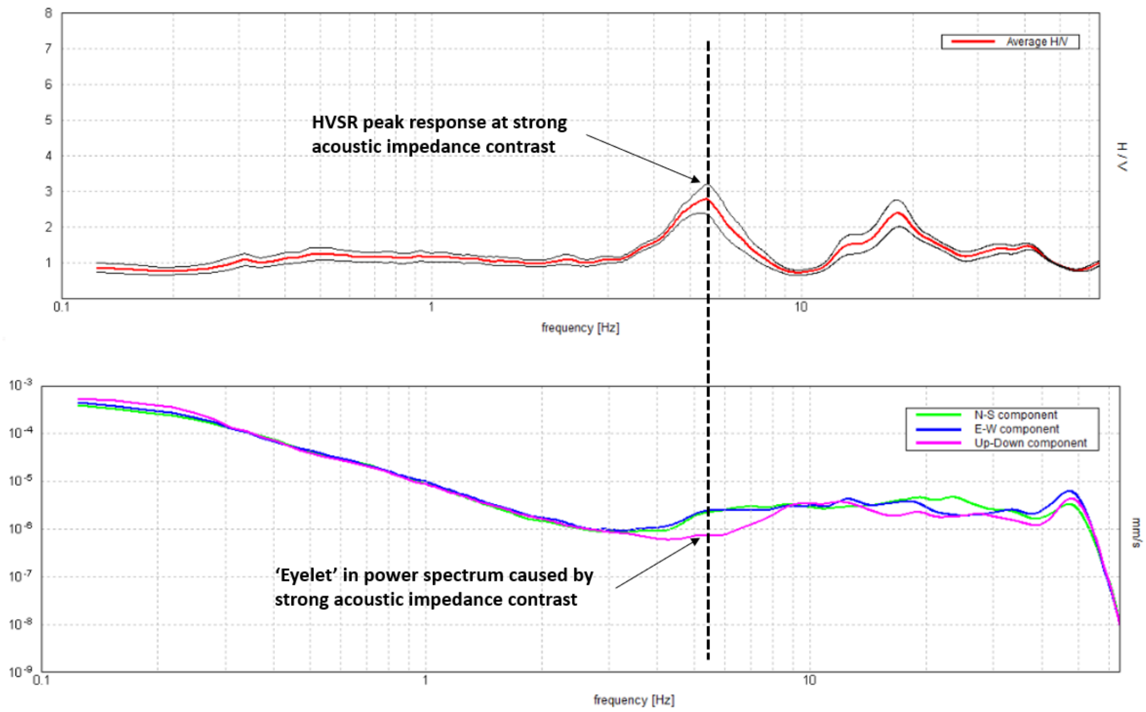


Figure 2: *Example passive seismic HVSR profile (top panel) and the associated frequency power spectrum of the tri-axial component vibrations from station 4024 on survey Line 26.*

A total of 282 passive seismic HVSR recording stations were acquired by Atlas using a nominal station spacing of 400 m along nine survey lines of variable length and orientations. The passive seismic HVSR data were acquired using a 20-minute recording period and a sampling frequency of 128 Hz. In general, the majority of HVSR station recordings resolved a high frequency and mid-to-high amplitude HVSR resonant frequency response interpreted to be caused by an undulating shallow and strong acoustic impedance contrast. This HVSR response may reflect a shallow acoustic impedance contrast interface from within the soft cover and regolith deposits, or potentially represent the top of the weathered or fresh Georgina Basin sediments, and further work is required for more accurate interpretation.

During ongoing data QA/QC throughout the survey period, ResPot observed a number of the HVSR station recordings along passive seismic HVSR survey lines 4, 6, 11 and 12 contained a broad low frequency (<10 Hz) response initially interpreted to be caused by higher levels of wind noise during acquisition, as well as suboptimal ground surface conditions caused by porous top soil in the floodplains resulting in poor coupling of the seismometer with the ground. Therefore, ResPot proposed a single test survey line along a creek bed, with Atlas field crews requested to place the Tromino® seismometer in areas with more suitable ground conditions, such as sand, to attempt to reduce noise associated with poor ground coupling. Passive seismic HVSR data acquired along this test survey line showed cleaner data recordings and a notable reduction in noise at lower frequencies (see Line 20 shown in Figure 4), prompting the planning and acquisition of Lines 21, 22 and 23 along other creek beds identified in satellite imagery.

Passive seismic HVSR data acquired along survey line 20 resolved a similar high frequency (shallow) acoustic impedance contrast commonly observed on the other survey lines in this project area. However, the HVSR data recordings along half of this survey line also suggest the presence of a much subtler and lower frequency response. This HVSR response did not display the typical "eyelet" shape between the horizontal and vertical components, was not consistent throughout the 20-minute recording period, and the source of the signal always appeared to originate from one direction, indicating that it may not reflect a geological response. While this low frequency HVSR response is most likely caused by noise, it is also possible that the resolved near surface acoustic impedance contrast could be masking the response of a deeper HVSR response caused by a subtle acoustic impedance contrast between two geological layers such as the Georgina Basin and the South Nicholson Basin.

A single passive seismic HVSR survey transect, Line 26, was acquired along Ranken Road located to the west of the survey area, and is located coincident to the existing regional 2D seismic reflection survey line 19GAB2 in order to compare the results of the passive seismic HVSR survey to the processed and depth converted reflection seismic survey section (see Figure 5). This integration and comparison remains ongoing at the time of this memorandum.

The passive seismic HVSR results have resolved a shallow acoustic impedance contrast on all survey lines, which may reflect the interface between soft regolith cover and the underlying hard Georgina Basin sediments, or alternatively shallower acoustic impedance contrasts from within the soft regolith cover. A subtle, low frequency HVSR response was observed on Line 20, which may be related to an acoustic impedance contrast between the Neoproterozoic to Lower Palaeozoic Georgina Basin and the underlying Paleoproterozoic to Mesoproterozoic South Nicholson Basin, or alternatively it may be related to noise and poor ground conditions. Additional integration of the passive seismic HVSR data with other regional geological, geophysical, geochemical and drillhole datasets is recommended to assist with the interpretation of these passive seismic HVSR responses.

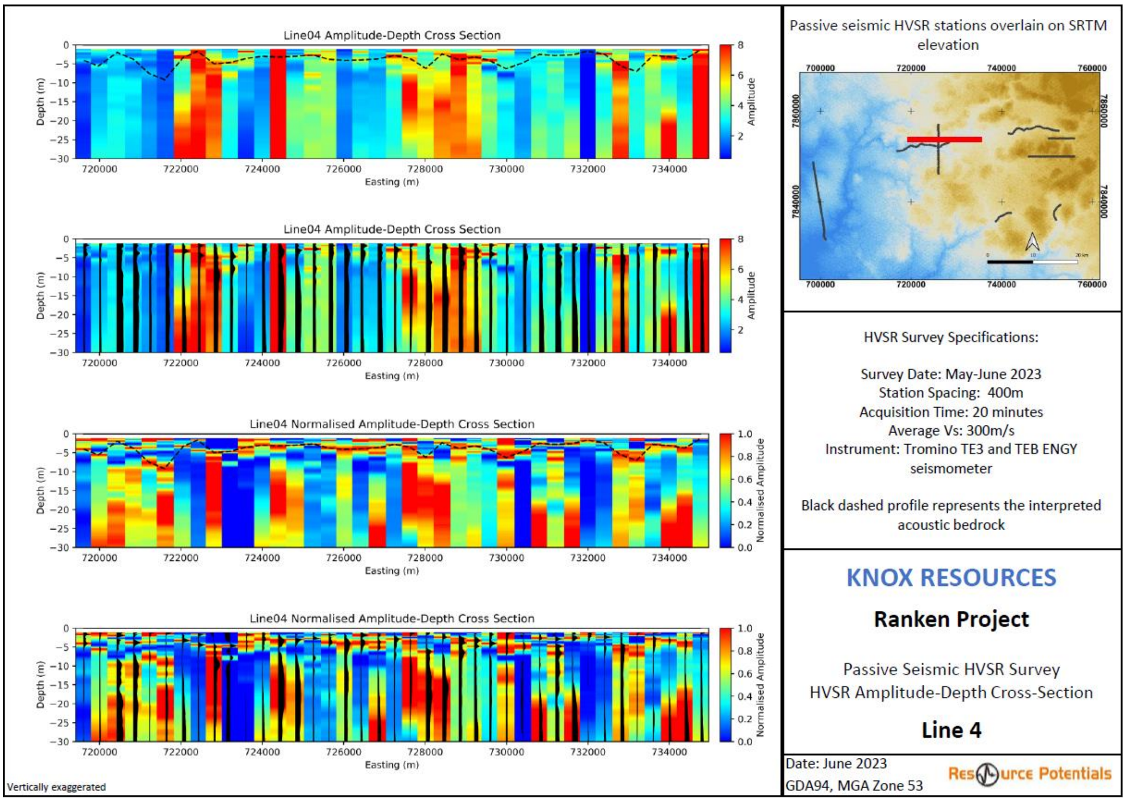


Figure 3: *Passive seismic HVSR survey Line 4 map layout including amplitude-depth cross sections normalised to the high frequency (shallow) HVSR response.*

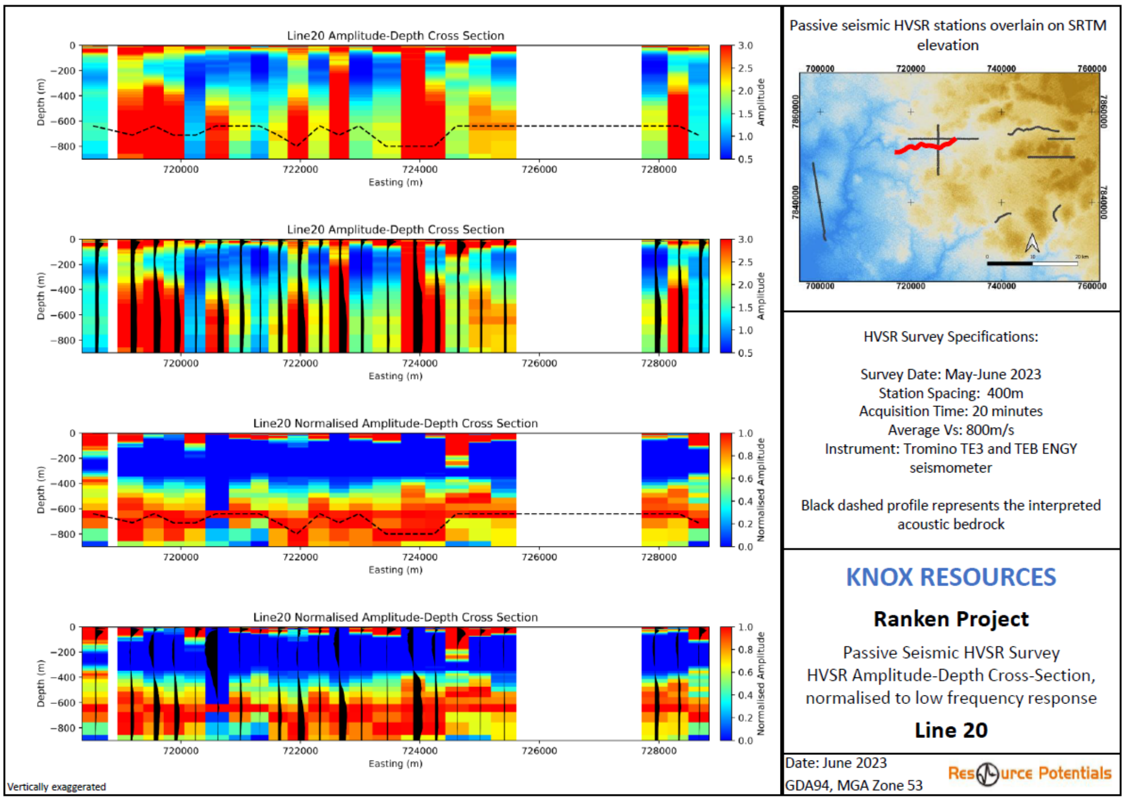


Figure 4: *Passive seismic HVSR Line 20 map layout including amplitude-depth cross sections normalised to the subtle low frequency HVSR response observed between 0.25-0.35 Hz. These cross sections were depth converted using an average Vs of 800 m/s to reflect an increase in seismic velocity with depth due to compaction. Passive seismic HVSR recording stations which contained much higher levels of noise and which did not record any subtle HVSR response within this low frequency range has been excluded from the cross sections.*

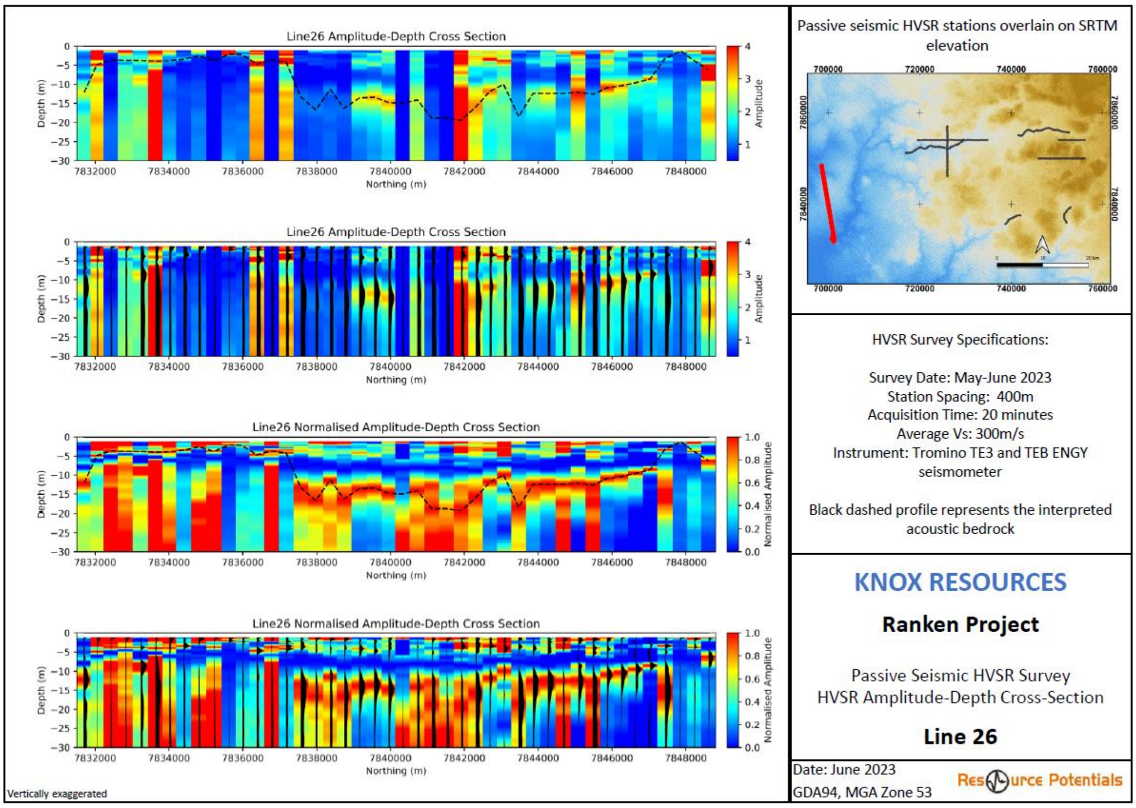


***Figure 5**: Passive seismic HVSR survey Line 26 map layout including amplitude-depth cross sections normalised to the high frequency (shallow) HVSR response, located coincident to the existing regional 2D seismic reflection survey line 19GAB2.*

Appendix A.2 Ground gravity and passive seismic data/reports

Only Field acquisition memo from Atlas Geophysics included.
Raw data and images provided separately.

Atlas Geophysics Memorandum M2023081

Rankin Gravity Survey

ASTRO RESOURCES NL

Memo completed by:

Richard Allpike
Geophysicist

T 08 6278 2898
PO BOX 1049
MORLEY WA 6943
AUSTRALIA

info@atlasgeo.com.au

ABN 68 123 110 243

12th June 2023

TABLE OF CONTENTS

APPENDICES

1.0 Project Brief

Project P2023081 involved the acquisition and processing of **1,047** new gravity stations for Astro Resources NL over an area approximately 150km east of Barkley Roadhouse in the Northern Territory of Australia (Figure 1).

Gravity stations were acquired using a 1km x 1km infill grid configuration. Atlas Geophysics completed the acquisition of the dataset with one crew utilising UTV-borne gravity methods.

Acquisition for the projects commenced on the 20th of May 2023 and finished on the 6th of June 2023. Final data were delivered shortly after project completion.

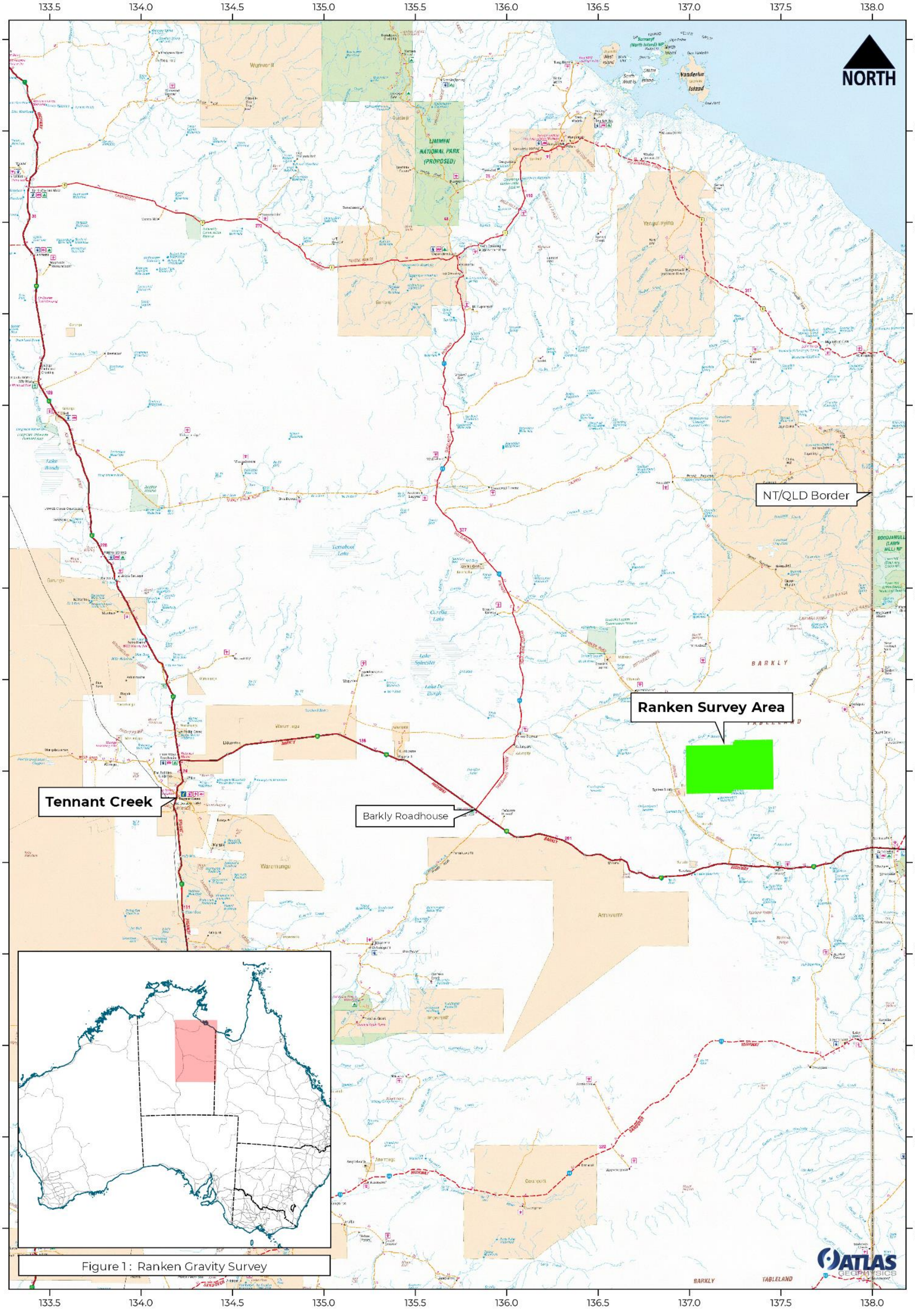


Figure 1 : Ranken Gravity Survey

2.0 Equipment and Instrumentation

The following instrumentation was used for acquisition of the gravity data:

- One CG-5 Autograv Gravity Meter
  - (Serial Number: 40382, SF: 1.000000)
- One CHCi70+ GNSS Rover Receiver
- One CHCi70+ GNSS Base Receiver

Ancillary equipment included:

- Laptop computer for data download and processing
- Garmin autonomous GPS receivers for navigation
- InReach personal satellite tracking units
- Iridium satellite phones for long distance communications
- Personal Protective Equipment for all personnel
- Batteries, battery chargers, solar cells, UPS System
- Survey consumables
- Tools, engineering, and maintenance equipment for vehicle servicing
- First aid and survival kits
- Tyres and recovery equipment

3.0 Calibration and Control

The gravity meter used for the survey had been recently calibrated on the Guildford Cemetery – Helena Valley Primary School calibration range (2010990117 - 2010990217) in Western Australia. The calibration process validated the gravity meter's scale factor to ensure reduction of the survey data produces correct Observed Gravities from measured dial reading values.

One new GNSS/gravity control station 202308100001 "Ranken" was used to control all field observations throughout the project.

GNSS control was established at 202308100001 by, submitting three 10-hour sessions of static data to Geoscience Australia's AUSPOS processing system, where possible, producing first-order geodetic coordinates. These coordinates are accurate to better than 10mm for the x, y, and z observables.

Gravity control was established at station 202308100001 via two ABA ties to existing Atlas Geophysics control stations 202108300002 "Alexandria Station". Standard deviation of the ties is 0.006mGal.

4.0 GNSS-Gravity Acquisition

Gravity data were acquired concurrently with GNSS data using one Scintrex CG-5 and gravity meter. Data were acquired in single shifts of up to 12 hours duration, with each shift consisting of a single loop controlled by observations at the gravity control station. Each loop contained a minimum of two repeated readings so that an interlocking network of closed loops was formed. A total of **38** repeat readings representing **3.63%** of the survey were acquired for quality control purposes. Repeat readings were evenly distributed, where possible, on a time-basis throughout each of the gravity loops.

GNSS data were acquired with the rover receiver operating in post-process kinematic (PPK) mode with the GNSS rover sensor mounted to the frame of the UTV. Static data were logged at the control station with a base receiver operating in post-process static (PPS) mode with the GNSS sensor mounted on a fixed tripod.

5.0 GNSS Processing and QC

The acquired GNSS raw data were processed daily using Novatel Waypoint GrafNav v8.90 post-processing software.

GrafNav was used to transform the GNSS-derived WGS84 coordinates to GDA94 coordinates for each gravity station location. MGA coordinates were then derived by projecting the GDA94 geodetic coordinates with a Universal Transverse Mercator (UTM) transform using the appropriate zone. It should be noted that WGS84 and GDA94 coordinates (x, y, and z) are no longer roughly equivalent, with a difference in horizontal coordinates of greater than 1.0m and a difference in elevation of 90-100mm. GrafNav produced GDA94 ellipsoidal heights for each gravity station location; and elevations above the Australian Height Datum (AHD) were modelled using the AUSGEOID09 geoid model, with separations (N values) added to GDA94 ellipsoidal heights.

The resulting GrafNav data (output in Atlas Geophysics standard format) were then imported into Atlas Geophysics Reduction and Interpretation Software (AGRIS) for QC and used in the reduction of the gravity data. A module built into AGRIS allows the user to examine data quality factors such as station repeatability between multiple control stations, coordinate velocity, dilution of precision, coordinate quality factor and standard error for each gravity station location. The procedure is carried out before merging the positional data with gravity data for final reduction to Bouguer Anomaly. Comprehensive statistics, repeatability analysis and histogram plotting are also performed.

QC procedures were applied to the GNSS data daily and any gravity stations not conforming to the quoted specifications were repeated by the company at no cost to the client.

6.0 Gravity Processing and QC

The acquired gravity data were processed using the company's in-house gravity pre-processing and reduction software, AGRIS. This software allows for full data pre-processing, reduction to Bouguer Anomaly, repeatability, and statistical analysis, as well as full quality control of the output dataset.

Once downloaded from the gravity meters, the data were analysed for consistency and preliminary QC was performed to confirm that observations meet specification for standard deviation, reading rejection, temperature, and tilt values. Once the data were verified the software averaged the multiple gravity readings and performed a merge with the previously QC-passed GNSS data. The software then applies a linear drift correction and earth tide correction. Any gravity stations not conforming to the quoted specifications were repeated by the company at no cost to the client.

The following corrections were further applied to the dataset to produce Spherical Cap Bouguer Anomalies on the GDA94 transform of the GRS80 ellipsoid and AAGD07 gravity datum. For legacy reasons, Geoidal Bouguer Anomalies on the Australian Height Datum (AHD) and ISOGAL84 gravity datum have also been calculated.

The formulae below produce data in μms^{-2} or gravity units (GU). To convert to mGal, divide by a factor of 10.

Instrument scale factor: This correction is used to correct a gravity reading (in dial units) to a relative gravity unit value based on the meter calibration.

$$r_c = 10 \cdot (r \cdot S(r))$$

where,

r_c corrected reading in gravity units

r gravity meter reading in dial units

$S(r)$ scale factor (dial units/milliGal)

Earth Tide Correction: The earth is subject to variations in gravity due to the gravitational attraction of the Sun and the Moon. These background variations can be corrected for using a predictive formula which utilises the gravity observation position and time of observation. The Scintrex CG-5/CG-6 gravity meter automatically calculates ETC but uses only an approximate position for the gravity observation so is not entirely accurate. For this reason, the Scintrex ETC is subtracted from the reading and a new correction calculated within AGRIS software.

$$r_t = r_c + g_{tide}$$

where,

r_t tide corrected reading in gravity units

r_c scale factor corrected reading in gravity units

g_{tide} Earth Tide Correction (ETC) in gravity units

Instrument Drift Correction: Since all gravity meters are mechanical, they are all prone to instrument drift. Drift can be caused by mechanical stresses and strains in the spring mechanism as the meter is moved, knocked, reset, subjected to temperature extremes, subjected to vibration, unclamped etc. The most common cause of instrument drift is due to extension of the sensor spring with changes in temperature (obeying Hooke's law). To calculate and correct for daily instrument drift, the difference between the gravity control station readings (closure error) is used to assume the drift and a linear correction is applied.

$$ID = \frac{r_{cs2} - r_{cs1}}{t_{cs2} - t_{cs1}}$$

where,

ID	Instrument Drift in gu/hour
r_{cs2}	control station 2nd reading in gravity units
r_{cs1}	control station 1st reading in gravity units
t_{cs2}	control station 2 time
t_{cs1}	control station 1 time

Observed Gravity: The preceding corrections are applied to the raw gravity reading to calculate the earth's absolute gravitational attraction at each gravity station. The corrections produced Observed Gravities on the AAGD07 and ISOGAL84 datums.

$$G_o = g_{cs1} + (r_t - r_{cs1}) - (t - t_{cs1}) \cdot ID$$

where,

G_o	Observed Gravity in gravity units (ISOGAL84 or AAGD07)
g_{cs1}	control station 1 known Observed Gravity in gravity units
r_t	tide corrected reading in gravity units
r_{cs1}	control station 1 reading in gravity units
t	reading time
t_{cs1}	control station 1 time
ID	instrument drift in gravity units/hour

Theoretical Gravity 1980: The theoretical (or normal) gravity value at each gravity station is calculated based on the assumption that the Earth is a homogeneous ellipsoid. The closed form of the 1980 International Gravity Formula is used to approximate the theoretical gravity at each station location and essentially produce a latitude correction. Gravity values vary with latitude as the earth is not a perfect sphere and the polar radius is much smaller than the equatorial radius. The effect of centrifugal acceleration is also different at the poles versus the equator.

$$G_{t80} = 9780326.7715((1 + 0.001931851353(sin^2 l)/(SQRT(1 - 0.0066943800229(sin^2 l)))$$

where,

G_{t80}	Theoretical Gravity 1980 in gravity units
l	GDA94 latitude at the gravity station in decimal degrees

Theoretical Gravity 1967: The theoretical (or normal) gravity value at each gravity station is calculated based on the assumption that the Earth is a homogeneous ellipsoid. The 1967 variant of the International Gravity Formula is used to approximate the theoretical gravity at each station location and essentially produce a latitude correction. Gravity values vary with latitude as the earth is not a perfect sphere and the polar radius is much smaller than the equatorial radius. The effect of centrifugal acceleration is also different at the poles versus the equator.

$$G_{t67} = (9780318.456 \cdot \left(1 + 0.005278895 \cdot sin^2(l) + 0.000023462 \cdot sin^4(l)\right))$$

where,
G_{t67} Theoretical Gravity 1967 in gravity units
l GDA94 latitude at the gravity station in decimal degrees

Atmospheric Correction: The gravity effect of the atmosphere above the ellipsoid can be calculated with an atmospheric model and is subtracted from the theoretical gravity.

$$AC = 8.74 - 0.00099 \cdot h + 0.0000000356 \cdot h^2$$

where,
AC Atmospheric Correction in gravity units
h elevation above the GDA94 transformed GRS80 ellipsoid in metres

Ellipsoidal Free Air Correction: Since the gravity field varies inversely with the square of distance, it is necessary to correct for elevation changes from the reference ellipsoid (GDA94 transformed GRS80). Gravitational attraction decreases as the elevation above the reference ellipsoid increases.

$$EFAC = -(3.087691 - 0.004398\ sin^2 l) \cdot h + 7.2125 \cdot 10^{-7} \cdot h^2$$

where,
$EFAC$ Ellipsoidal Free Air Correction in gravity units
l GDA94 latitude at the gravity station in decimal degrees
h elevation above the GDA94 transformed GRS80 ellipsoid in metres

Geoidal Free Air Correction: Since the gravity field varies inversely with the square of distance, it is necessary to correct for elevation changes from the reference geoid (AHD). Gravitational attraction decreases as the elevation above the reference geoid increases.

$$GFAC = \left(3.08768 - 0.00440 sin^2(l)\right) \cdot h - 0.000001442 \cdot h^2$$

where,
$GFAC$ Free Air Correction in gravity units
l GDA94 latitude at the gravity station in decimal degrees
h elevation above the reference geoid (AHD) in metres

Spherical Cap Bouguer Correction: If a gravity observation is made above the reference ellipsoid, the effect of rock material between the observation and the ellipsoid must be considered. The mass of rock makes a positive contribution to the gravity value. The correction is calculated using the closed form equation for the gravity effect of a spherical cap of radius 166.7km, based on a spherical Earth with a mean radius of 6,371.0087714km, height relative the ellipsoid and rock densities of 2.67, 2.40 and 2.20 tm^{-3} (gm/cc).

$$SCBC = 2\pi G\rho((1+\mu)\cdot h - \lambda R)$$

where,
$SCBC$ Spherical Cap Bouguer Correction in gravity units
G gravitational constant = $6.67428 \cdot 10^{-11} m^3 kg^{-1} s^{-2}$
ρ rock density (2.67, 2.40 and 2.20 tm^{-3})
h elevation above the GDA94 transformed GRS80 ellipsoid in metres
R $(R_o + h)$ the radius of the earth at the station
R_o mean radius of the earth = 6,371.0087714 km (on the GDA94 transformed GRS80 ellipsoid)
μ & λ are dimensionless coefficients defined by:

$$\mu = ((1/3)\cdot \eta^2 - \eta)$$

where,
η h/R

$$\lambda = (1/3)\{(d + f\delta + \delta^2)[(f-\delta)^2 + k]^{\frac{1}{2}} + p + m\cdot ln(n/(f - \delta + [(f-\delta)^2 + k]^{\frac{1}{2}})\}$$

where,
d $3\cdot cos^2\alpha - 2$
f $cos\alpha$
k $sin^2\alpha$
p $-6\cdot cos^2\alpha \cdot \sin(\alpha/2) + 4\cdot sin^3(\alpha/2)$
δ (R_o/R)
m $-3\cdot k \cdot f$
n $2\cdot[sin\,(\alpha/2) - sin^2(\alpha/2)]$
α S/R_o with S = Bullard B Surface radius = 166.735 km

Geoidal Bouguer Correction: If a gravity observation is made above the reference geoid, the effect of rock material between the observation and the ellipsoid must be considered. The mass of rock makes a positive contribution to the gravity value. The slab of rock makes a positive contribution to the gravity value. Rock densities of 2.67, 2.40 and 2.20 t/m^{-3} (gm/cc) were used in the correction.

$$GBC = 0.4191\cdot\rho\cdot h$$

where,
GBC Geoidal Bouguer Correction in gravity units
ρ rock density (2.67, 2.40 and 2.20 tm^{-3})
h elevation above the reference geoid (AHD) in m

Ellipsoidal Free Air Anomaly: The Ellipsoidal Free Air Anomaly is the difference between the observed gravity and theoretical gravity that has been computed for latitude and corrected for the elevation of the gravity station above or below the reference ellipsoid.

$$EFAA = G_{oAAGD07} - (G_{t80} - AC) - EFAC$$

where,
$EFAA$ Ellipsoidal Free Air Anomaly in gravity units
G_o Observed Gravity on the AAGD07 datum in gravity units
G_{t80} Theoretical Gravity 1980 in gravity units
AC Atmospheric Correction in gravity units
$EFAC$ Ellipsoidal Free Air Correction in gravity units

Geoidal Free Air Anomaly: The Geoidal Free Air Anomaly is the difference between the observed gravity and theoretical gravity that has been computed for latitude and corrected for the elevation of the gravity station above or below the reference geoid.

$$GFAA = G_{oISOGAL84} - G_{t67} + GFAC$$

where,
$GFAA$ Free Air Anomaly in gravity units
G_o Observed Gravity on the ISOGAL84 datum in gravity units
G_{t67} Theoretical Gravity 1967 in gravity units
$GFAC$ Geoidal Free Air Correction in gravity units

Spherical Cap Bouguer Anomaly: The Spherical Cap Bouguer Anomaly is computed from the Ellipsoidal Free Air Anomaly above by removing the attraction of the spherical cap calculated by the Spherical Cap Bouguer Correction.

$$SCBA = EFAA - SCBC$$

where,
$SCBA$ Spherical Cap Bouguer Anomaly in gravity units
$EFAA$ Ellipsoidal Free Air Anomaly in gravity units
$SCBC$ Bouguer Correction in gravity units

Geoidal Bouguer Anomaly: The Geoidal Bouguer Anomaly is computed from the Geoidal Free Air Anomaly above by removing the attraction of the slab calculated by the Geoidal Bouguer Correction.

$$GBA = GFAA - GBC$$

where,
GBA Geoidal Bouguer Anomaly in gravity units
$GFAA$ Geoidal Free Air Anomaly in gravity units
GBC Geoidal Bouguer Correction in gravity units

7.0 Gravity Results

The gravity survey was completed in **14** days of acquisition. An average acquisition rate of around **75** stations per day of production was achieved for the survey. The survey progressed well without and issues.

Final data have met and exceeded quoted project specifications. Repeatability of the data was excellent, with the standard deviation of the elevation repeats at **0.017m** and the standard deviation of the gravity repeats at **0.009mGal**. The production report contains summary statistics and histograms for repeatability.

8.0 Data Formats and Deliverables

Final reduced ASCII data for the project have been delivered in ASEG-GDF2 and standard Atlas format. Table 2 overleaf details the format of the final gravity database supplied. All fields are comma delimited.

Appendix A contains a plot of final station locations, images of GNSS Derived Elevation (GDA94 transformed GRS80), Spherical Cap Bouguer Anomaly and first vertical derivative of Spherical Cap Bouguer Anomaly.

All data, both raw and processed, have been supplied with this memorandum using a cloud-based service. Table 1 below summarises the deliverables. Should the reader require further copies of the deliverables, please contact Atlas Perth Operations.

Final Delivered Data	Format	Data
Gravity Database	Comma Space Delimited .csv	·
Gravity Database	Point located data ASEG-GDF2	·
Raw Positional Data	AGRIS format, comma delimited	·
Raw Gravity Data	Scintrex CG-5 format	·
Final Grids	ER Mapper Grids .ers	·
Final Images	GIS compatible Geotiff .tif	·
Acquisition Memo	PDF .pdf	·

Table 1: Final Deliverables

Field Header	Field Description	Format	Units
PROJECT	Atlas Geophysics Project Number	A9	None
STATION	Unique Station ID	I8	None
STATIONCODE	Unique Station Code	A13	None
LINE	Line ID	I8	None
TYPE	Observation Type : Base, Field or Repeat	A8	None
EASTING	Coordinate Easting UTM projection of the Geographic coordinates	F11.3	M
NORTHING	Coordinate Northing UTM projection of the Geographic coordinates	F12.3	M
ZONE	UTM Zone Number	F8.0	NA
LATITUDE	Coordinate Latitude (Refer DATUM column for Geographic Datum)	F15.10	DD
LONGITUDE	Coordinate Longitude (Refer DATUM column for Geographic Datum)	F15.10	DD
ORTHOHTM	Coordinate Elevation Orthometric (Refer GEOID column for Geoid used)	F9.3	M
ELLIPHTM	Coordinate Elevation Ellipsoidal	F9.3	M
N	Geoid Separation (Refer GEOID column for Geoid used)	F8.3	M
DATE	Observation Date	I8	None
TIME	Observation Time	I8	None
DIALMGAL	Gravity Dial Reading	F9.3	mGal
ETCMGAL	Earth Tide Correction (Longman)	F8.3	mGal
SCALE	Scale Factor Applied to Dial Reading	F9.6	None
OBSG84MGAL	Observed Gravity ISOGAL84	F11.3	mGal
OBSG84GU	Observed Gravity ISOGAL84	F11.2	Gu
OBSGAAGD07GU	Observed Gravity AAGD07	F13.2	Gu
OBSGAAGD07MGAL	Observed Gravity AAGD07	F16.3	mGal
DRIFTMGAL	Drift Applied to Dial Readings	F10.3	mGal
TGRAV67GU	Theoretical Gravity 1967	F11.2	Gu
TGRAV67MGAL	Theoretical Gravity 1967	F12.3	mGal
TGRAV80GU	Theoretical Gravity 1980	F11.2	Gu
GFACGU	Geoidal Free Air Correction	F8.2	Gu
GFACMGAL	Geoidal Free Air Correction	F9.3	mGal
GFAAGU	Geoidal Free Air Anomaly	F8.2	Gu
GFAAMGAL	Geoidal Free Air Anomaly	F9.3	mGal
GBC267GU	Geoidal Bouguer Correction 2.67 tm^-3	F9.2	Gu
GBC240GU	Geoidal Bouguer Correction 2.40 tm^-3	F9.2	Gu
GBC220GU	Geoidal Bouguer Correction 2.20 tm^-3	F9.2	Gu
GBC267MGAL	Geoidal Bouguer Correction 2.67 tm^-3	F11.3	mGal
GBC240MGAL	Geoidal Bouguer Correction 2.40 tm^-3	F11.3	mGal
GBC220MGAL	Geoidal Bouguer Correction 2.20 tm^-3	F11.3	mGal
GBA267GU	Geoidal Bouguer Anomaly 2.67 tm^-3	F9.2	gu
GBA240GU	Geoidal Bouguer Anomaly 2.40 tm^-3	F9.2	gu
GBA220GU	Geoidal Bouguer Anomaly 2.20 tm^-3	F9.2	gu
GBA267MGAL	Geoidal Bouguer Anomaly 2.67 tm^-3	F11.3	mGal
GBA240MGAL	Geoidal Bouguer Anomaly 2.40 tm^-3	F11.3	mGal
GBA160MGAL	Geoidal Bouguer Anomaly 1.60 tm^-3	F11.3	mGal
TGRAV80ACGU	Theoretical Gravity 1980 Atmospheric Corrected	F11.2	gu
EFACGU	Ellipsoidal Free Air Correction	F9.2	gu
EFAAGU	Ellipsoidal Free Air Anomaly	F8.2	gu
SCBC267GU	Spherical Cap Bouguer Correction 2.67 tm^-3	F10.2	gu
SCBC240GU	Spherical Cap Bouguer Correction 2.40 tm^-3	F10.2	gu
SCBC220GU	Spherical Cap Bouguer Correction 2.20 tm^-3	F10.2	gu
SCBA267GU	Spherical Cap Bouguer Anomaly 2.67 tm^-3	F10.2	gu
SCBA240GU	Spherical Cap Bouguer Anomaly 2.40 tm^-3	F10.2	gu
SCBA160GU	Spherical Cap Bouguer Anomaly 1.60 tm^-3	F10.2	gu
SCBA267MGAL	Spherical Cap Bouguer Anomaly 2.67 tm^-3	F12.3	mGal
SCBA240MGAL	Spherical Cap Bouguer Anomaly 2.40 tm^-3	F12.3	mGal
SCBA160MGAL	Spherical Cap Bouguer Anomaly 1.60 tm^-3	F12.3	mGal
TCINNERGU	Inner Terrain Correction	F8.2	gu
TCINNERMGAL	Inner Terrain Correction	F8.3	mGal
QFINNER	Quality Factor Inner TC	I2	None
TCOUTERGU	Outer Terrain Correction	F8.2	gu
TCOUTERMGAL	Outer Terrain Correction	F8.3	mGal
QFOUTER	Quality Factor Outer TC	F2	None
TCTOTALGU	Total Terrain Correction	F8.2	gu
TCTOTALMGAL	Total Terrain Correction	F8.3	mGal
CGBA267GU	Complete Geoidal Bouguer Anomaly 2.67 tm^-3	F11.3	gu
CGBA267MGAL	Complete Geoidal Bouguer Anomaly 2.67 tm^-3	F11.3	mGal
CSCBA267GU	Complete Spherical Cap Bouguer Anomaly 2.67 tm^-3	F12.2	gu
CSCBA267MGAL	Complete Spherical Cap Bouguer Anomaly 2.67 tm^-3	F12.2	mGal
DIFFEASTM	Repeat Error for Easting Observation	F8.3	m
DIFFNORTHM	Repeat Error for Northing Observation	F8.3	m
DIFFHTM	Repeat Error for Elevation Observation	F8.3	m
DIFFOBSGMGAL	Repeat Error for Observed Gravity	F8.3	mGal
DIFFOBSGGU	Repeat Error for Observed Gravity	F8.2	gu
METERSN	Serial Number of Gravity Instrument	I8	None
CLOSUREGU	Loop Closure in gu	F8.2	gu
CLOSUREMGAL	Loop Closure in mGal	F8.3	mGal
HDIFF	Horizontal Difference between Acquired and Proposed Station	F7.3	m
GRVBASE	Gravity Base	A11	None
GNSSBASE	GNSS Base	A11	None
DATUM	Geographic Datum	A10	None
GEOID	Geoid Model	A10	None
GRAVDATUM	Gravity Datum	A10	None

Table 2: Final Gravity Database Format

9.0 Project Safety

Prior to survey commencement, a Hazard Identification and Risk Assessment (HIRA) was carried out for all new tasks not covered under Atlas Geophysics Standard Operating Procedures (SOP's) or the company's Health Safety Environment (HSE) field manual.

APPENDIX A
Control Station Descriptions

202308100001 – Ranken

GEODETIC COORDS GDA94		GRID COORDINATES MGA Z51	
Latitude (DD MM SS)	19° 28' 26.89327"S	***Easting***	732,621.243
Longitude (DD MM SS)	137° 12' 57.96389"E	***Northing***	7,845,208.674
Ellipsoidal Height	295.009	***Orthometric Height (AUSGEOID09)***	255.296

OBSERVED GRAVITY		Established: 20/05/2023
gu AAGD07	9785480.12	

Occupation Method/Location Details

The GNSS control point consists of a steel star picket driven into the ground to a height of 15cm above ground level. This control station is witnessed by a star picket with a plaque. The gravity control point is located within 0.5m of the small picket.

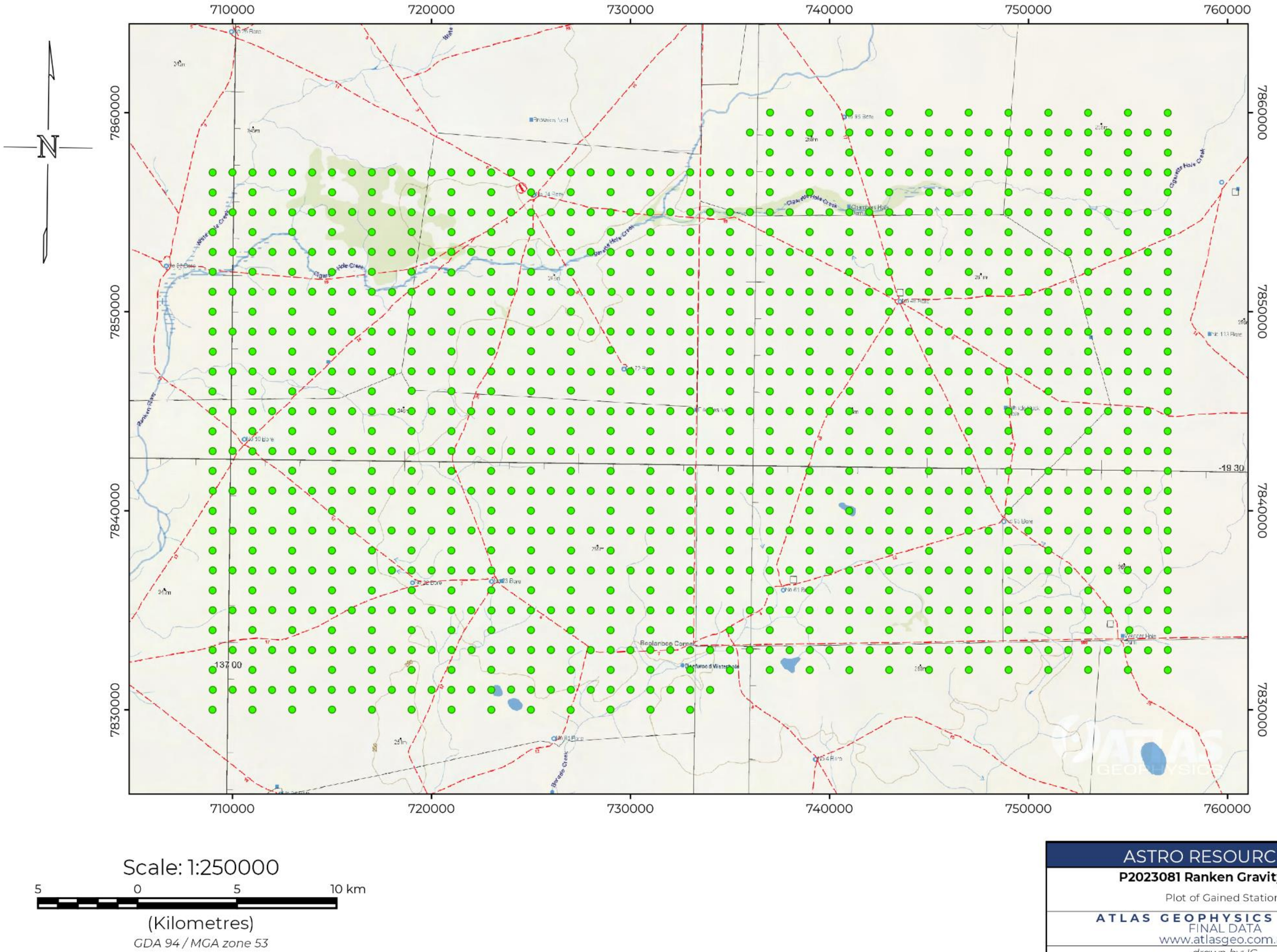
Gravity Control was established via two ABA ties to existing Atlas Geophysics control station 202108300002 “Alexandria Station”. Standard deviation of the ties is 0.006mGal.

GNSS Control was established by submitting three 10-hour sessions of static data to Geoscience Australia’s AUSPOS processing system, producing first-order geodetic coordinates. These coordinates are accurate to better than 10mm for the x, y, and z observables.

The control station can be reached by travelling east from Barkley homestead for 260km then turning left on to Ranken Road. Follow Ranken Road for 60km and the control station will be 500m directly west of the dam.

Photograph of Control Station 202308100001 and surrounds

APPENDIX B
Plots and Imagery



ASTRO RESOURCES NL

P2023081 Ranken Gravity Survey

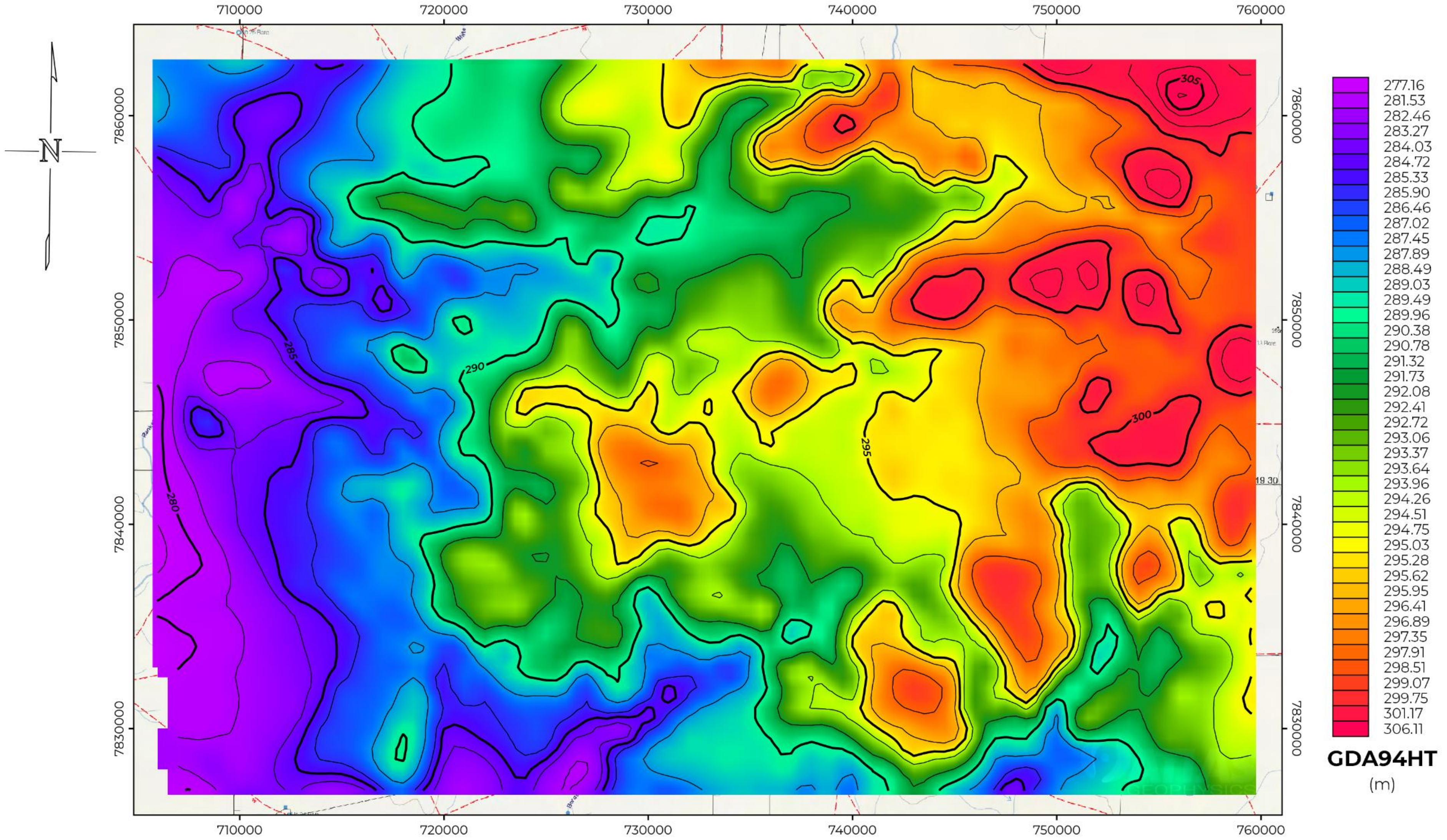
Plot of Gained Stations

ATLAS GEOPHYSICS PTY LTD

FINAL DATA

www.atlasgeo.com.au

drawn by: IC



Scale: 1:250000

5 0 5 10 km

(Kilometres)

GDA 94 / MGA zone 53

ASTRO RESOURCES NL

P2023081 Ranken Gravity Survey

Pseudocoloured Image of GNSS Derived Elevation (GDA94HT)

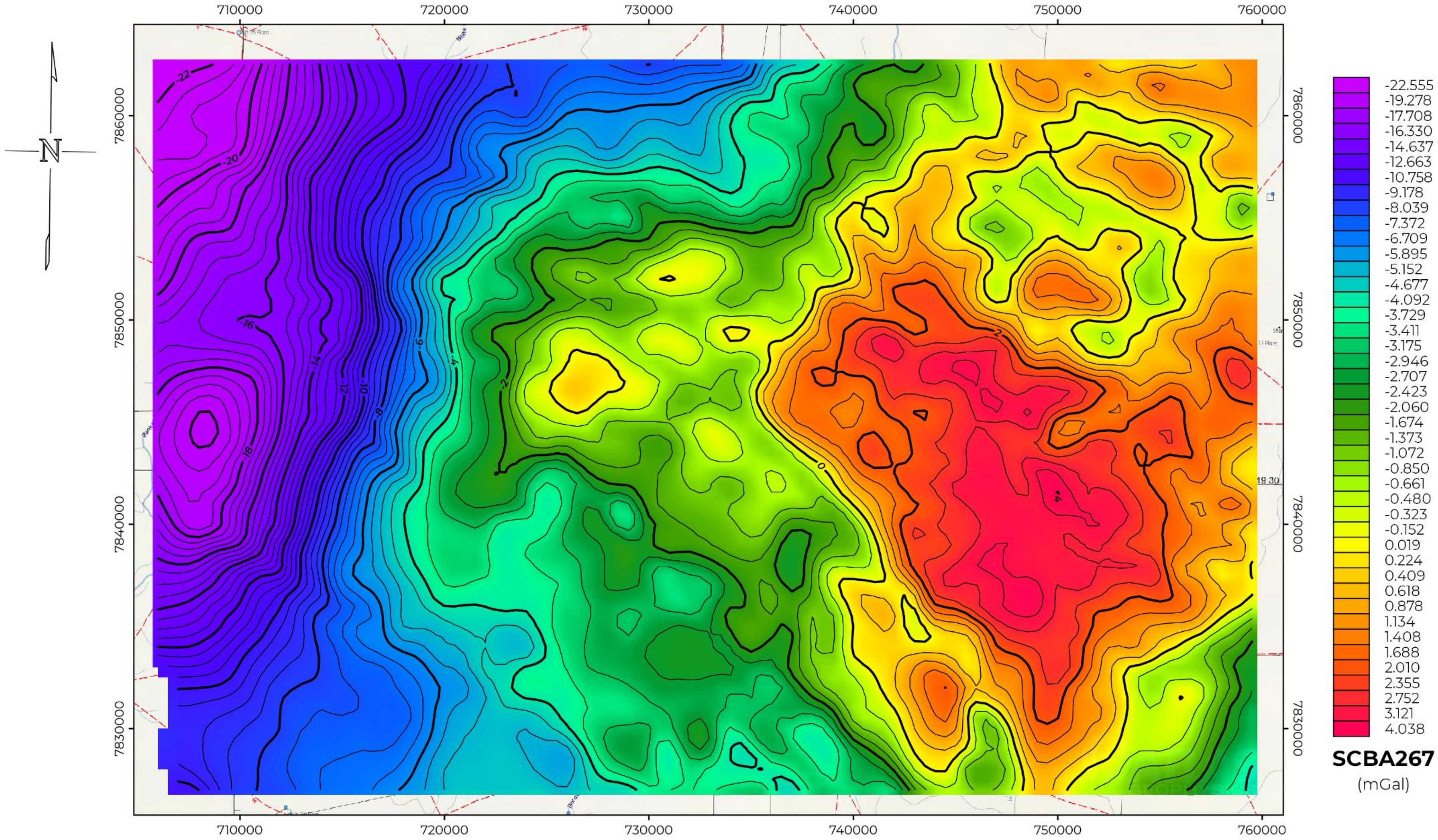
Shade = None, Contours = 2.00m, Histo = Equalised

ATLAS GEOPHYSICS PTY LTD

FINAL DATA

www.atlasgeo.com.au

drawn by: IC



Scale: 1:250000

5 0 5 10 km

(Kilometres)

GDA 94 / MGA zone 53

ASTRO RESOURCES NL

P2023081 Ranken Gravity Survey

Pseudocoloured Image of SC Bouguer Anomaly (2.67gm/cc)

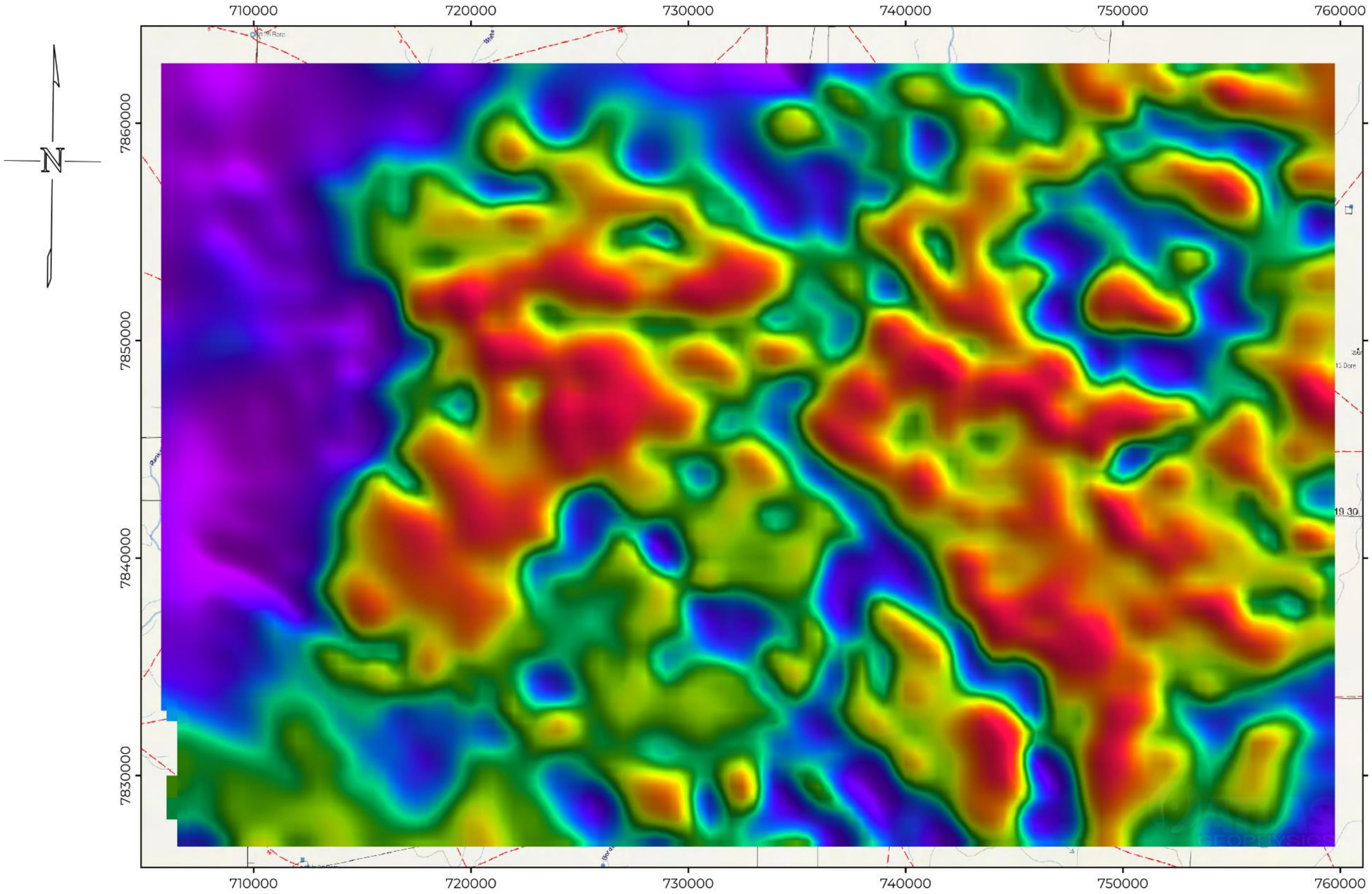
Shade = None, Contours = 0.50mGal, Histo = Equalised

ATLAS GEOPHYSICS PTY LTD

FINAL DATA

www.atlasgeo.com.au

drawn by: IC



-0.0024
-0.0016
-0.0012
-0.0009
-0.0008
-0.0006
-0.0004
-0.0003
-0.0003
-0.0002
-0.0001
-0.0001
-0.0000
0.0000
0.0001
0.0001
0.0001
0.0002
0.0002
0.0002
0.0003
0.0003
0.0003
0.0004
0.0004
0.0004
0.0004
0.0005
0.0005
0.0005
0.0006
0.0006
0.0006
0.0007
0.0007
0.0008
0.0008
0.0009
0.0009
0.0010
0.0011
0.0012
0.0016

1VD

Scale: 1:250000

5 0 5 10 km

(Kilometres)

GDA 94 / MGA zone 53

ASTRO RESOURCES NL

P2023081 Ranken Gravity Survey

Pseudocoloured Image of 1VD of SC Bouguer Anomaly (2.67gm/cc)

Shade = NE, Contours = None, Histo = Equalised

ATLAS GEOPHYSICS PTY LTD

FINAL DATA

www.atlasgeo.com.au

drawn by: IC

APPENDIX C
GNSS Control Information

202308100001 Ranken
0001 -19 28 26.89328 137 12 57.96385 295.005 255.292 GDA94
0001 -19 28 26.89323 137 12 57.96393 295.013 255.300 GDA94
0001 -19 28 26.89327 137 12 57.96393 295.008 255.295 GDA94

GDA94AVE
-19 28 26.89327
137 12 57.96389

-19.47413702
137.21610108

GDA94HT
295.009

AHDHT
255.296

N
39.713

MGA53
732621.243
7845208.674

AMG53
732493.087
7845038.252

Atlas Geophysics Memorandum M2023081

Ranken Seismic Survey

ASTRO RESOURCES NL

Memo completed by:

Richard Allpike
Geophysicist

T 08 6278 2898
PO BOX 1049
MORLEY WA 6943
AUSTRALIA

info@atlasgeo.com.au

ABN 68 123 110 243

12th June 2023

TABLE OF CONTENTS

APPENDICES

1.0 Project Brief

Project P2023081 involved the acquisition and processing of **282** new passive seismic stations for Astro Resources NL over 10 traverses between 170km and 340km east of Tennant Creek in the Northern Territory of Australia (Figure 1).

Atlas Geophysics completed the acquisition of the dataset with one crew utilising UTV-borne passive seismic methods.

Acquisition commenced on the 21st of May 2023 and was completed on the 8th of June 2023. Final data was delivered shortly after project completion.

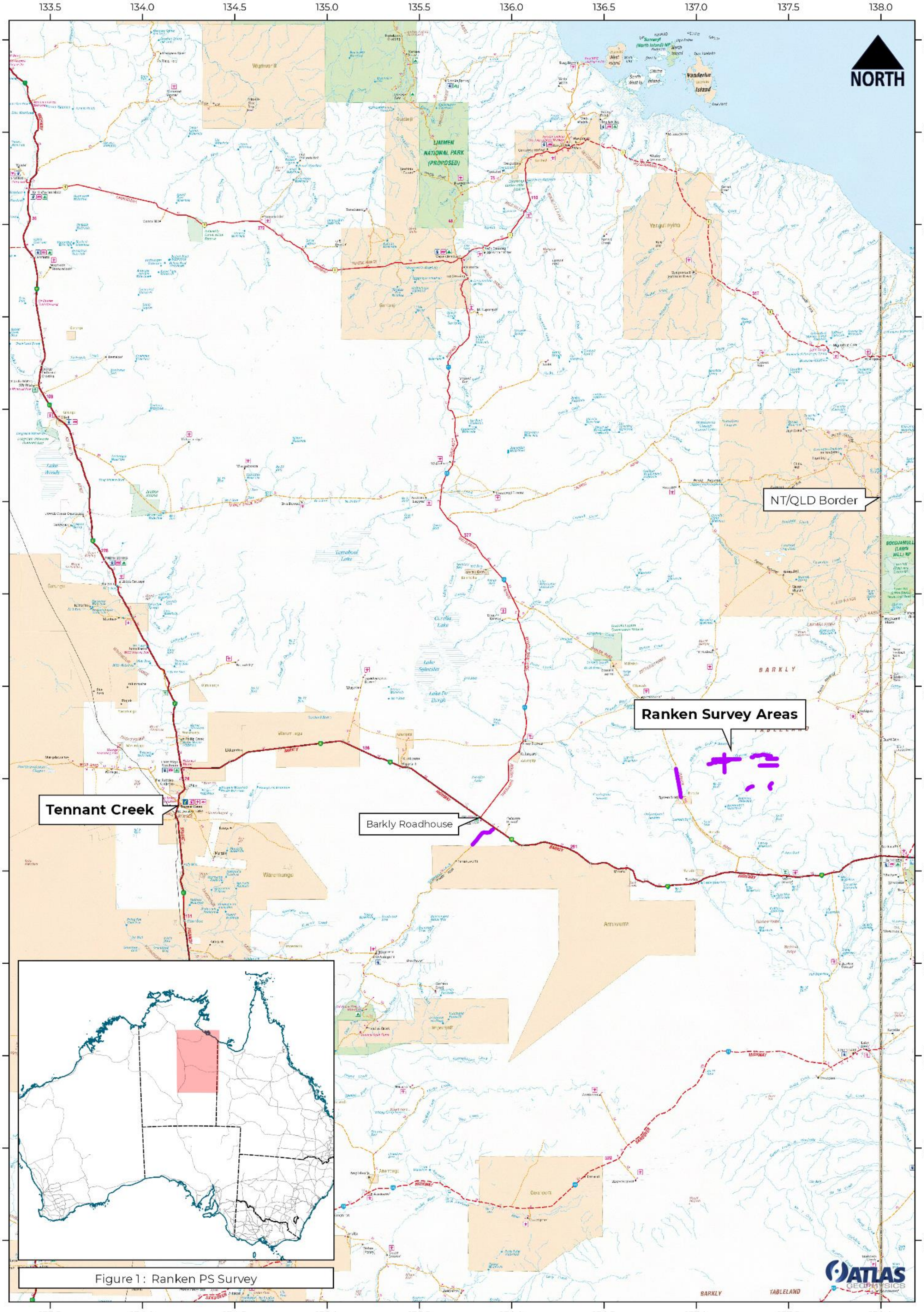


Figure 1: Ranken PS Survey

2.0 Passive Seismic Acquisition

The following instrumentation was used for acquisition of the passive seismic data:

- Eight MoHO Tromino units

Ancillary equipment included:

- Laptop computer for data download and processing
- Garmin autonomous GPS receiver for navigation
- InReach personal satellite tracking unit
- Iridium satellite phone for communications
- Personal Protective Equipment for all personnel
- Batteries, battery chargers, solar cells, UPS System
- Survey consumables
- Tools, engineering, and maintenance equipment for vehicle servicing
- First aid and survival kits
- Tyres and recovery equipment

Tromino units were set to acquire data for 20 minutes per station. Data were acquired in a single shift of 10 hours duration. An autonomous GPS unit was used to navigate to each station.

3.0 Passive Seismic Processing and QC

The acquired raw Tromino data was downloaded in the field at the end of each shift using the Grilla 9.8.5 software package. Frequency domain data was exported from Grilla and parsed into an Atlas Geophysics software package, Toasta, for QC and H/V peak determination. Images and csv files were generated and used for profiling and grid generation. Depth to peak can be determined using a known average shear-wave velocity or known depth to H/V frequency ratio, using the relationship; Vs = d(4f).

4.0 Passive Seismic Results

The **282** passive seismic stations were acquired in **10** days of acquisition. An average acquisition rate of around **28** stations per day was achieved. The survey progressed well with some minor delays due to mechanical issues.

5.0 Data Formats and Deliverables

Final reduced ASCII passive seismic data for the project have been delivered in standard Atlas format. Table 2 details the format of the final passive seismic database. All fields are comma delimited.

All data, both raw and processed, have been supplied with this memorandum using a cloud-based service. Table 1 below summarises the deliverables. Should the reader require further copies of the deliverables, please contact Atlas Perth Operations.

Final Delivered Data	Format	Data
Passive Seismic Database	Comma Space Delimited .csv	•
Raw Passive Seismic Data	Tromino Binary Format	•
Passive Seismic HVSR Profiles	Portable Network Graphic .png	•
Acquisition Memo	PDF .pdf	•

Table 1: Final Deliverables

Field Header	Field Description	Units
SITE	GRILLA Site Field ID	None
STATION	Unique Station ID	None
LINE	Line ID	None
EASTING	Coordinate Easting	M
NORTHING	Coordinate Northing	M
ZONE	Zone Number	NA
LATITUDE	GPS Derived Latitude	DD
LONGITUDE	GPS Derived Longitude	DD
ORTHOHTM	Coordinate Elevation Geoidal	M
ELLIPSHTM	Coordinate Elevation Ellipsoidal	M
N	Geoid Separation	M
DATE	Observation Date	None
START_TIME	Observation Start Time	None
STOP_TIME	Observation Finish Time	None
TRACE_LENGTH	Length of Observation time	Mins
HVSR	Frequency of the Main H/V Peak	Hz
Vs	S-Wave Velocity of the first peak (if used)	m/s
PSEUDO_DEPTH	Depth of first peak using Vs=d(4f) (if used)	m
RL	AHD Height of Interpreted Feature	m
SATS	Number of Satellites	None
HDOP	Horizontal Dilution of Precision	None
INSTRUMENT	Instrument ID	None
SAMPLE_RATE	Sampling Rate	Hz

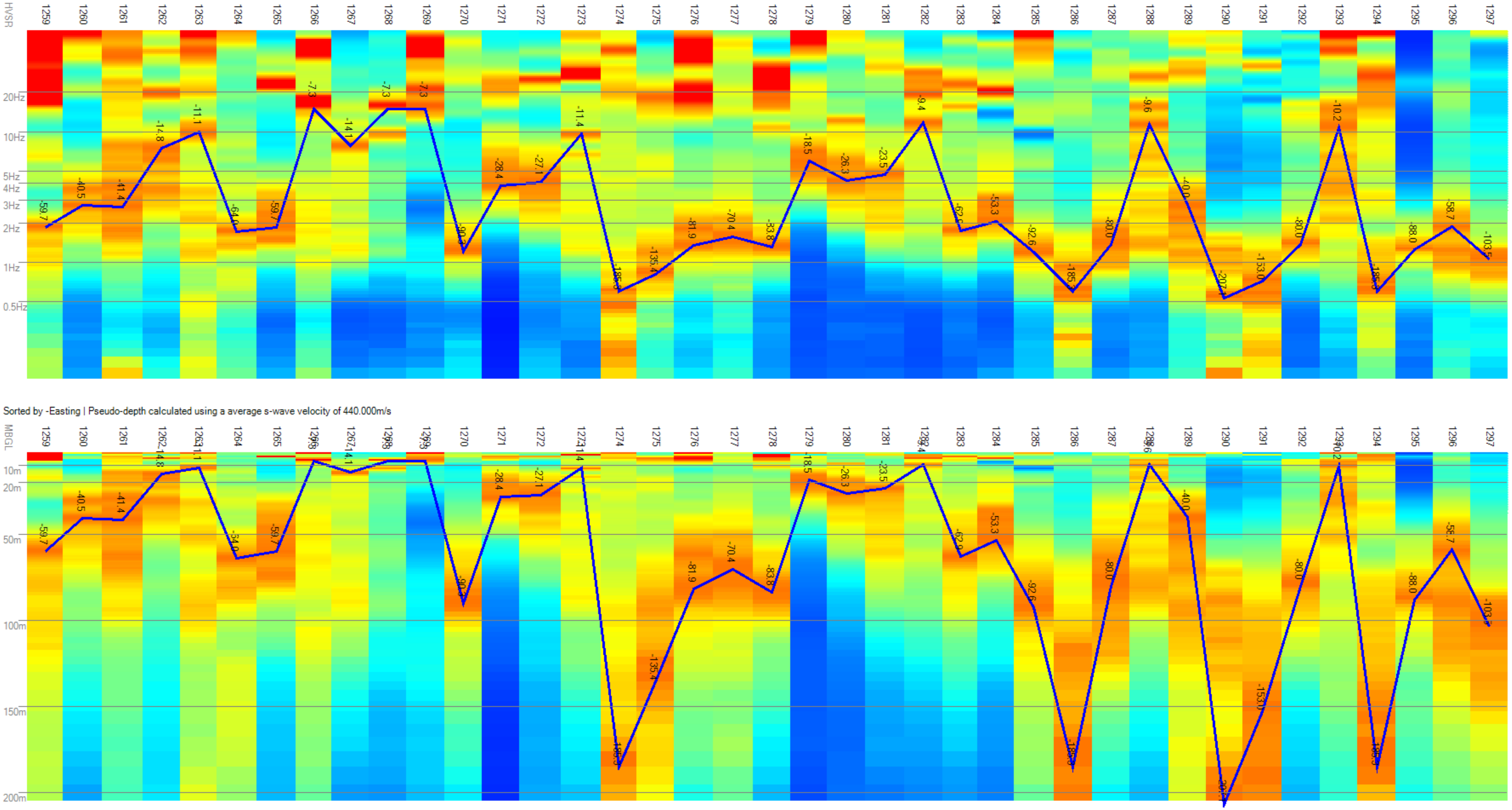
Table 2: Final Passive Seismic Database Format

6.0 Project Safety

Prior to survey commencement, a Hazard Identification and Risk Assessment (HIRA) was carried out for all new tasks not covered under Atlas Geophysics Standard Operating Procedures (SOP's) or the company's Health Safety Environment (HSE) field manual.

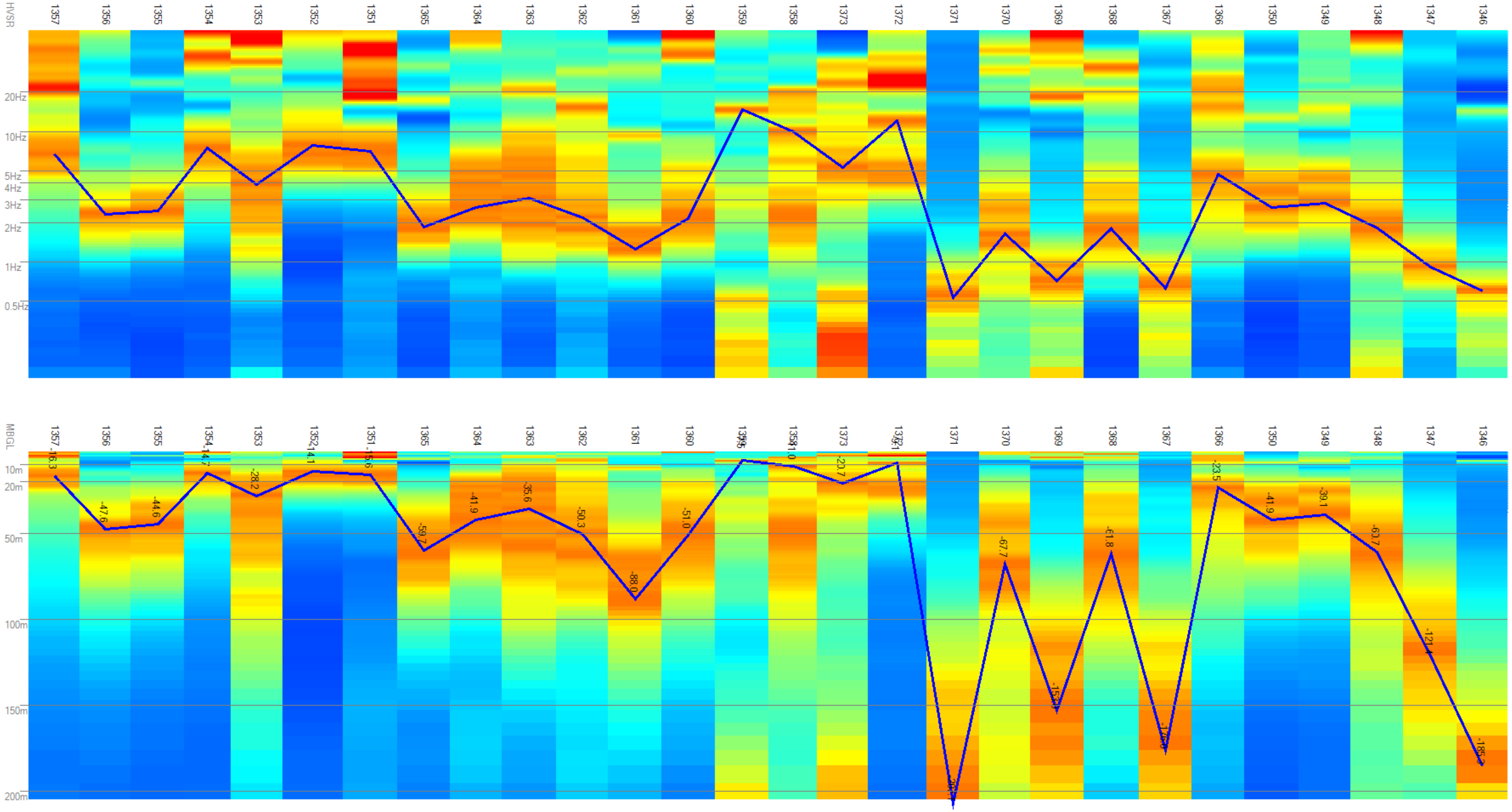
APPENDIX A
Plots and Imagery

Line 04



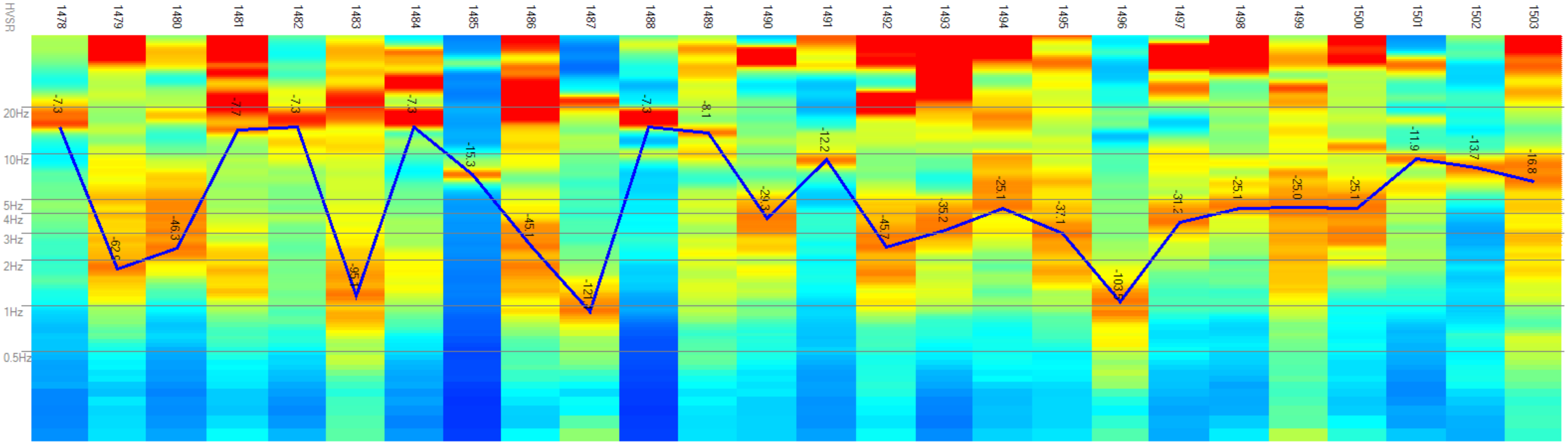
Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Line 06

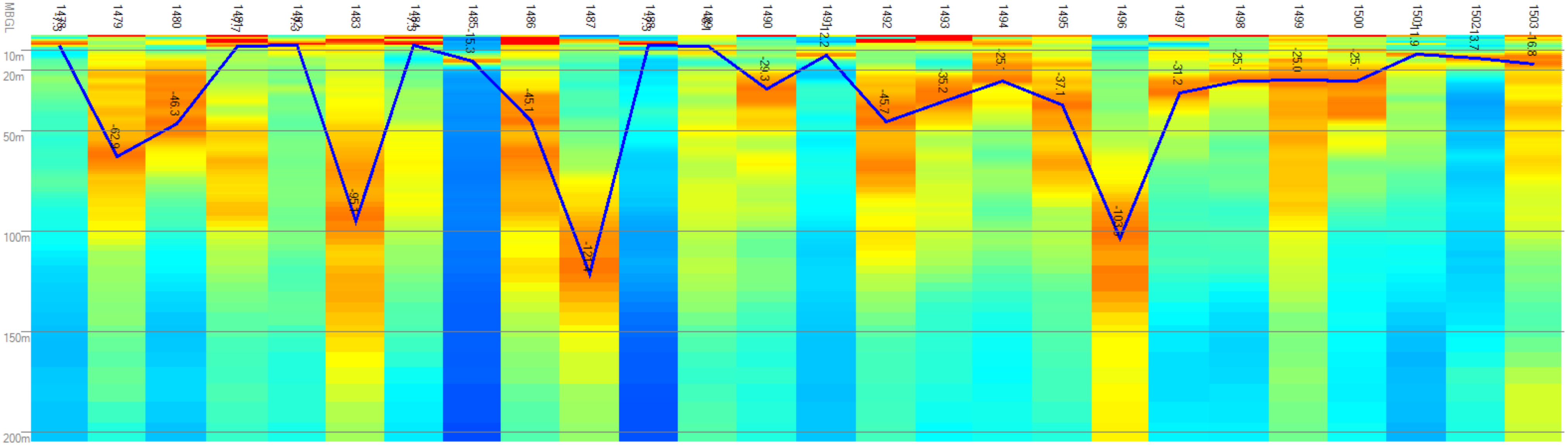


Sorted by -Northing | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Line 11

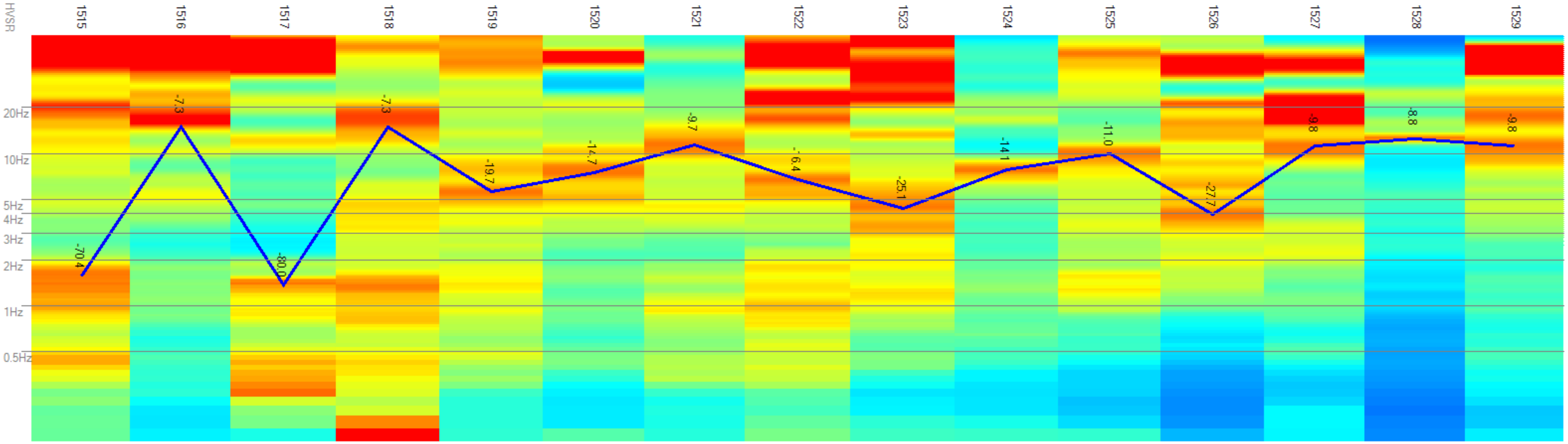


Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

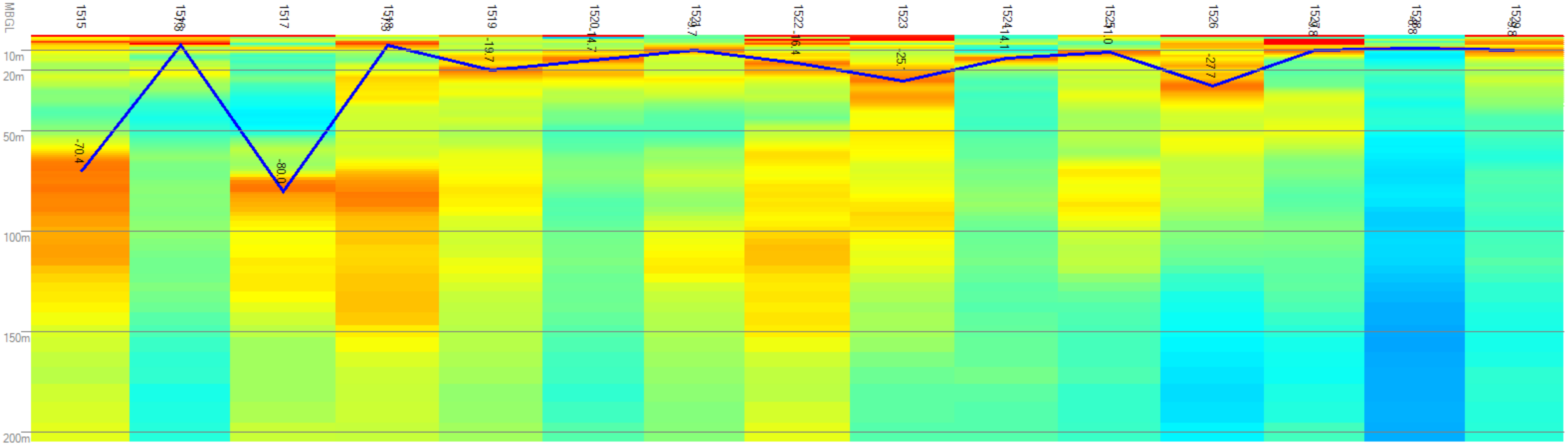


Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Line 12

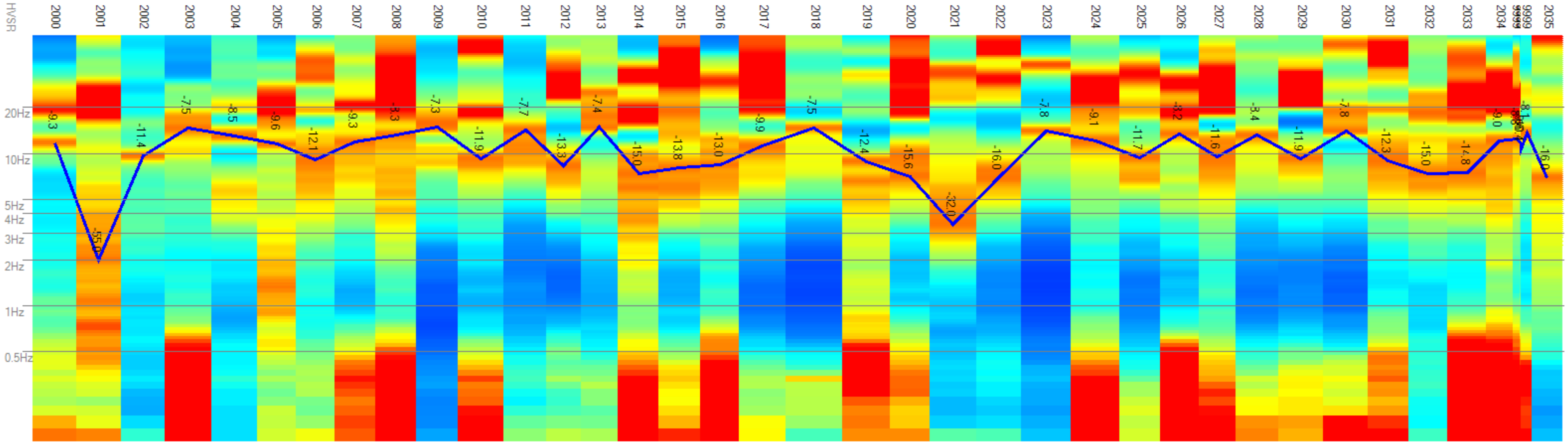


Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

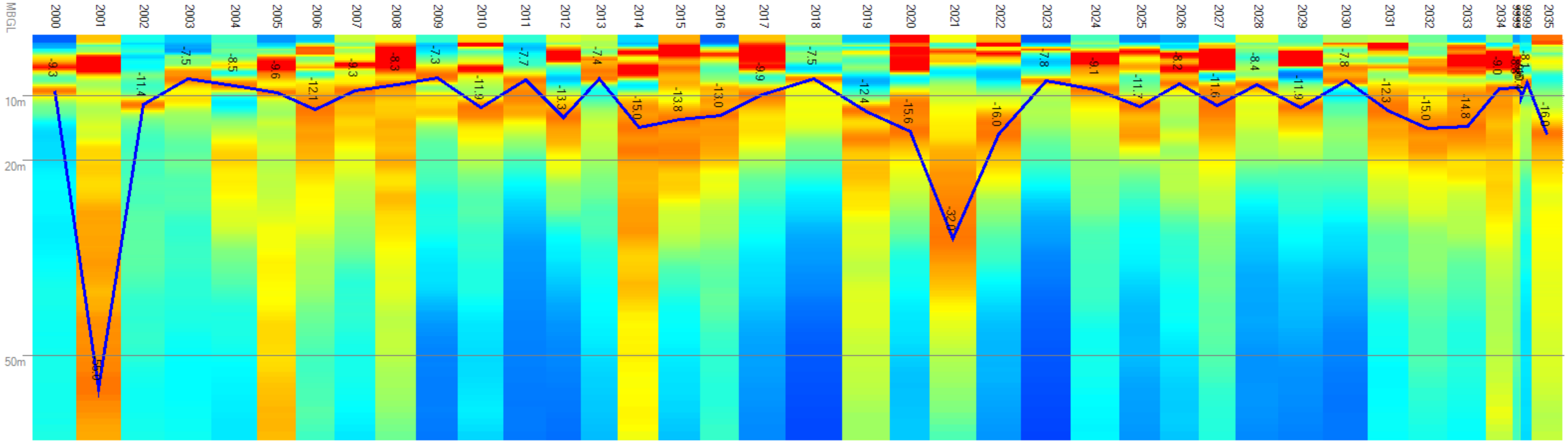


Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Line 20

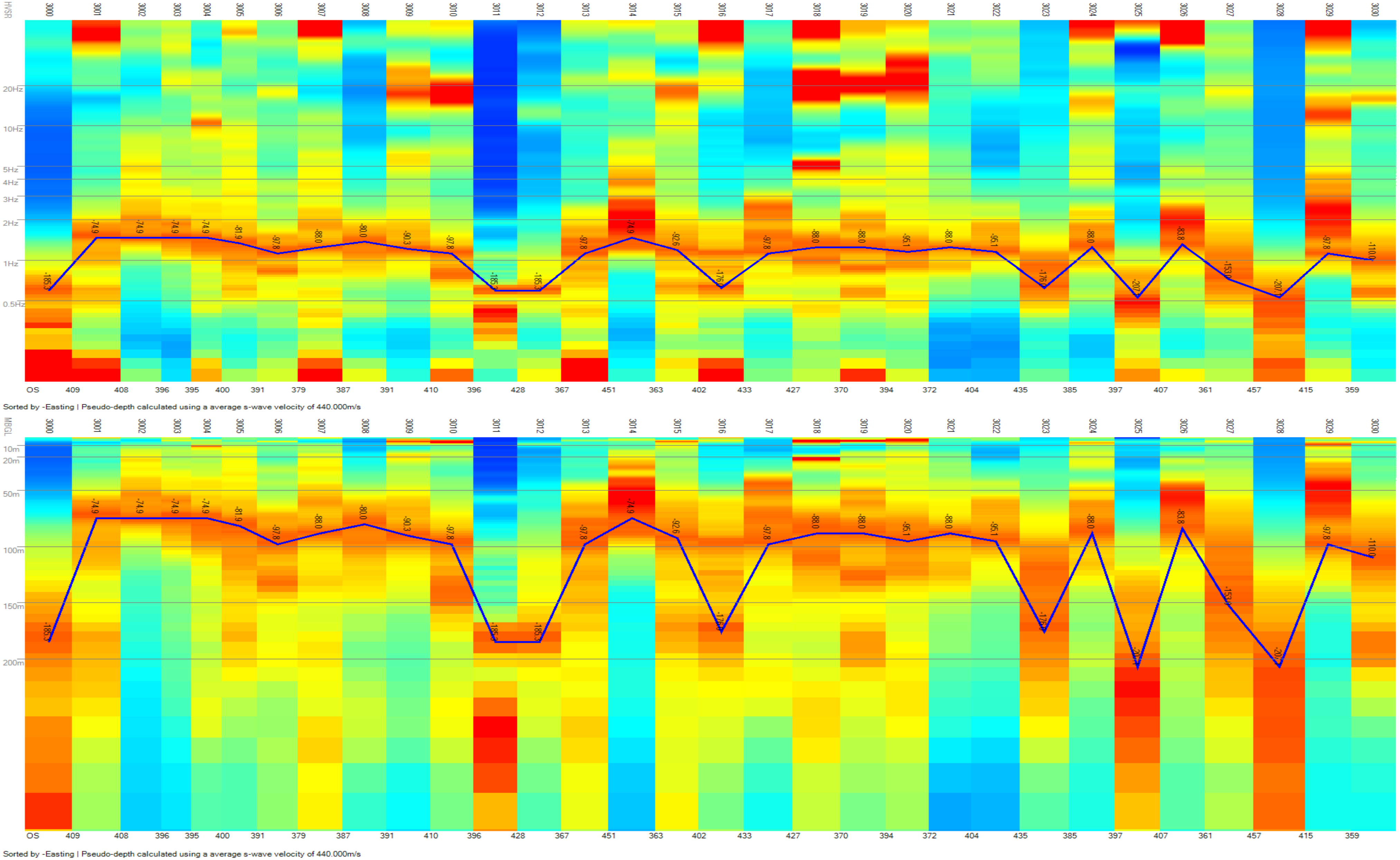


Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s



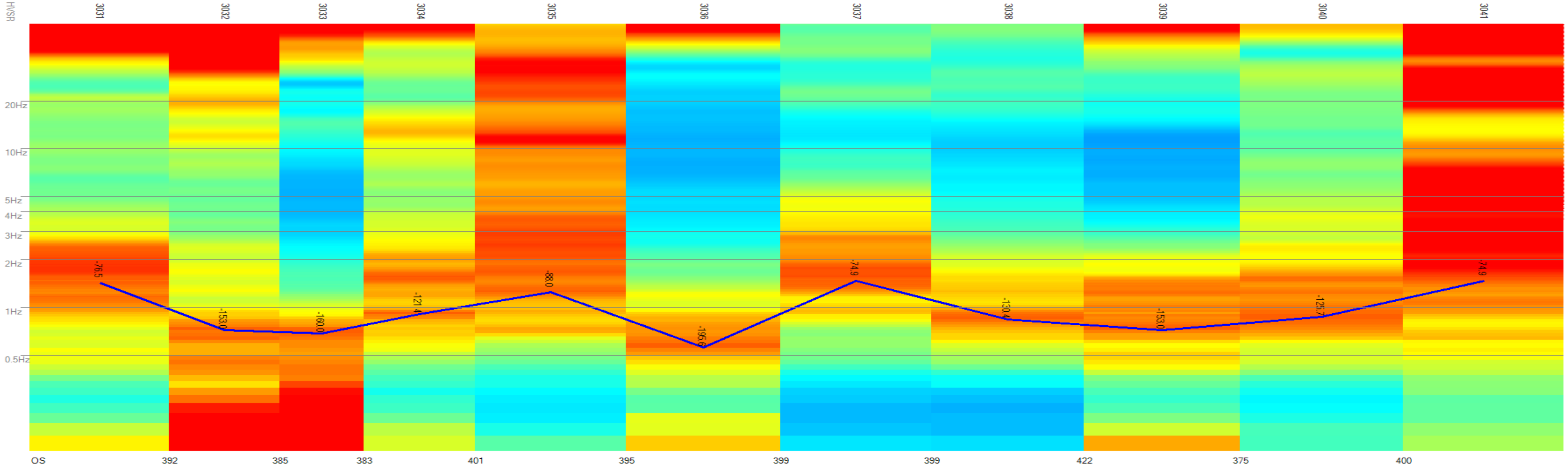
Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Line 21

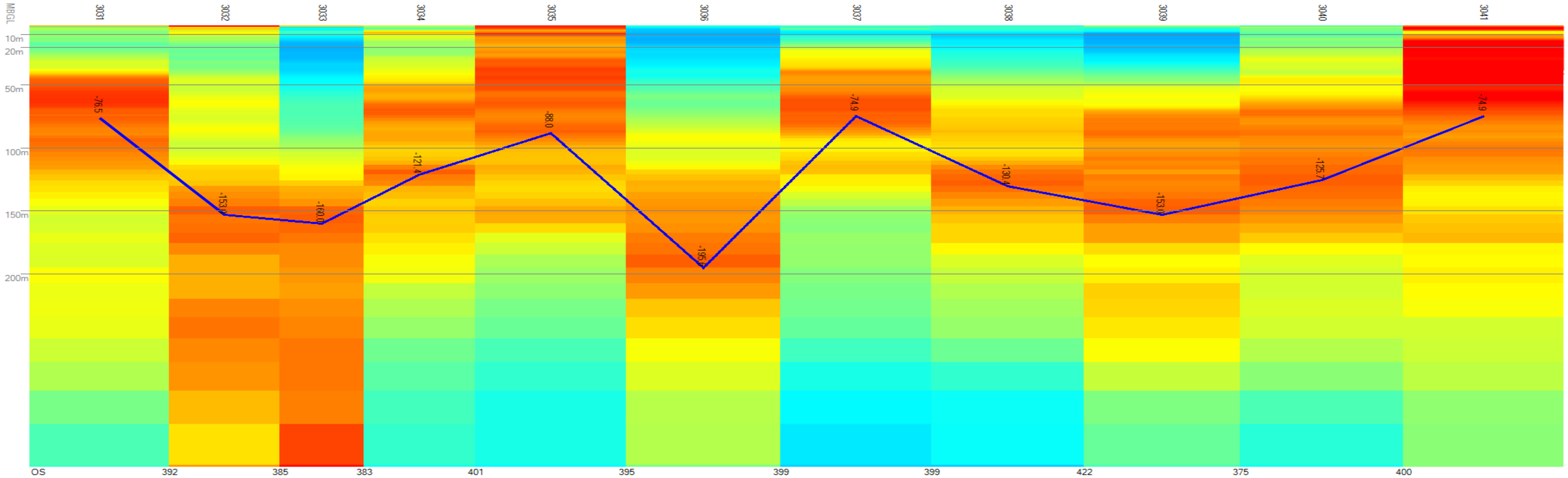


HVSR
20Hz
10Hz
5Hz
4Hz
3Hz
2Hz
1Hz
0.5Hz
OS 409 408 396 395 400 391 379 387 391 410 396 428 367 451 363 402 433 427 370 394 372 404 435 385 397 407 361 457 415 359
Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s
MBGL
10m
20m
50m
100m
150m
200m
OS 409 408 396 395 400 391 379 387 391 410 396 428 367 451 363 402 433 427 370 394 372 404 435 385 397 407 361 457 415 359
Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Line 22

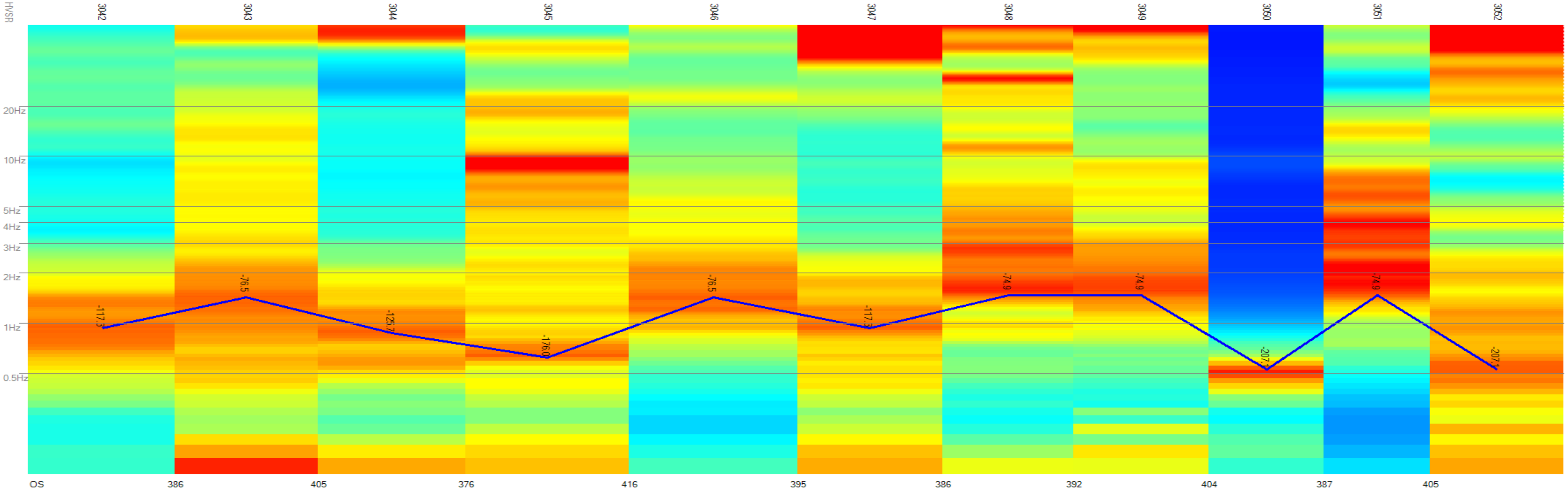


Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

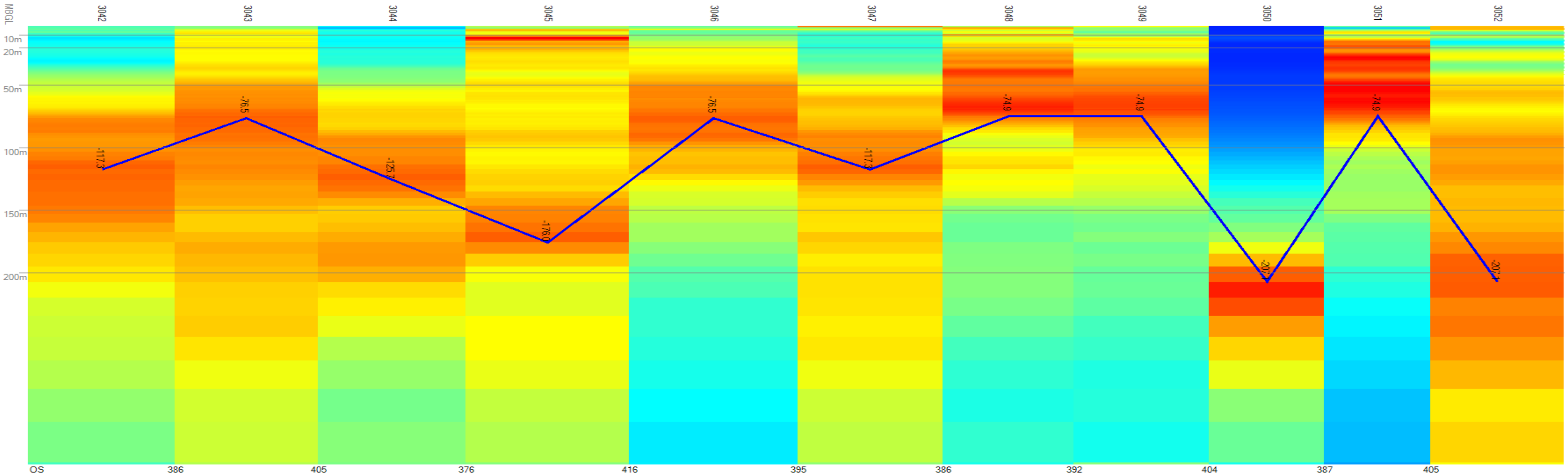


Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Line 23

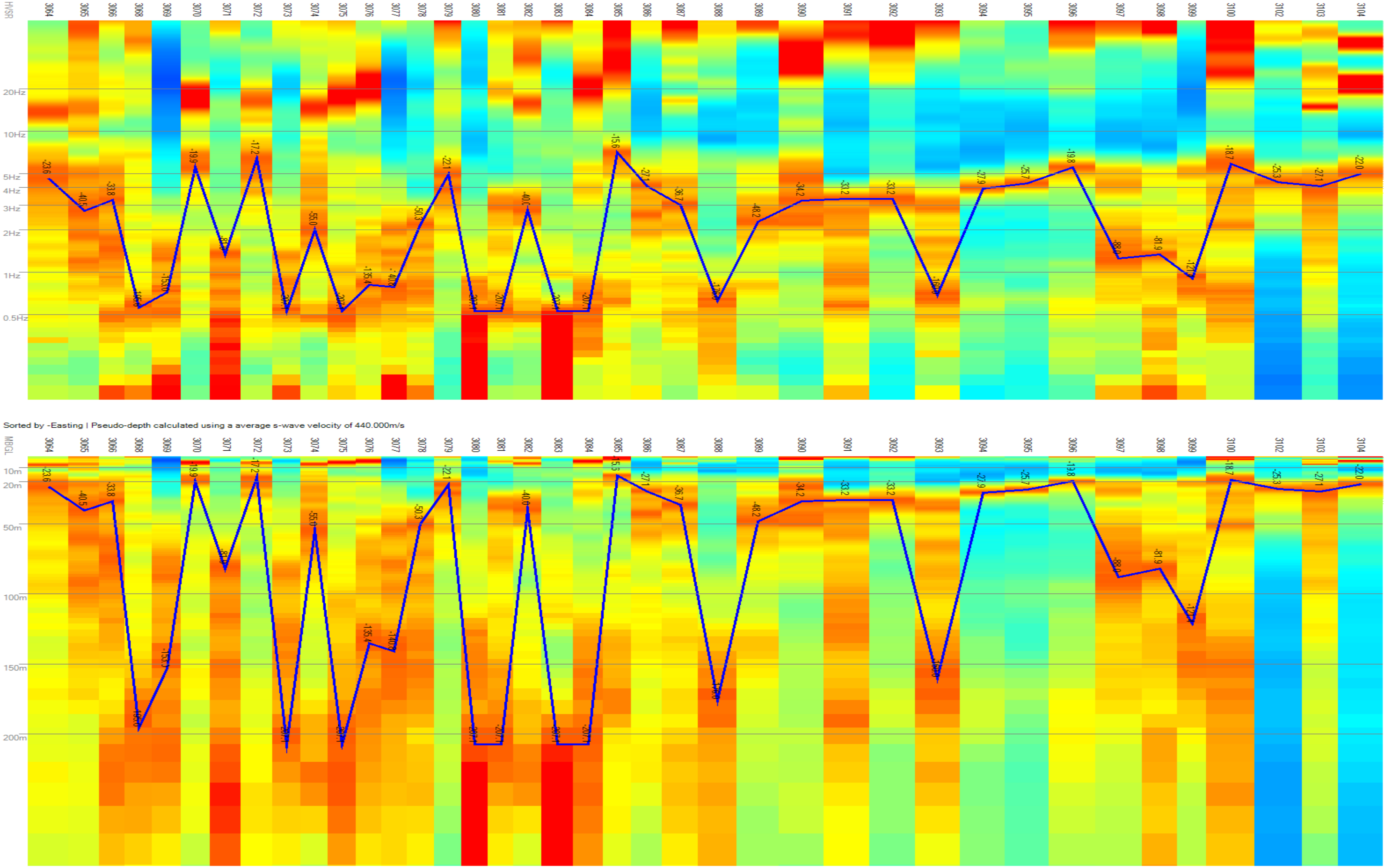


Sorted by -Northing | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s



Sorted by -Northing | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

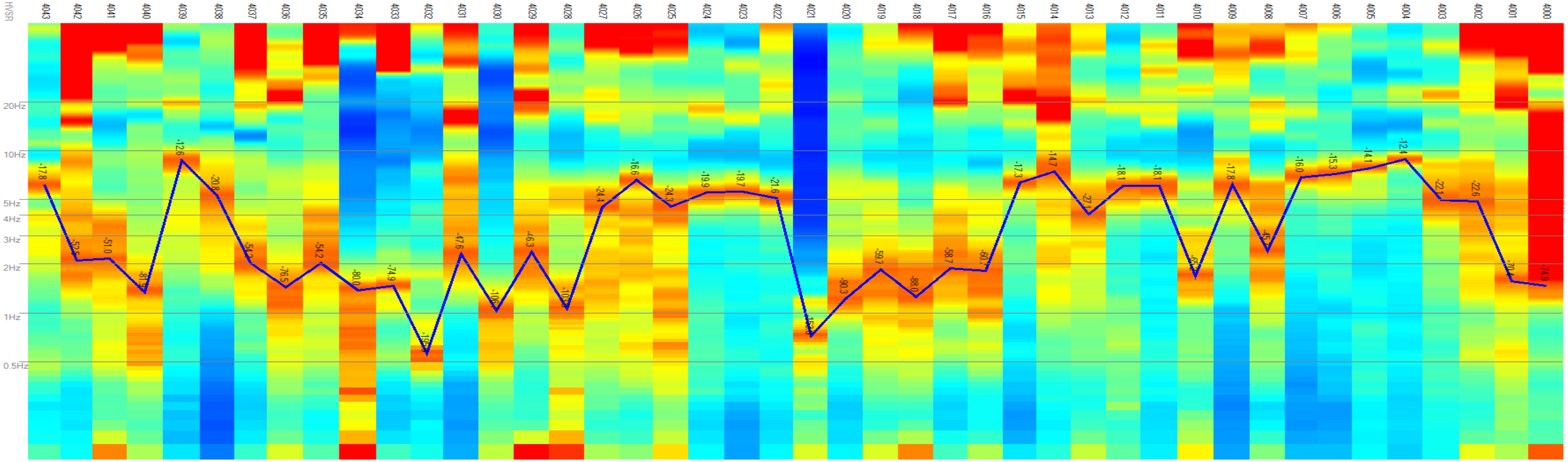
Line 25



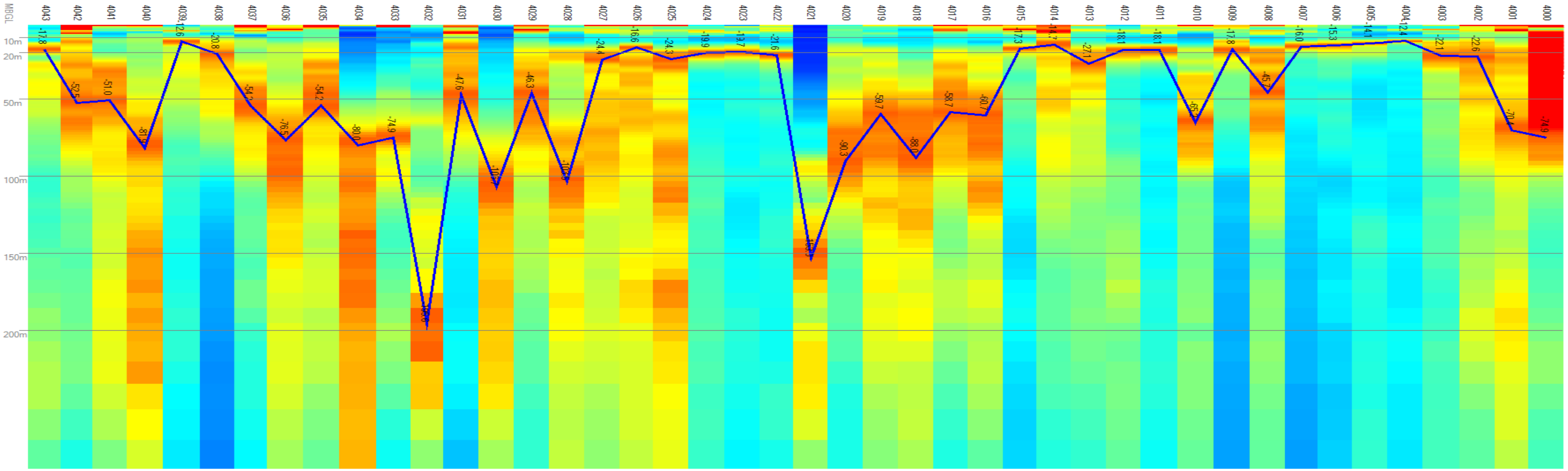
Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Sorted by -Easting | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s

Line 26



Sorted by -Northing | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s



Sorted by -Northing | Pseudo-depth calculated using a average s-wave velocity of 440.000m/s