Appendix 16 Report ARU - 17 - 001 Responses to comments on Arafura's EIS for the Nolans Project, submitted May 2016 (Arafura, 2017)

ARAFURA
RESOURCES LIMITED

ABN 22 080 933 455

Report ARU-17-001

Responses to comments on Arafura's EIS for the Nolans Project, submitted May 2016.

By

Kelvin James Hussey
BSc Hons, MAIG, FSG.

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Appendices (Digital data only)

1. INTRODUCTION

Comments on Arafura's Draft EIS for the Nolans Project were received from the NT EPA and then collated and reviewed by Brian Fowler and Kelvin Hussey of Arafura together with Nicole Conroy of GHD. During this process, each comment was assessed and sorted into EIS related categories before being assigned an issue number and allocated to internal or external responders.

Many comments/issues are related to the same general topic or have multiple responders. Hence numerous responses may apply to a single issue or one response may apply to many issues.

In this report, and as per ANCOLD guidelines, long-term is 1000 years. This has been used throughout the EIS.

Closure and Rehab comments.

DME*:*

1. *Upon closure, stock piles, waste dumps and residue storage facilities that contain radioactive material will be capped with benign waste rock to a thickness of 2m to ensure underlying waste and tailings will not be exposed or eroded in the long term.*

2. *Provide evidence the 2m of waste rock will be sufficient to support this above statement.*

Australian Radiation Protection and Nuclear Safety Agency:

1. *The proposed closure and rehabilitation strategy appears to be deficient, in particular with regard to the capping layer.*

2. *App W 2.2: What does long term storage mean in this context? Since most of the materials to be stored contain elevated levels of thorium-232, which has a radioactive half-life of 14 billion years, long term storage is meaningless. Best practice with this type of material is near surface disposal, which for this situation would mean returning wastes, residues, tailings, etc., to the mined out pits and covering with clean soil.*

Geoscience Australia

1. *How was the one metre of benign cover material reached?*

2. *The proponent notes they will comply with relevant radioactive waste management legislation, specifically capping/closure methods in Section 2.2, however do not mention any radiation control barriers. Additional discussion could be provided about the proposed tailings and residual cover methods and likely exposure levels.*

3. *Arafura notes the likelihood of earthquake occurring, however the proponent does not identify a time period this will occur over. The TSF & RSFs will be rehabilitated to permanent features of the landscape, so may be affected by seismicity*.

Arafura Response

The material to close out and rehabilitate is a mixture of natural benign (inert and non-radioactive) rock and Naturally Occurring Radioactive Material (NORM). The NORM is a mixture of rocks and processed material.

The RSF and TSF will be designed and constructed to ANCOLD guidelines. As per ANCOLD guidelines, 1000 years is long-term. This is standard practice in the mining industry. The above comments address the radiation exposure risk and the risk of erosion in the long term. It also addresses the nature of the benign material to be used as a covering cap.

Firstly, with respect to radiation exposure risks. Radiation measurements and surveys completed at Nolans Bore itself during Arafura's extensive exploration and ongoing rehabilitation activities clearly demonstrate that 30-50cm of the natural occurring soil is sufficient to effectively mask and shield radioactive residues and mineralisation. Arafura routinely uses a 1m soil cover to bury all drilling and radioactive residues as per our approved Mining Management Plan (MMP), which is required to complete exploration activities. Surveys and maps have been provided to the NTGS/NT DPIR and are presented in the draft EIS, prove that one-metre of soil cover effectively shields and masks the radioactivity from even the highest grades of mineralisation at Nolans Bore. For example, the environmental dose-rate surveys associated with the most recent burial pit are shown in Table 1 below.

The average natural background environmental dose rate around this pit is 0.30 µSv/hr. This is based on 16 additional surveys completed around the margins of this pit at the same time, with individual values ranging from 0.15-0.38µSv/hr. The environmental dose rate measurements across the rehabilitated pit average of 0.30 µSv/hr. Hence this result is indistinguishable from the background in this area. Thus, the proposed two-metres of cover will be even more effective at masking and shielding the radioactive material.

Table 1. Environmental dose-rate surveys in µSv/hr as measured by Arafura's calibrated Ludlum Measurements Survey Meter Model 2241-3 across the centre of the MMP Approved disposal pit. Survey 1 was done soon after the pit was excavated, and prior to the disposal of any radioactive material. Survey 2 was done after about 1000t of Nolans Bore drilling residues was placed in the pit. Survey 3 was completed after a nominal 1m of soil cover was placed on top the radioactive material. The location of this disposal area is shown in Figure 1.

Location	Comment	MGA94 E	MGA94 N	Survey 1 22/7/2016	Survey 2 28/7/2016	Survey 3 31/7/2016
1	outside NW end of pit	318932	7502079	0.25	0.32	
2	within pit	318939	7502070	0.6	6.5	0.27
3	within pit	318943	7502063	0.82	7.5	0.27
4	within pit	318947	7502056	0.27	8.6	0.29
5	within pit	318953	7502049	0.23	7.4	0.35
6	within pit	318959	7502039	0.18	6.3	0.33
7	on access ramp	318965	7502031	0.32	3.6	0.34
8	on access ramp	318970	7502024	0.36	0.5	0.25
9	outside SE end of pit	318975	7502015	0.26	0.36	0.35
10	outside SE end of pit	318980	7502006	0.33	0.35	0.29

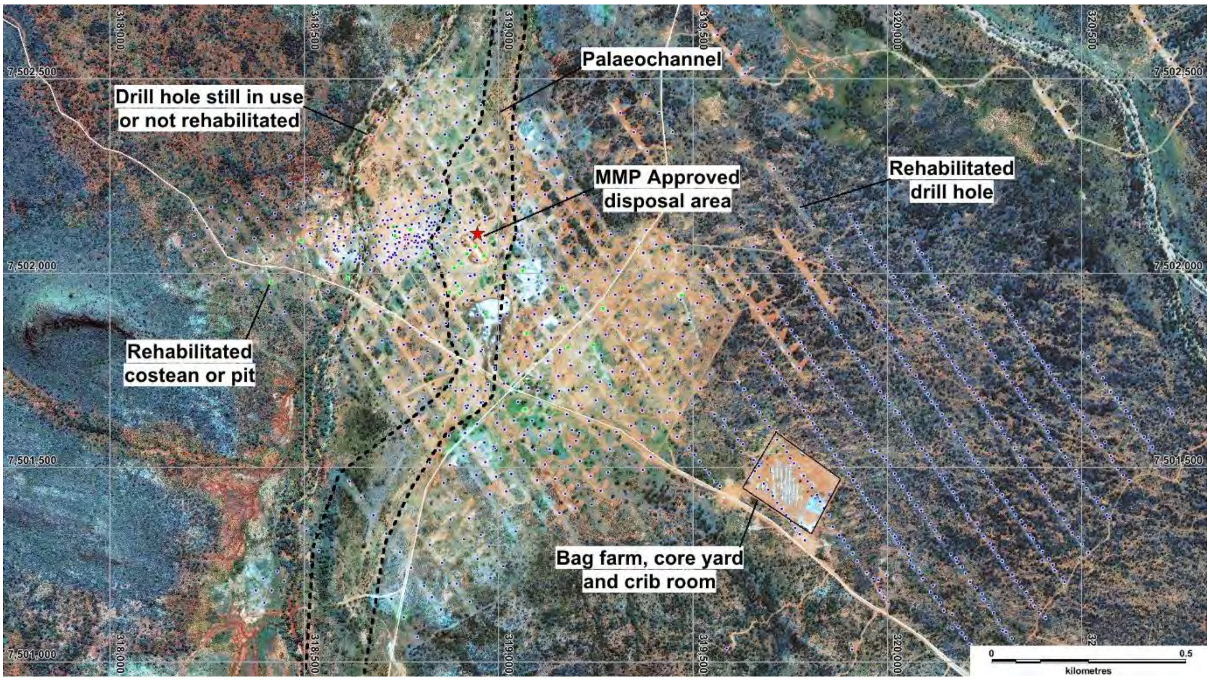

Figure 1. Location of MMP Approved radioactive disposal area within the 2-4m thick palaeochannel that crosses through the centre of the deposit.

This masking and shielding relationship will also hold true for benign waste rock as the waste rock typically contains significantly lower quantities of radionuclides and it is not considered radioactive. Hence a 2m-thick capping of benign waste rock will effectively mask and shield this level of radioactivity. In fact, the waste rocks to be utilized as capping material will be much more enduring and longer lasting than the soil layer which currently covers the deposit. It is a given that these waste rocks will be much more resistant to weathering and erosion than soil in the long term.

Drilling and excavation activities at Nolans Bore clearly demonstrate that the country rocks are very hard, with extremely slow penetration rates observed in both percussion and core drilling. Rock-breakers and rippers are required to break and dig up even strongly weathered waste rocks at Nolans Bore. Drilling and blasting will be required to break up the waste rock during the mining process. The strength and competency of the waste rocks at Nolans Bore is due to their annealed (interlocking) crystalline metamorphic textures and their composition. Due to the nature of the fabrics in the waste rocks, this also means that the gneiss and pegmatite units, which form the bulk of the waste rocks, will naturally break up into large angular blocky boulders, while the schists (and mylonitised gneiss) will naturally tend to form blocky or tabular slabs. Thus, when the broken waste rocks from Nolans Bore are stacked and packed as a 2m thick capping, the waste rock boulders will effectively "lock" into place and provide a stable interlocked erosion resistant barrier.

The outcropping rocks in the immediate surrounds are the same as those to be dug from the open pit. They are slightly to moderately weathered and geological mapping indicates the current landforms are essentially stable with very slow erosion rates. Geological evidence indicates the bevel rises around the deposit have existed since the mid-Tertiary (Hill 2009). It is recognized that land surfaces and landforms do exist forever; they are slowly modified and eroded over geological time. However, it can be argued from a geological point of view that the observed land surfaces are ancient and closely approximate the actual geomorphic expressions expressed by the current geology given that erosion rates are very slow in Central Australia.

Secondly, with respect to the erosion risk and break down of this covering cap. Australia is one of the most arid, low-relief continents on earth. It has undergone prolonged weathering and erosion for millions of years under variable climatic conditions. Studies have demonstrated that weathering and erosion rates are extremely slow in central Australia with erosion rates for natural rocks and rocky areas varying from less than one and up to about 15mm per thousand years (Bierman and Caffee 2002; Belton et al 2004; Heimsath et al 2010; Quigley et al 2010). These studies cover a large part of central Australia, and extend northwards into the tropics where there are much wetter climates. In general, the results from central Australia typically indicate the long term integrated erosion rates of less than 10mm per 1000 years. Similar long-term erosion rates have also been measured at the Devils Marbles where average rainfall is about 340mm. This is about 10% higher than the average around Nolans Bore and Alice Springs. It is noted from the above-mentioned studies, that areas with three or more times the average rainfall of central Australia (*e.g.* Kakadu) have slightly higher erosion rates but they are still about the same order of magnitude as those measured for more arid environments in central Australia.

The waste rocks are also chemically inert and contain only trace amounts of sulfide (as small pyrite cubes). AMD test work and initial mining planning assessments have shown that the vast majority of the waste rock are non-acid forming (this is discussed in another response). Hence the waste rocks will not will not rapidly breakdown and degrade due to the oxidation of sulfide. The waste rocks are typical rock types and they do not contain components that will readily breakdown upon exposure.

The above indicates that a 2m thickness of a benign rock cap is suitable and it will be stable and resistant to erosion in the long term.

The mineralisation at Nolans Bore contains an average of 11.7 Bq/g of combined U and Th. This activity concentration is based on the 2017 Mineral Resource. The samples buried within the disposal pit are typical of average mineralisation and Table 1 demonstrates that this level of activity is shielded by 1m of cover.

The combined average activity concentration of U and Th has been calculated based on their deportment to waste rock dumps, TSF and RSF (Table 2), It has been assumed that all waste rock as defined will report to the waste rock dumps. This includes unclassified resources and low grade mineralisation that may eventually be upgraded to ore. Therefore the value for the waste rock dumps may be slightly overstated. Test work suggests 25% of U and Th will report to the TSF, and 75% of U and Th will end up in the RSF. The amount of U that will end up in the RSF is likely to be less because a small and currently unknown amount of U will remain in the phosphoric acid. Thus, the estimated activity concentration for the RSF is likely to be a little high.

Table 2. Estimated activity concentrations based on mining and processing the Nolans Bore deposit as described in the EIS. The average deposited value is lower because the mined and processed material will remain moist due to small particle sizes. A moisture content of 5% has been assumed for the Waste and 25% for the TSF and RSF.

Source	Activity concentration (Bq/g) - Average dry	Activity concentration (Bq/g) - Average deposited
Ore	11.7	11
Waste Rock Dumps	1.5	1.4
TSF	5.9	4.6
RSF	15.4	11.5

ANCOLD guidelines account for the seismicity risk of the area. Geoscience Australia have assessed the seismic risk of the area; it is considered low. Major earthquakes are a rare event in Australia and none have been recorded in the project area. The nearest major earthquake occurred about 300km to the north near Tennant Creek in 1988 and this area has been the focus of numerous seismic events ever since. Geoscience Australia's database of historic earthquakes (since 1955) was queried using a series of concentric search radii centered on the Nolans Bore (-22.59 and 133.24). No earthquakes have been recorded within 25 km of the mine site. Three earthquakes have been recorded within 50km of the mine site, nine are within 100km and 42 are within 200km. Most of the recorded events are small insignificant earthquakes, with only five of these events within 200km described as significant (>3.5 ML or Mb) in this database. The nearest significant earthquake had a magnitude 4.8 Mb and occurred about 38km SW of Nolans Bore on 2/8/1968. The location of this earthquake makes geological sense. It coincides with a major E-W crustal structure in the Arunta basement rocks. This structure remains distal to Nolans Bore and the project area.

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Geoscience Australia:

- *The proponent has successfully identified groundwater resources and basin geometries from the AEM dataset. There is no mention of the system, the processing or modelling conducted, nor is there any conductivity depth images (CDI) or 2D image slices of the AEM data to validate these statements. It appears there is an assumption the reader has knowledge of previous geophysical reports and datasets. Could this be attached as an appendix, or a summary of the data be provided.*

Arafura Response

Background

Groundwater resources have long been known west of about Day Creek on Napperby Station (*e.g.* Jones and Quinlan 1962) and geological logging indicates this groundwater is hosted within Cenozoic stratigraphic units. Hence it has been speculated that the Cenozoic stratigraphy probably also continued to the east of Day Creek, and that this geology may correlate with or link to other Cenozoic basins in the region (*e.g.* Ti Tree Basin). Prior to Arafura's exploration there was a lack of geological data to the east of Day Creek. Hence the lateral extent of the Cenozoic units was largely speculative.

Arafura's groundwater investigations began in 2010/11 and initially targeted known saline waters in the deeper parts of the Cenozoic Ti Tree Basin, about 40-45km east of the proposed mine site. The company identified substantial groundwater in this region but shifted its groundwater exploration focus to the southern basins in 2012 following perceived and identified community concerns about possible impacts to the potable groundwater supplies in the Ti Tree Basin.

The extent of groundwater resources in the southern basins area was not known before Arafura's groundwater exploration activities began in this area in 2012. The geological logs of the nearest stock bores on Aileron Station indicated all holes were in metamorphic basement rocks or shallow calcrete aquifers on metamorphic basement rocks. Clearly there were stock bores and exploration drill holes into this Cenozoic basin around Day Creek and further west on Napperby Station, but there were limited stock bores and no exploration drill holes in this basin to the east of about Day Creek (Figure 2).

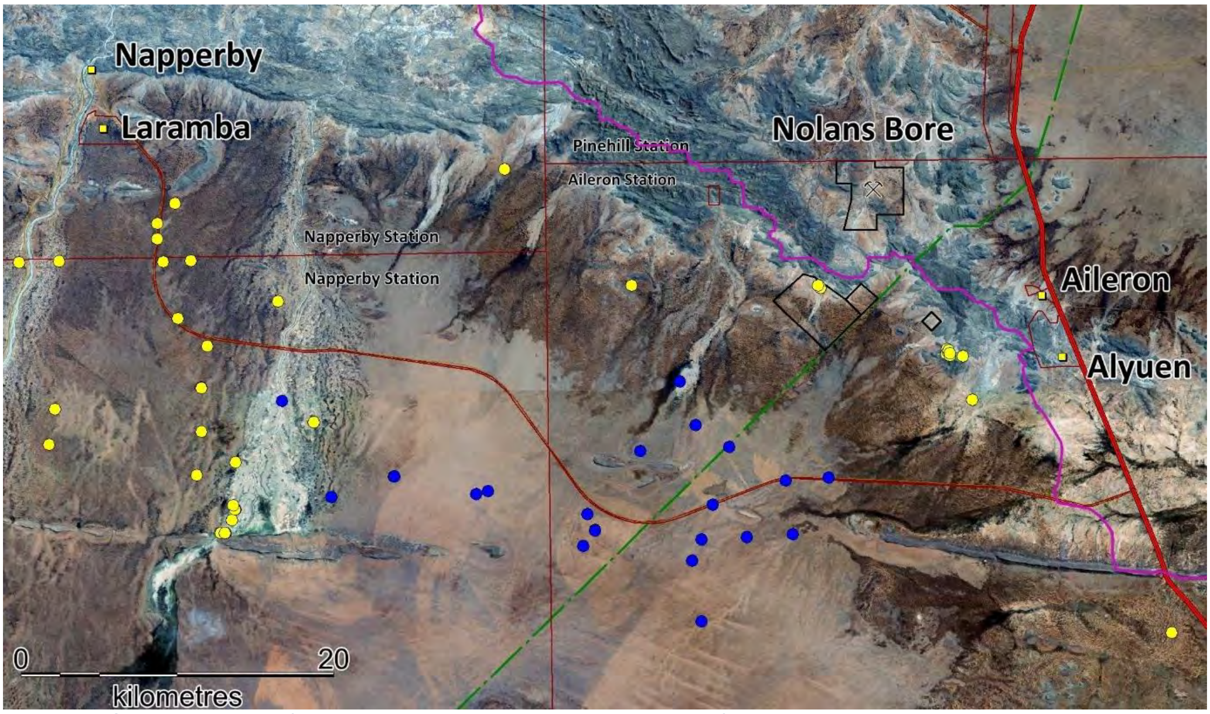


Figure 2. Satellite image of the project area showing the location of water bores within the southern basins area. Pre-existing holes are shown as yellow dots. Arafura's holes are shown as blue dots. The pink line is watershed divide separating the southern basins from the Ti Tree Basin.

Despite the lack hard geological data, the drainage and vegetation features evident on the satellite imagery suggested there were likely to be Cenozoic palaeochannels/basins concealed beneath the sand plains in this area (Figure 2). Furthermore, it was also noted that the vegetation types in some parts, and the rapid recovery of the area after fire, suggested a possible shallow water table.

Arafura's approach

Arafura took a geological approach to explore for groundwater resources in this unknown region. Geological maps, satellite imagery and airborne magnetic survey data were reviewed and modelled. The aeromagnetic surveys indicated some areas with high frequency magnetic detail, indicative of outcropping areas or shallowly buried metamorphic basement rocks. The aeromagnetic surveys also showed large areas where there was a lack of high frequency magnetic detail, suggesting substantial Cenozoic cover on top of the metamorphic basement rocks.

Depth to magnetic features were modelled across Arafura's entire project area to assist in the identification of explorable near surface basement areas that might be prospective for additional Nolans Bore type mineralisation. Fortuitously this magnetic modelling also aided the initial groundwater exploration of the region. Depth solutions are dependent on the magnetic response but they are not always possible everywhere in the dataset. For example, depth to magnetic modelling is not possible in areas of subdued or uniform magnetic character. This is typical of the large granite bodies that dominate parts of the region. To further hinder interpretations, the sedimentary units of Ngalia Basin are essentially non-magnetic and these sometimes overlie the Arunta basement rocks and underlie the Cenozoic basins. Hence the depth solutions may indicate the depth to the metamorphic basement rather than the depth to the Ngalia Basin sedimentary units. Although the magnetic surveys are useful in a broad sense, they do not provide a detailed model of the Cenozoic basin/basement relationships.

Fortunately for Arafura, a number of regional airborne electromagnetic (AEM) surveys existed over most of the project area. These AEM surveys were specifically acquired by other companies as an exploration tool to evaluate the Cenozoic geology in this region for uranium. AEM surveys measure conductivity responses and they are suited to evaluating basin architectures and their groundwater potential.

The TEMPEST AEM survey data was sourced from open-file company reports held by the Northern Territory Geological Survey (NTGS), NT Department of Primary Industries and Resources (Rafferty 2008, Blair 2009, Rafferty 2009, Moore 2012). These datasets were all acquired by Fugro Airborne Surveys and the details of the acquisition and processing of each survey reported in Rafferty (2008, 2009), Blair (2009) and Moore (2012). Rafferty (2008, 2009), Blair (2009) and Moore (2012) also provide detailed Conductivity Depth Image (CDI) images of all flight lines. These reports are free and readily downloadable from the NTGS.

All open-file AEM data that was available at the time in this region was reprocessed by David McInnes of Montana GIS, using in-house proprietary software and 1D Layered Earth Inversion (LEI) modelling. The rationale behind this approach is presented by McInnes in Appendix 1. The AEM data was reprocessed station by station, using automated routines to build up and generate conductivity-depth profile data for each flight-line section. The resultant five Layered Earth Inversion (5LEI) model of AEM flight-line section data was then used to plan the location and target depth for subsequent drilling.

An example of a CDI is presented in Figure 3 below. The corresponding data used to construct this CDI image is shown in Figure 4 and the reprocessed 5LEI model is show in Figure 5.

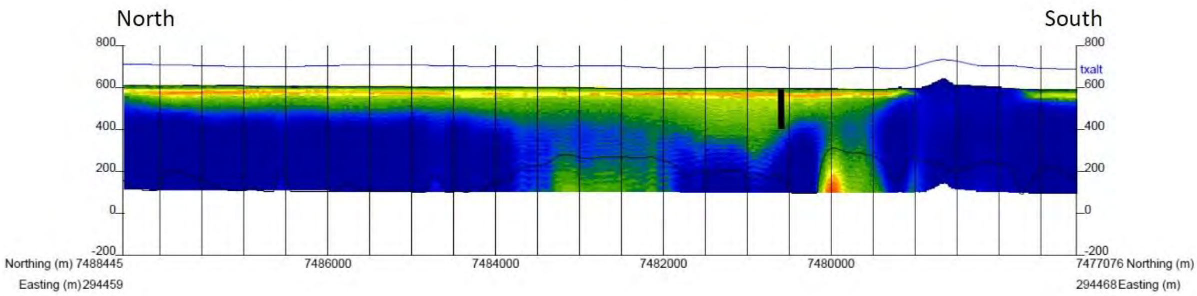


Figure 3. Fugro's CDI image for line 30033801. Note McInnes renamed this north-south AEM flight line 294500 in reprocessing, to match its easting. The black vertical bar is the approximate location of RN19030-RN19033 (all drilled at target KH6).

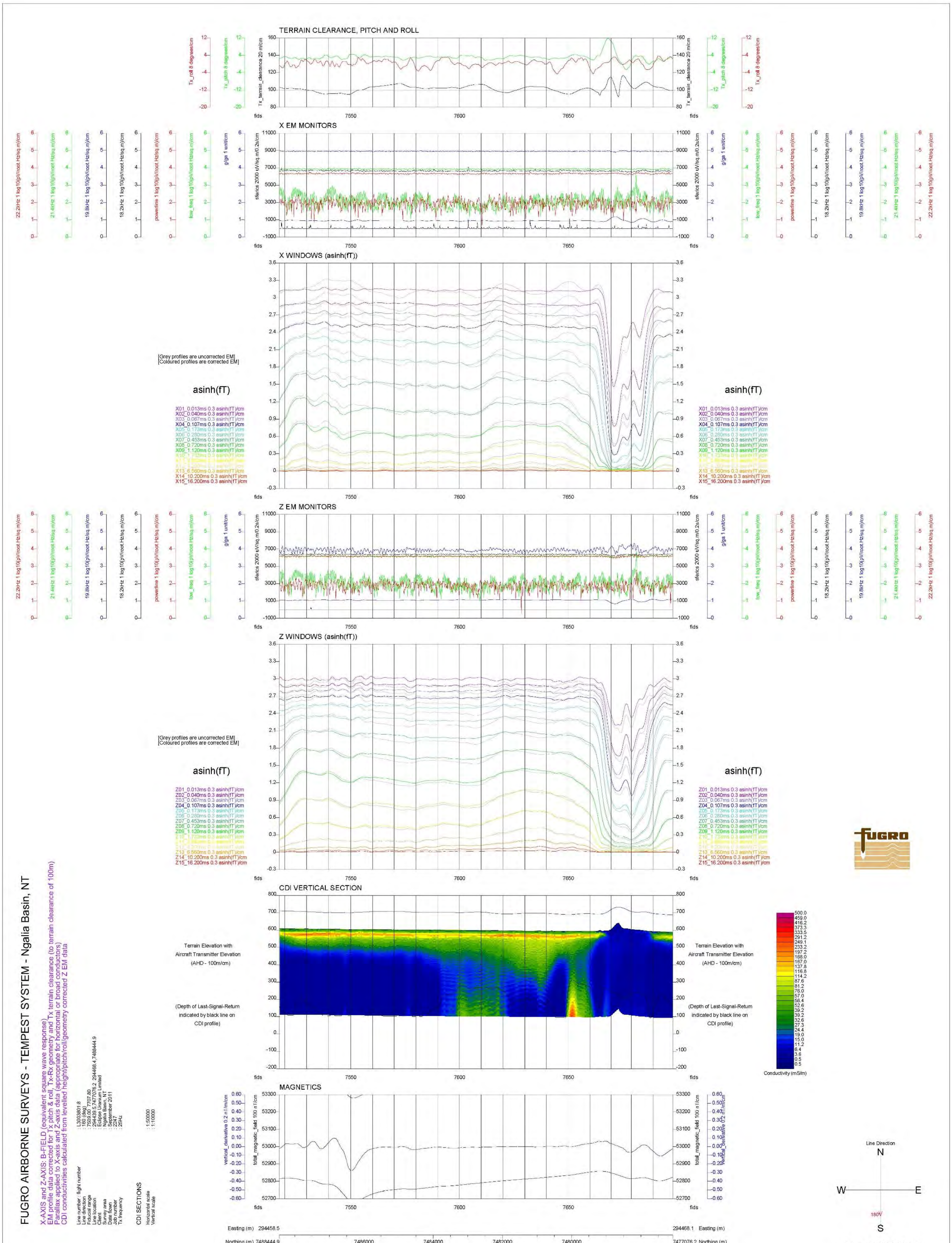


Figure 4. Fugro's TEMPEST AEM survey data and CDI image for line 30033801. Note McInnes renamed this line 294500 to match its easting.

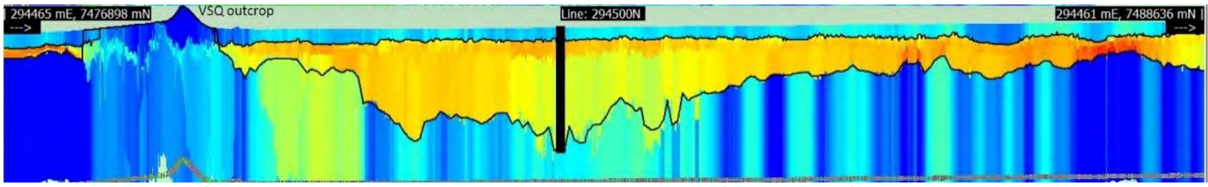


Figure 5. Reprocessed AEM survey data showing a 5LEI model for Furgo's flight line 30033801 (renamed as 299450) and the location of drilling target KH6 (RN19030-RN19033 inclusive) in the deepest part of the inferred basin. Note the north and south ends of this line are reversed in comparison to Figures 3 and 4. This section is 11.7km long and has a ten times vertical exaggeration.

Drilling has demonstrated that Arafura's modelled depths to the base of the conductor and the underlying resistive units (*i.e*. inferred basement), as represented by the lowermost black line coinciding with the boundary between warm and cool colours in Figure 5, is within an acceptable/anticipated error. The overlying conductive zone (warmer colours in the middle parts of the image) is consistent with brackish water hosted within Cenozoic sedimentary units overlying resistive basement rocks. However as shown in Figure 5 the base of the conductor can vary over small distances; this may not be correct and model dependent or it may be 'real' due to geological variations. Furthermore, the boundary is clearly an interpretation as its conductivity value differs along the section. The top of the conductor also slightly varies along each section; again, this might be model dependent or it may be a geological. Drilling has shown that the top of the conductor is generally consistent with the top of the saturated zone or the Standing Water Level (SWL).

The modelled conductivity-depth data for each flight line was assessed and the top and bottom of the conductor digitised. The black lines shown in Figure 5 coincide with modelled AEM data, each point having a specific coordinate (easting, northing and RL) and a conductivity value. This digitized sectional data was then gridded to produce a two-dimensional picture of the conductive zones (Figure 7 and 8). Arafura also used this data to produce a 3-dimensional picture of the Southern basins using SURPAC (mining software). The 3D views of this model are not shown here as they offer little to this discussion. The 3D models are hindered by the large area concerned and the lack of vertical exaggeration across the region. Nevertheless, they proved useful. It should be noted that all AEM surveys were reprocessed the same way, so each individual survey is now directly comparable.

The conductance image shown in Figure 9 provides a method of viewing the architecture of the Cenozoic basins in this region that Arafura calls the Southern Basin, although caution is warranted because conductance is the product of conductivity and thickness (depth). Hence conductance does not provide depth information on the conductor (*cf.* Figure 7 and 8). For example, a thin layer of very conductive material (*e.g.* salty water) may have the same conductance as a thick layer of weakly conductive material (*e.g.* brackish water). This is phenomena is apparent around Lake Lewis where highly saline groundwater is known from exploration drilling. Furthermore, the geology of the region needs to be considered as some basement rock units are also conductive. For example, the Truer Member in the Ngalia Basin is a conductor, and in places the Cenozoic basins directly overlie this unit. This means there may be regions in the surveyed area where the depth to the base of the conductor is not the depth to the base of the Cenozoic basin. Hence caution is warranted and the inferred geological model needs to be carefully evaluated based on geological evidence.

Figures 7, 8 and 9 provide evidence to demonstrate that the Ti Tree Basin in the northeast is separated and geologically distinct from the southern basins in the southwest. Figure 8clearly indicates that the base of the conductor/resistive "basement" contact (*i.e*. inferred unconformity surface) varies greatly across the surveyed area. Figure 7 shows that the top of the conductor (SWL) forms a prominent high between the two regions with surface dipping away from a central divide and Figure 8 shows a similar broadly coinciding ridge at this location as well. These figures therefore indicate that the Ti Tree Basin and the Southern basins are broadly linked in the upper most parts near the surface. However, the geological units that were deposited in each region are clearly separated from each other by a prominent northwest-southeast topographic ridge of basement rocks. This basement ridge therefore serves as a geological barrier which defines the geological provenance (source) of the sedimentary rocks deposited into these basins. In addition, Figure 8 shows that the southern basins contain at least two major palaeochannels. This is supported by exploration drilling and stock bores in the south,

The northern east-west palaeochannel has been termed the Reaphook palaeochannel by Arafura while the deep southern-most palaeochannel is here termed the Burt paleochannel. Both palaeochannels continue further westward towards the NT/WA border. The Burt palaeochannel continues westward south of Lake Lewis and north of Kintore where seismic surveys indicate it is up to about 500m thick.

Within the area explored by Arafura, the Reaphook palaeochannel is predominantly composed of quartz-rich sandstones and granule-pebble conglomerates (*e.g.* Figure 6) with lessor siltstone. These sedimentary rocks have been derived from the surrounding proximal basement units exposed in the nearby ranges, *i.e*. coarse grained granitoids/gneisses of the Arunta Region and the quartz-rich sedimentary units of the Ngalia Basin.

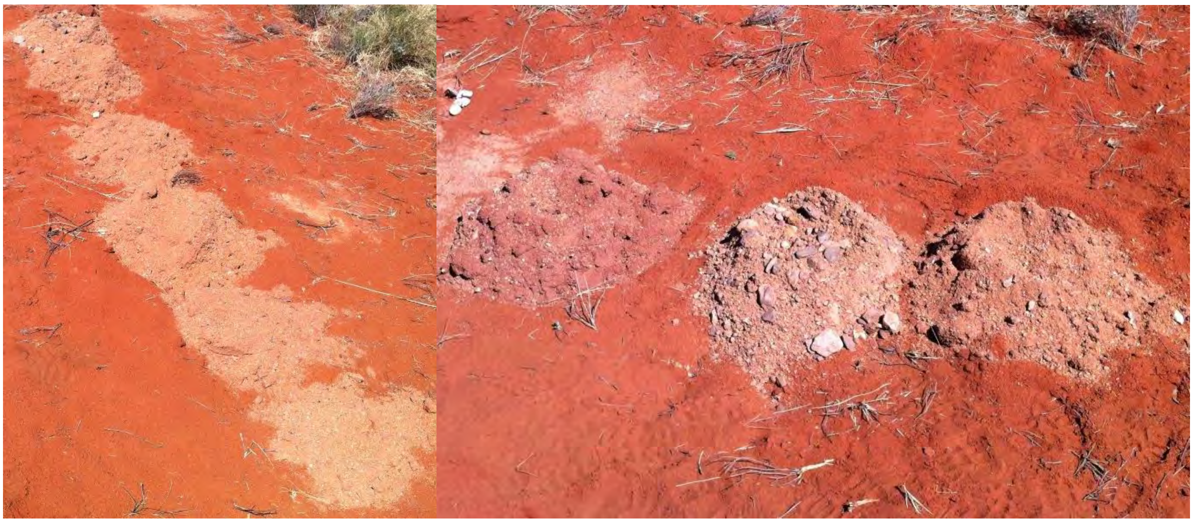


Figure 6. Drill chips from KH6 (RN19030) showing typical examples of the recovered coarse-grained sandstones and pebble conglomerates. Each pile is about 30cm across and equates to 3m of drilling. The geological log of this hole is presented in Graham Ride's borehole reports.

The predominantly coarse-grained stratigraphy of the Reaphook palaeochannel strongly contrasts with extensive clay-rich nature of the terrestrial succession intersected by exploration companies in Burt palaeochannel (*e.g*. NuPower's BP010 at 314006E 7440489N stored in NTGS Alice Springs core library). The stratigraphic units in the Burt palaeochannel have clearly been sourced from a different geological provenance to the Reaphook palaeochannel. The Burt palaeochannel provenance contains a significant amount of outcropping mafic granulites to the south and east (Figure 11) with lessor exposures of coarse grained granitoids. In addition, this area also has distal mica-rich sources which together with the above rock types, weathering and transport favour the deposition of finer grained and more clay-rich sedimentary units (*i.e*. mudstones, claystones and siltstones).

The Ti Tree Basin to the north and northeast of Nolans Bore also has a different geological provenance to the Reaphook palaeochannel; notably it also has mafic rocks in the southeast of its provenance and distance suggest a higher transport component. The Cenozoic stratigraphy in the Ti Tree Basin contains a higher proportion of fine grained units (mudstone, claystone and siltstone) than the Reaphook palaeochannel and it also contains lignite. This suggests a more quiescent environment. Lignite has not been observed in the eastern parts of Reaphook palaeochannel by Arafura, but it has been intersected in stratigraphic drilling further west; *e.g* near Napperby Creek in BMR Napperby 1. The limited amounts of finer grained detritus and the absence of lignites in the eastern parts of the Reaphook palaeochannel indicate a higher energy fluvial environment in this area. It is noted that conglomerates and coarser-grained sandstone units are present in the Ti Tree Basin but they are typically subordinate. Conglomerates and coarser-grained sandstone units are much more extensively developed in the Reaphook palaeochannel.

The above geological differences indicate there will be variable/different hydrological and groundwater settings across the region.

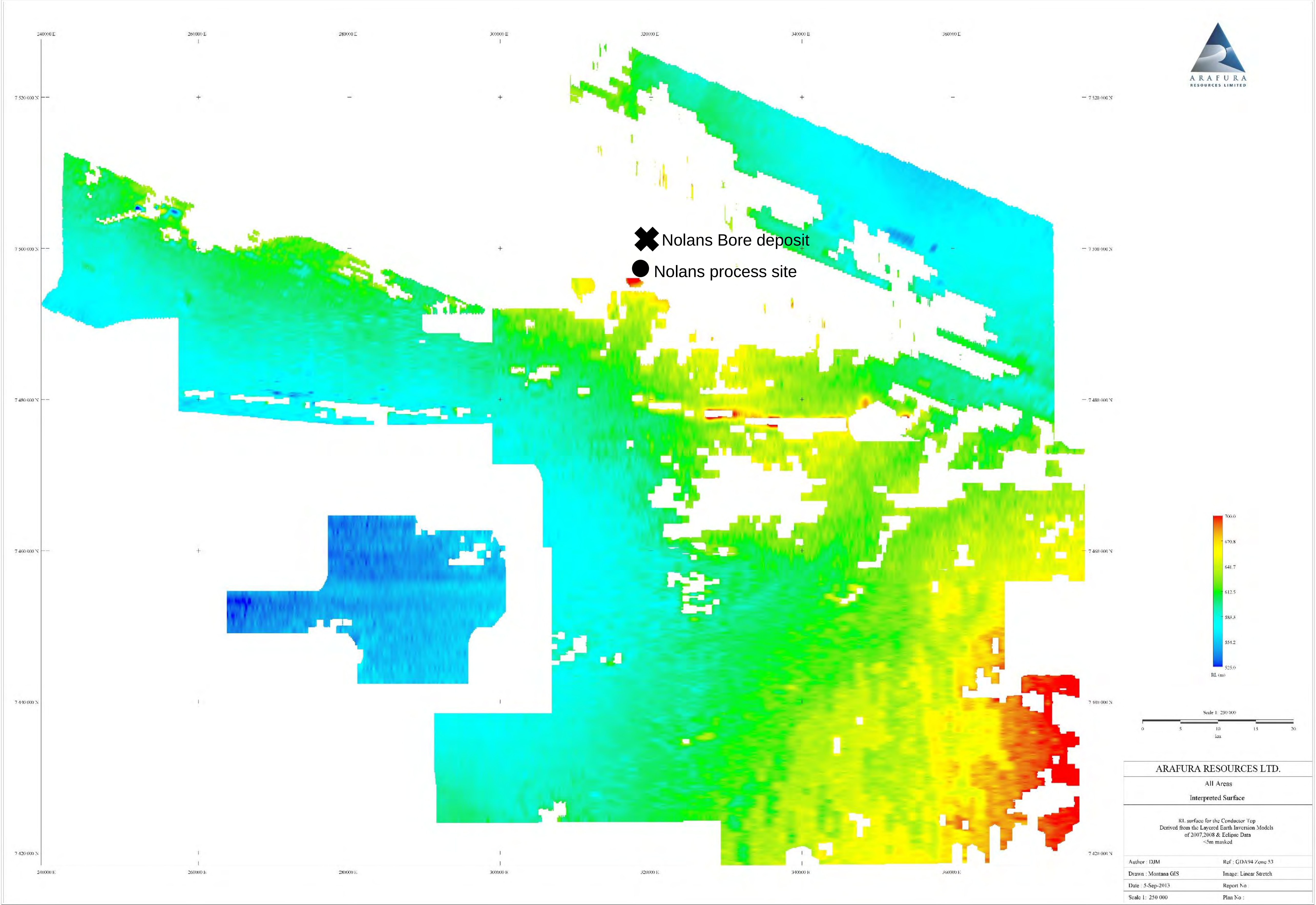


Figure 7. RL to top of conductor based on Arafura's 5LEI model. Note depth solutions that are with 5m of the surface are masked out (white) to indicate near surface or outcrop areas. AEM flight lines are shown in Figures 10 and 11.

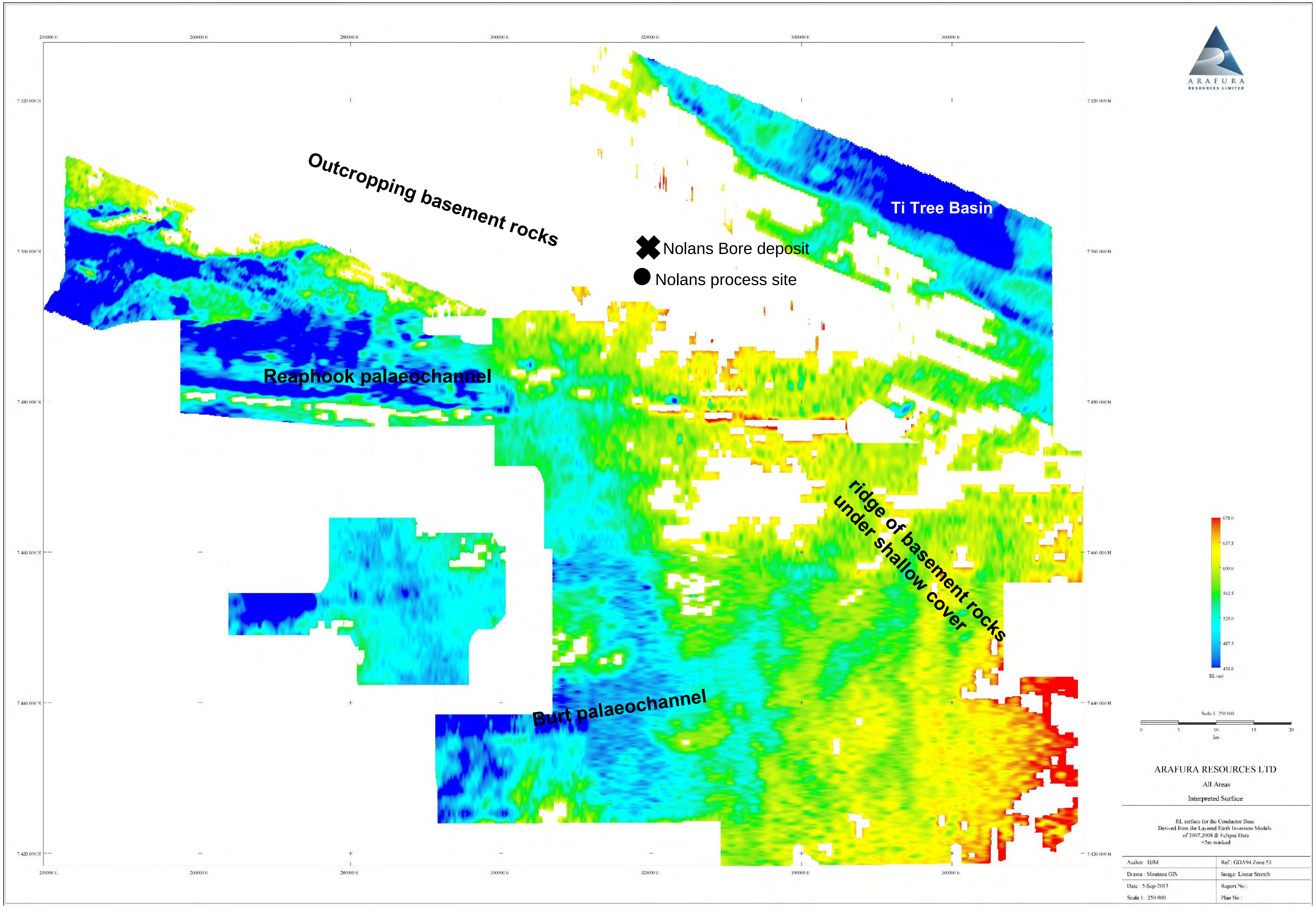


Figure 8. RL to base of conductor based on Arafura's 5LEI model. Note depth solutions that are with 5m of the surface are masked out (white) to indicate near surface or outcrop areas. AEM flight lines are shown in Figures 10 and 11.

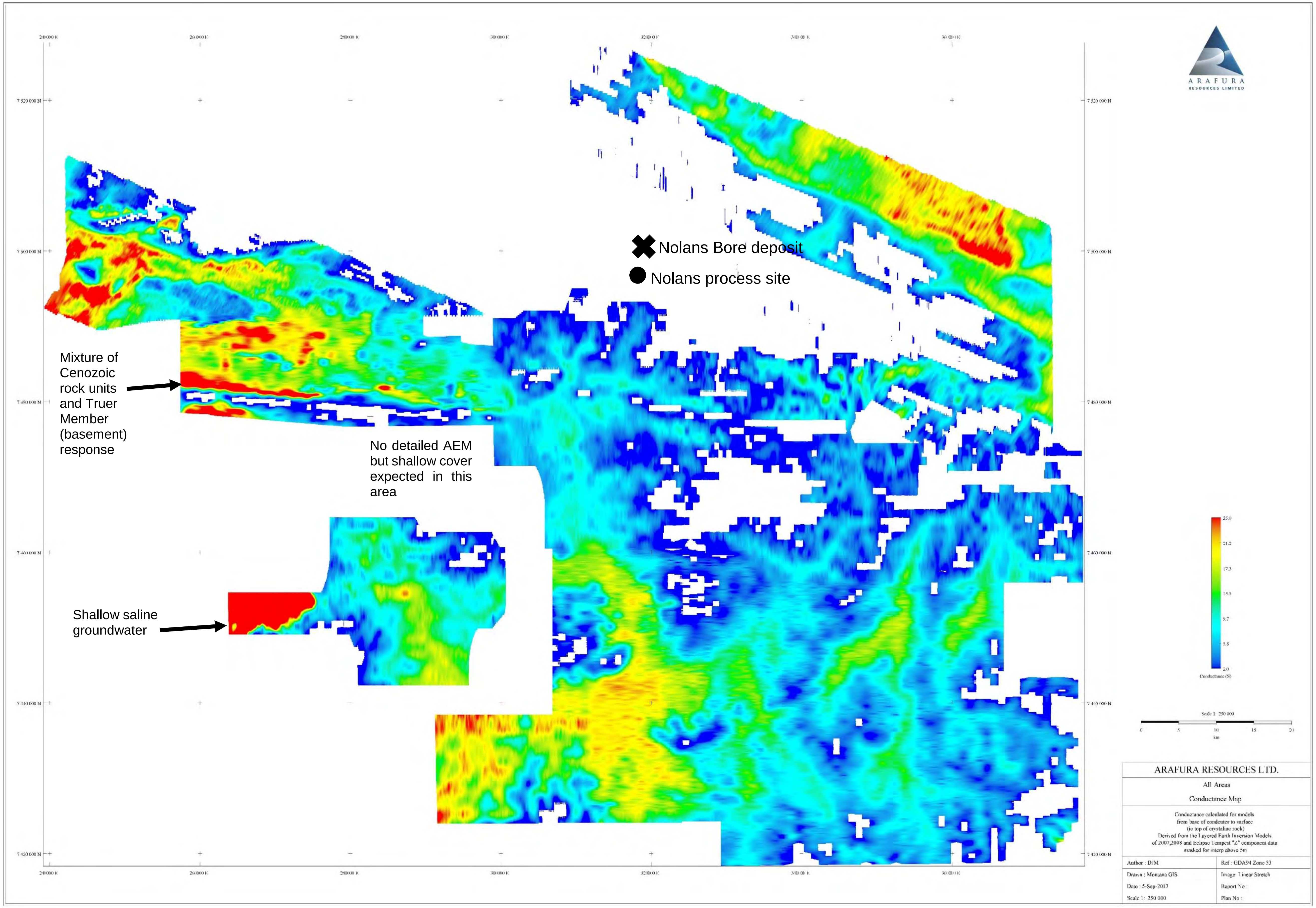


Figure 9. Total conductance to 300m below the surface based on Arafura's 5LEI model. Note depth solutions that are with 5m of the surface are masked out (white) to indicate near surface or outcrop areas. AEM flight lines are shown in Figures 10 and 11.

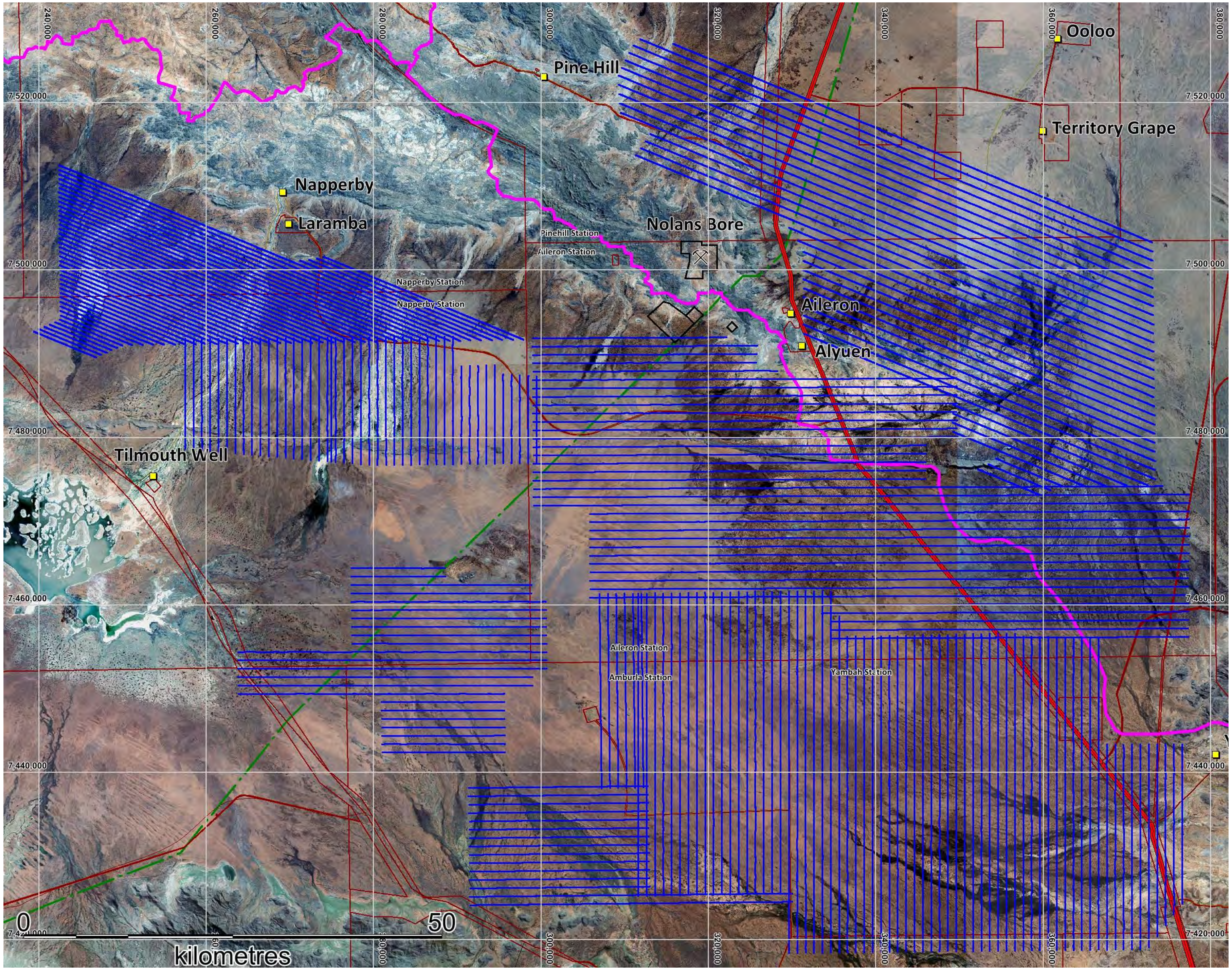


Figure 10. Satellite image showing location of the flight lines for the open file TEMPEST AEM survey data that were reprocessed and used in the construction of Arafura's 5LEI model data presented in Figures 7, 8 and 9.

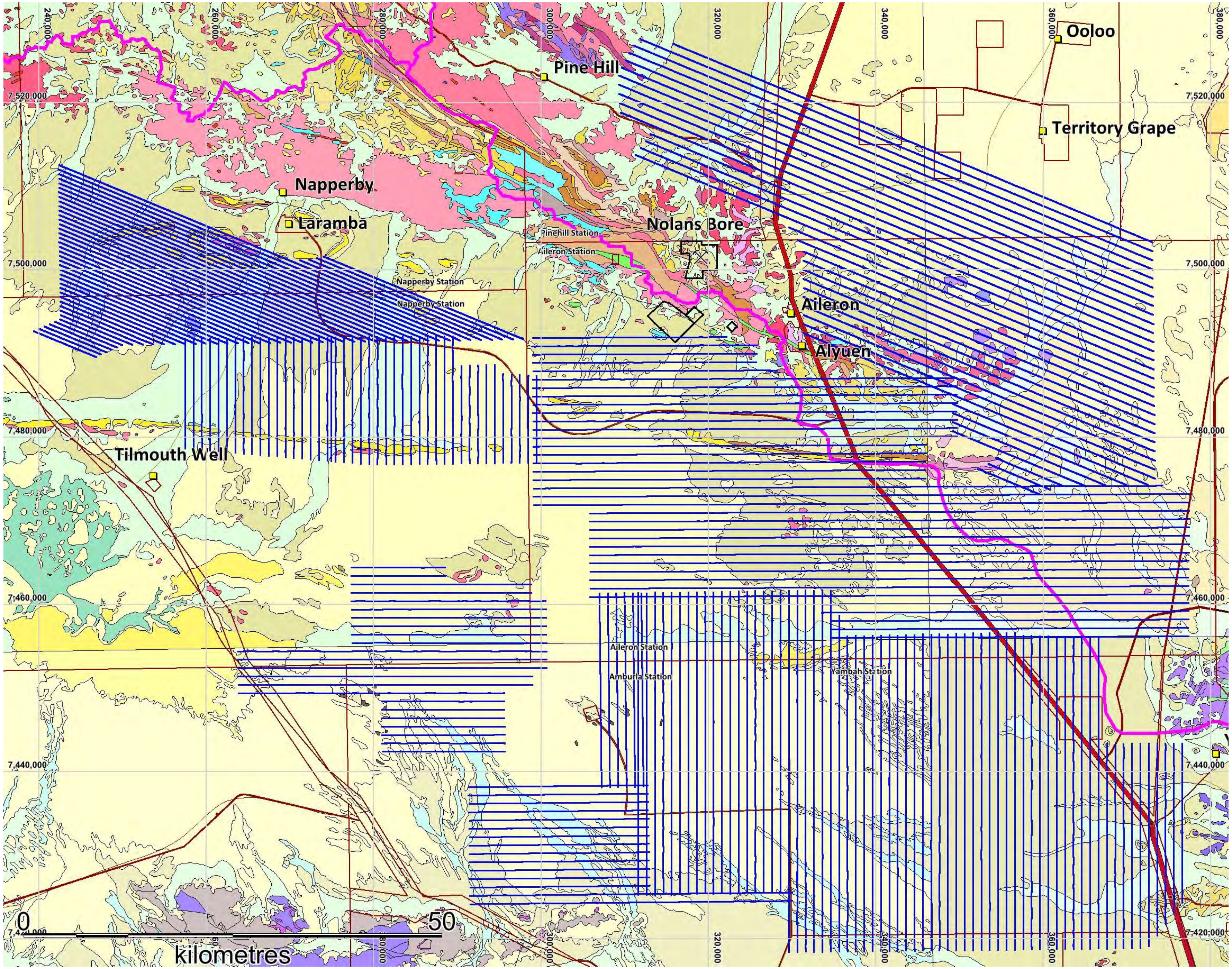


Figure 11. Published geology showing location of the flight lines for the open file TEMPEST AEM survey data that were reprocessed and used in the construction of Arafura's 5LEI model data presented in Figures 7,8 and 9. Mafic rocks (purple) occur in the S and E.

Underflow Issue

Issue 182

DME:

- *Anecdotal evidence suggests that subsurface flow occurs within the alluvium of creeks and this could presumably provide a path for the dispersion of contaminants.*
- *What is the consequence of this pathway for WRDs and the TSF/RSFs being built on top of creek lines? (Fig 3-1).*

Arafura response:

The infrastructure design plan presented in the draft EIS was preliminary and drafted by our consultants (AMC) without reference to the underlying substrate/regolith. Additional planned sterilization and geotechnical drilling will to ensure infrastructure is not placed on concealed mineralisation or palaeochannels.

The dark blue areas in Figure 12 below shows the areas of thickest alluvial cover on top of basement rock. The dark blue includes all active sandy drainage features, but it also includes all known older palaeochannels. The light blue indicates calcrete. The remainder of the area is outcrop or thin skeletal soil on top of outcrop where the cover is less than about a metre, and mostly 0.2m-0.5m or less.

Exploration has demonstrated that the calcrete bodies are thin disconnected superficial units. Drilling indicates they are 1-6m thick and all calcrete bodies are well above the current water table. Exploration drilling demonstrates that the calcrete body in the south is the thickest while those near the deposit are only 1-3m thick. The calcrete bodies form local topographic highs and all are actively being eroded and incised. They are best described as topographically inverted perched mounds, 1-6 metres above the current surrounding land surface. The calcrete bodies sit above the floor, or are at the same level as the adjacent palaeochannels; geologically the calcretes are cemented alluvial sediments and they are related to the consolidated palaeochannel sediments. The active drainage systems are topographically lower and are incised into the calcretes and older palaeochannels. Hence underflow in the calcrete and the older consolidated palaeochannels are highly unlikely. Although the calcretes may hold limited amounts of water in solution cavities until the evaporate.

Drilling and exploration mapping demonstrates unconsolidated sandy bases are likely only within the larger active drainage features within the dark blue shaded areas, where depths to the bedrock range from 1-5m maximum. The remainder of the unshaded area has thin skeletal soils and rocky outcrops. Most drainages in these areas are directly incised into bedrock and underflow is therefore not possible.

The large shaded area SE of the ML has >2.5m of unconsolidated sandy cover, based on four widely spaced trenches dug north of the station track. Most of this material is on the banks of the creek and 1-3m above current bed of the creek. This material has been identified as a potential borrow site for topsoil/growth media at closure. Further northwest along this feature in the NE corner of the ML, drilling indicates the unconsolidated sandy cover is 1-3m thick on either side of the creek bank. This feature might have small underflows outside of the active creek bed however most underflow will be restricted to the existing creek bed which is topographically lower. Most of this unconsolidated material on the creek banks in the NW of the ML sits above the active creek bed that runs through it. Arafura plans to excavate and stockpile the unconsolidated sandy material (soil) in the NE of the ML prior to placing infrastructure in this area.

The dark blue shaded area that enters the ML from the SW is mostly a consolidated (cemented) sandy soil, indicating it is a relict palaeochannel with a granite outcrop “island” in the middle. This palaeochannel also has a very thin veneer of an active channel. This palaeochannel is likely to be 1-3m thick based on exposures and limited drilling within the ML, however given that most of this is consolidated, there underflow is unlikely in this area, only surface flows.

A palaeochannel the runs through the centre of the deposit and is well known from extensive drilling to be 2-4m thick. The base of this perched palaeochannel above the RL of the base of the nearby active drainage feature (creek) which also run across the top of the deposit further west. This palaeochannel has 0-3m of unconsolidated sandy soil.

The two main tributaries of Kerosene Camp Creek that cross the ML have sandy bases, but both tributaries have numerous exposed rock bars indicating that any underflow is likely stored as a series of “bath-tubs” along the creek. A source of water and underflow is therefore expected in these creeks given the Riparian vegetation growing along the creek banks. However it should be noted that stressed and dead trees were observed along both of these creeks in 2008 and 2009 due to a prolonged drought period, indicating that the water supply is limited and underflow is periodic.

Hence only the active creeks within the blue areas are likely to have any underflow at the bedrock contact, although underflow is ponded by the rock bars and clearly periodic in this desert environment.

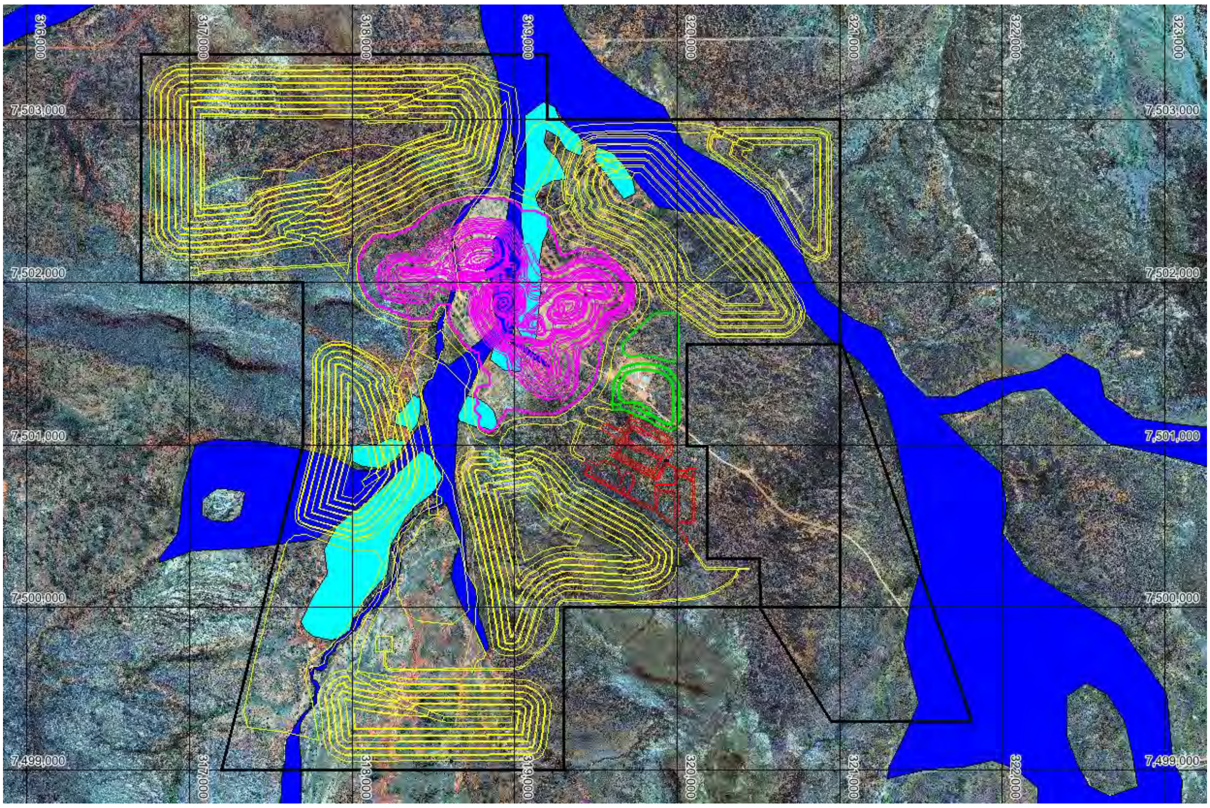


Figure 12. Map indicating the type of drainage and areas of subsurface flow. See text for discussion on this area.

Detailed drilling to assess of the depth of regolith cover in the processing and RSF area has not been done yet. Preliminary geological mapping (Figure 13) indicates most areas are likely to have very shallow cover of colluvial sheet flow sand over basement units. Hence underflow is considered highly unlikely in most of the ML. A deeper alluvial channel may occur near the alluvial deposits in the middle of the larger ML and this will need to be assessed before infrastructure is placed here. The ML area is considered large enough to allow for infrastructure to be sited in optimal locations.

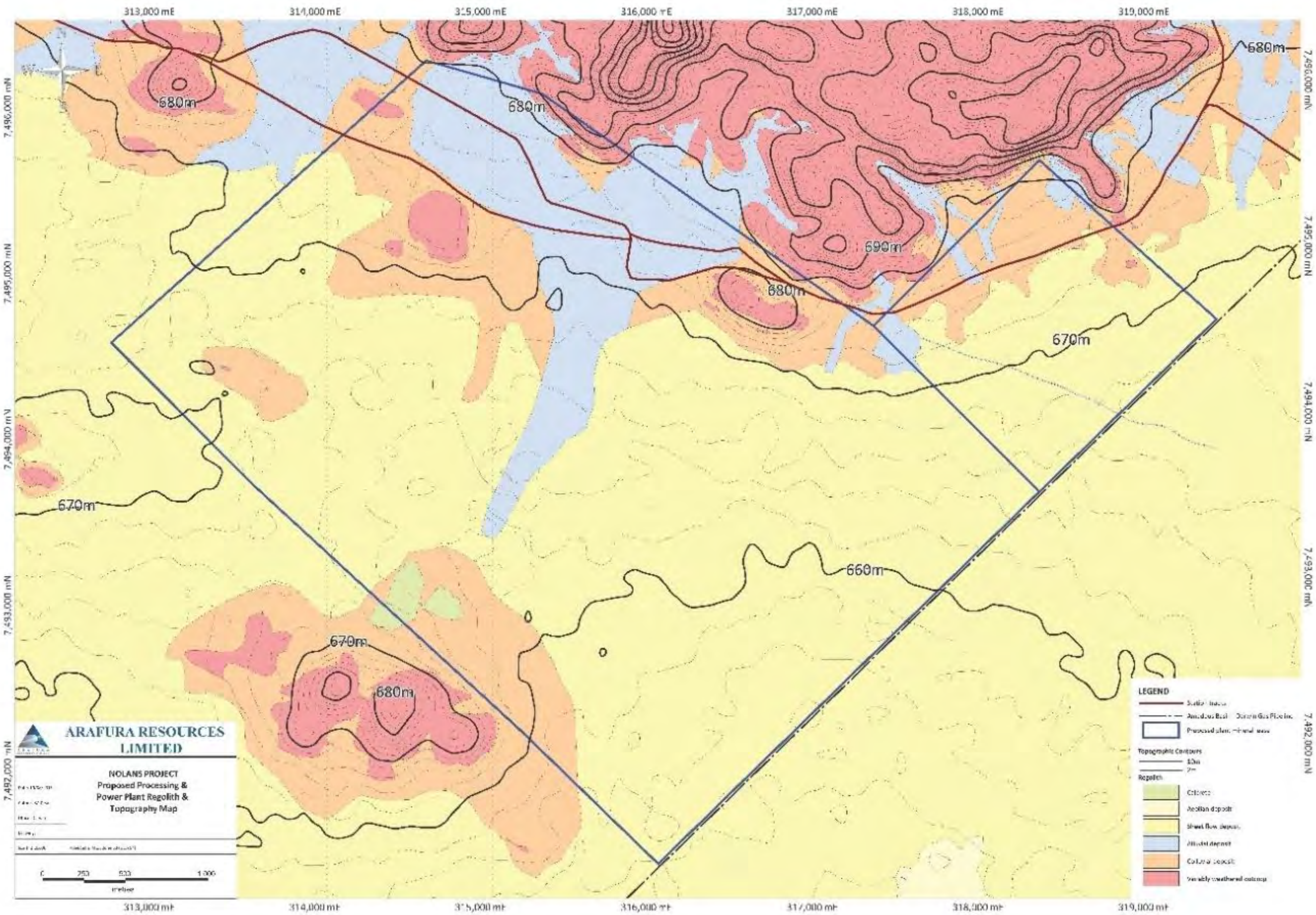


Figure 13. Geology of the processing and RSF sites.

Creek Diversion

Issue 235

DOE: Riparian vegetation impacts
Clarify what the area (ha) of riparian vegetation is which will be irreversibly impacted by the Kerosene Creek Diversion.

Arafura response:
The loss of riparian vegetation is a given within the pit (pink outline in Figure 14). Riparian vegetation will be lost both north and south of the pit as shown by the brown areas in Figure 14, although it is likely that some of the northern end will survive due to thicker alluvium and underflow from the southeast. The estimated maximum total area of impact is 11ha. Although in the long term, riparian vegetation will most likely establish along the path of the creek diversion. This area is shown in bright green and is estimated to be about 17ha.

The creek diversion occurs in an area of almost no outcrop. The route contains limited outcrops of metamorphic rocks (schist, gneiss and quartz veins) and the surface geology is predominantly colluvial or alluvial sandy soils. The metamorphic rocks that have been observed along the proposed route are analogous to those found in the outcrops immediately north and south of this route. This channel route has not been drilled however mapping in the Nolans area shows that the predominant geological/structural trends are NW-SE and hence new/different rock types are highly unlikely.

The proposed diversion channel will therefore likely be constructed through quartzite, schist and gneiss units similar to those found in the adjacent hills and in exploration drilling at Nolans Bore. There is also at least one unmineralised quartz vein outcrop along this route which is similar to the rare quartz veins observed at Nolans Bore. Based on the AMD test work and the geochemical assessment of waste rock for the proposed mine site, the diversion channel is therefore likely to be comprised of chemically inert rock types. There is a chance that a narrow zone of mineralisation might be intersected near the actual diversion point although exploration drilling in this area suggests it may not extend this far. Irrespective, local radioactive highs associated with outcropping mineralisation and other natural country rocks (NORM) are not unusual in the Nolans Bore area.

Arafura plans to map and representatively analyse the various rock units extracted from the diversion channel when samples become available, *e.g*. during geotechnical drilling and construction.

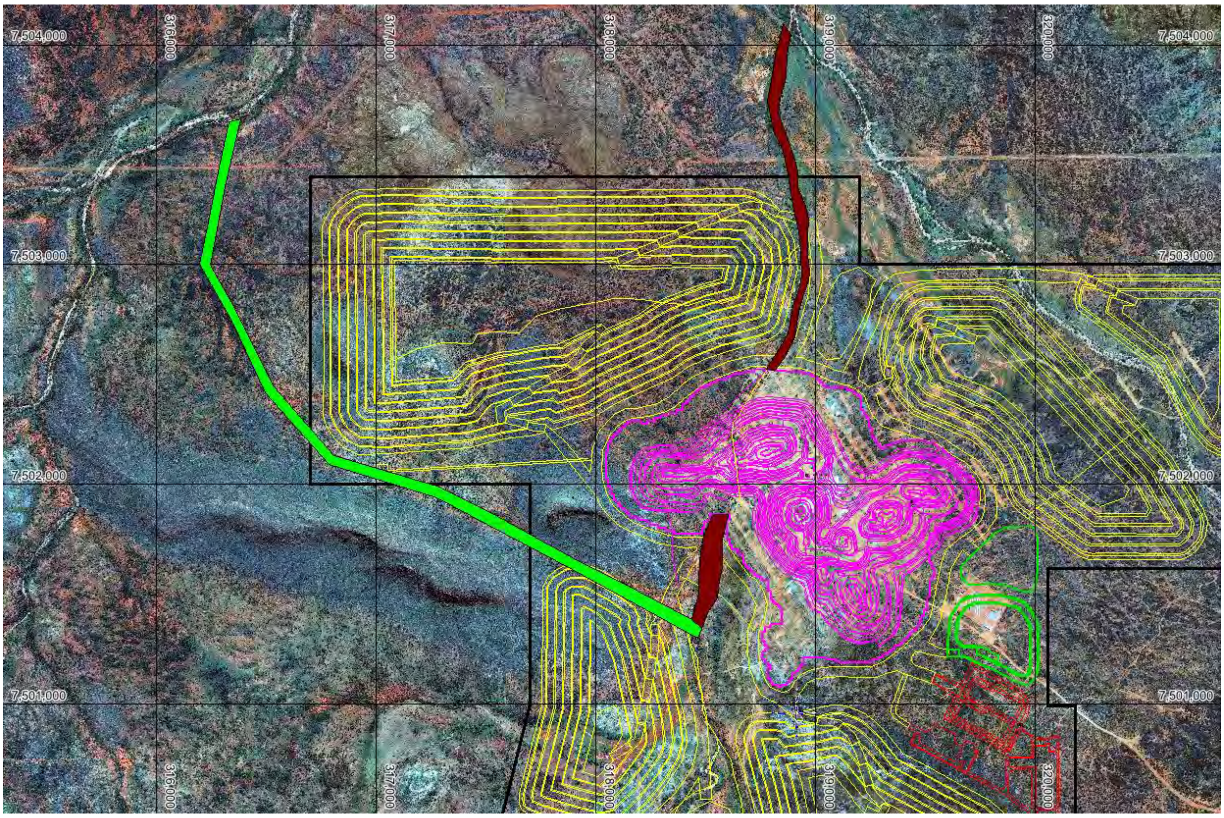


Figure 14. Creek Diversion around the Nolans Bore mine.

Issue 237

Geoscience Australia: Hydrology

The Woodfoorde River Lineament is a possible neotectonic feature associated with reactivated basement structures. This feature lies immediately to the north of the minesite, and controls the channel of the Woodforde River for approximately 35 km. There have not been any recorded earthquakes associated with this feature. This feature may represent an area in the landscape which is more susceptible to fluvial incision than the surrounding landscape.

Arafura response

Arafura assumes that the Woodforde River lineament mentioned above is the interpreted linear feature coinciding with the eastern margin of the Wordforde River drainage channel north of the Pinehill access road, and shown as a dashed white line in Figure 15 below. This lineament starts about 20km NNE of the mine site and continues northwards, ceasing near the Ti Tree farms. This lineament is clearly at a high angle to the prominent regional geological fabric of the region and it is not coincident with any identifiable deep-seated basement structure (Figure 16).

I agree that this feature could be a possible neotectonic structure as there is small change in elevation across the lineament along the Stuart Highway to Arden Soak access track which crosses this feature about 10km north of the Pinehill access road. There is also a difference in the regolith units either side of the river channel. The eastern side of this lineament has a stabilised aeolian component with linear dunes overlying consolidated red sandy soils, but the stabilised aeolian dune component is largely missing or is very thin on west side of the creek. This suggests some erosion on the western side, possibly associated with minor neotectonic activity sometime in the past.

This lineament does not propagate southward into the outcropping Arunta basement rocks on satellite imagery, nor is the southern extension of it evident in Arafura's detailed low-level geophysical dataset. If this is a real geological structure (*i.e*. neotectonic fault), I suspect it is probably restricted to the Cenozoic Ti Tree Basin because the magnetic data indicates the satellite lineament ceases at the northern edge of the NW-SE Pinehill Shear Zone (Figure 16). However as noted above there are no coincident basement structures evident in the available geophysical data which casts some doubt on the validity of a geological feature.

The Woodforde River and its tributaries are all generally incised by similar amounts (2-4m) all the way from Ti Tree upstream into the headwaters in the Reynolds Ranges. There is no significant difference in the amount of incision coincident with the Woodforde lineament. The Woodforde drainage system actively erodes into carbonate-cemented hardpan soils and gravels which suggests the river system and associated palaeochannels have been in place for considerable geological time and migrated across the valley floor. There is also clear evidence in the satellite imagery for the capture and diversion of drainage features on the west side of this lineament.

Hence this lineament may be a neotectonic feature but the landscape has largely recovered and stabilized.

There is unlikely to be any hydrological or fluvial incision risk to the project area from a possible neotectonic feature that commences some 20km to the NNE. Furthermore it is significantly down gradient of the mine site and it parallels the Woodforde River. The infrastructure for the Nolans project will be designed to ANCOLD guildelines re the potential siesmicity risk of the area.

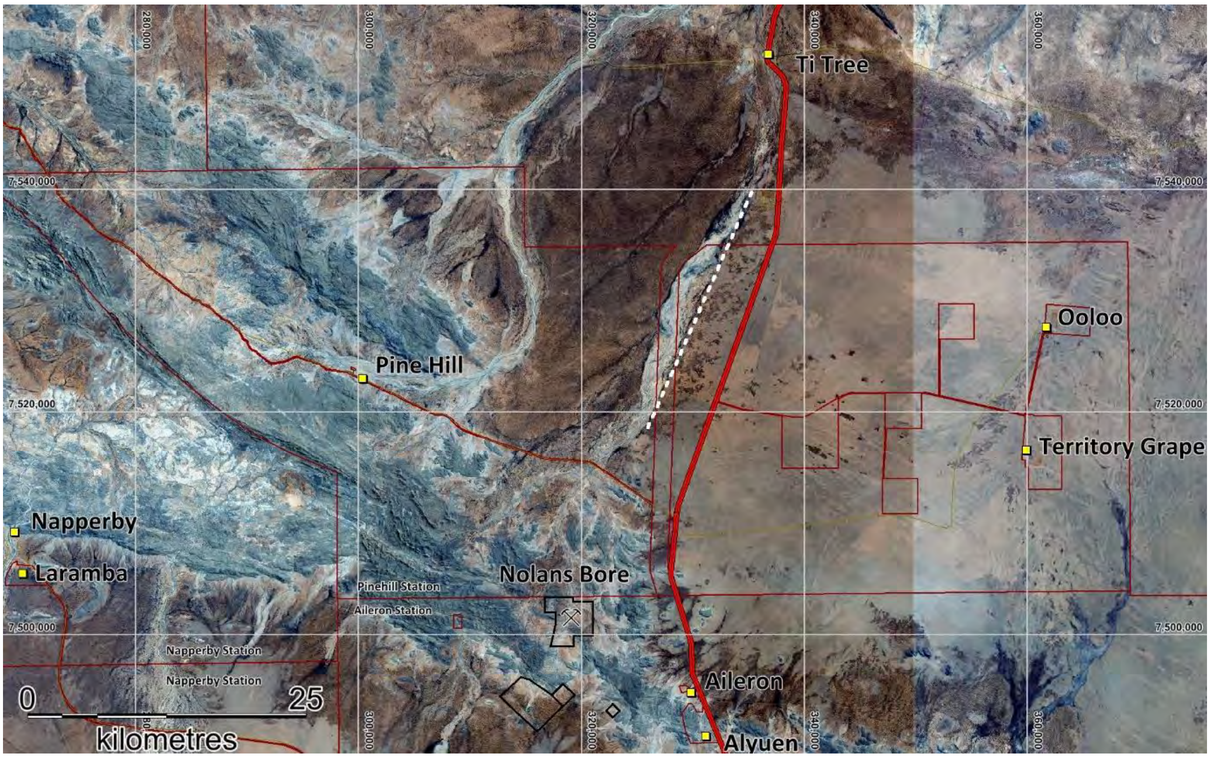


Figure 15. Satellite image showing the inferred location of Woodforde lineament.

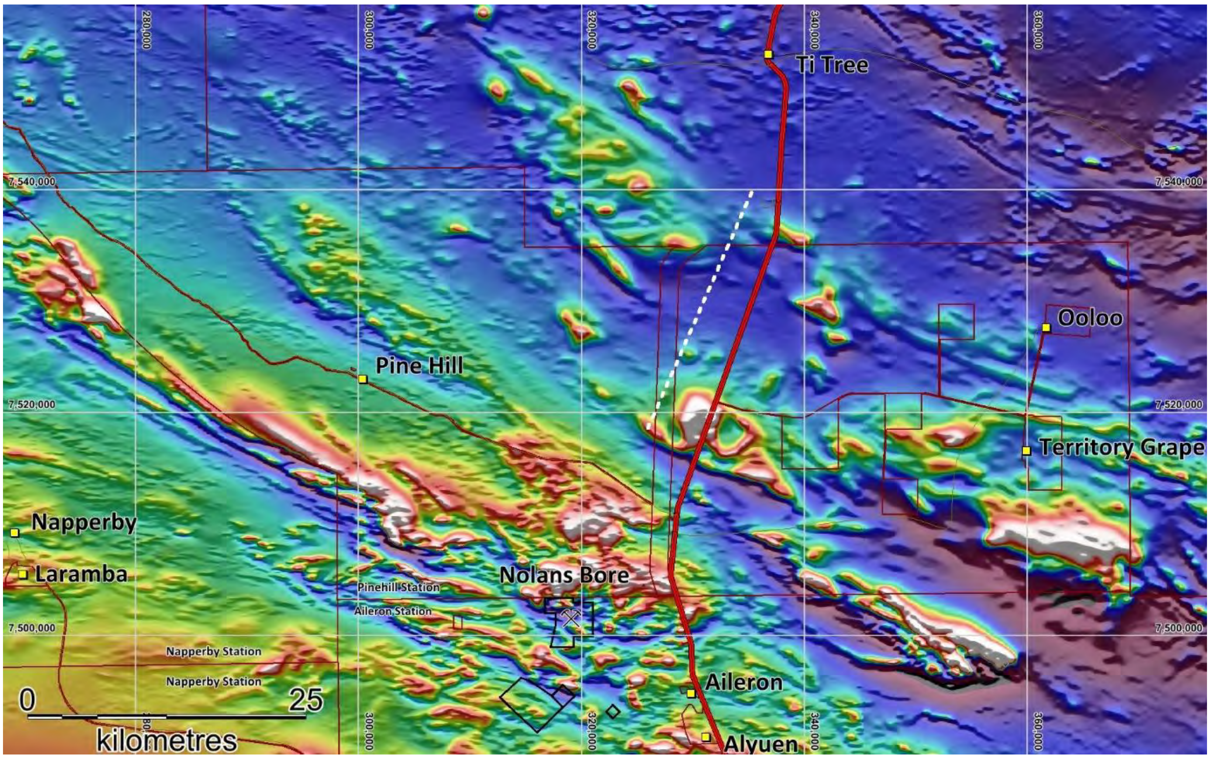


Figure 16. Magnetic image showing the location of the Woodforde lineament. Note this does not correspond to a basement feature. Most geological structures in this region trend NW.

Issue 302

DME:

- *It is indicated in the Section 8.5.5 that samples for AMD testing were taken of pegmatite, mineralisation, gneiss and schist. Provide geology maps of the deposit showing the surface distribution of the geology in context to the proposed pit outline. Provide geological cross-sections of the deposit, showing the outline of the proposed pit and zones of mineralisation.*

Issue 304

DME:

- *The distribution of the mineral resource categories has been described and illustrated. Provide details of the main categories, material types and distribution of the waste rock material.*

Issue 305

DME:

- *Calcsilicate mineralisation - the mineralisation has elevated concentrations of calcium, phosphorous, thorium, uranium, strontium and fluorine.*
- *What are elevated concentrations in the different waste rock types?*
- *Provide cross-sections of the resource model which shows the distribution of the two broad styles of RE bearing mineralisation i.e. apatite and calcsilicate mineralisation.*

Issue 424.

DME:

- *There are significant inconsistencies in the presentation of the historical geochemical dataset:*
    - *The number of elements is stated as both 38 and 42;*
    - *Sulfur results were not presented;*
    - *Analytical techniques are not clear;*
    - *The summary table in section 4.2.2 appears to combine historical data and data from stage 1 and 2 EIS investigations. It is not clear which samples were subject to field XRF, benchtop XRF or Inductively Coupled Plasma (ICP) analysis.*
- *More information is required and must include:*
    - *Source of the samples (exploration chips, core etc);*
    - *Suitability for analysis (i.e. any oxidation prior to analysis);*
    - *Lithological description;*
    - *Total sample numbers of each major lithological unit;*
    - *Parameters analysed; and*
    - *Parameters calculated along with assumptions.*
    - *Figures must be included showing the sample locations and where appropriate, cross-sections showing the vertical distribution of the sample locations with respect to the dominant rock types and proposed footprint of the open pit.*

Arafura's response.

This response combines discussion on the waste rocks for AMD, radioactivity, and the oxidation states

As noted by DME the mineral resource categories were described and illustrated in the draft EIS. The details of the main resource categories were provided in Table 3-3 and the distribution of these categories is shown in Figure 3-6. The main types of mineralisation are described in Section 3.5.2 and the description and proportions of the mineralised material types are presented in Table 3-4. The distribution of the mineralised material types is presented in Figure 3-7 on pages 3-16 and 3-17. The Mineral Resources was updated in June 2017. There was no material change to these resources.

The waste rocks and their distribution were omitted from the diagrams in the draft EIS for clarity. The waste rock categories and their estimated volumes are presented in the draft EIS in Table 4 in Hussey in Appendix P. Since then a new Mineral Resource model and statement has been released. The differences in volumes and grades between the 2015 and the 2017 model are very minor and immaterial to the EIS. The only significant difference in these models is the re-classification of mineralised material types. This reclassification was completed to quantify ore types that treat more favorably using the

PAPL flowsheet, *i.e*. return higher recoveries of rare earths and phosphate. The ore referred to as non-preferred is likely to treated later in the projects life when lower recoveries of these resources is less critical.

Geological and geochemical background

The Nolans Bore geological model is based on 99,340m of drilling and costeans in and around the deposit. All drill samples have been geologically logged with the radioactively measured by hand-held Geiger meters at the time of drilling. A total of 56,048m of drilling has also been radioactively logged in 5cm intervals using calibrated downhole gamma probes providing a continuous representative log of the radioactivity at Nolans Bore and surrounds. The downhole surveys provide the best unbiased determination of the radioactivity of the deposit and its host rocks. There is a total of about 8,114m of drilling outside of the identified resource and Arafura's understanding of the local geology is further enhanced by observations and measurements at more than 5,000 local and regional sites.

Arafura has assayed a total of 29,012 drill and costean intervals at Nolans Bore. This equates to 46,724.59m or 47% of the total drill and costean metres. The un-assayed material (about 53% of the drilling) is typical un-mineralised/unaltered country rocks that host the deposit. Assays were specifically focused on intervals of mineralisation, alteration and their immediate surrounds. All rocks with radioactivity measurements above background radioactivity where also assayed. Hence the overall assay population is strongly biased towards the more radioactive rocks with the non-radioactive material assayed less frequently. This was done because the REE grade strongly correlates with the radioactivity of the sample.

Most of the primary assay samples were assayed for Al, Ba, Ca, Fe, P, Sr, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y, U and Th at Northern Territory Environmental Laboratories (NTEL) using their G321 method which is an ore-grade digest suitable for Nolans Bore-type mineralisation. Four batches of primary assay samples were assayed at AMDEL using similar protocols. These primary assay results have all been verified by systematic 1/20 field duplicates and routine 1/20 or more inter-laboratory check assays. To ensure a better understanding, the inter-laboratory check assay samples differ from the field duplicates and were only chosen after the initial primary result were reported. Inter-laboratory check assays include the standard Nolans Bore elemental suite (Al, Ba, Ca, Fe, P, Sr, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Y, U and Th) plus combinations of Hf, Li, Mg, Mn, Nb, K, Rb Si, Ta, Ti, V and Zr, and were determined via fusion/ICMPS at Intertek Genalysis in Perth. Genalysis's interlaboratory check results confirmed that NTEL's results were acceptable for elements of economic interest in mineralisation although elements such as Al, Ca and Fe are clearly under-reported at NTEL in some cases due to silicate digest issues. The REE-Th-U values in waste rocks are sometimes slightly under-reported at NTEL, although the vast majority of most primary/check assays agreed within stated laboratory errors. All assay results are verified and checked based on CRM and internal standards and duplicates/blanks.

In 2016, Arafura decided to shift to the phosphoric-acid pre-leach (PAPL) process. This processing route specifically targets the phosphate-rich REE mineralogy of the deposit. This differs from the sulfuric acid pre-leach (SAPL) process discussed in the original draft EIS which targeted REE recovery from all REE-bearing minerals. This new processing route means that phosphate can also be recovered. It also involves considerably less material handling, and is more efficient and cheaper to build and operate.

The shift to PAPL required a complete revision of the geological model and a better understanding (new model) of the distribution of the various mineralised material types at Nolans Bore. Hence a comprehensive material type re-classification was necessary because Arafura's test work indicated different REE and P recoveries for different material types. Furthermore, the original classification that has been used for all mine planning studies since 2012 was inadequate for PAPL. The new material type re-classification is shown in **Error! Reference source not found.** Table 3.

Consequently, the material types of 27,657 individual assay intervals within the LOM pit shell were individually re-evaluated based on a thorough analysis of the geology and mineralogy of the stored drill core and RC chips. To assist with this deposit-wide material type re-classification, 3,500 representative whole rock fusion/XRF assays were done at Genalysis using existing pulps. The XRF assays included Al_2O_3, BaO, CaO, Ce_2O, Eu_2O_3, Fe_2O_3, Gd_2O_3, K_2O, La_2O_3, MgO, MnO, Na_2O, Nd_2O_3, P_2O_5, Pr_6O_{11}, SiO_2, SO_3, SrO, Sm_2O_3, ThO_2, TiO_2, U_3O_8 and Y_2O_3 plus LOI at 1000°C. A selection of these pulps were also assayed for F by SIE. Detailed assessments indicate the new XRF results are more precise than the previous data and most importantly these results confirm and enhance the understanding of the previous REE and P assays. The new XRF results also provide additional robust Fe and Al data, which is required for mine planning studies.

There are now a total of 4,769 representative whole rock assays at Nolans Bore. These cover all rock types and the LOM, and have been used to estimate deleterious elements such as Fe and Al across the deposit. Together the material type re-classification and the whole-rock assays allow the mineralisation to be re-classified into various groups depending on their mineralogy for mine planning studies. These groups are:

- PAPLP (PAPL preferred)
- NP1 (non-preferred1)
- NP2 (non-preferred2)
- WASTE

Table 3. Material type reclassification (MAT2016) for Nolans Bore. The different MAT types have been grouped for detailed geological assessment and mining studies.

MAT type	MAT Group	Description	Comments
0A	WASTE	Country rock with no evidence of MIN.	Waste rock with TREO <0.5%. No evidence of MIN (veins) in core. Some country rock pegmatites exceed 0.5% TREO however these have a distinct chemistry with low P_2O_5.
0B1	WASTE	Country rock with evidence of minor MIN but <0.5% TREO.	Essentially waste. Narrow/minor MIN veins can be present but low grade.
0B2	WASTE	Country rock with evidence for minor MIN but >0.5% TREO.	Probable waste in many cases. Isolated or narrow/minor MIN but generally low grade.
0B3	WASTE	Country rock but geochemical evidence for MIN in interval. No obvious MIN in RC chips.	Only used for RC samples. Mineralogy of stored sample is not consistent with chemistry of >1% TREO and elevated P_2O_5. This is not unusual in RC drilling if the stored sample was poorly sampled.
0C	WASTE	Altered country rock with <0.5% TREO.	Essentially waste but the style of alteration is geologically associated with MIN. Examples include extensive epidote-rich alteration, calcsilicate alteration selvages, bleached zones (*i.e.* plagioclase alteration with minor tremolite veins) and extensive zeolite alteration.
1	PAPLP	Cream/green apatite with <2% allanite (<30% clay and <25% calcsilicate).	Unoxidised massive apatite MIN with trace or no obvious allanite. Typically containing minor carbonate especially if trace allanite. Lacks obvious hematite/goethite staining and therefore should have lower Fe than MAT2. High P_2O_5 and elevated TREO and P_2O_5/TREO typically >4. Fresh country rock nearby.
2	PAPLP	Brown apatite with <2% allanite (<30% clay and <25% calcsilicate).	Oxidised massive apatite MIN with trace or no obvious allanite. Typically contains voids with chalcedony and hematite/goethite. Should have higher Fe than MAT1. High P_2O_5 and elevated TREO and P_2O_5/TREO typically >4.
3A	NP1	Fine grained monazite and crandallite-rich MIN >30% clay	>30% clay is essential. High grade “cheralite” MIN with P_2O_5/TREO <2.5. Typically described as ‘puggy baby-shit’ coloured stuff but many clay-rich examples with suitable chemistry have a much lighter hue.
3B	PAPLP	TREO >0.5% and >30% clay with oxidised apatite, cheralite, kaolin and clay	>30% clay is essential. MIN similar to type2 but with higher clay content and variable TREO grades. P_2O_5/TREO >2.5. Note not classified where TREO and P_2O_5 are low because material should be assigned to type 3C.
3C	WASTE	TREO <0.5% and >30% clay with mixture of oxidised country rock, apatite, cheralite, kaolin and clay	>30% clay is essential. Low grade clayey intervals often associated with MIN but essentially altered waste rock. Examples include extensive low-grade kaolin alteration. This classification is differentiated from type 0C largely due to the abundance of clay and kaolin. It is often closely associated with types 3A and 3B.
4A	PAPLP	Apatite with 2-10% allanite	Massive apatite with minor allanite (mostly type 1 observed), < 25% calcsilicates and <30% clay.
4B	NP2	Apatite with >10% allanite	Massive apatite with significant allanite (mostly type 1 observed); <25% calcsilicates; <30% clay. Note Central Zone often has apatite+allanite+amphibole rocks which are best classified as type 5B2.
5A1	PAPLP	>25% OH-free calcsilicates + apatite + <10% allanite	OH-free calcsilicate minerals (pyroxene and garnet) are key minerals in this type. Variable amounts of apatite and <10% allanite; often a mixture of veins and variably altered selvages. Trace or minor allanite is often associated with calcsilicate-rich parts. <30% clay.
5A2	NP2	>25% OH-bearing calcsilicates + apatite + <10% allanite	OH-bearing calcsilicate minerals (*e.g.* epidote, amphibole, zeolite etc) are key minerals in this type. Variable amounts of apatite and <10% allanite Trace or minor allanite is often associated with calcsilicate-rich parts. <30% clay.
5B1	NP2	>25% OH-free calcsilicates + apatite + >10% allanite	This type was devised for allanite-rich type 5A1. However as expected, no samples were identified in this category.
5B2	NP2	>25% OH-bearing calc-silicates + apatite + >10% allanite	This type was devised for allanite-rich type 5A2. Epidote and/or amphibole often dominate this type, and sometimes zeolite; the apatite + allanite + amphibole breccias in the Central Zone fall into this category; <30% clay
6B	WASTE	>30% clay, >25% calcsilicates + apatite + allanite; TREO > 0.5%	Rare. Dominated by clay and calcsilicates. Probable waste.
6C	WASTE	>30% clay, >25% calcsilicates + apatite + allanite; TREO < 0.5%	Rare. Dominated by clay and calcsilicates. Essentially waste

The distribution of the new mineralised material types at Nolans Bore is geologically complex and it is not easy to portray visually. Many blocks in the current Mineral Resource model contain mixed material types. To simplify matters these re-classified material types are best interpreted and view in terms of their MAT group. There are large parts of the deposit where PAPLP material types dominate, however there are also numerous places throughout the deposit where mineralised blocks have mixed MAT groups. The requested cross-section showing the distribution and apatite vs calcsilicate mineralisation no longer applies given the re-classification of material types. Nevertheless, Figure 17-22 shows both a plan view and a cross-section for each mineralised MAT group. The colour code is shown in Figure 17 and applies to Figure 17-22.

The PAPLP material types covers all mineralisation that is likely to yield the highest processing recoveries. The non-preferred types are likely to have lower REE and P recoveries, but only limited data is available at present to quantify this; further work is planned; The non-preferred mineralisation contains phosphate-bearing REE minerals however the presence of other REE bearing minerals such as allanite means there will be lower REE and P recoveries in the PAPL process. NP1 is likely to have similar recoveries to PAPLP in beneficiation however the higher Al and Fe contents may inhibit REE recoveries in the hydrometallurgical stages. Again further work is planned.

By definition, waste rock (WASTE) is all material containing less than 1% TREO in the Nolans Bore Mineral Resource model. Geologically, waste rock is commonly equated to the unmineralised country rock that hosts the deposit. At Nolans Bore, this includes gneiss (GNE), pegmatite (PEG) and schist (SCH) and it represents the vast majority of the waste rock (*i.e*. nearly 100%). Some waste rock occurs within the identified bodies of mineralisation (Mineral Resources) but this is typically treated as dilution and is considered part of the ore during mining if the grade is high enough, and removed where possible during beneficiation. Conversely, waste rock also includes narrow or discrete bodies of mineralisation which are too small to be geologically modelled as a separate body or classified as Mineral Resources. Unclassified resources are not unusual in a geological model and they are typically defined as waste rock. In most cases, this unclassified mineralisation is low-grade and at Nolans Bore it typically represents a small component of the total waste rock volume. This unclassified mineralisation is unlikely to be of economic interest based on the current understanding. However with better geological information, such as infill or grade control drilling, some of this unclassified mineralisation may eventually be upgraded from waste rock to Mineral Resource status.

The mineralisation at Nolans Bore has a unique geochemical signature and contains elevated concentrations of Ca, P, REE, Th, U, Sr and F. Together with oxygen, these elements are the principle constituents that form the mineral, fluorapatite. Fluorapatite is the dominant mineral species in Nolans Bore-type mineralisation, accounting for up to 90% or more of the total volume. The mineralisation also often includes a variety of calc-silicate minerals (*e.g* clinopyroxene, amphibole and epidote-allanite) as well as REE phosphates, oxides, silicates, and carbonates. Fluorapatite is not an unusual mineral, as it also occurs as a common trace mineral all of the country rocks at Nolans Bore (*i.e.* <0.1%). However apart from trace amounts of monazite (a REE phosphate) and fluorapatite, the waste rocks are completely devoid of minerals that typify Nolans Bore-type mineralisation. Thus mineralogically speaking, it is very easy to identify which is which. The unusual thing about Nolans Bore mineralisation is the concentration and large quantity of fluorapatite in this deposit. Whole rock assays indicate the mineralisation may contain up to a maximum of about 50% CaO, 40% P_2O_5, 50% TREO, 5% ThO_2, 4000ppm U_3O_8, 2.5% SrO and 2.7% F.

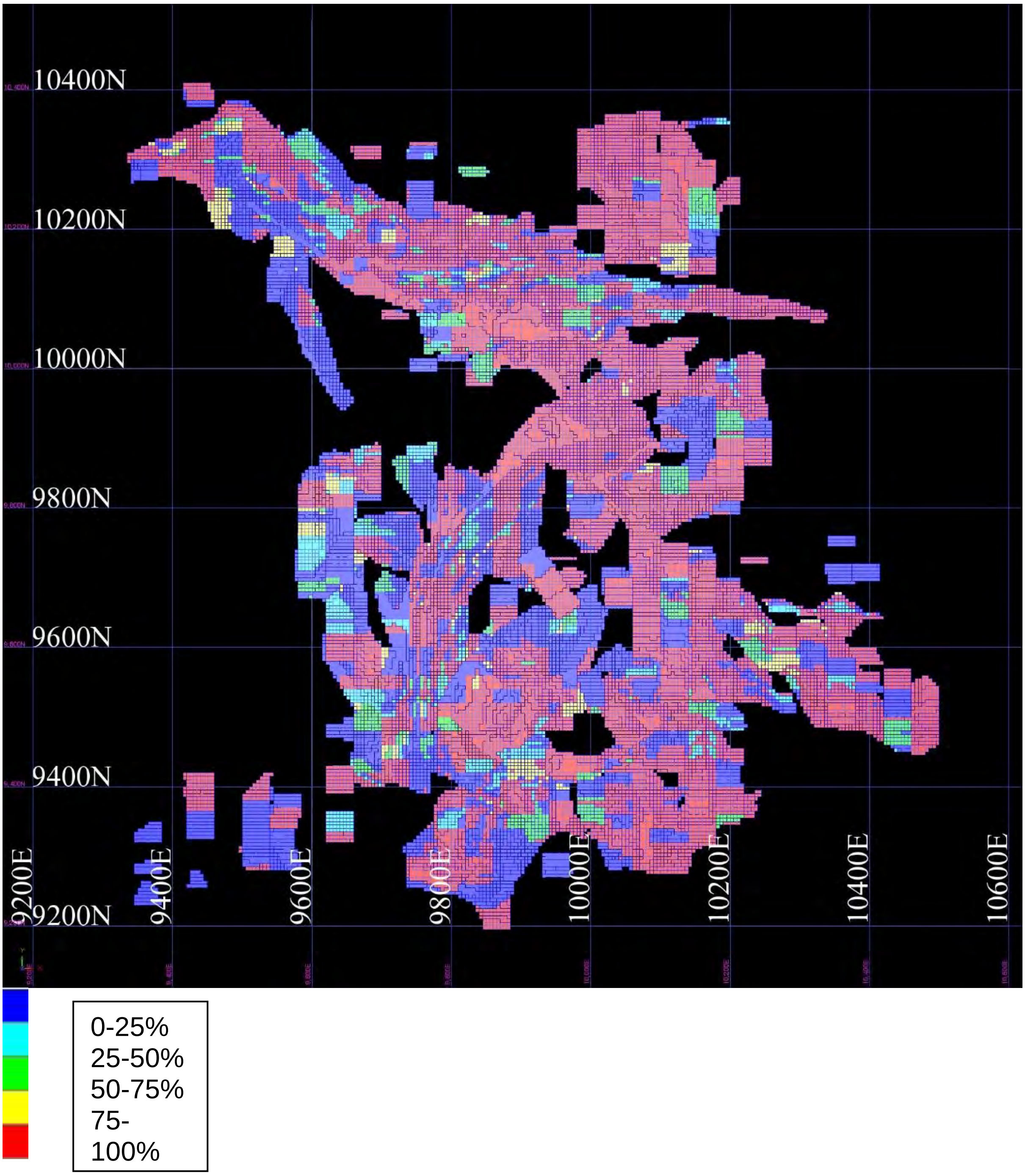


Figure 17. Plan view of Nolans Bore showing the distribution of PAPLP colour-coded by the fraction of this material type in each resource block. This colour code applies to Figures 17-22.

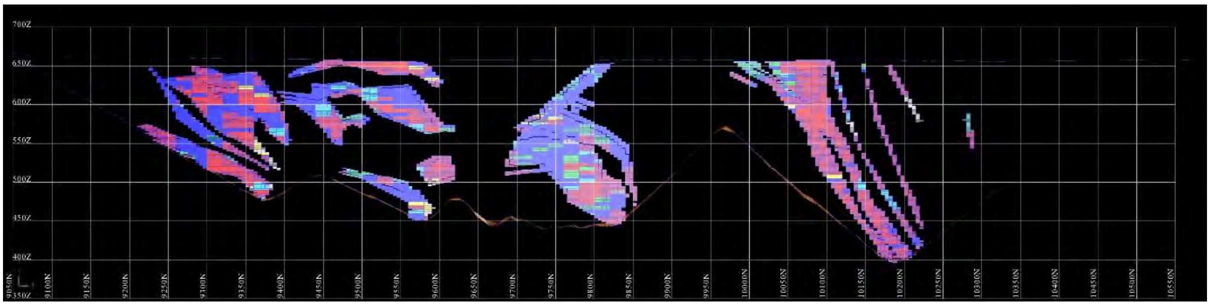


Figure 18. Section 9840E showing the distribution of PAPLP colour-coded by the fraction of this material type in each resource block.

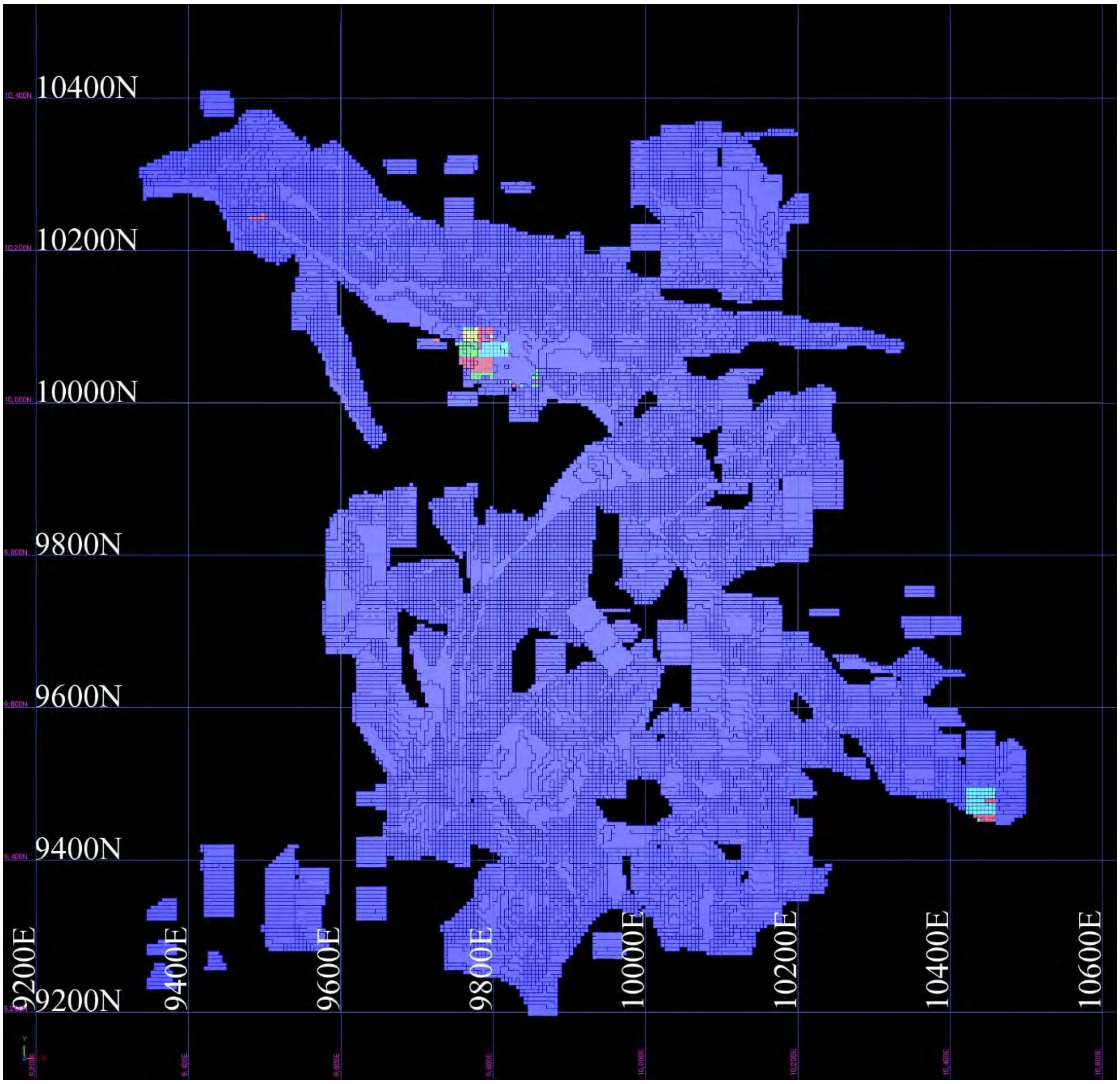


Figure 19. Plan view of Nolans Bore showing the distribution of NP1 colour-coded by the fraction of this material type in each resource block. Note NP1 contains gigh-grade mineralisation and is clearly restricted to discrete parts of the deposit.

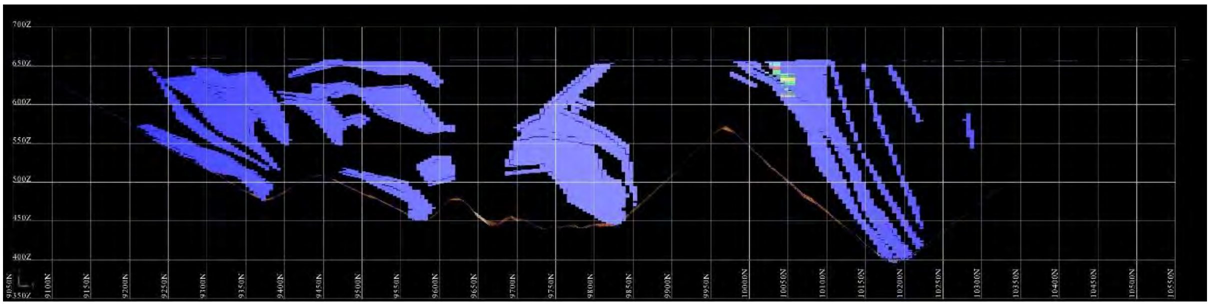


Figure 20. Section 9840E showing the distribution of NP1 colour-coded by the fraction of this material type in each resource block.

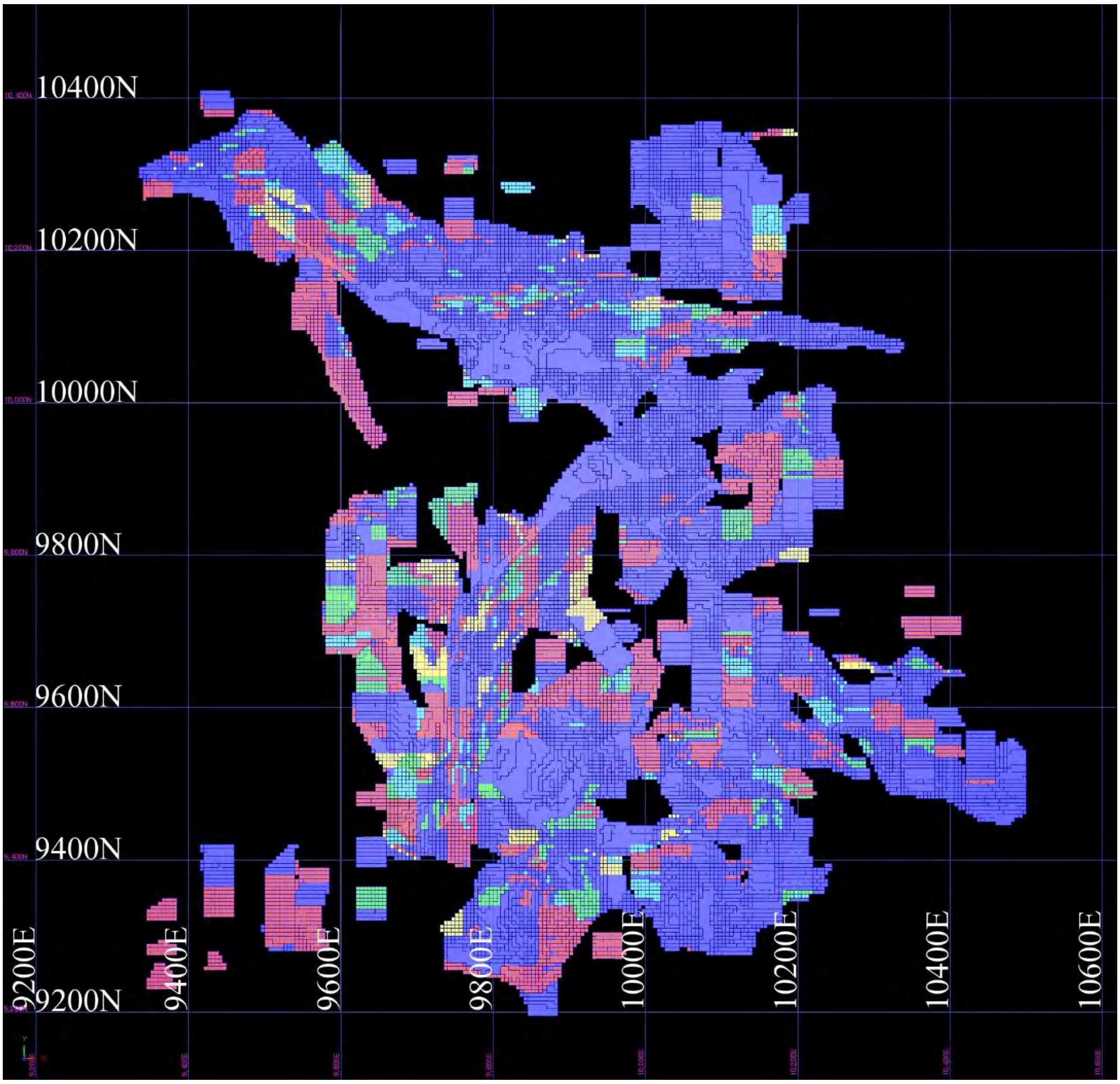


Figure 21. Plan view of Nolans Bore showing the distribution of NP2 colour-coded by the fraction of this material type in each resource block.

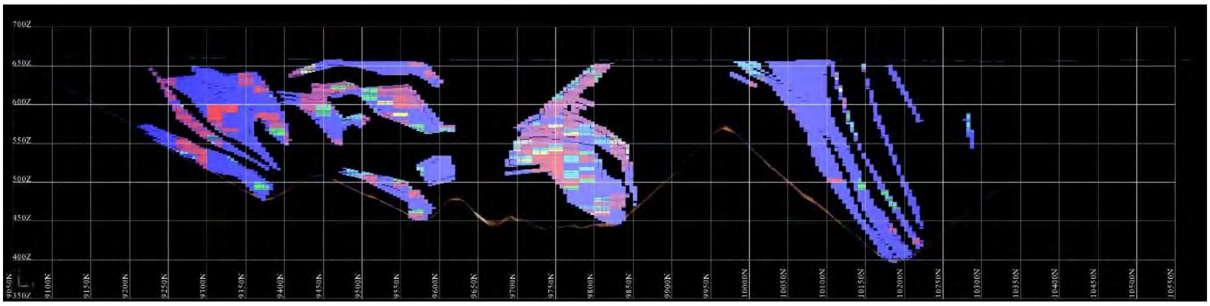


Figure 22. Section 9840E showing the distribution of NP2 colour-coded by the fraction of this material type in each resource block.

Sulfur

SO_3 was added to the XRF assay suite for Arafura's material type re-classification program. These XRF results therefore provide additional information with respect to the samples selected for AMD studies that were reported in the draft EIS below (the locations and lithologies of these AMD test samples are provided Figures 19-25 below). The additional sulfur analyses also allowed Arafura to geologically and geochemically model the sulfur content, and therefore further enhance our understanding of potential AMD material (See Below). There are now a total of 3,473 sulfur assays at Nolans Bore. Note these sulfur results and the new model does not include Arafura's in-house pXRF data. The sulfur data is considered representative and meaningful with respect to the mineral resource, waste rock and the various weathering states.

Sulfides are in general rare at Nolans Bore and in the surrounding region. Drilling and exploration of the country rocks that surround and host the deposit, and form the waste rocks discussed here, indicate there are only trace amounts of disseminated pyrite cubes to <1mm in size. Pyrite has been observed in all waste rock units but these are generally rare. No other sulfide mineral species have been observed in the waste rocks.

The mineralisation at Nolans Bore is predominantly apatite together with REE oxides, silicates and carbonates. This mineralisation formed as part of an oxidized mineral system. Hence the sulfur in the mineralisation is already in an oxidized form, occurring as a small amount of non-acid generating sulfate in apatite, gypsum and barite. Both gypsum and barite are present as trace components of the mineralisation and hence most of the sulfur will therefore be in the apatite. Trace pyrite is occasionally observed in some of the mineralisation but this is rare and only in specific parts of the deposit.

The highest sulfur assay from Nolans Bore is 2% S. This sample is weakly mineralised and contains some pyrite. This sample will most likely be mined together with the adjacent mineralisation. The highest S assay for a waste rock sample interval is 0.74% S. GHD has indicated that rocks exceeding about 3000 ppm S (*i.e.* 0.3% S) have the potential to be acid-forming, depending on their neutralizing capacity. There is often a small amount of carbonate in the mineralisation but this is not found in the waste rocks. The waste rocks are mostly silicates so their neutralizing capacity is likely to be limited. Only 40 assay samples exceed 3000 ppm S however 29 of these are mineralised apatite-rich mineralisation where the sulfur occurs in non-acid forming sulfate-bearing minerals. A total of 194 assays exceed a much more conservative cut-off of 2000 ppm S, however 177 of these samples are again apatite-rich mineralisation which is unlikely to be acid-generating. Representative whole rock analyses and geological modelling shows that the amount of potential acid-generating material is therefore very small at Nolans Bore.

Arafura could readily neutralise this potential AMD waste rock material if required by utilising the superficial calcrete units that outcrop within ML26659. Confirmatory ANC tests completed on several samples from the area indicate this material has the capacity to neutralise about 650kg of H2SO4 per tonne (Dean 2012). Comprehensive whole rock assays were not done on this test material, only the major elements were assayed. Systematic exploration drilling demonstrates that the U and Th contents are typically very low although rare parts of the calcrete are weakly radioactive as a small number of samples exceed 80 ppm U.

The LOM pit and various rock types are shown in Figure 23 below. These Figures demonstrate that the waste rock units and MIN are widespread across the deposit and there is a complex geological relationship. The schist unit is most prevalent on W and S sides of the LOM pit, but patches of schist have also been mapped throughout the deposit. The schist unit forms an arcuate belt the sweeps around the western and southern margins of the deposit. Geological logging and the foliation trends indicate to the schist unit wraps around the deposit, with most SCH outside or below the western and southern sides LOM pit. The schist unit only forms a small part (13 vol%) of the LOM pit. The gneiss unit (GNE) is the largest waste rock unit within the LOM (59% by volume), dominating the north, central and eastern part of the pit and it continues to the north and east. Pegmatite makes up the balance of the waste lithology.

The distribution of GNE, PEG, SCH and MIN samples analysed as part of the EIS waste rock characterisation program are shown on the plots below (Figures 27-33). Fifty representative samples of each rock type were selected by Arafura and submitted to ALS Brisbane on behalf of GHD. The results of this test work are reported by GHD in the Draft EIS Appendix L. To supplement GHD's test work, and to limit assay costs, Arafura assayed an additional 679 representative samples in-house using a pXRF, making a total of 879 samples which is line with the recommended guidelines provided by GHD (Table 4). The selected samples lie within the LOM pit based on the 2012 Mineral Resource model and cover the variations of these units (Figure 27-33). These samples were selected to provide a comprehensive spread of data from various lithologies and weathering states across the deposit. To ensure an adequate coverage and representativity, 2m assay samples were selected from one of the following depth ranges 0-50m, 50-175m and 175-250m drilling depth. These depths broadly coincide with zones of oxidised, transitional/mixed and fresh/unweathered rocks although it should be noted that the geology is complex and the intensity of weathering varies considerably across the deposit as shown in Figure 26. All samples were selected from the most recent drilling program (2011) to limit oxidation effects and 500g pulps were supplied to ensure adequate volumes. Of the 200 samples investigated by GHD, a total of 174 were from drill core with the remaining 26 from selected from RC drill holes. These 26 samples were all schist. Of the 679 assayed in-house, 546 were from drill core, with 133 schist and pegmatite samples coming from RC drill holes.

The pXRF assays were calibrated against 15 CRM standards with routine systematic duplicates included as well. Arafura also re-assayed 23 samples from ALS were to confirm the pXRF calibration. The pXRF results are consistent with those commercially assayed at ALS with all assay results presented in Appendix 2.

Figure 37 and Table 5 indicate that 46% of the LOM waste rock is not radioactive (*i.e.* <1 Bq/g). This is more than enough to cover and cap the radioactive material on the TSF and RSF. The remainder of the waste rock (54%) in this model exceeds 1 Bq/g and is therefore considered radioactive. However clearly there is more non-radioactive waste rock material than reported in the resource model. This occurs because unclassified resources occur within the waste rocks and by definition, blocks that contain less than 1% TREO are treated as waste rock. Hence the overall radioactivity of the waste rock is biased by the presence of mineralisation. As mining progresses, the radioactivity of the waste rocks will be better defined and it is possible that some of this mineralisation might be separated from the non-radioactive waste rock during grade control.

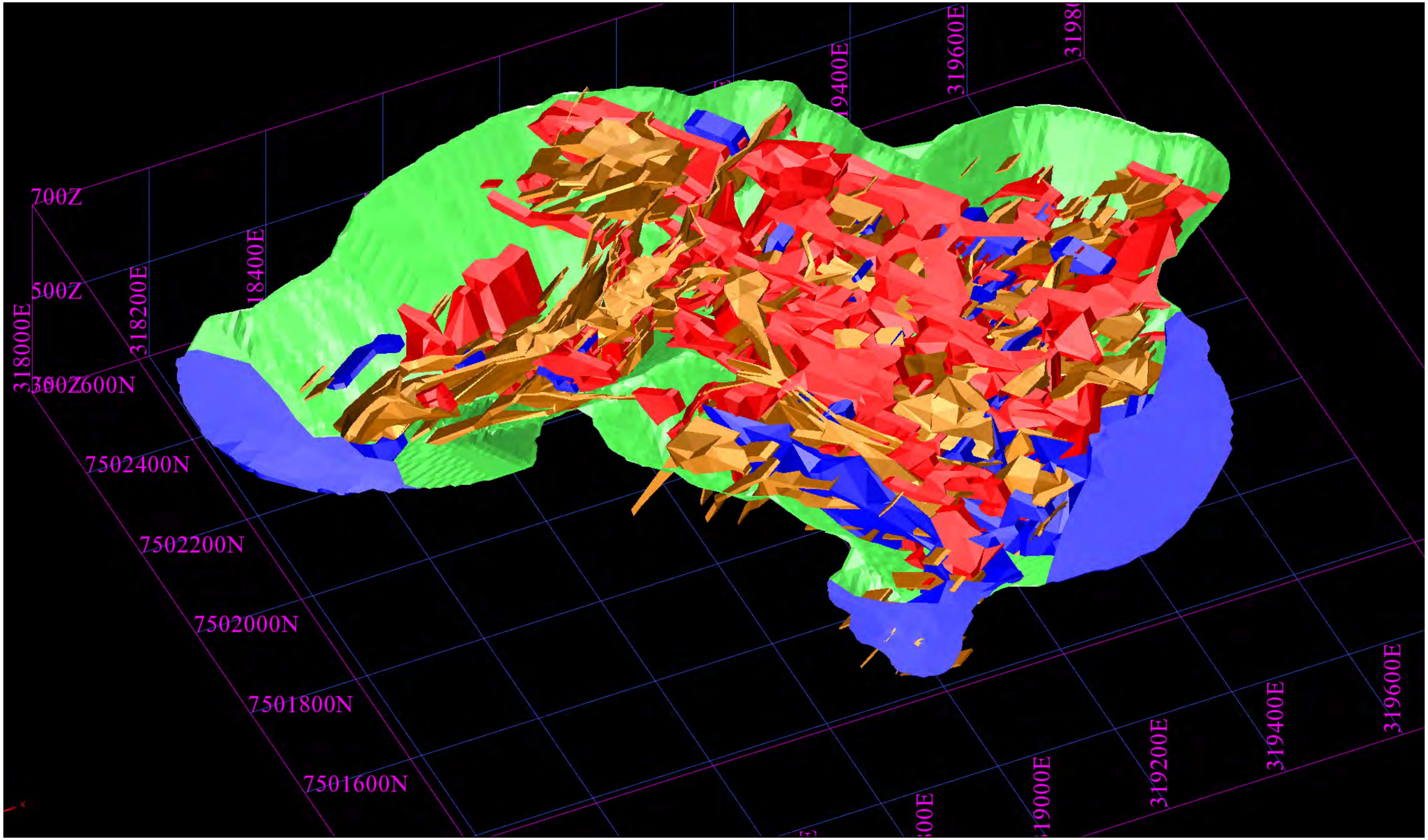


Figure 23. An inclined view of the LOM pit (green surface) showing mineralisation (MIN) in brown, pegmatite and coarse-grained gneiss (PEG) in red and schist (SCH) in blue. The remainder of the pit is gneiss (GNE) which has been omitted here for clarity. Note the LOM pit shell is based on the 2012 mining study. A new scoping study to define the LOM pit shell for the 2017 model has commenced. The differences between the 2012 and 2017 models are likely to be small and essentially immaterial to the overall volumes discussed in the report. A local mine grid was used for this model. It is based on the principal drill sections is used for the mineral resource estimate and the plots below. Local grid north is about 325° true.

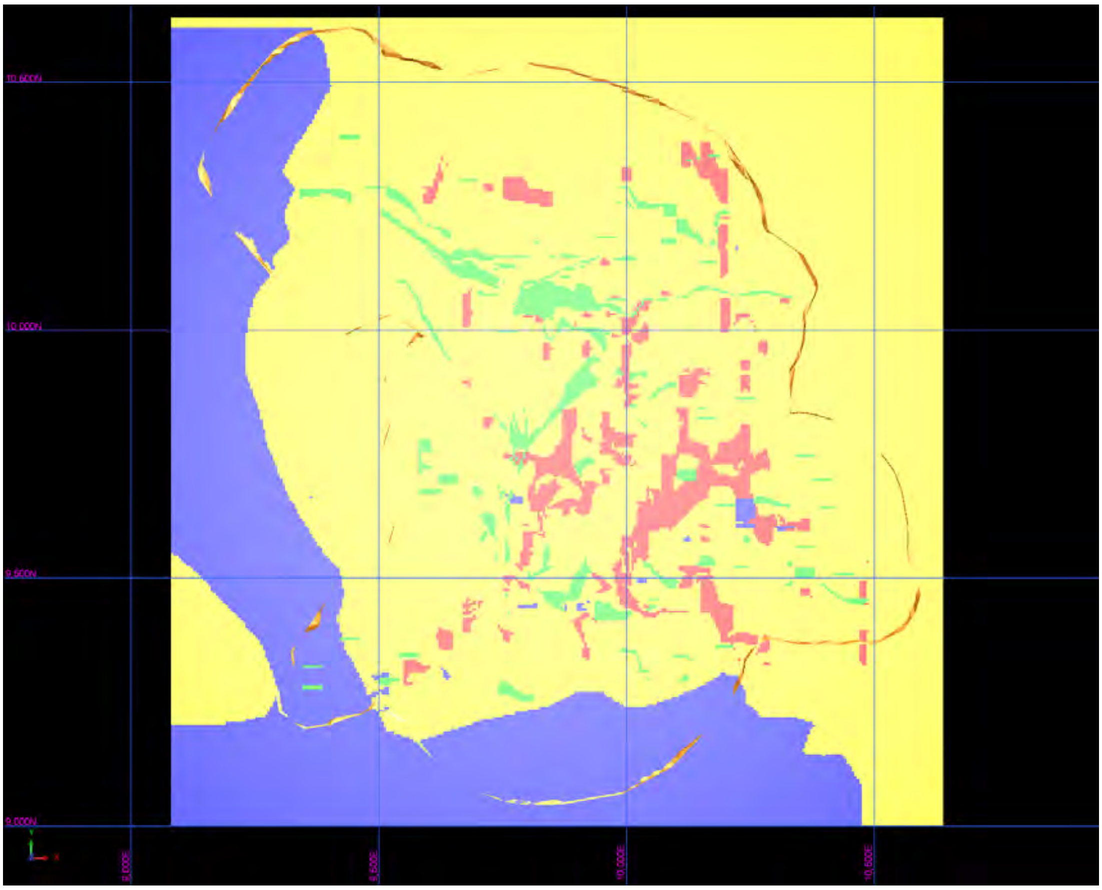


Figure 24. Geology with the soil removed. MIN, GNE, PEG and SCH are shown in green, yellow, red and blue respectively. The extent of the LOM pit is shown in brown.

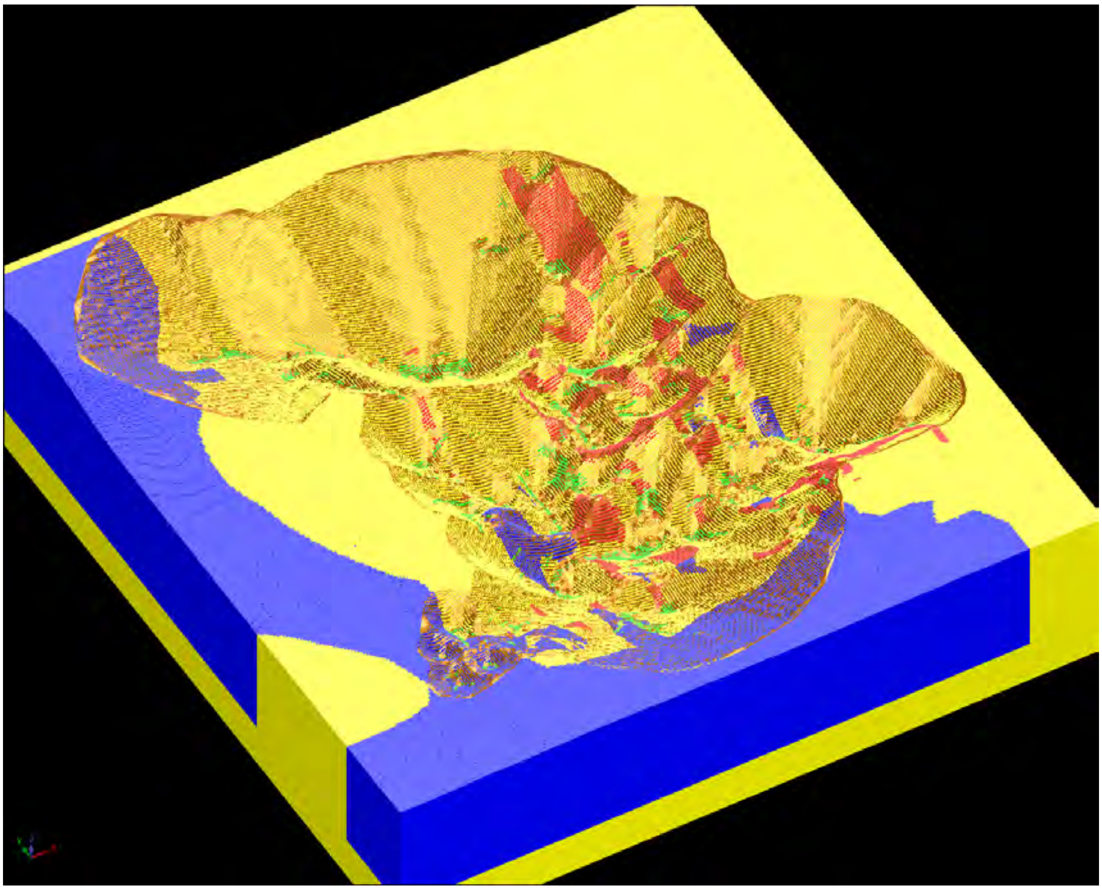


Figure 25 Geology of the pit walls based on the LOM pitshell. MIN, GNE, PEG and SCH are shown in green, yellow, red and blue respectively

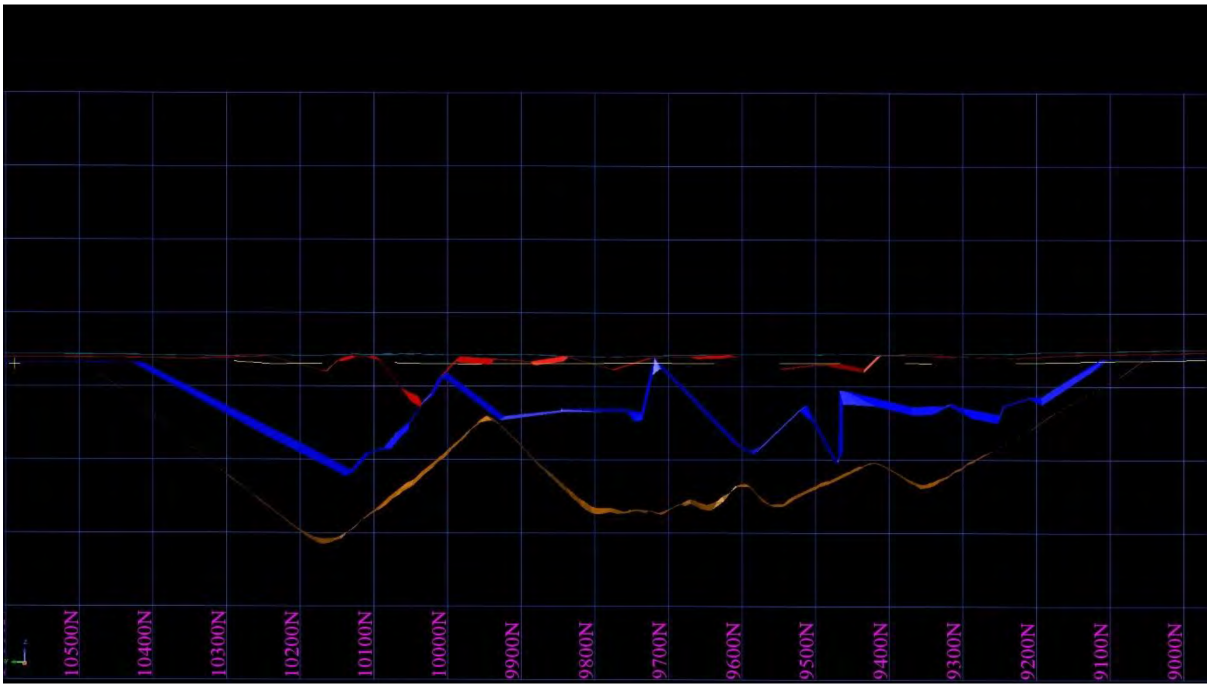


Figure 26. Section 9840E showing the extent of weathering and the various oxidation states within the LOM pit for the Nolans Bore deposit. Note this figure has been redrawn for the supplement report.

Table 4. Breakdown of the samples assayed as part of the EIS waste rock characterisation program.

	ALS	pXRF	Total
GNE	50	298	348
PEG	50	131	181
SCH	50	124	174
MIN	50	126	176
	200	**679**	**879**

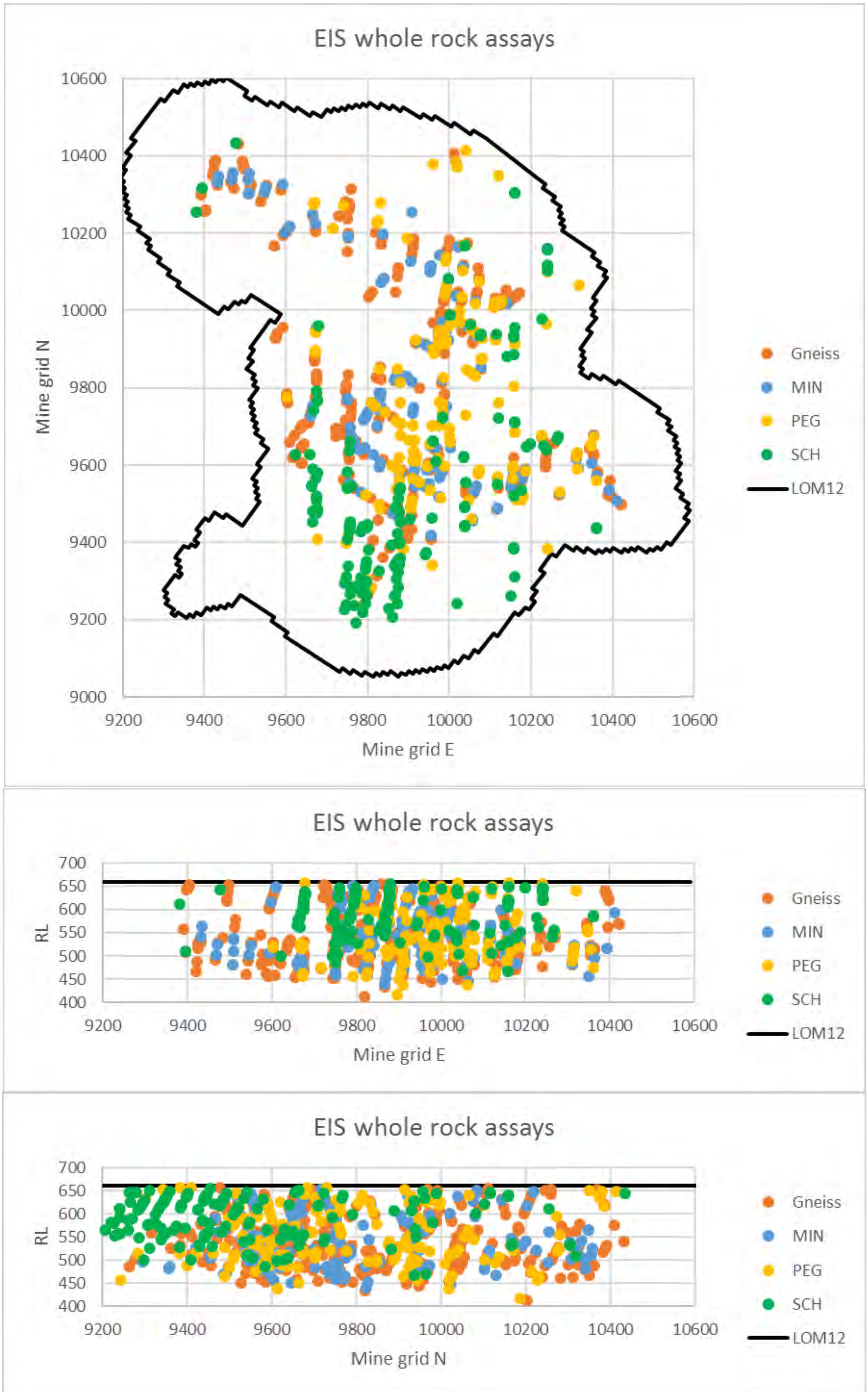


Figure 27. Location of whole rock assay samples for EIS waste rock characterisation.

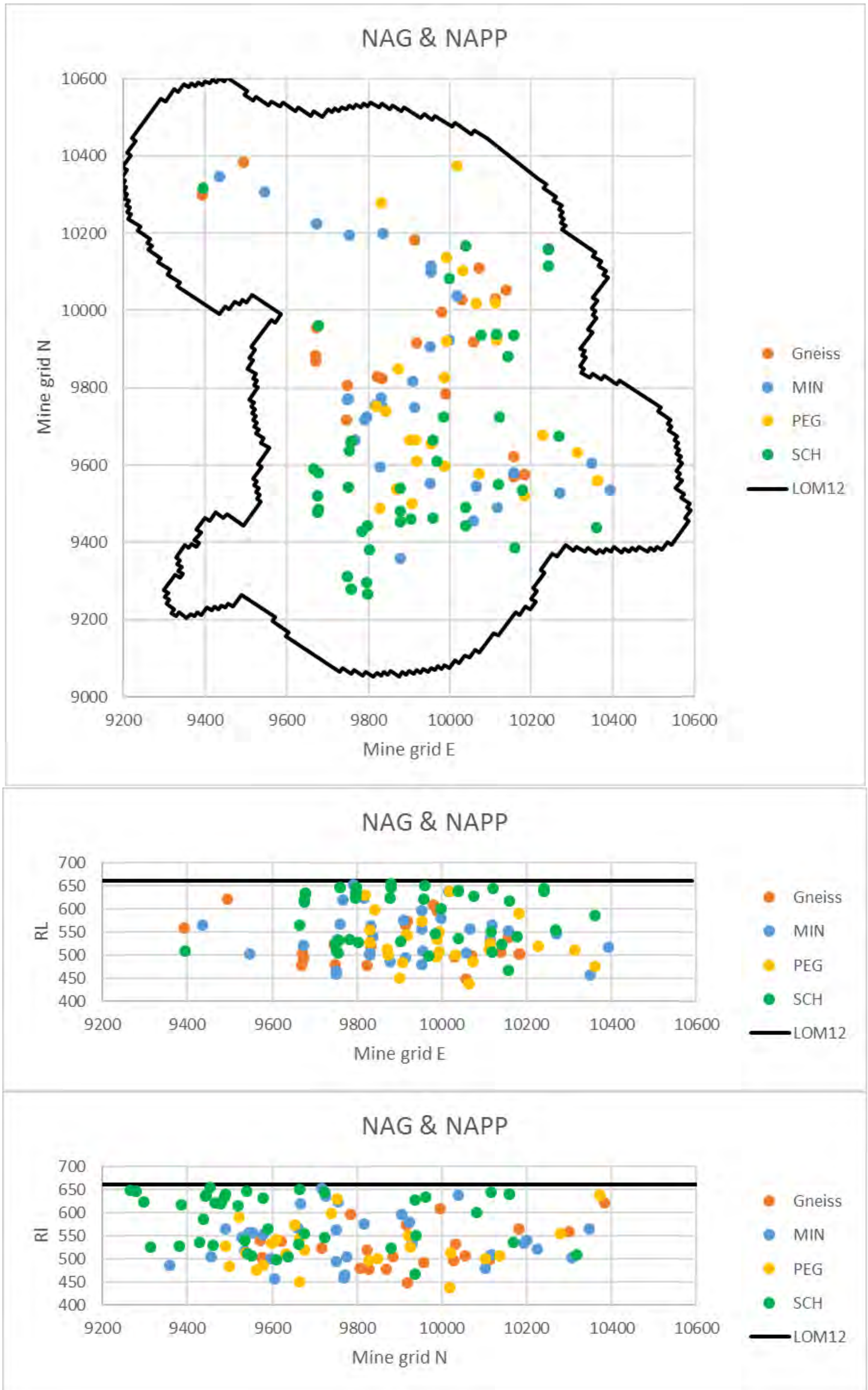
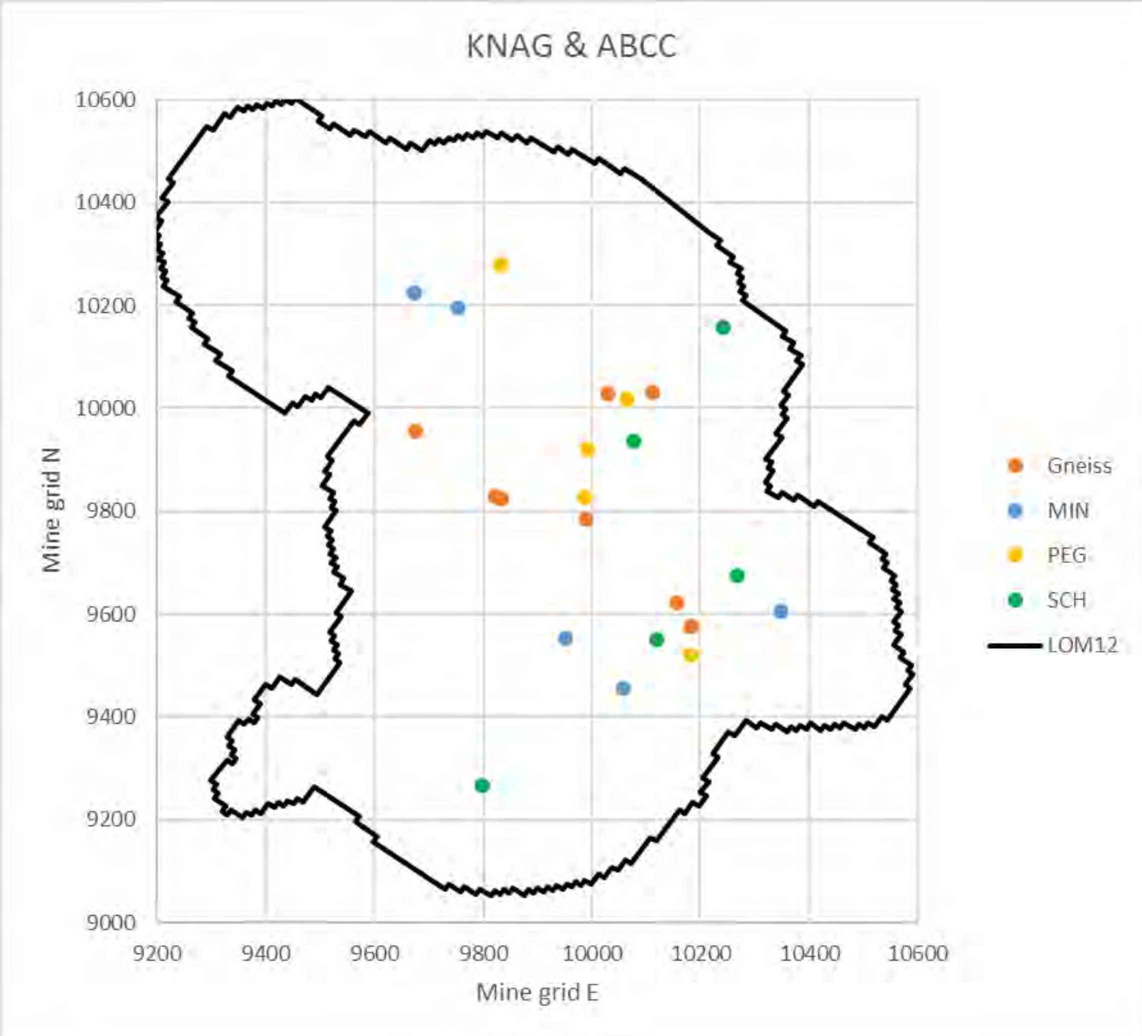
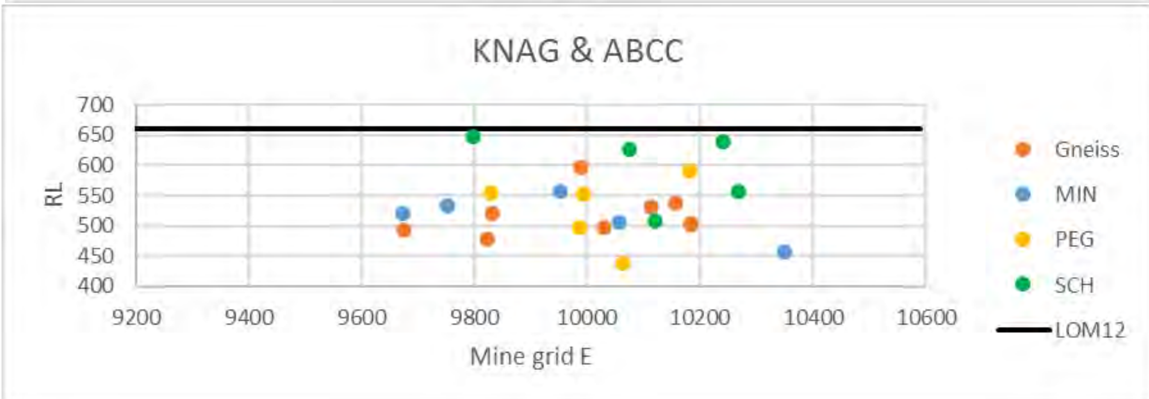


Figure 28. Location of NAG and NAPP samples.





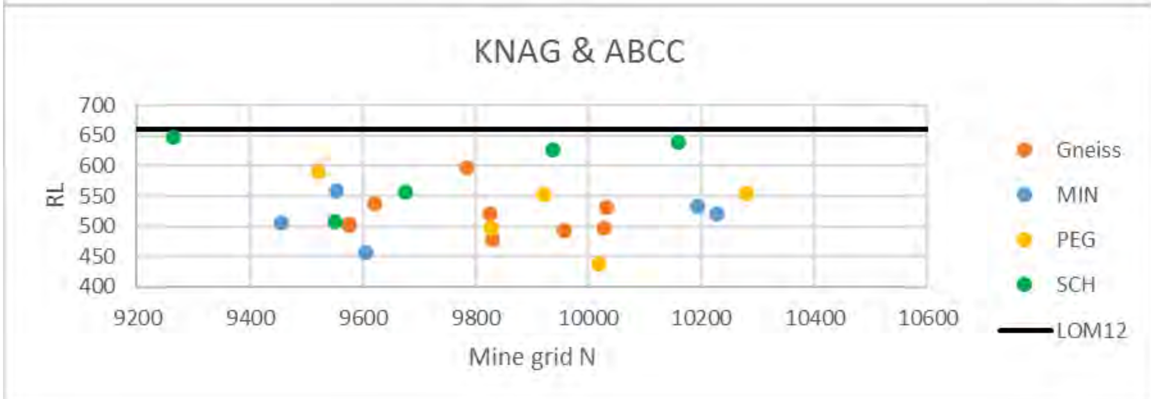
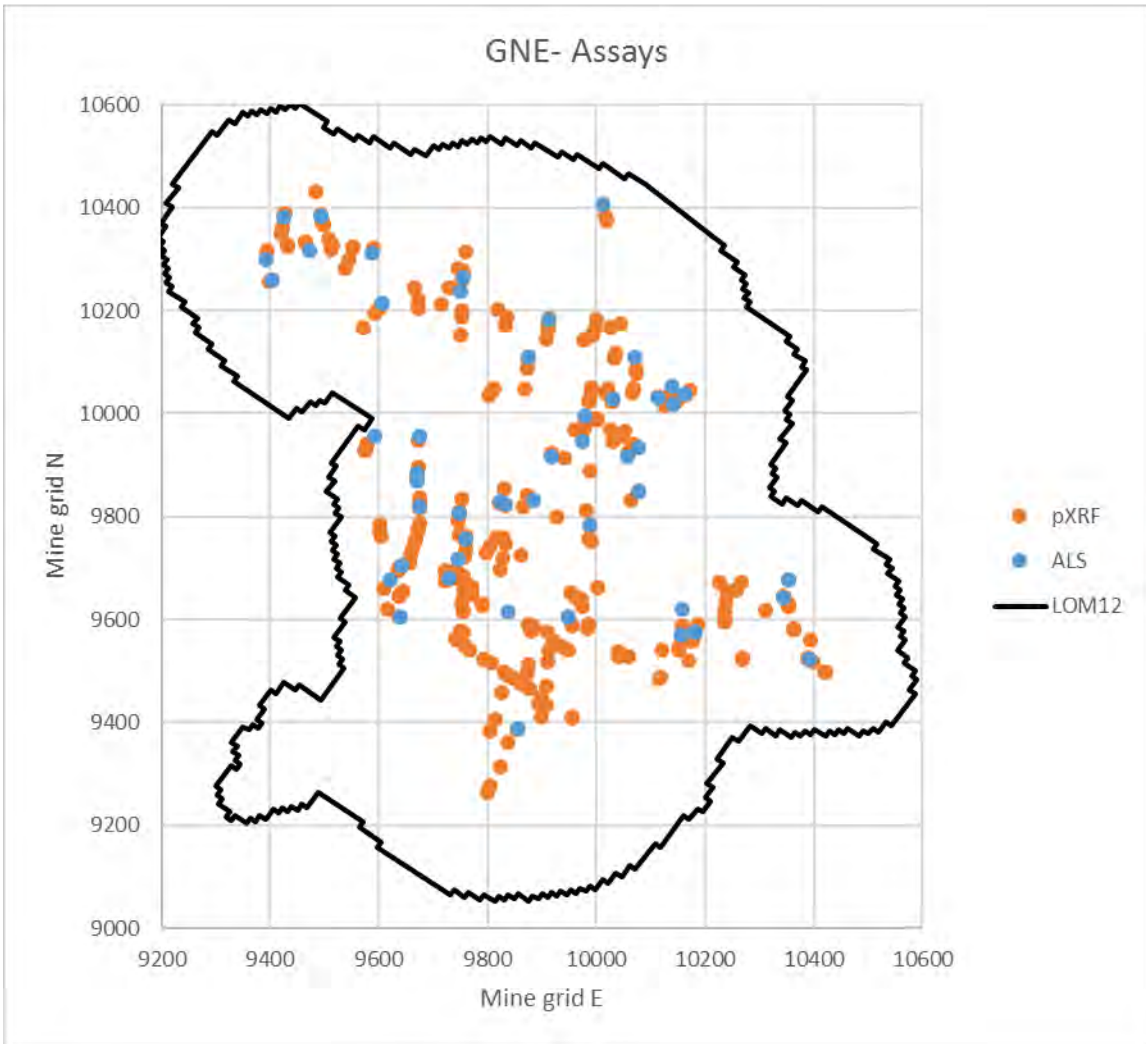
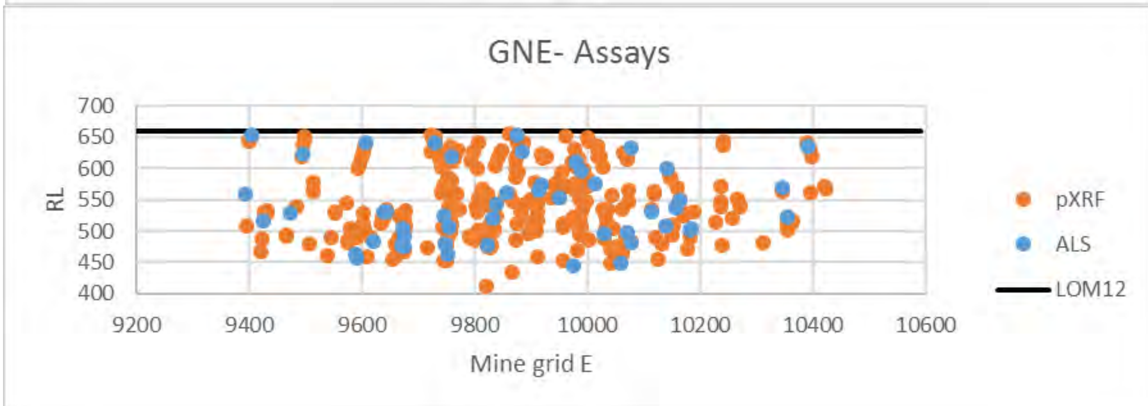


Figure 29. Location of KNAG and ABCC samples.





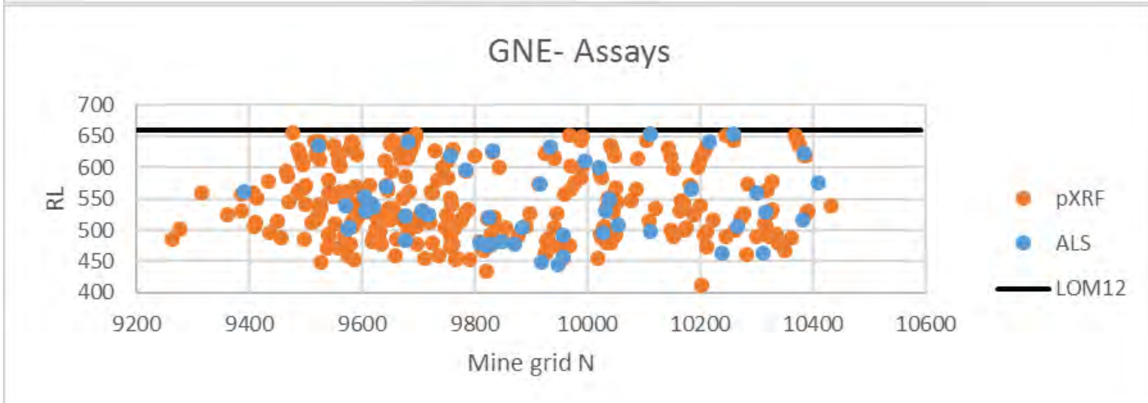


Figure 30. Location of different whole rock assays for GNE.

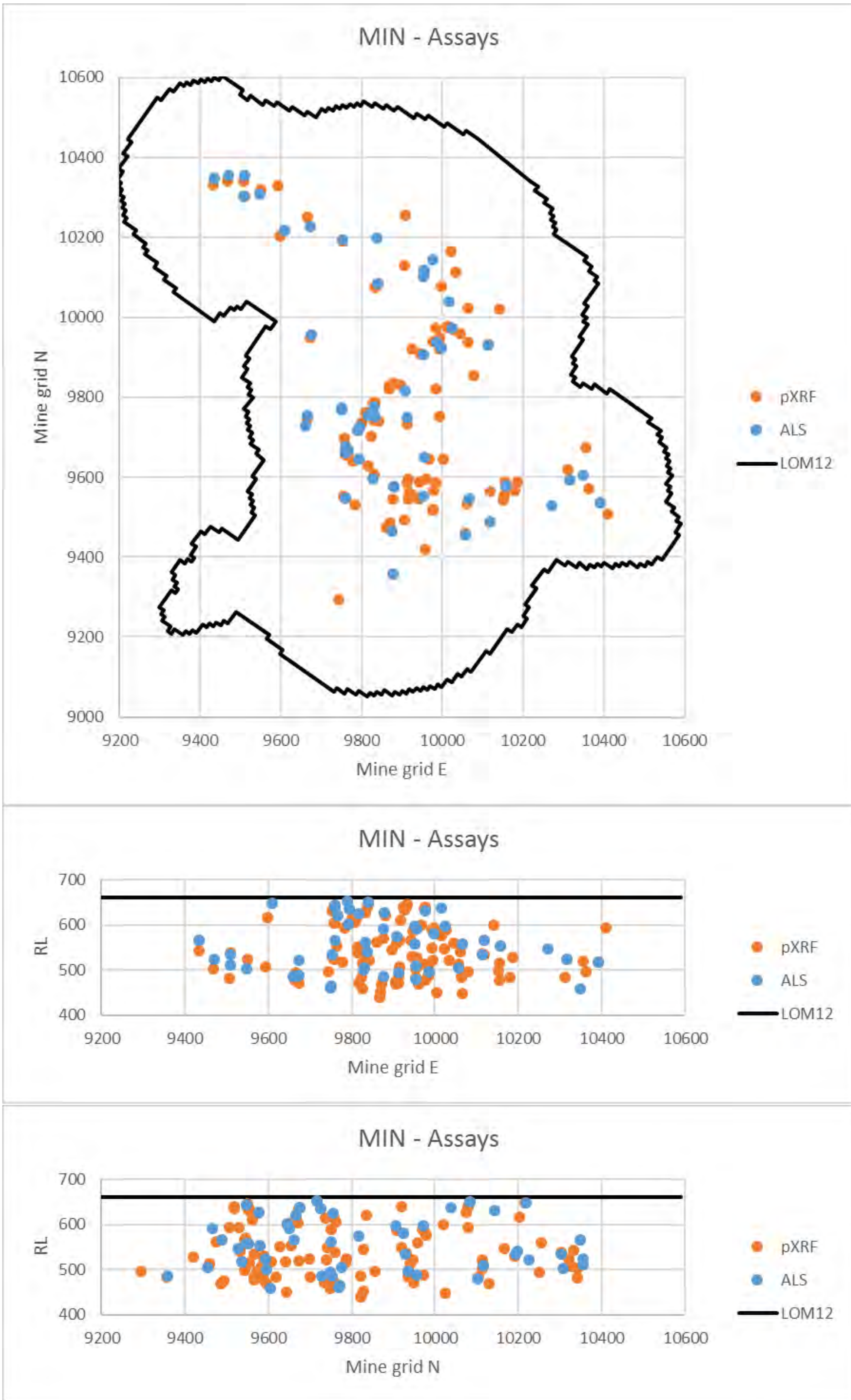


Figure 31. Location of different whole rock assays for MIN.

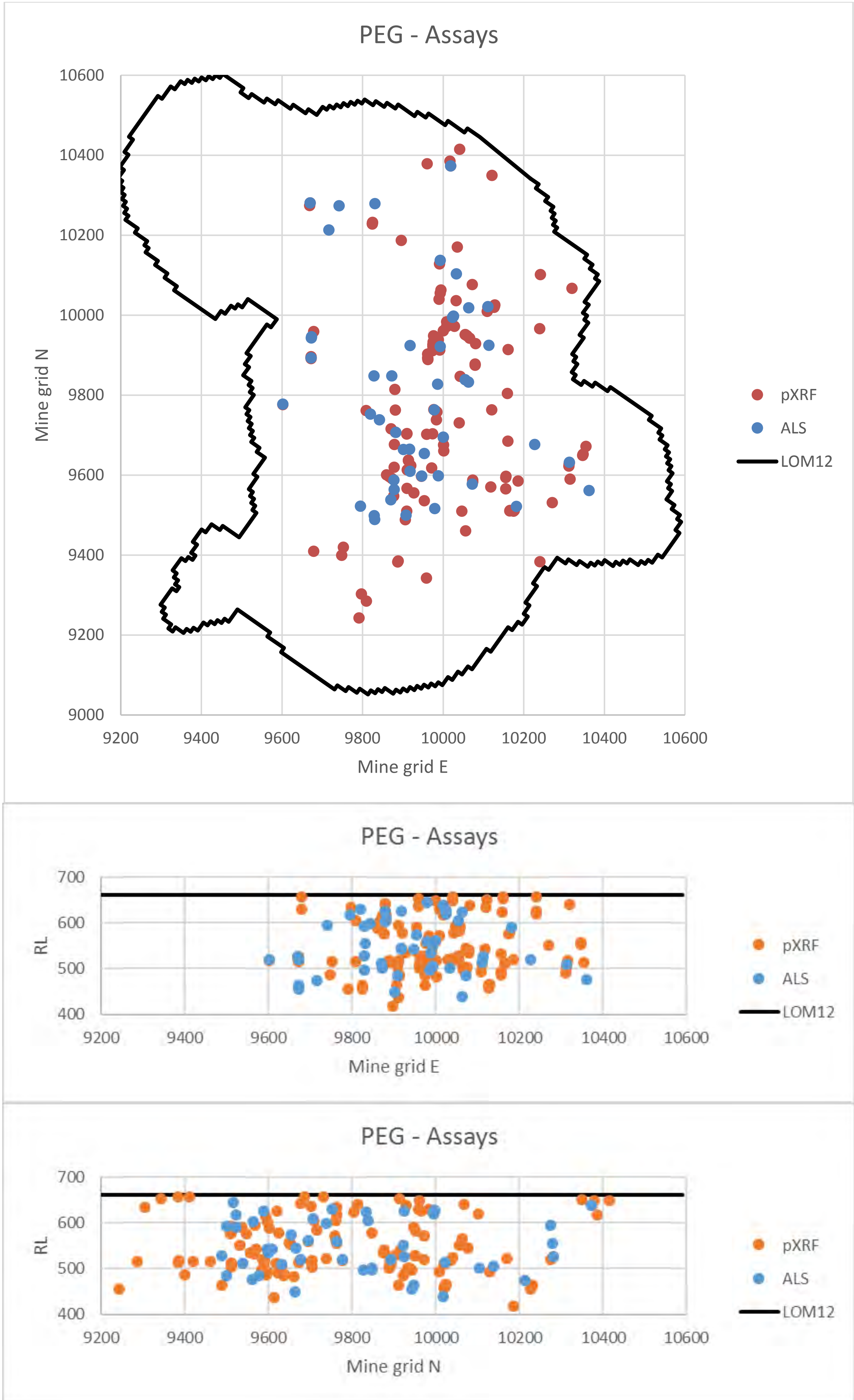


Figure 32. Location of different whole rock assays for PEG.

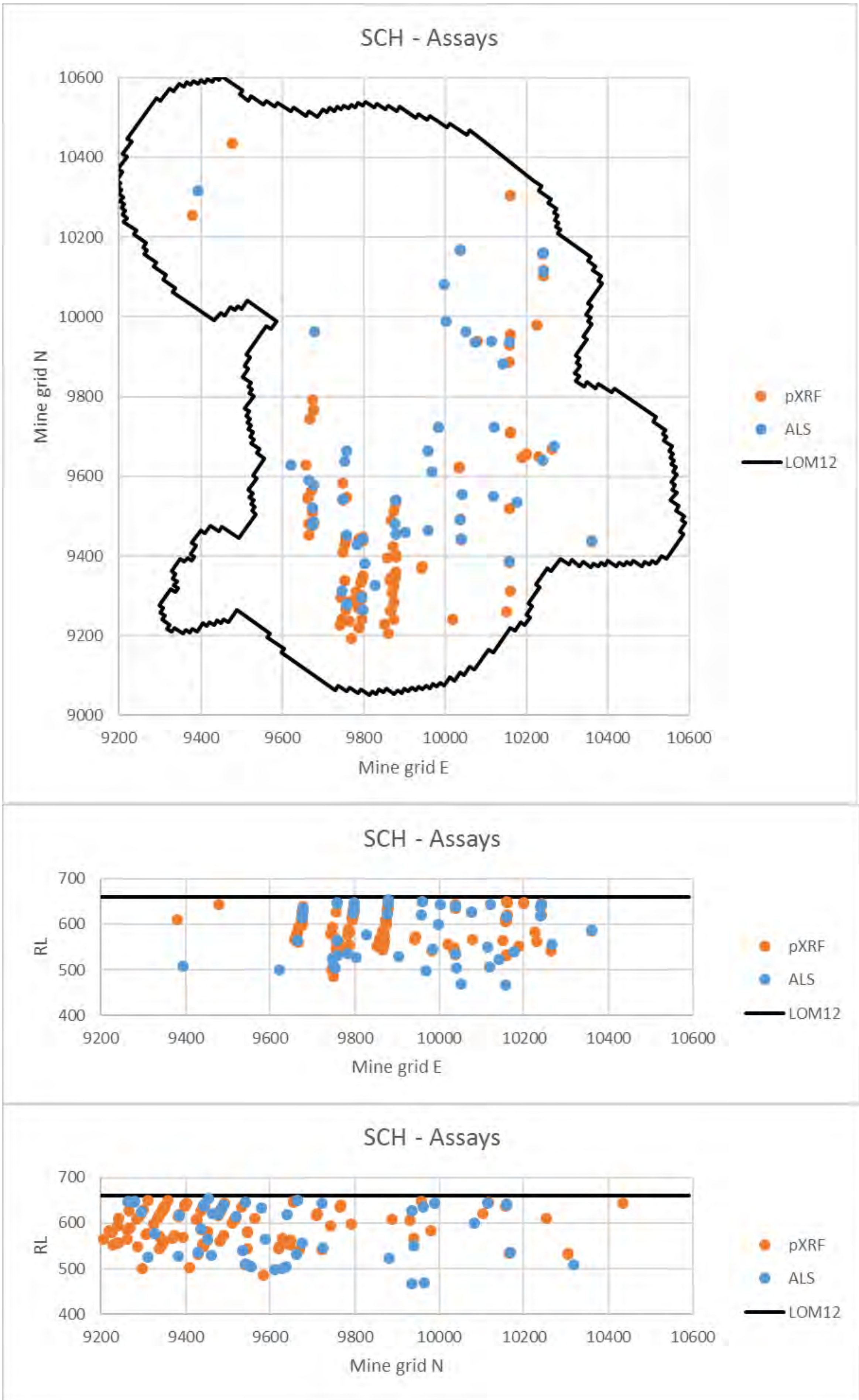


Figure 33. Location of different whole rock assays for SCH.

Statistical analysis of the 2017 Mineral Resource model indicates there are a total of 307 Mt of waste rock in 75,655 blocks within the LOM12 pit below the soil. The average, standard deviation, median, 99.5 percentile and maximum for the S content of the waste rocks in this geological model are 294ppm, 165 ppm, 271 ppm, 904 ppm and 3505 ppm, respectively. This is shown graphically in Figure 34 and is further itemised in Table 5 and 6. The location of the waste rock blocks with elevated total sulfur are shown in Figure 35 and the sulfur content of the LOM pit walls are show in Figure 36.

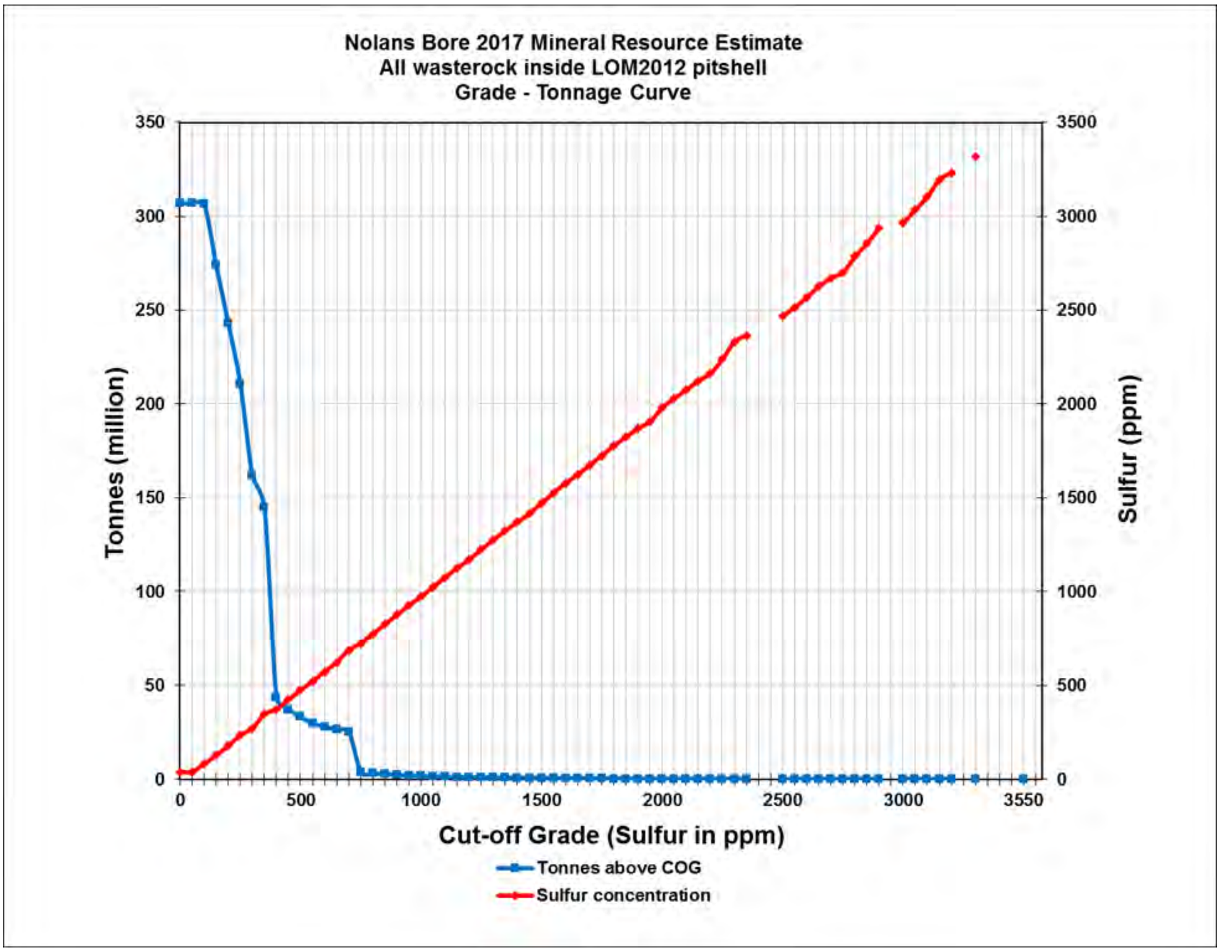


Figure 34. Sulfur grade-tonnage curve for all waste rocks in the 2017 Mineral Resource model within the 2012 LOM pit shell for Nolans Bore. This plot is read by determining the tonnes or grade that match the desired cut-off grade for sulfur on the x-axis. It clearly demonstrates that there is very little material which exceeds 3000 ppm S. Most waste rocks have less than 1000 ppm S and the maximum is 3505 ppm. The values reported here will be slightly different for 2017 LOM pit shell when available however they are likely to be similar.

Table 5. Quantities and total sulfur content of the waste rocks for the 2017 Mineral resource model within the 2012 LOM pit. The quantities reported here will be slightly different for 2017 LOM pit shell when available however they are likely to be similar.

	Inside LOM12 pitshell							
Unit	Tonnes below soil	Average grade of S in ppm	Maximum grade of S in ppm	Tonnes above 3000ppm S	Tonnes above 2500ppm S	Tonnes above 2000ppm S	Tonnes above 1500ppm S	Tonnes above 1000ppm S
Gneiss	220,000,000	300	3,319	18,600	75,000	183,000	518,000	1,307,000
Pegmatite	50,000,000	153	3,250	6,400	13,000	20,000	46,000	214,000
Schist	37,000,000	442	689	-	-	-	-	-
All waste rocks	**307,000,000**	**292**	**3,319**	**25,000**	**88,000**	**203,000**	**564,000**	**1,521,000**
% of all waste rocks	100			0.01	0.03	0.07	0.18	0.50
All mineralisation (note S as SO_4)	53,600,000	638	2412	-	-	75,000	278,000	2,870,000

Table 6. Quantities of the various rock types and oxidation states for the 2017 Mineral Resource model within the 2012 LOM pit. The quantities reported here will be slightly different for 2017 LOM pit shell when available however they are likely to be similar. Note number may not compute due to rounding.

	Inside LOM12 pitshell			
	Total	**Fresh**	**Transitional/mixed**	**Oxidised**
Gneiss	220,100,000	117,800,000	84,900,000	17,400,000
Pegmatite	50,300,000	22,100,000	24,400,000	3,800,000
Schist	36,600,000	20,800,000	13,400,000	2,400,000
All waste rock	**307,000,000**	**160,700,000**	**122,700,000**	**23,600,000**
% of all waste rocks	100	52	40	8

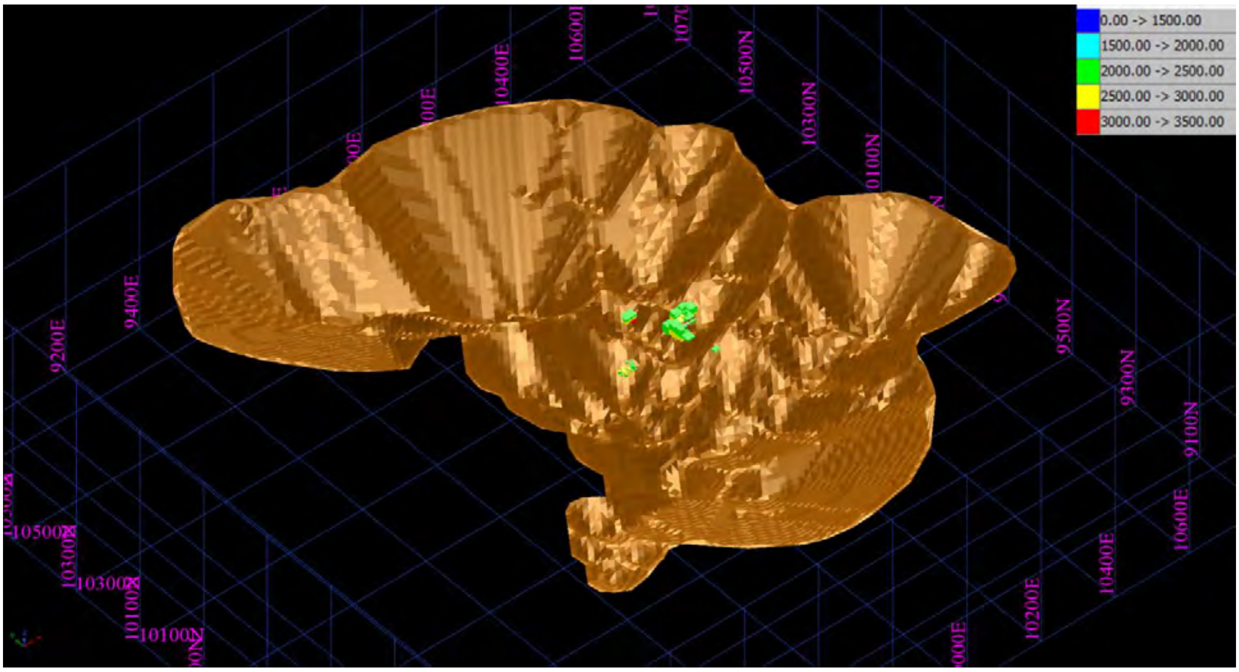


Figure 35. 2017 Resource model showing where the waste rock exceeds a 2000 ppm S cut-off limit within the 2012 LOM pit shell. This very conservative cut-off highlights there are only a few areas where possible AMD waste rock material might occur within the 2012 LOM pit shell. This also indicates that mining of this material is manageable.

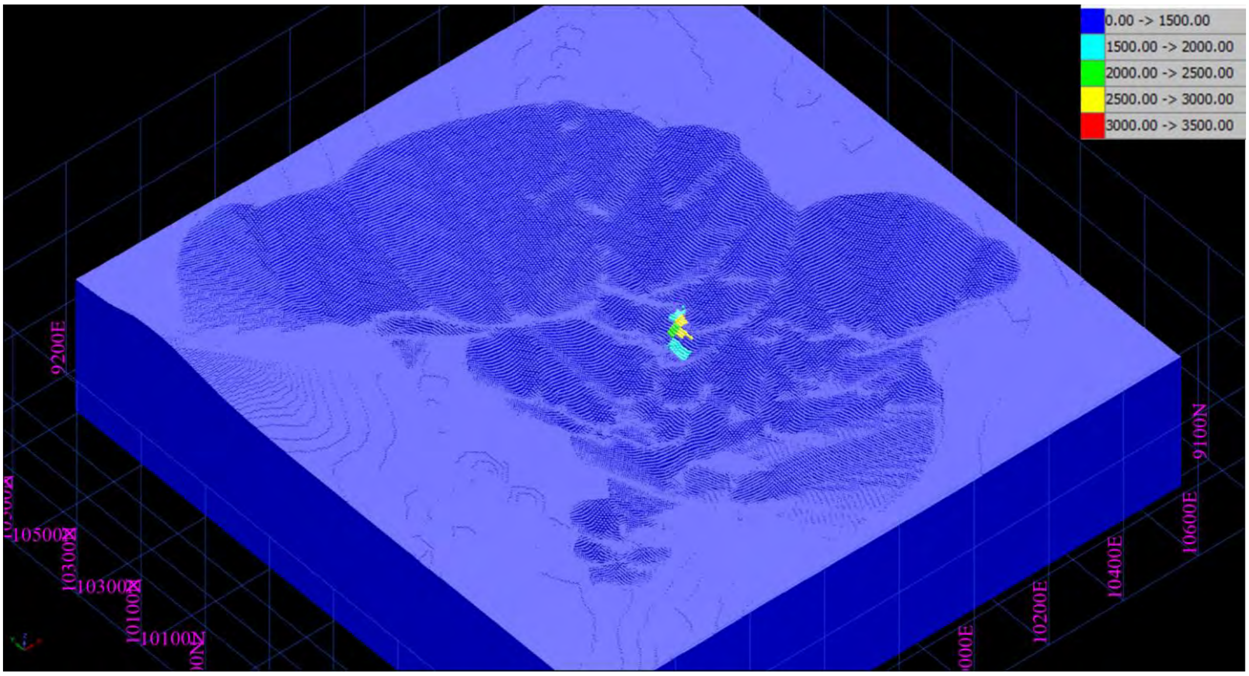


Figure 36. 2017 Resource model showing the sulfur content of the 2012 LOM pit walls. The sulfur content is low and less than 3000 ppm S. The elevated material is a mixture of waste rock and mineralisation. The quantities and location of the material reported here may be slightly different for 2017 LOM pit shell when available however they are likely to be similar.

The radioactivity of the waste rock in the 2017 Resource model in shown in Figure 37Figure 2 and Table 7.

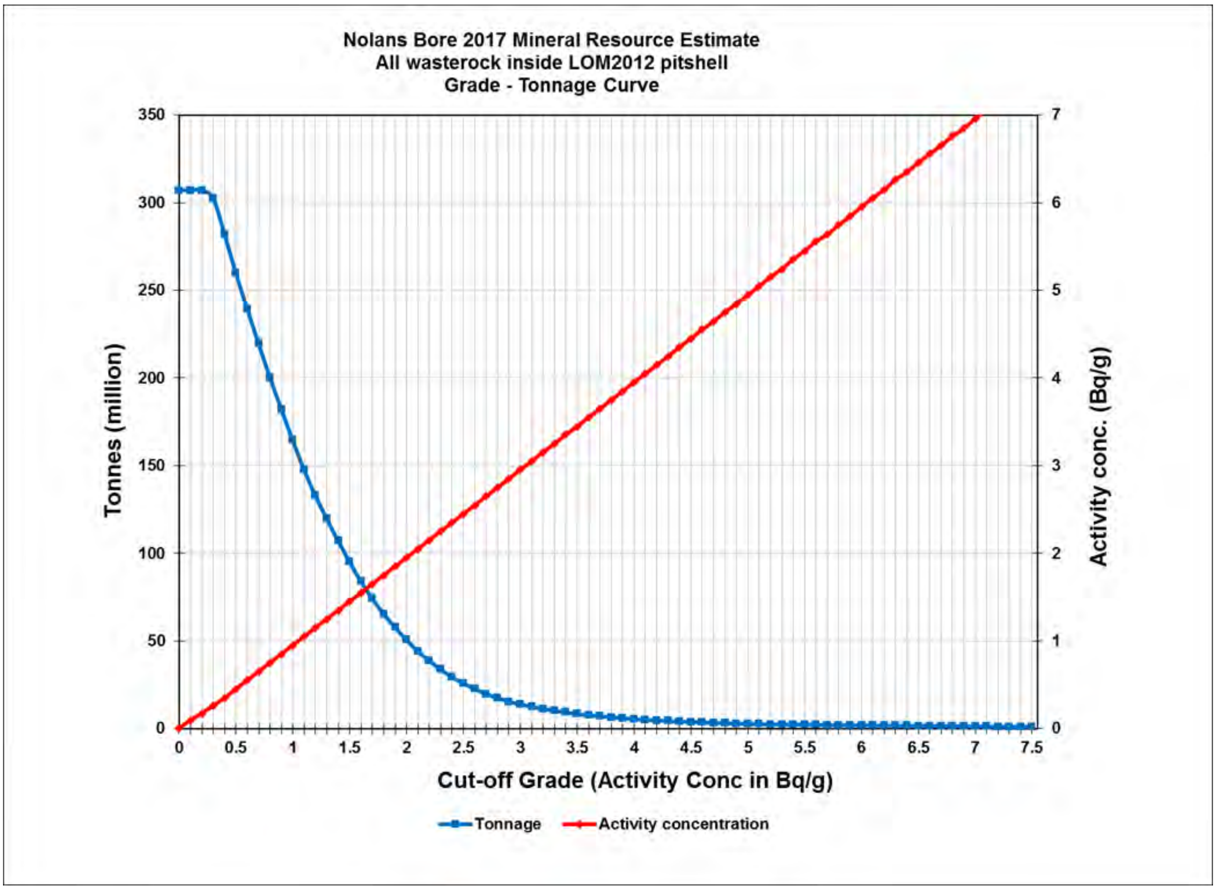


Figure 37.Activity concentration grade-tonnage curve for the waste rocks at Nolans Bore based on the 2017 Mineral Resource model and the 2012 LOM pit shell. The values reported here will be slightly different for 2017 LOM pit shell when available however they are likely to be similar.

Table 7. Quantities and the radioactivity of the waste rocks for the 2017 Mineral resource model within the 2012 LOM pit. The quantities reported here will be slightly different for 2017 LOM pit shell when available however they are likely to be similar. Note number may not compute due to rounding.

	Inside LOM12 pitshell						
Unit	Tonnes below soil	Average activity in Bq/g	Maximum activity in Bq/g	Tonnes below 1Bq/g	Tonnes above 1Bq/g	Tonnes above 2Bq/g	Tonnes above 5Bq/g
Gneiss	220,000,000	1.1	16.4	114,800,000	105,200,000	31,300,000	2,400,000
Pegmatite	50,000,000	1.7	14.7	3,500,000	46,500,000	15,100,000	100,000
Schist	37,000,000	0.9	7.6	24,100,000	12,900,000	4,200,000	200,000
All waste rocks	**307,000,000**	**1.2**	**16.4**	**142,500,000**	**164,500,000**	**50,600,000**	**2,700,000**
% of all waste rocks	100			46	54	16	1

Issue 478

NTEPA

Appendix I – Section 3.3.1 states '… distinct creeks which eventually drain into the Southern Basins and Lake Lewis 70 km to the west..' However, Figures 2.6 and 3.3 do not appear to show this connection with Lake Lewis.

Annas Reservoir (mentioned in Section 16.3.2) does not appear to be described in EIS sections on surface or groundwater, or biodiversity. The Heritage site is described as a permanent waterhole,~10km from the mine site. Describe its hydrological basis, biodiversity values and current status? To what extent could the Project impact on the hydrology and other values of the site?

Response to issue 478.

All creeks and the Lake Lewis playa are ephemeral. The distinct creeks within the southern basins catchment area eventually drain into the Southern Basins. Lake Lewis is localised depression within the greater Southern basins (Figure 38). Only the Napperby Creek has stream flows that actually reach Lake Lewis and this requires a significant rainfall event. All the other creeks in the region flow into the sand plain (flood out) which overlies the Southern Basins (Figure 39 and 40). Day Creek which is at the western end of the project area, ends some 30km from Lake Lewis.

The satellite image clearly shows that Day Creek at the extreme western end of the Nolans project area is impeded by the Reaphook Range, and its stream flows are diverted westward towards a narrow gap in the Range before spilling south and flooding out on to the sand plain. Arafura's reprocessed AEM dataset and the regional geology map clearly highlight outcrops or very shallow basement to the south of the Range in the Day Creek area. This means that subsurface stream flows are likely to be impeded by the basement geology to the south of the Reaphook Range in this location with most of the subsurface groundwater likely to be diverted westward along the Reaphook palaeochannel. Clearly this also provides a mechanism to recharge to groundwater in the Patty Well area. This contrasts with the Napperby Creek system further west where the AEM dataset, geology and borehole information indicates a more significant gap in the Range and a considerable thickness of cover (about 20-70m) south of the Range.

The small creeks near the processing plant are drainage lines and barely make the sand plain.

The natural water bodies are shown in Figure 42. There are no permanent bodies of surface water in this region. Most if not all of these water bodies are best described semi-permanent to ephemeral and most if not all are likely to be dry in extended periods of drought. The heritage site 10km from Nolans Bore is Anna's Reservior. This is a semi-permanent rock hole that is well known to dry up in drought periods. (*e.g. pers comm*. Chris Day, NT DENR Alice Springs). Anna's is separated from Nolans by hills and is also up gradient of the water table at Nolans Bore (Figure 43).

Arafura has reviewed the DNER Fauna Atlas and has verified that there are no official recorded observations of the Spangled Perth within any of these semi-permanent water bodies located in the project area (Figure 42). Antidotally we are aware of some unofficial sightings of this fish species in the 20 mile waterhole which is above Napperby Station homestead in the Napperby Creek headwaters (Figure 41) and long distance and upgradient of the project.

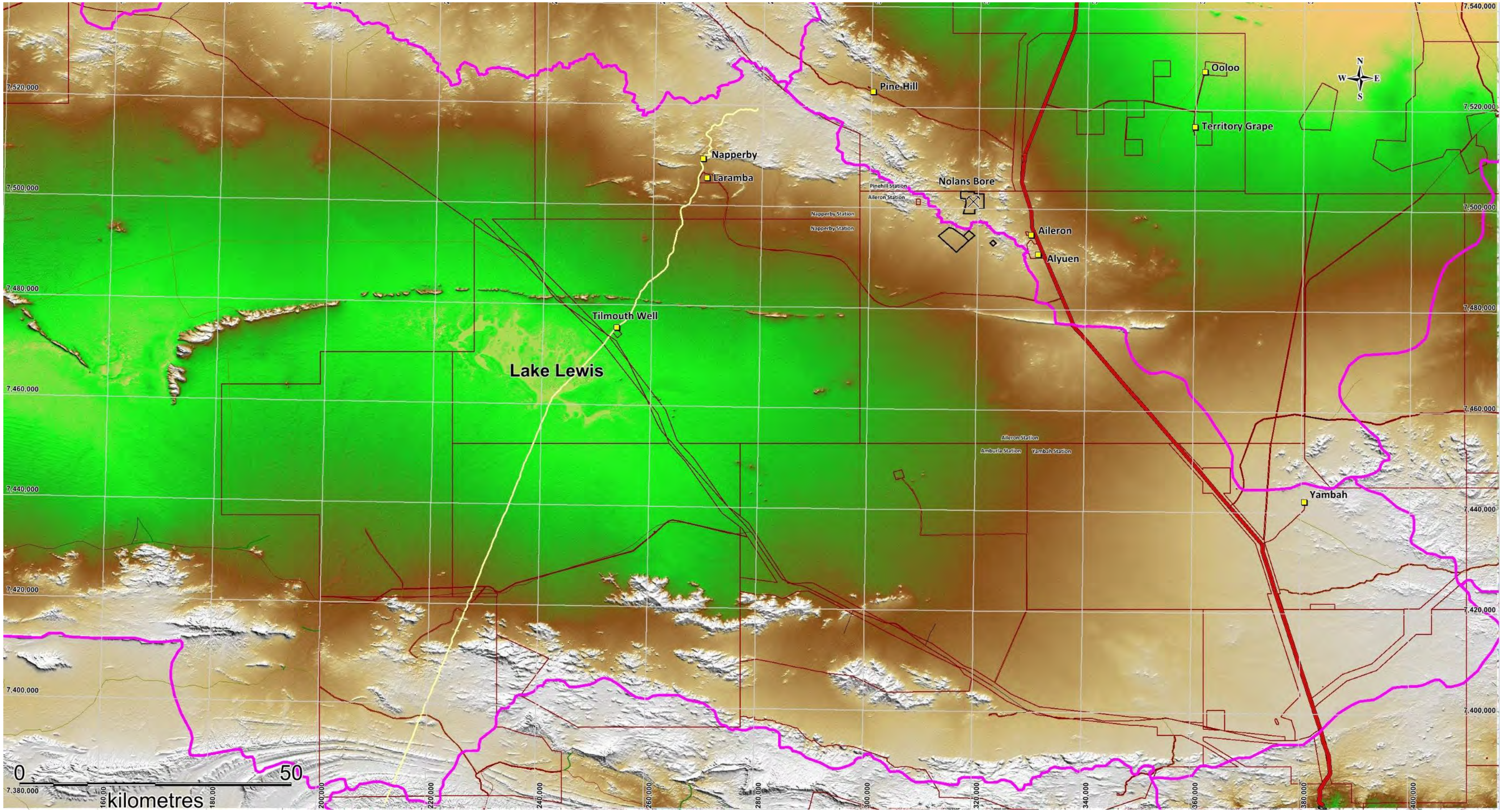


Figure 38. Digital elevation model derived from the shuttle radar showing most of the catchment area for Lake Lewis. The surface water catchment divide is shown as a pink line. White is the highest elevation and is greater than brown and then green with yellow being the lowest elevation. Lake Lewis clearly forms a localised depression within a much larger system. Section corresponding to the yellow line is shown below.

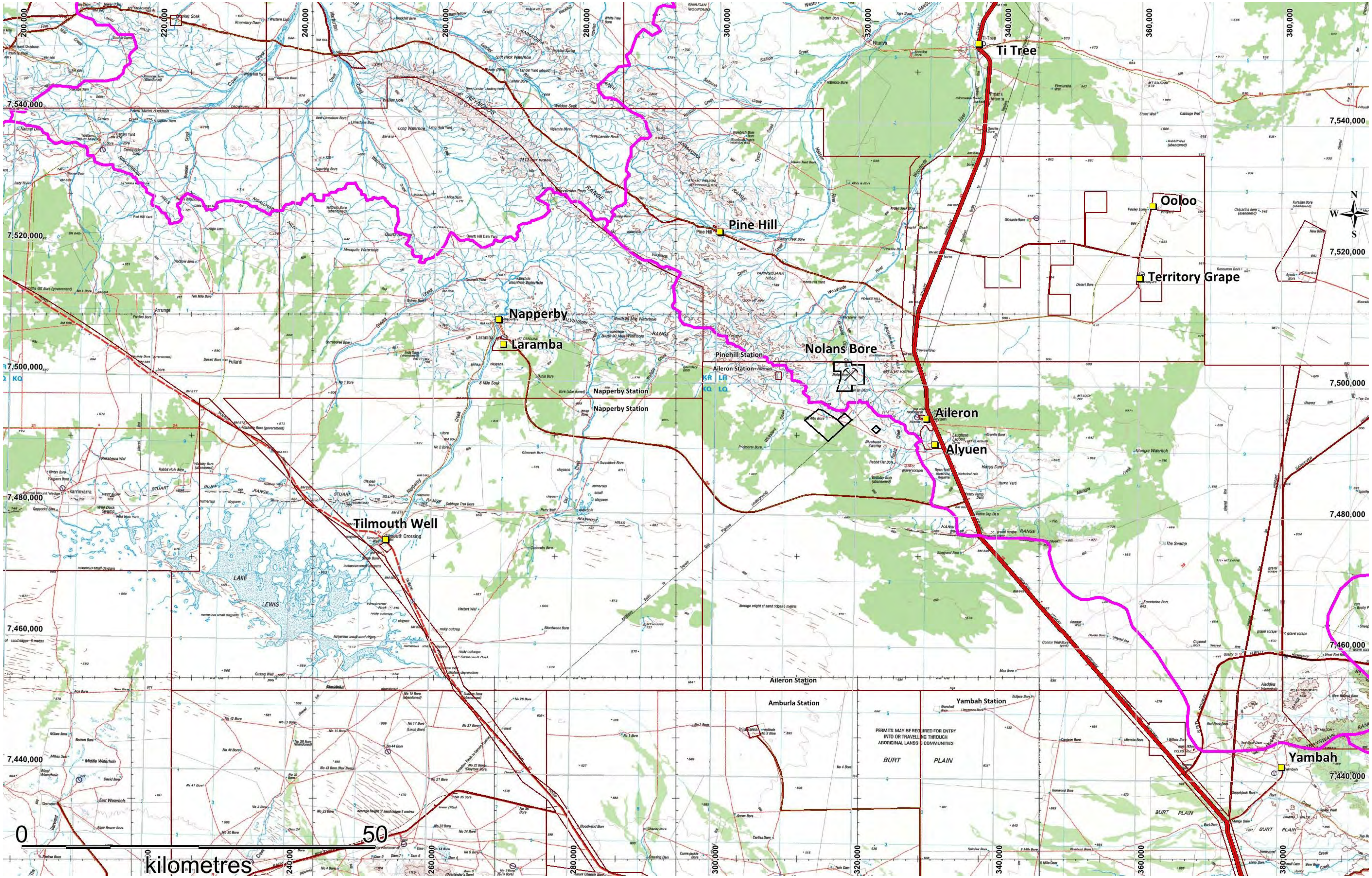


Figure 39. Published map showing the main topographic features of the project region including Lake Lewis. This map has been annotated to show the surface water drainage divide (pink line) and the principal localities and property boundaries in the region.

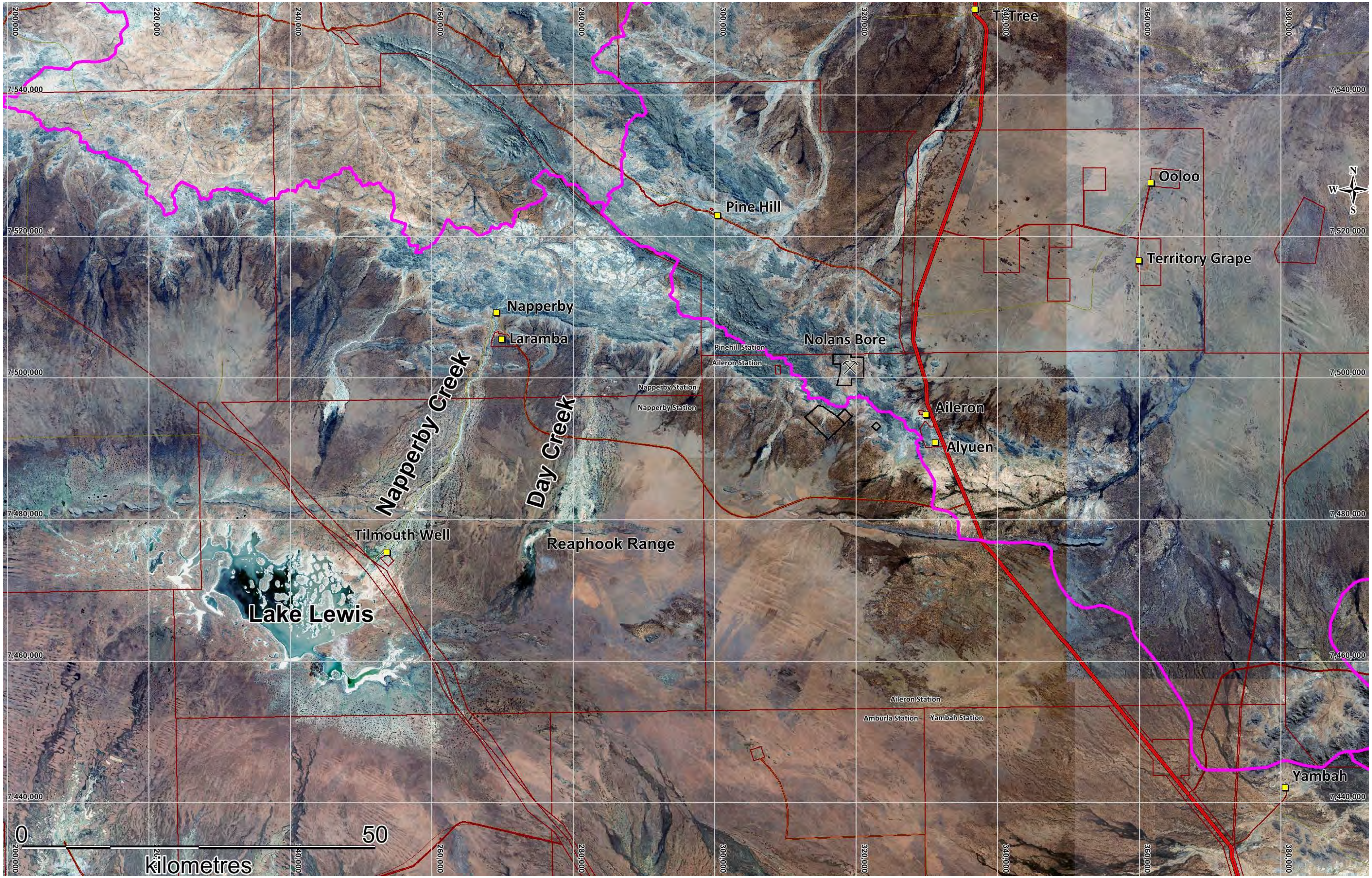


Figure 40. Satellite image of the project region and Lake Lewis. Lake Lewis is ephemeral and can be dry for many years. Only Napperby Creek reaches Lake Lewis. Arafura's proposed borefield is located south of the Napperby access road and east of Day Creek..

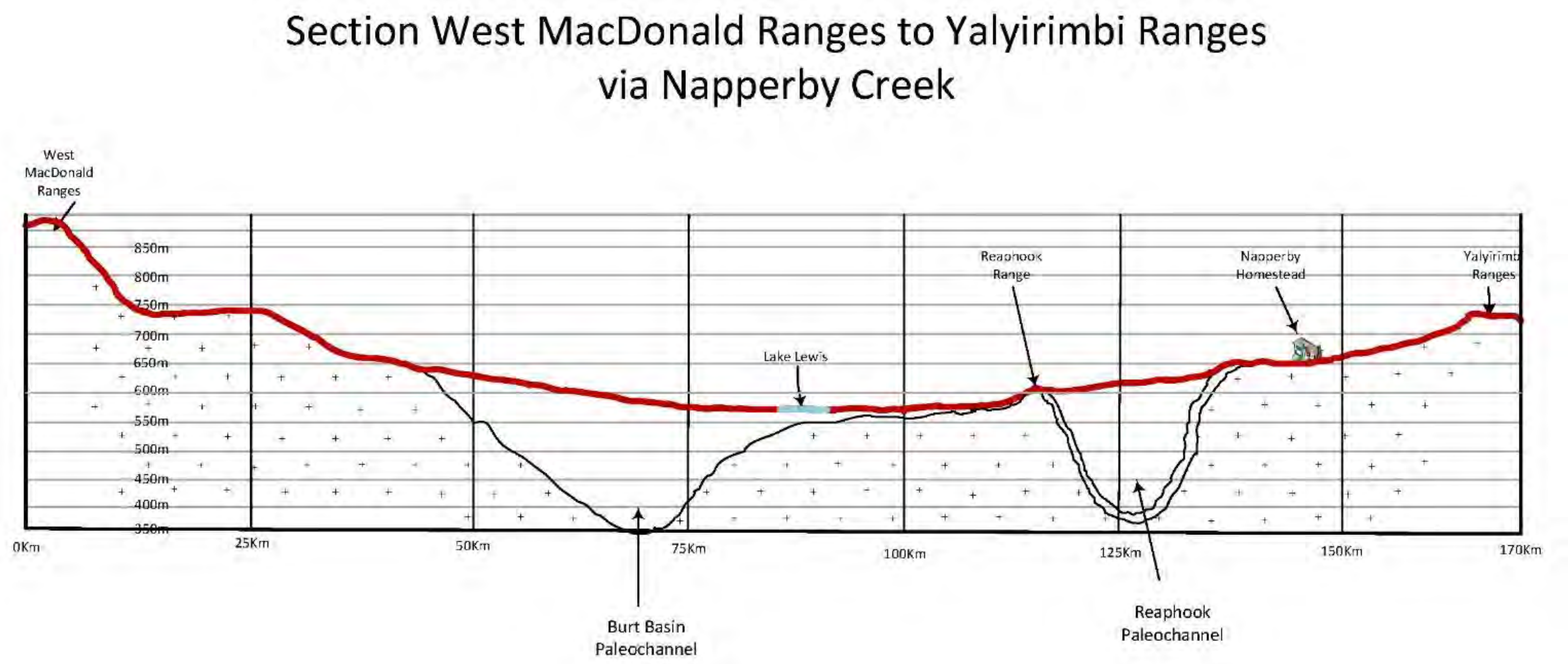


Figure 41. Cross section demonstrating the elevation changes and underlying basins/palaeochannels from north to south (left to right) along the yellow line in Figure 38.

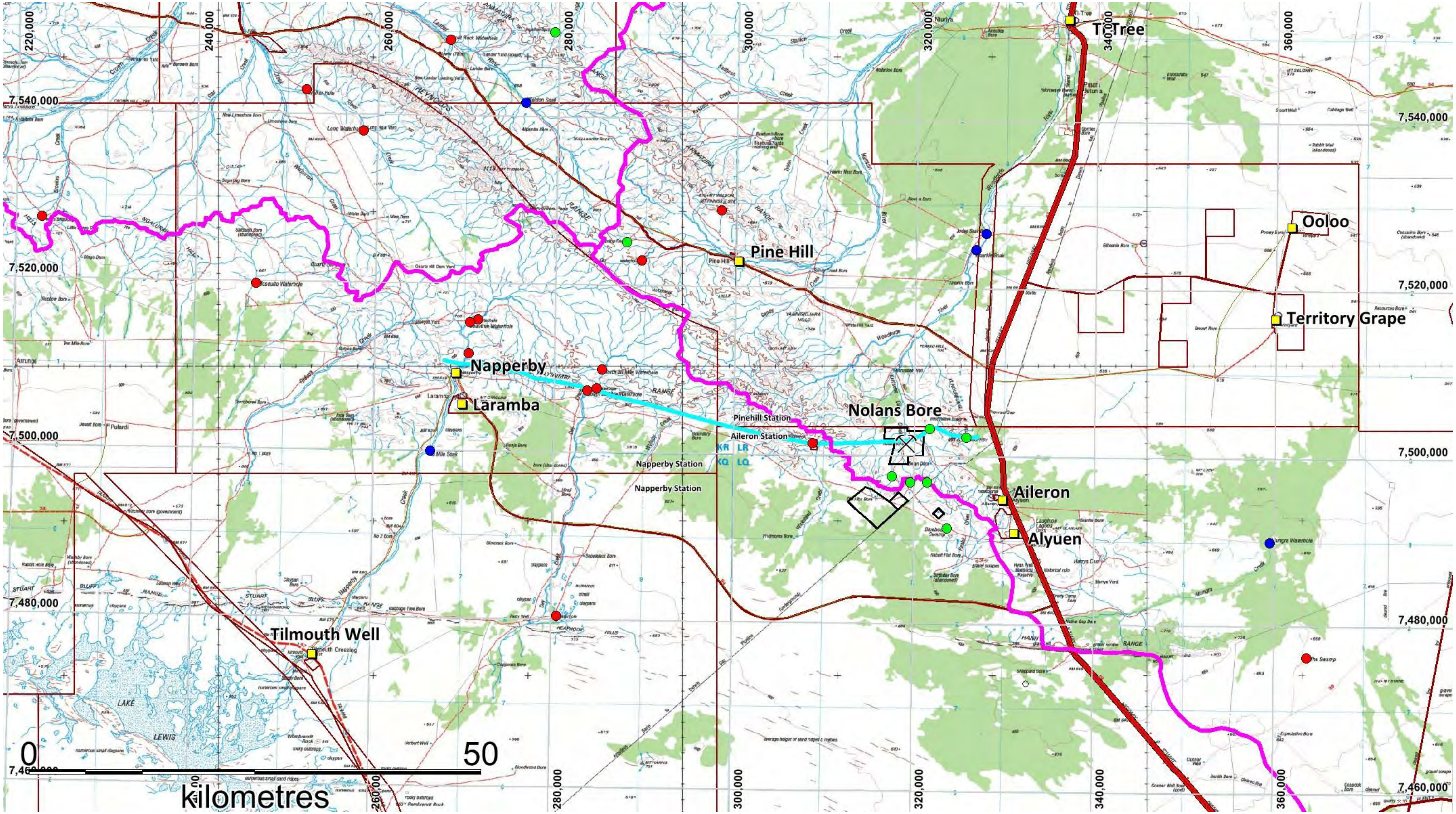


Figure 42. Natural water bodies in the Nolans project region and surrounds classified according to guidelines provided by Lee Evans of GHD. Red circles indicate rockholes (and natural depressions) with semi-permanent to ephemeral water bodies that are recharged by rainfall only. Blue circles indicate riverine refuges. These are semi-permanent to ephemeral water bodies in riverine sediments which are recharged by rainfall the interaction with semi-permanent shallow aquifers within the riverine system. The green circles highlight interflow discharge sites. These are ephemeral discharges due to rainfall that has infiltrated into and moves laterally through soil, sediment and or rock and has with no interaction with the water table or aquifer. An E-W section along the light blue line is shown below in Figure 43.

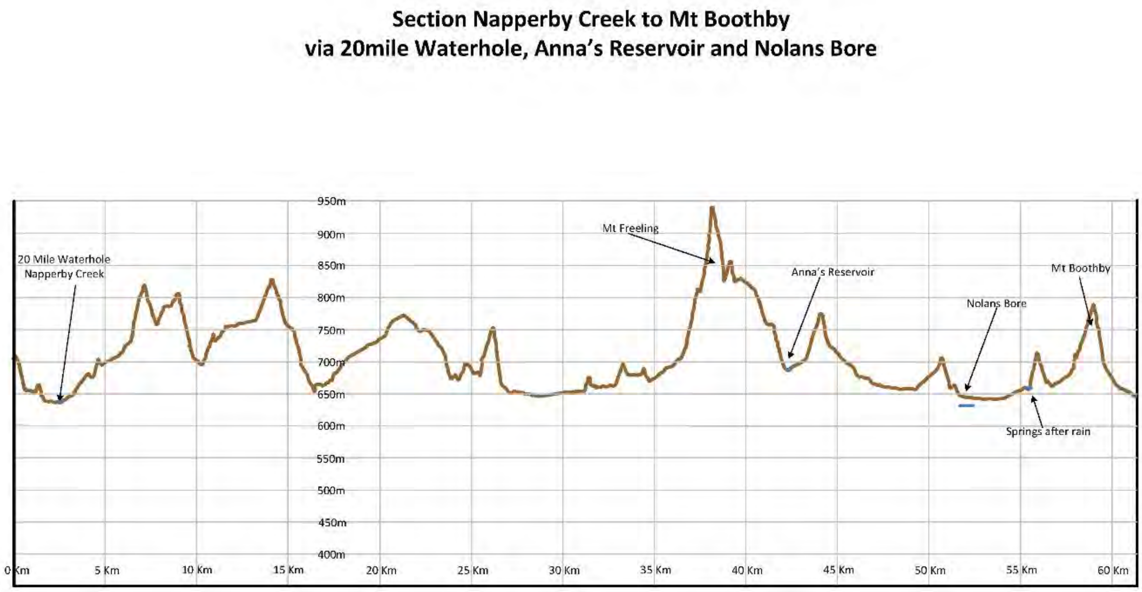


Figure 43. Cross section showing the relationship between elevation along the ranges, natural water bodies and the water level at Nolans Bore. The "spring after rain" to the east of Nolans Bore is classified as an interflow discharge site occurs at the base of a small hill to the east of the mine. Other interflow discharge sites are also suspected in this region. A number of rockholes (natural depression in the drainage) are shown on this section as well. The nearest example is Anna's Reservoir which is clearly a separated by hills, is within the Southern basins water catchment and above the groundwater level at Nolans Bore.

Issue 429

DME.

- *Describe what representative sized sample intervals will be used for the acquisition of additional geochemical data if the samples are taken from the blast holes.*
- *Explain whether these samples are able to be correlated with the current resource drilling samples. If sample analysis is completed with the portable XRF, explain if samples can be correlated and compared with those analysed by Lab XRF. Clarify if the portable XRF has the detection capacity to analyse for the required resolution of sulphur.*

Arafura Response

A representative sample can be anything from 100 gms to kilograms, depending on the sample split and the material being assayed. Sampling methodology and strategy will be developed to ensure that we obtain a representative sample from the bench height/interval being tested once determined. The analytical method and elements have not yet been determined but it is likely that XRF will be used at a site laboratory as this will provide a rapid turnaround.

Geological and assay data collected from blast holes will be used for grade control assessments and to refine material type analysis to aid the selective mining of the mineralisation in this deposit. The geological and assay data collected will be critical to evaluating and confirming the current resource model. Based on knowledge off the mineralisation, it is expected that the blast hole data and the mineral resource drilling data will strongly correlate and the confidence in this is aligned with the defined Mineral Resource classification.

Current assays in the resource database have included representative samples between about 100g and 8 kg. These assays are considered representative splits of the material they were testing.

Arafura are unlikely to routinely use pXRF on site. Although pXRF instruments have provided useful data for Arafura, they are timely to use and the inherent REE spectral interferences complicate interpretations of the reported result. This occurs because there are different calibration curves for different matrices, one must therefore first know if there are REE present in the rock. Thus, in Arafura's experience, the reported pXRF result is dependent on an accurate calibration curve for the desired matrix. This means knowing what the rock may contain before analysis. The presence or absence of Nolans Bore type mineralisation is much more readily determined by the mineralogy, colour and radioactivity and laboratory assay results are more clearly robust. There is a very strong correlation between radioactivity and rare earth grade.

As pointed out in the above AMD section, there is very little sulfur in the waste rocks at Nolans Bore and the areas where this is likely to occur have been clearly outlined. A more detailed assessment of these areas and their immediate surrounds will be undertaken to better define and understand these rocks later in operation, once mining approaches these places. Arafura are confident of our waste rock AMD analysis as our assessment is based on 3,473 total sulfur results.

Arafura was able to calibrate a pXRF to detect the sulfur well below the suggested 3000ppm trigger value that might indicate material with potential AMD. The manufacturer indicated a detection limit of about 50ppm S however 100-200 ppm appears more realistic given the requirement for rapid field measurements.

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montana G.I.S

AEM4GeoMapping.docx

TO: Kelvin Hussey

CC: Richard Brescianini

FROM: David McInnes

DATE: July 22, 2013

SUBJECT: Use of Airborne Electromagnetic (AEM) data modeling for geological mapping.

The concept of using AEM data modelling to map geological boundaries (unconformities, contacts and faults) is based on Andrew Bissett's paper, "Detecting unconformity related alteration using Tempest - An example from Arnhem land, Australia." (figure 1). This paper formed the basis of this author's AEM modelling and interpretation processes and software development; which has been utilised in the Westmorland area, throughout the Curnamona and Gawler Cratons, adjacent to Ranger, in Arizona/Utah and other various areas in Australia, Eastern Europe and the south pacific.

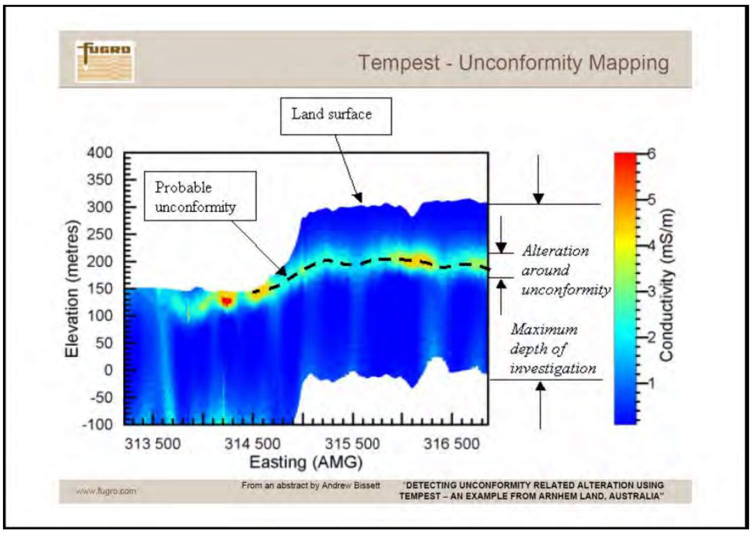

Figure 1: A figure from Bissett's paper demonstrating how a Conductivity depth cross section model derived from the AEM data can be used to interpret the location and offsets in the unconformable surface.

The Electromagnetic method responds to conductors such as the cover sequences, historic exposed paleo-surfaces (unconformity) and the crystalline basement due to the significant electrical contrast between the younger overlying unconsolidated sediments (conductors) and the crystalline basement units (resistors). It is also sensitive to faults within the lower crystalline basement as they are generally better conductors due to:

- The shearing that occurs along the fault plane, generally developing more platy better interconnect minerals.
- The increased conductivity of the minerals developed within the shear (clays/graphite)
- The generally higher water content within the fault plane
- And the increased porosity/permeability within the fault plane.

All of the above improves the electrical interconnectivity of the fault plane decreasing its resistivity in contrast to the more resistive crystalline basement.

MONTANA GIS,
Geophysical & Geographical Information Services
88 Long Point Street, Potato Point NSW 2545
ph +61 2 4473 5972 D mobile +61 419 863 303 R mobile +61 419 863 966
montana@bigpond.com
ABN 61 073 425 724

By undertaking 1D Layered Earth Inversion modelling (LEIs) of the observed data, for all stations along a traverse, geo-electrical cross section of the earth can be constructed (figure 2). LEI's differ from Conductivity Depth Images (CDIs) in that a CDI is a point transform of the observed AEM data at a specific time without taking into consideration the signal response at adjacent times down the electromagnetic decay. Whereas the LEI is a holistic model of the time decay where a geo-electric model is derived that replicates the total time decay of the signal. Therefore it is postulated that the LEI model is a better representation of the electrical variations within the earth, which enables a better model construction with sharper contacts between the lithological units, enhancing interpretation and consequently improving targeting.

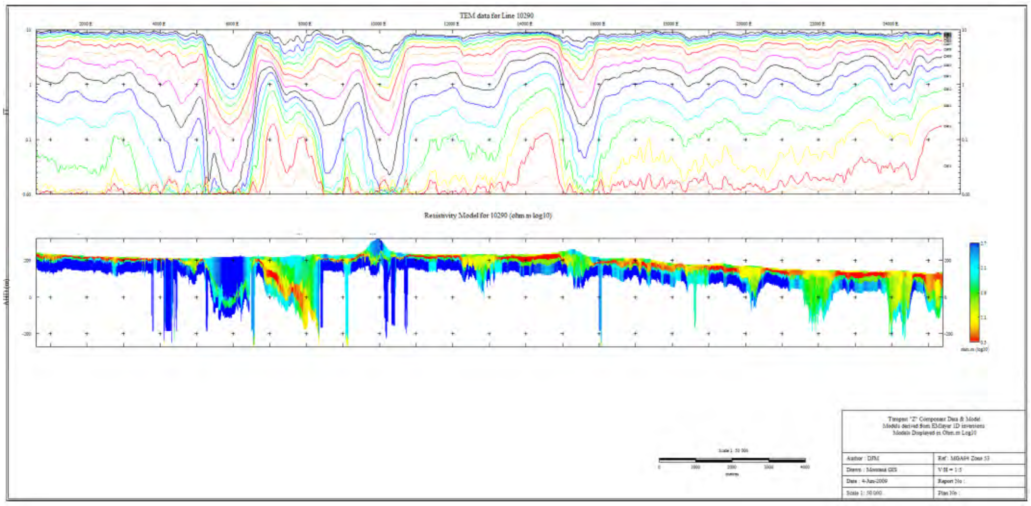

Figure 1: An example of the observed data along with the LEI model.

From these electrical cross section models the thickness of the overlying sediments/unconformity and the crystalline basement contact can be interpreted and consequently the palaeo-topography of the basement constructed (figure 3a and 3b). Where significant changes in the depth to the top of the basement are modelled basement faults can be inferred. Also any conductive structures that are contained within the basement will be detected due to their decreased resistivity as previously explained above.

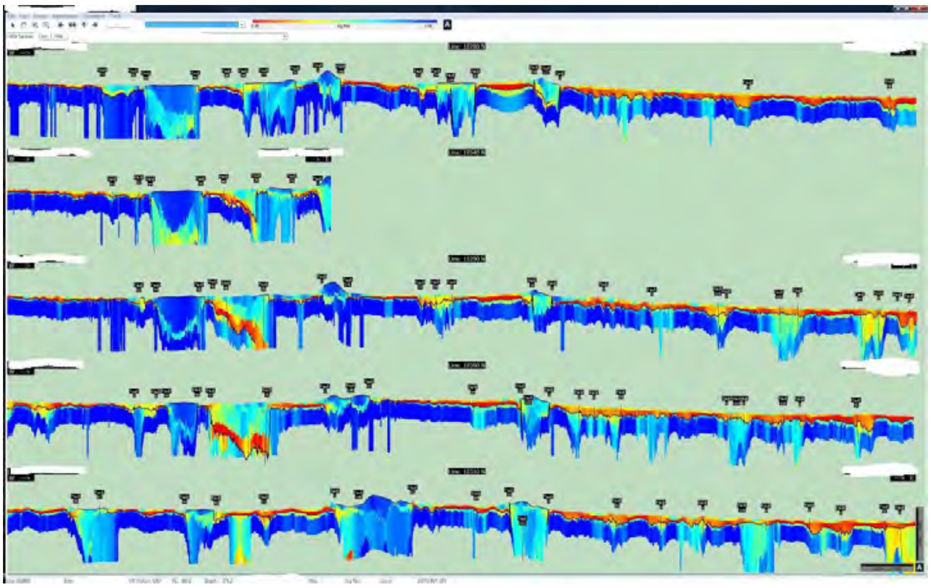

Figure 3a: A Screen snap shot from the model interpretation software, it demonstrates the concept of the cover/unconformity and basement along with the fault interpretation. Note the indexing of the faults to establish continuity of the structures across survey lines.

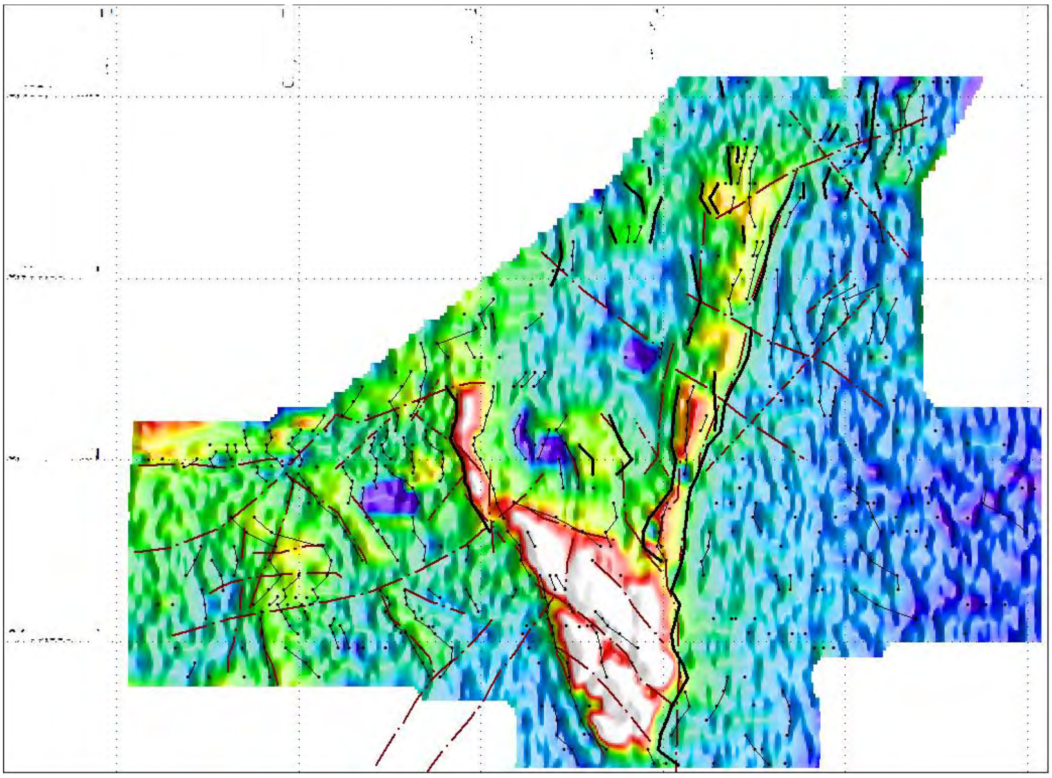

Figure 3b: The fault interpretation overlain on the crystalline basement interpretation. Also shown are the regional structures. The smaller faults are connected through the fault index allocation. Isolated points are where no similar fault could be identified on adjacent lines. It is interesting to note that terminations of the smaller faults appears to correlate with truncations by the regional basement structures.

This modelling and interpretation of the AEM data is integrated with other data in a 3D model to identify target areas (figure 4).

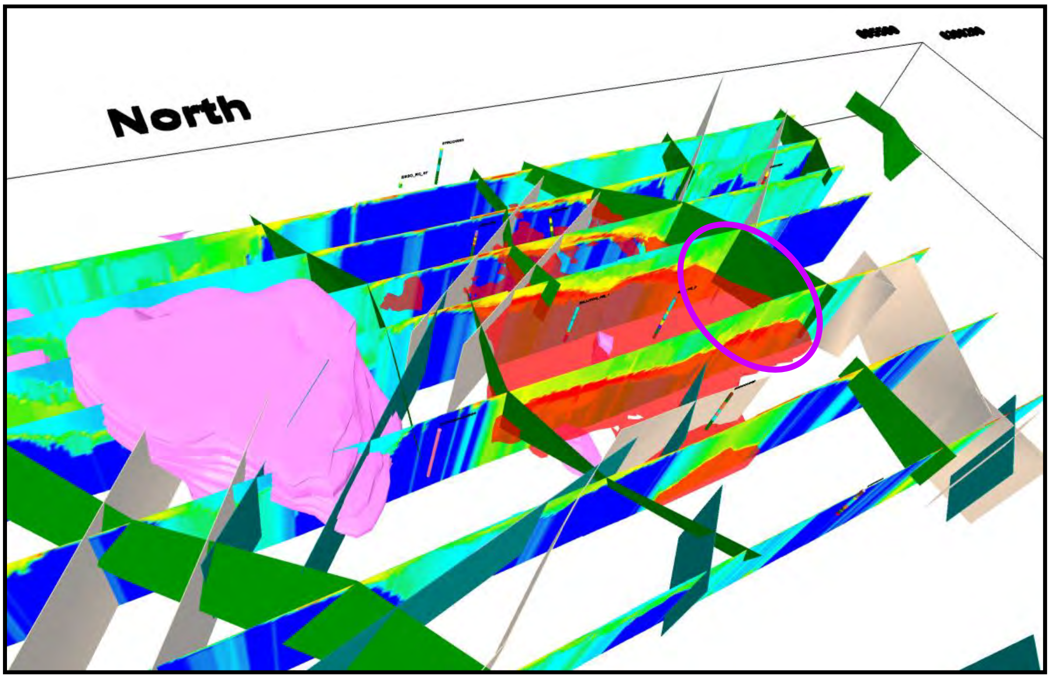

Figure 12: A snap shot of the 3D model displaying the model sections, the interpreted faults and historic drill holes, these intersect the unconformity at depths comparable with the AEM model holes. A shell of the unconformity has been constructed based on the AEM conductor that correlates with it. The area where this abuts the fault is considered perspective to host uranium (magenta circle). The pink solid is mapped granite

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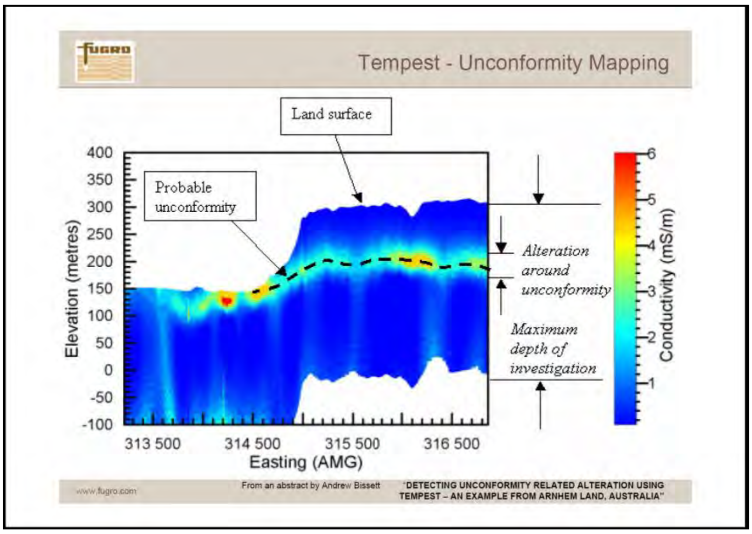

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MONTANA GIS,
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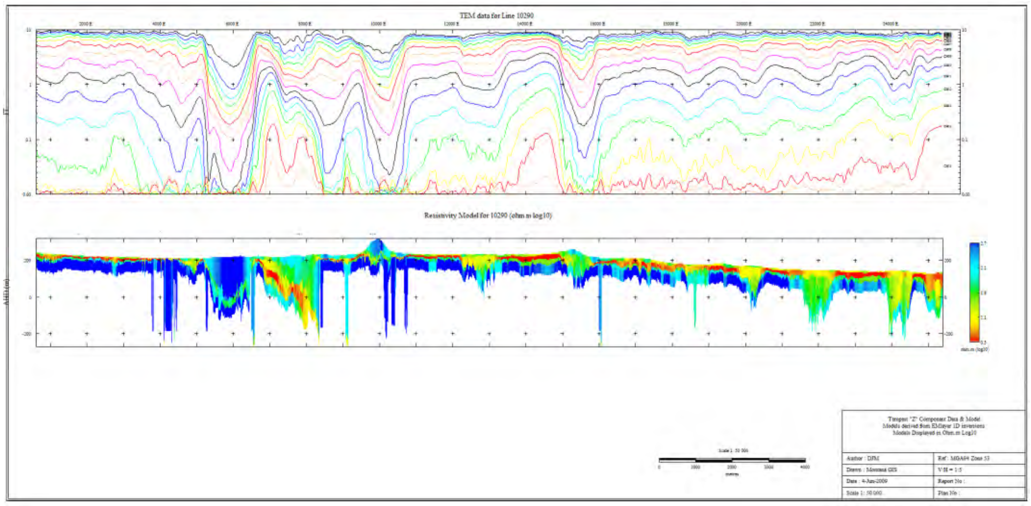

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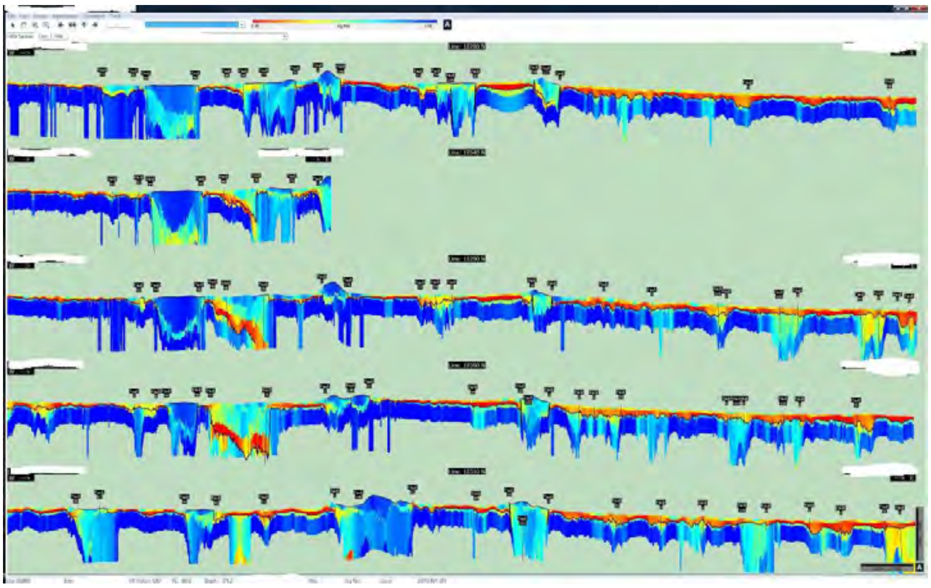

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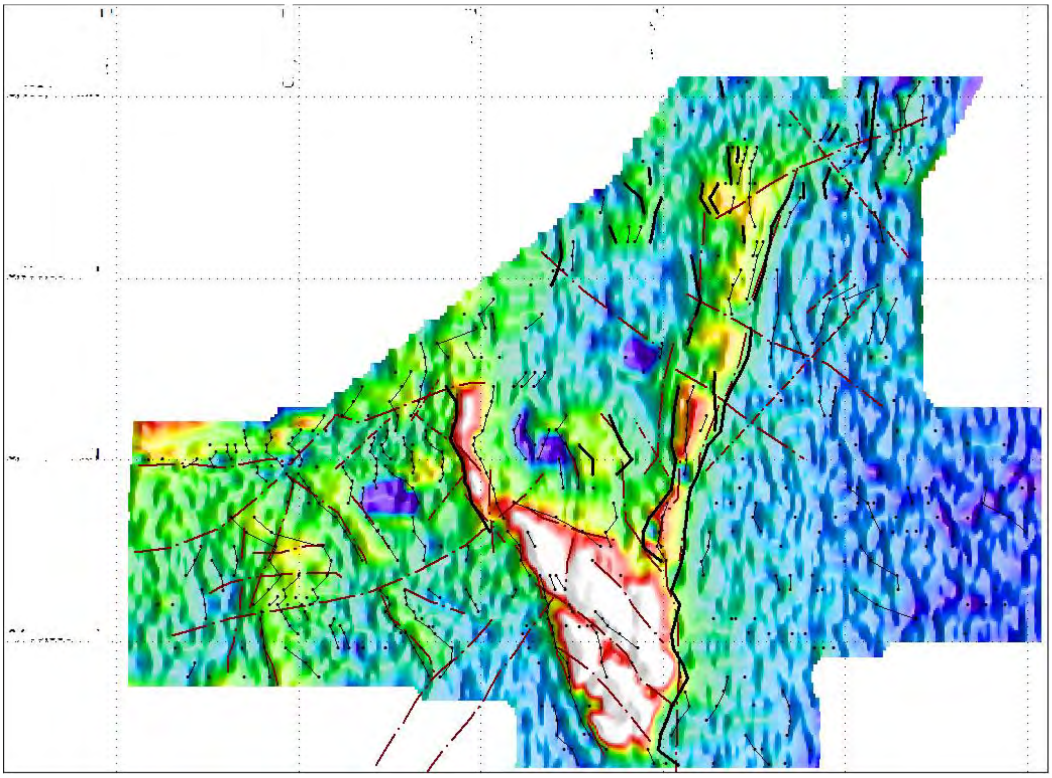

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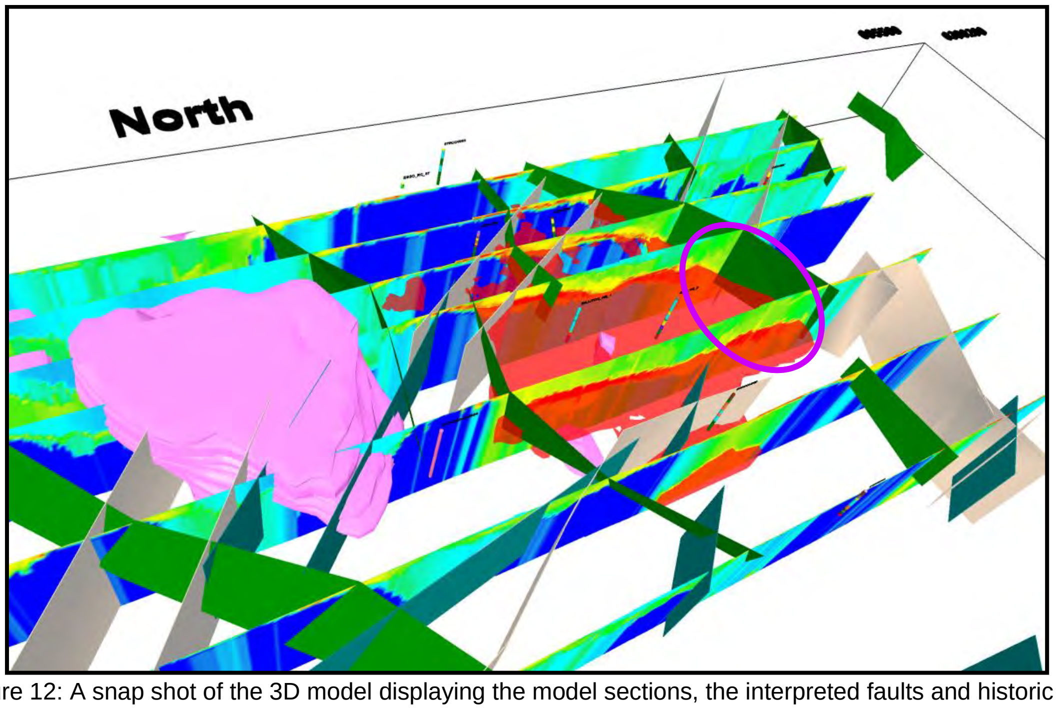

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ABN 22 080 933 455

Report ARU-15/010

NOLANS PORTABLE XRF WASTE ROCK & MINERALISTION CHARACTERISATION

By

R.A. Dean BSc(Hons)

Copyright statement

Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
■ E: arafura@arultd.com ■ W: www.arultd.com

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Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
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Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
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Appendices

Appendix 1 Results of pXRF investigation
Appendix 2 Calibration data for pXRF investigation
Appendix 3 QAQC data for pXRF investigation
Appendix 4 Report figures and other photographs
Appendix 5 Miscellaneous files associated with pXRF investigation

Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
■ E: arafura@arultd.com ■ W: www.arultd.com

INTRODUCTION

Arafura Resources Ltd (Arafura) has undertaken an investigation designed to geochemically characterise Nolans Bore waste rock and mineralisation. This investigation is an integral component of the Environmental Impact Statement (EIS) currently being prepared by GHD Environmental Consultants. This report outlines the geochemical analysis of a representative set of 679 Nolans Bore sample pulps using a portable benchtop XRF (pXRF) unit. The sample set comprises the three primary waste lithologies in quantities that reflect their abundance in the resource drilling domain; gneiss (298), pegmatite (131), and schist (124), as well as Nolans Bore mineralisation (126). The samples were selected from drill core obtained during the 2011 drilling campaign and are selected from a wide spatial and depth range throughout the resource drilling domain. Parallel to this investigation, and with the same selection criteria, a representative set of 200 sample pulps were dispatched to ALS laboratories in Brisbane for assay of a suite of elements by ICPMS and ICPAES. A subset of 23 of these samples (included in the total 679 samples selected) were analysed with the pXRF and the results subsequently used in the calibration of the machine. The following sections will outline the methods involved in collection of the pXRF geochemical data and the results obtained. The reader is directed to Hall et al. (2014) for a comprehensive evaluation of pXRF units including the Olympus X-5000 series used in this investigation, and the calibration of pXRF units using control reference materials.

METHODOLOGY

Equipment & Settings

The equipment used during the investigation was the Olympus X-5000 Series Mobile XRF. Each sample pulp was placed in a Premier Lab Supply SC-4331 XRF sample cup with a Premier Lab Supply TF-240-255 polypropylene 4µm XRF thin filter. The Olympus X-5000 series was run on two modes for all samples. The two beam *Geochem* mode was utilised for analysis of the light elements Mg, Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe and LE (a total for elements lighter than Mg), and the three beam *Soil* mode was utilised in analysis of the heavy elements Co, Ni, Cu, Zn, As, Se, Rb, Sr, Y, Zr, Mo, Ag, Cd, Sn, Sb, Ba, La, W, Au, Hg, Pb, Bi, Ce, Th and U. Each mode was run with a beam time of 60 seconds.

Sample Selection

The samples analysed were selected primarily from inspection of core photos by identifying intervals typical of a lithology type which had been sampled for assay. Samples were selected from the 2011 diamond drill core holes where possible; however some RC intervals were selected where core samples could not be obtained. The 2011 drill core intervals were chosen as they are the most recent samples available and hence should have the least amount of oxidation of sulphides and other reactive minerals. A database of potential samples was built up until all 2011 diamond drill core holes had been investigated. From this database the final samples were selected and the assay pulps collected from the sample pulp library in the Darwin warehouse. Not all assay pulp could be located quickly as they are not stored entirely in sequence, and when this occurred, a replacement sample of the same lithology and depth within the resource drilling domain was selected.

Sample Preparation

The assay pulps were collected in increasing sample number order and seven batches of roughly 90 samples were compiled. The sample bags in each batch were labelled with a cup number starting at 1 for the first sample and continuing through the batch sequentially. A small amount (about a teaspoon or approximately 5g) of each pulp was placed in a pre-prepared XRF soil cup with an XRF thin film

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base, and the pulp was then pressed gently with a piece of wooden dowel on a small sheet of rubber matting to ensure the sample pulp was packed flush with the XRF thin film and to minimise voids within the pulp. The desired thickness of sample pulp within the cup was a minimum of 5mm, but could be anywhere up to 10mm. The XRF thin film was then wiped with a clean cloth to minimise any contamination before XRF analysis and the cup was placed on a numbered sheet so each sample could be easily identified (Figure 1). After use the cups were emptied, washed with water from a strong stream and dried for reuse in the next batch.

pXRF Operation

Prior to the commencement of work with the pXRF, a training season was conducted by an accredited Olympus representative and a radiation safety and instrument user certificate was granted to the operators. Before operation of the XRF unit each day a self-calibration check was undertaken. This involved placing the stainless steel calibration disc supplied with the pXRF over the measuring unit and running the *Cal Check* mode. This task would be performed at one or two other times during the day's operation.

Arafura purchased 18 certified standards from ORE (Ore Research & Exploration) Pty Ltd for the purpose of calibrating the XRF unit and for QAQC purposes (Figure 1). An additional standard was used during the analysis, Arafura's internal standard ARA09-01, which has been analysed extensively by 4-Acid Digest ICP during Nolans Bore drilling campaigns. Table 1 outlines the standards used during the investigation.

Table 1 List of standards used during pXRF analysis

Arafura Standard ID	Standard ID	Description
A	BLANK	Silicon Dioxide Blank
B	ARA09-01	Nolans Bore Mineralisation
C	OREAS 460	Carbonatite Supergene REE-Nb Ore (TREO 0.53%)
D	OREAS 461	Carbonatite Supergene REE-Nb Ore (TREO 1.06%)
E	OREAS 462	Carbonatite Supergene REE-Nb Ore (TREO 1.54%)
F	OREAS 463	Carbonatite Supergene REE-Nb Ore (TREO 2.08%)
G	OREAS 464	Carbonatite Supergene REE-Nb Ore (TREO 5.10%)
H	OREAS 465	Carbonatite Supergene REE-Nb Ore (TREO 9.88%)
I	OREAS 24b	Granodiorite Lithogeochem / Blank
J	OREAS 24c	Alkali Olivine Basalt
K	OREAS 25a	Soil Lithogeochem / Blank
L	OREAS 40	High Grade Iron Ore
M	OREAS 45d	Anomalous Ferruginous Soil
N	OREAS 101b	Uranium Ore Multi-Element
O	OREAS 106	High Grade Uranium Ore
P	OREAS 70b	Nickel Sulphide Ore
Q	OREAS 152b	Porphyry Copper-Gold Ore
R	OREAS 701	High Grade Tungsten-Copper-Gold-Magnetite Ore
S	OREAS 921	Copper Bearing Siltstone

Before any of the sample pulps were analysed all the standards were run on both the *Geochem* and *Soil* mode in order to calibrate the unit for the desired elements. The Arafura internal standard, Standard B, was then run 11 times in *Geochem* Mode and 10 times on *Soil* Mode in order to assess the unit for precision. The results of can be found in the following QAQC section.

Once the analysis of the standards in both modes was complete the selected assay pulps were analysed. A batch would be completed in one mode completely before analysis in the other mode was undertaken. Duplicate analyses were done every twenty samples and the duplicate analysis was

Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ▪ PO Box 5773, Adelaide Terrace, Perth WA 6831 ▪ T: +618 6210 7666 ▪ F: +618 9221 7966
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labelled with the suffix '_D'. Standard A is a quartz blank and was analysed after each duplicate analysis followed by one of the Standards *C* to *O* in progressive order. The same standard was analysed during the assay sequence in both *Geochem* and *Soil* modes. During the analysis of Batch 3 a change in the analysis of the standards was implemented whereby Standard B (ARA09-01) was inserted one in every twenty samples after Standard A in the assay sequence. This was maintained until the end of the XRF investigation.

Figure 1 ***Left:*** *The certified standards starting with A in the top left and finishing with O in the bottom right of the box.* ***Right:*** *The Olympus X-5000 Series Mobile XRF unit with a batch of pulps pressed into the sample cups on the numbered sheet. Also notice the stainless steel calibration disc to the right of the pXRF*

After completion of a batch the results would be downloaded from the unit and analysed for inconsistences in the duplicate and Standard A elemental concentrations. The analytical procedures outlined were applied to the first 7 batches over a period of approximately two weeks. Batch 8 was comprised of the remaining 20 primary sample as well as 23 of the 200 samples which had previously been assayed via ICPMS and ICPAES at ALS laboratories, Brisbane. These 23 samples were analysed for Al, Sb, As, Ba, Bi, B, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Hg, Mo, Ni, Se, Ag, Sr, S, Tl, Th, Sn, U, V and Zn. Batch 8 also contained 18 samples from batches 2, 3, 5 and 6 which due to recording or sampling uncertainties were deemed to be unreliable and were repeated in whichever mode the uncertainty was obtained. The remainder of Batch 8 was comprised of replacement sample pulps for samples which could not be easily located in the Darwin warehouse.

The pXRF results from the analysis of the standards were compiled with their highest ranking certified values obtained from the literature that accompanied each standard. The ranking that was applied to the certified values was firstly Fusion XRF results if listed, then Fusion ICP, then 4-Acid Digest ICP and lastly Aqua Regia Digest ICP. The results were tabulated for each element along with the assay results from the 23 Nolans Bore samples returned from ALS Brisbane and plotted in order to establish calibration formulas. Due to difficulty in getting a calibration for sulphur, four whole-rock sample pulps with S values greater than 1000ppm were obtained from Northern Territory Geological Survey (NTGS). These sample pulps were also used for the calibration of other elements in the suite. Table 2 outlines the details of these samples.

The correlation between XRF results and certified or laboratory analysed values varied dramatically between the elements and matrix-matched corrections (country rock and mineralisation) were produced for certain elements where there appeared to be two distinct populations with differing slopes (Figure 2). The pXRF calibration plots have the certified or laboratory values on the x-axis and pXRF values on the y-axis. A line of best fit was applied and a linear calibration formula derived.

Table 2 NTGS whole-rock samples used in pXRF analysis

Arafura Standard ID	NTGS Sample ID	Description
W	GV14JAW037	Amphibolite xenolith
X	GV14SKR012A	Diorite xenolith
Y	GV14BLR010C-F	Melville Bay Metamorphics (migmatite)
Z	GV14SKR214	Drimmie Head Granite

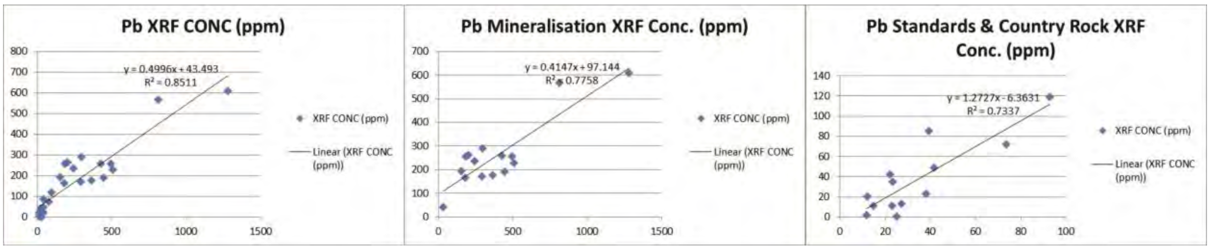

Figure 2 *Calibration plot for lead (Pb) with combined matrices (left), mineralisation matrix-matched (middle), and country rock-matrix matched (right).*

RESULTS

The raw and corrected data from the portable XRF machine can be found in Appendix 1. The file *XRF Results.xlsx* contains a number of sheets, the first of which, labelled *Data*, is the complete set of raw data from the pXRF with unreliable data replaced with repeat analyses from Batch 8. The sheets labelled *Geochem* and *Soil* have the corrected data for each mode tabled against the samples lithology and sample number.

The tabulated data and plots of the certified standards, ALS-assayed Nolans Bore samples and NTGS samples can be found in Appendix 2. The file *Calibration XRF.xlsx* contains the combined matrix corrections for each element of interest. The file *Calibration XRF_Lithologies.xlsx* contains the matrix-matched corrections for each element. The first matrix-matched correction being for REE mineralisation which includes Standards C, D, E, F, G and H (Carbonatite Supergene REE-Nb Ore), as well as the ALS-assayed Nolans Bore samples which represent REE mineralisation. The second matrix-matched correction is for country rock and includes all remaining standards, the ALS-assayed Nolans Bore samples that represent gneiss, pegmatite or schist and the NTGS samples. The calibration formulas applied to the pXRF raw data for each element are outlined in table 3.

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Table 3 Calibration formula applied to raw pXRF data

Element	Combined Matrix Formula	Mineralisation Matrix Formula	Country Rock Matrix Formula
Al	y = 0.2949x + 42559		
Sb	XRF Raw Values		
As		y = 0.006x + 13.373	y = 0.744x + 15.36
Ba	y = 0.6441x + 338.23		
Bi	XRF Raw Values		
Cd	XRF Raw Values		
Cr		REE Spectral Interference	y = 0.621x + 63.782
Co	Unreliable		
Cu	y = 0.8762x + 14.492		
Fe	y = 1.1415x + 23503		
Pb		y = 0.4147x + 97.144	y = 1.2727x - 6.3631
Mn		REE Spectral Interference	y = 0.8347x + 164.18
Hg	Unreliable		
Mo	y = 0.9426x + 0.6523		
Ni	y = 0.8349x + 30.883		
Se	XRF Raw Values		
Ag	XRF Raw Values		
Sr		y = 0.0501x + 130.43	y = 1.8355x + 27.614
S	y = 1.1388x + 422.5		
Tl	No XRF data		
Th	y = 0.9403x + 879.32		
Sn	XRF Raw Values		
U		y = 0.1301x - 2.7068	y = 1.58x - 80.142
V		REE Spectral Interference	y = 2.1297x
Zn	y = 0.7252x + 20.42		

The next section of the report outlines the rationale behind the calibration/s applied for each element and gives a summary of the corrected pXRF concentration including the minimum, maximum, average, median & standard deviation of each element within each lithology. Also noted is the average concentration of each element in upper continental crust (Rudnick, 2003) for comparison.

Element Analyses

Aluminium (Al)

The pXRF was calibrated for aluminium using a combined matrix formula; however the data was very poorly correlated and couldn't be resolved into mineralisation and country rock matrices. The detection limit for the pXRF is 1% and the average upper continental crust concentration is 8.15%. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 6.2% and the average for all 200 samples was 1.3% Table 4 summarises the corrected pXRF data.

Table 4 Calibrated pXRF data for aluminium (Al)

Lithology	Minimum (%)	Maximum (%)	Average (%)	Median (%)	Standard Deviation (%)
Gneiss	<DL	20	5.4	5.2	3.3
Mineralisation	<DL	9.9	0.3	<DL	1.5
Pegmatite	<DL	13	7.4	7.4	2.0
Schist	<DL	18	5.5	5.4	2.9

Antimony (Sb)

The pXRF could not be calibrated for antimony as there was only one certified standard for which the pXRF concentration was greater than the detection limit of the unit. The detection limit for pXRF is

Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
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20ppm and the average upper continental crust concentration is 0.4ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 0.6ppm and the average for all 200 samples was 0.1ppm. The results summarised in Table 5 are the raw pXRF data.

Table 5 Raw pXRF data for antimony (Sb)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	<DL	<DL	<DL	<DL
Mineralisation	<DL	<DL	<DL	<DL	<DL
Pegmatite	<DL	<DL	<DL	<DL	<DL
Schist	<DL	<DL	<DL	<DL	<DL

Arsenic (As)

The pXRF was calibrated for arsenic using a matrix-matched formula for country rock, which has a fair correlation, and REE mineralisation which is very poorly correlated. Matrix-matched calibrations were applied as no sensible correlation could be identified in the combined matrix plot. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 4.8ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 390ppm and the average for all 200 samples was 23ppm. Table 6 summarises the corrected pXRF data.

Table 6 Calibrated pXRF data for arsenic (As)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	7.9	<DL	<DL	0.79
Mineralisation	<DL	12000	650	<DL	1800
Pegmatite	<DL	35	<DL	<DL	<DL
Schist	<DL	11	<DL	<DL	<DL

Barium (Ba)

The pXRF was calibrated for barium using a combined matrix formula. The data is very poorly correlated but it couldn't be resolved into mineralisation and country rock matrices. The detection limit for the pXRF is 20ppm and the average upper continental crust concentration is 628ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 1150ppm and the average for all 200 samples was 237ppm. Table 7 summarises the corrected pXRF data.

Table 7 Calibrated pXRF data for barium (Ba)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	10000	1600	1300	1400
Mineralisation	<DL	12000	250	<DL	1300
Pegmatite	130	4300	1100	890	780
Schist	<DL	4200	1200	1000	760

Bismuth (Bi)

The pXRF could not be calibrated for bismuth as there were only two certified standards for which the pXRF concentration was above the detection limit of the unit. The detection limit for the pXRF is 5ppm

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Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
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and the average upper continental crust concentration is 0.16ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 12ppm and the average for all 200 samples was 1.0ppm. The results summarised in Table 8 are the raw pXRF data.

Table 8 Raw pXRF data for bismuth (Bi)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	<DL	<DL	<DL	<DL
Mineralisation	<DL	<DL	<DL	<DL	<DL
Pegmatite	<DL	<DL	<DL	<DL	<DL
Schist	<DL	<DL	<DL	<DL	<DL

Cadmium (Cd)

The pXRF could not be calibrated for cadmium as no certified standards, ALS-assayed Nolans Bore samples or NTGS samples had measured XRF concentrations above the pXRF detection limit. The detection limit for the pXRF is 10ppm and the average upper continental crust concentration is 0.09ppm. The results summarised in Table 9 are the raw pXRF data. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 0.3ppm and the average for all 200 samples was 0.07ppm.

Table 9 Raw pXRF data for cadmium (Cd)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	<DL	<DL	<DL	<DL
Mineralisation	<DL	<DL	<DL	<DL	<DL
Pegmatite	<DL	<DL	<DL	<DL	<DL
Schist	<DL	<DL	<DL	<DL	<DL

Chromium (Cr)

The pXRF was calibrated for chromium using a matrix-matched formula for country rock; however no sensible correlation was observed for REE mineralisation. This is due to spectral interference between the K peaks of chrome and the L peaks of the light REEs. A good correlation however was observed for country rock. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 92ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 100ppm and the average for all 200 samples was 16ppm. Table 10 summarises the corrected pXRF country rock data. These values appear unusually high and atypical for these rock types. It is suggested that REE interference is likely adding to the chromium result.

Table 10 Calibrated pXRF data for chromium (Cr)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	4900	180	67	460
Mineralisation	Interference	Interference	Interference	Interference	Interference
Pegmatite	<DL	7200	360	200	710
Schist	<DL	4500	340	110	700

Cobalt (Co)

The pXRF could not be calibrated for cobalt as there was no sensible correlation between the certified standards, ALS-assayed Nolans Bore samples and NTGS samples, and the measured XRF concentrations. Matrix matching the XRF results did not aid in generating reasonable correlations and hence the data is deemed unreliable. The detection limit for pXRF is 10ppm and the average upper continental crust concentration is 17.3ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 39ppm and the average for all 200 samples was 7.6ppm.

Copper (Cu)

The pXRF was calibrated for copper using a combined matrix formula as the data has a very good correlation. The detection limit for the pXRF is 10ppm and the average upper continental crust concentration is 28ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 150ppm and the average for all 200 samples was 14ppm. Table 11 summarises the corrected pXRF data.

Table 11 Calibrated pXRF data for copper (Cu)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	200	<DL	<DL	22
Mineralisation	<DL	150	12	<DL	16
Pegmatite	<DL	600	10	<DL	54
Schist	<DL	100	10	<DL	19

Iron (Fe)

The pXRF was calibrated for iron using a combined matrix formula as the data has a very good correlation. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 3.9%. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 6.24% and the average for all 200 samples was 2.04%. Table 12 summarises the corrected pXRF data.

Table 12 Calibrated pXRF data for iron (Fe)

Lithology	Minimum (%)	Maximum (%)	Average (%)	Median (%)	Standard Deviation (%)
Gneiss	<DL	10	2.7	2.2	2.2
Mineralisation	<DL	15	1.7	0.13	2.6
Pegmatite	<DL	16	1.5	1.1	1.7
Schist	0.2	11	4.5	4.3	1.7

Lead (Pb)

The pXRF was calibrated for lead using a matrix-matched formula for country rock, which has a good correlation, and REE mineralisation which also has a good correlation. Matrix-matched calibrations were applied as the data has two distinct populations with different slopes. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 17ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 1280ppm and the average for all 200 samples was 83ppm. Table 13 summarises the corrected pXRF data.

Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
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Table 13 Calibrated pXRF data for lead (Pb)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	5	220	43	34	36
Mineralisation	<DL	1500	250	220	230
Pegmatite	9.9	450	75	61	49
Schist	5	530	30	16	<DL

Manganese (Mn)

The pXRF was calibrated for manganese using a matrix-matched formula for country rock; however no sensible correlation was observed for REE mineralisation. This is due to spectral interference between the K peaks of manganese and the L peaks of the light REEs. A very good correlation was observed for country rock. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 774ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 922ppm and the average for all 200 samples was 162ppm. Table 14 summarises the corrected pXRF country rock data.

Table 14 Calibrated pXRF data for manganese (Mn)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	2900	230	150	320
Mineralisation	Interference	Interference	Interference	Interference	Interference
Pegmatite	<DL	2400	165	91	300
Schist	<DL	1700	370	240	370

Mercury (Hg)

The pXRF could not be calibrated for mercury as only four selected ALS-assayed Nolans Bore samples, and no standards or NTGS samples had measured XRF concentrations above the pXRF detection limit as well as assay concentration above detection limit. The four points did not correlate and the data is deemed unreliable. The detection limit for pXRF is 5ppm and the average upper continental crust concentration is 0.05ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 1ppm and the average for all 200 samples was 0.07ppm.

Molybdenum (Mo)

The pXRF was calibrated for molybdenum using a combined matrix formula as the data has a good correlation. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 1.1ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 15.4ppm and the average for all 200 samples was 0.4ppm.Table 15 summarises the corrected pXRF data.

Table 15 Calibrated pXRF data for molybdenum (Mo)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	25	<DL	<DL	<DL
Mineralisation	<DL	14	6.0	6.4	<DL
Pegmatite	<DL	24	<DL	<DL	<DL
Schist	<DL	7.8	<DL	<DL	<DL

Nickel (Ni)

The pXRF was calibrated for nickel using a combined matrix formula as the data has a very good correlation. The detection limit for the pXRF is 10ppm and the average upper continental crust concentration is 47ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 56ppm and the average for all 200 samples was 9.2ppm.Table 16 summarises the corrected pXRF data.

Table 16 Calibrated pXRF data for nickel (Ni)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	68	<DL	<DL	<DL
Mineralisation	<DL	89	43	45	22
Pegmatite	<DL	28	<DL	<DL	<DL
Schist	<DL	85	<DL	<DL	16

Selenium (Se)

The pXRF could not be calibrated for selenium as there were only two certified standards which had XRF concentrations above the pXRF detection limit and certified assay values above detection limit. The detection limit for pXRF is 5ppm and the average upper continental crust concentration is 0.09ppm. The results summarised in Table 17 are the raw pXRF data. It should be noted that these appear to be strongly underestimated as the maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 626ppm and the average for all 200 samples was 30ppm.

Table 17 Raw pXRF data for selenium (Se)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	<DL	<DL	<DL	<DL
Mineralisation	<DL	6.0	<DL	<DL	<DL
Pegmatite	<DL	<DL	<DL	<DL	<DL
Schist	<DL	<DL	<DL	<DL	<DL

Silver (Ag)

The pXRF could not be calibrated for silver as there were no certified standards, ALS assayed Nolans Bore samples or NTGS samples with greater than detection limit values and XRF concentrations above the pXRF detection limit. The detection limit for the pXRF is 10ppm and the average upper continental crust concentration is 0.053ppm. The results summarised in table 18 are the raw pXRF data. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 2.3ppm and the average for all 200 samples was 0.08ppm.

Table 18 Raw pXRF data for silver (Ag)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	87	<DL	<DL	<DL
Mineralisation	<DL	170	<DL	<DL	15
Pegmatite	<DL	<DL	<DL	<DL	<DL
Schist	<DL	<DL	<DL	<DL	<DL

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Strontium (Sr)

The pXRF was calibrated for strontium using a matrix-matched formula for country rock, which was poorly correlated, and REE mineralisation which had a good correlation. Matrix-matched calibrations were applied as the data has two distinct populations with different slopes. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 320ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 5440ppm and the average for all 200 samples was 702ppm. Table 19 summarises the corrected pXRF data.

Table 19 Calibrated pXRF data for strontium (Sr)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	2000	400	360	270
Mineralisation	<DL	56000	5600	4600	6800
Pegmatite	33	1000	280	240	220
Schist	12	1200	340	330	210

Sulphur (S)

The pXRF was calibrated for sulphur using a combined matrix formula as the data has a fair correlation. The detection limit for the pXRF is 200ppm and the average upper continental crust concentration is 62ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 2300ppm and the average for all 200 samples was 250ppm.Table 20 summarises the corrected pXRF data.

Table 20 Calibrated pXRF data for sulphur (S)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	12000	<DL	<DL	840
Mineralisation	<DL	4300	1100	730	1000
Pegmatite	<DL	6800	<DL	<DL	610
Schist	<DL	2600	<DL	<DL	300

Thallium (Tl)

The pXRF was not configured to measure thallium. The average upper continental crust concentration is 0.9ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 2.0ppm and the average for all 200 samples was 0.4ppm.

Thorium (Th)

The pXRF was calibrated for thorium using a matrix-matched formula for country rock, which has a very good correlation and REE mineralisation which has a good correlation. Matrix-matched calibrations were applied as the data has two distinct populations with different slopes. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 10.5ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 7690ppm and the average for all 200 samples was 966ppm.Table 21 summarises the corrected pXRF data.

Table 21 Calibrated pXRF data for thorium (Th)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation

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					(ppm)
Gneiss	10	370	63	42	58
Mineralisation	<DL	23000	4500	4300	3100
Pegmatite	16	340	160	150	74
Schist	10	480	91	55	90

Tin (Sn)

The pXRF could not be calibrated for tin as there was only one certified standard and two ALS-assayed Nolans samples for which the XRF concentration was above the detection limit. The detection limit for pXRF is 20ppm and the average upper continental crust concentration is 2.1ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 11.8ppm and the average for all 200 samples was 2.1ppm. The results summarised in Table 22 are the raw pXRF data.

Table 22 Raw pXRF data for tin (Sn)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	37	<DL	<DL	<DL
Mineralisation	<DL	24	<DL	<DL	<DL
Pegmatite	<DL	<DL	<DL	<DL	<DL
Schist	<DL	46	<DL	<DL	<DL

Uranium (U)

The pXRF was calibrated for uranium using a matrix-matched formula for country rock which has a very good correlation and REE mineralisation which has a good correlation. Matrix-matched calibrations were applied as the data has two distinct populations with different slopes. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 2.7ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 919ppm and the average for all 200 samples was 68ppm. Table 23 summarises the corrected pXRF data.

Table 23 Calibrated pXRF data for uranium (U)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	60	7.1	<DL	11
Mineralisation	21	1400	330	320	150
Pegmatite	<DL	42	<DL	<DL	6.7
Schist	<DL	40	6.6	<DL	8.0

Vanadium (V)

The pXRF was calibrated for vanadium using a matrix-matched formula for country rock; however no sensible correlation was observed for REE mineralisation. This is due to spectral interference between the K peaks of vanadium and the L peaks of the light REEs. The correlation for country rock was very poor and the line of best fit was forced through the origin in order to get a positive gradient. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 97ppm. Table 24 summarises the corrected pXRF country rock data. These values appear to be high for the rock types and it is suggested that titanium interference may be adding to the vanadium. The

Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
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maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 134ppm and the average for all 200 samples was 31ppm.

Table 24 Calibrated pXRF data for vanadium (V)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	700	70	52	72
Mineralisation	Interference	Interference	Interference	Interference	Interference
Pegmatite	15	1000	94	76	98
Schist	<DL	600	82	51	94

Zinc (Zn)

The pXRF was calibrated for zinc using a combined matrix formula as the data has a very good correlation. The detection limit for the pXRF is 5ppm and the average upper continental crust concentration is 67ppm. The maximum concentration from the 200 samples assayed at ALS laboratories Brisbane was 70.0ppm and the average for all 200 samples was 16ppm. Table 25 summarises the corrected pXRF data.

Table 25 Calibrated pXRF data for zinc (Zn)

Lithology	Minimum (ppm)	Maximum (ppm)	Average (ppm)	Median (ppm)	Standard Deviation (ppm)
Gneiss	<DL	59	<DL	<DL	9.4
Mineralisation	<DL	120	10	<DL	18
Pegmatite	<DL	82	<DL	<DL	9.5
Schist	<DL	120	8.1	<DL	19

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QAQC

Evaluation of Standard B Precision

Consecutive Measurements

Eleven consecutive measurements of Standard B using Geochem mode and ten using Soil mode were undertaken at the beginning of the pXRF work in order to assess the precision of the machine. The average and standard deviation were calculated for each element and plotted to view the repeatability. The relative standard deviation was also calculated and it indicated a small error for most elements with an RSD less than 15%. The exceptions were Co, As and Se. The tabulated raw data for Standard B can be found in Appendix 1, *XRF Results.xlsx* in the sheets *Error Check_Geochem* and *Error Check_Soil*. The statistics and plots for each element can be found in Appendix 3, *QAQC_ARA09_01_Initial.xlsx*. Figure 3 shows an example of the error check for lead (Pb).

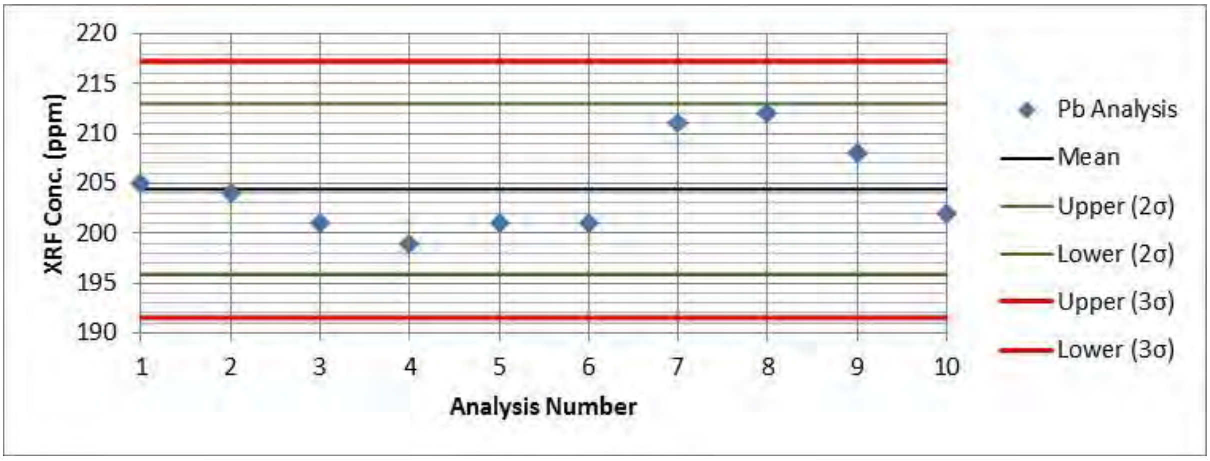

Figure 3 *Ten consecutive analysis of Standard B for lead (Pb) plotted. The RSD is 2.1% which indicates good error range of the machine for that element.*

Regular Measurements

Standard B was measured regularly throughout the pXRF investigation for a total of twenty five times in order to examine the machine for errors caused by machine drift. The raw data can be found in Appendix 1, *XRF Results.xlsx* in the sheets *Standards_Geochem* and *Standards_Soil*. The statistics and plots for each element can be found in Appendix 3, *QAQC_ARA09_01_Standard.xlsx*. All elements with the exception of Co, As, Mo, Se had an RSD of less than 15% with Mo being just slightly higher at 18.4%. This indicates a low error for most elements with no machine drift identified. Figure 4 shows an example of the error check for lead (Pb) which has a RSD of 13.4%.

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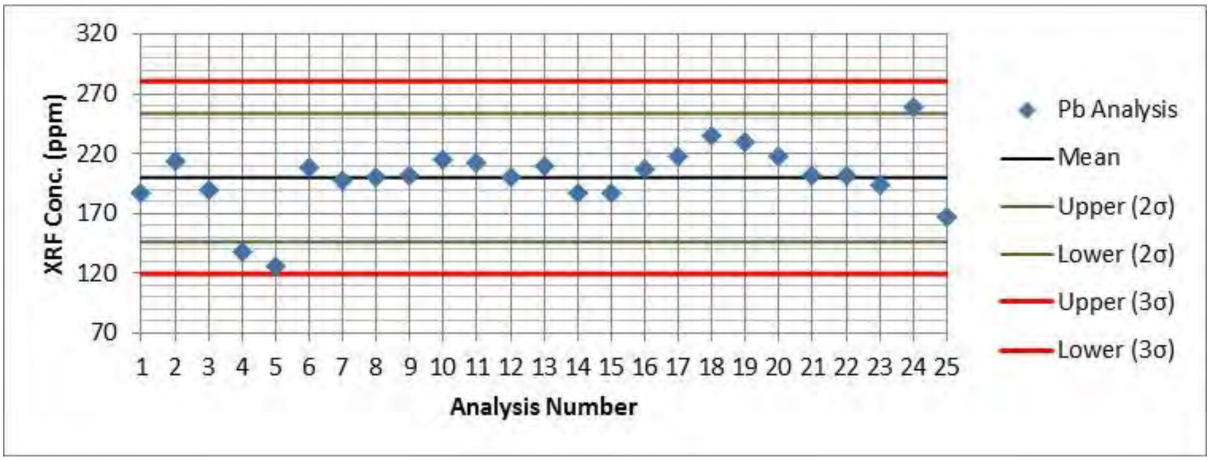

Figure 4 *The twenty five analyses of Standard B for Pb plotted. The RSD is 13.4% which indicates a good error range of the machine for that element.*

Evaluation of Standard A Accuracy

A blank silicon dioxide standard (standard *A*) was analysed every twenty samples for a total of 38 analyses in order to examine the machine for possible contamination. The raw data for the blank can be found in Appendix 1, *XRF Results.xlsx*, sheets *Blank_Geochem* and *Blank_Soil*. Results highlighted in red are above the pXRF detection limit of the machine. The statistics and plots for each element of interest can be found in Appendix 3 in *QAQC_Blank.xlsx*. The plots indicated that while there were some spikes in the data which are above detection limit for the pXRF such as in Al, Fe, and Th, none of them coincide with each other and are therefore deemed to be as a result of instrumental error rather than contamination. Figure 5 shows an example of the contamination check for iron.

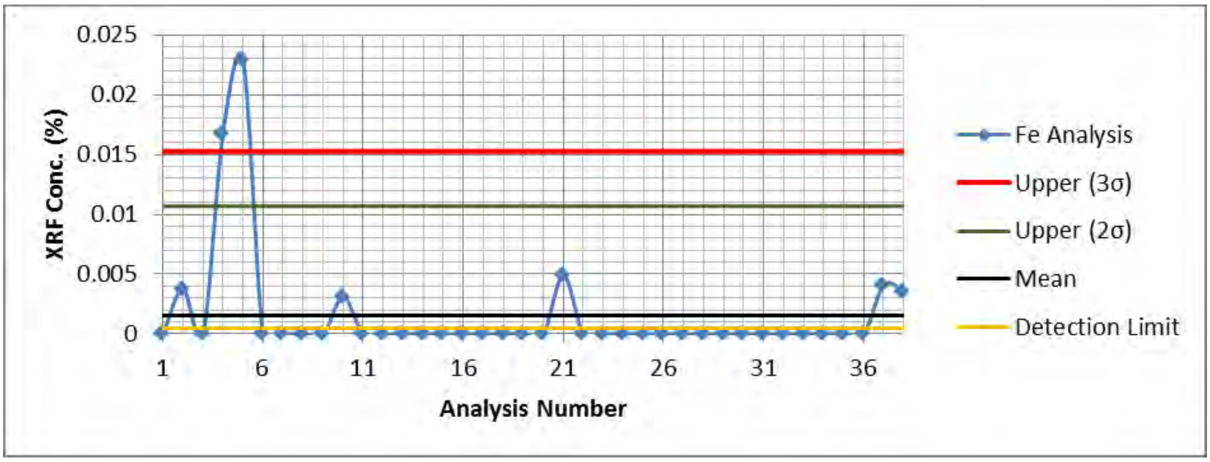

Figure 5 *Plot of the thirty eight analyses of Standard A analysed for Fe. Notice the five spikes which plot above the detection limit of the pXRF machine. The certified maximum value is 0.00002% and the detection limit of the pXRF is 0.0005%*

Duplicate Analyses

A duplicate analysis was undertaken on one in every twenty analyses in both *Geochem* and *Soil* mode. The raw data for the duplicates can be found in Appendix 1, *XRF Results.xlsx*, in sheets labelled *Duplicates_Geochem* and *Duplicates_Soil*. Within these data sheets an analysis was undertaken whereby half the total error of each measurement was added and from this the absolute difference between both measurements was subtracted. If the resulting value was positive then the values were within error of each other and the value in the table was highlighted green. If the resulting value was negative then the two data points were not within error of each other and the value was coloured red. This gave a quick visual inspection on the precision of the duplicate analyses. If the greater majority of the elements were within error, or very close to within error, then the original measurement was accepted.

The duplicate pXRF values were then plotted against the original pXRF values and a linear trendline applied to the data. A goodness of fit (r^2) value was obtained for each element and this along with the plots and data can be found in Appendix 3, *QAQC_Duplicates.xlsx*. An example of the duplicate plots, the plot for lead (Pb), can be seen in Figure 6. The goodness of fit was greater than 0.95 for most elements with the exception of Sb, Cd, Co, Au, Hg, Mo, Se, U, W, and Y. Both Co and Y were reasonably well correlated with an r^2 of greater than 0.93 and the remainder, aside from U were all poorly correlated due to the measurements being below or near the detection limit of the pXRF. Uranium was the only element where measurements above the detection limit of the pXRF (5ppm) were not well correlated with an r^2 of 0.81.

ASSOCIATED pXRF DATA FILES

Appendix 4 contains high resolution image files of the figures from this report along with photographs taken during the pXRF work in Darwin. Appendix 5 contains the remainder of the folders and files associated with pXRF work and the content or purpose of each file is outlined in the dot points below.

- The ***Data In*** folder contains the raw .csv files downloaded from the pXRF unit each day.
- The ***NTGS Whole Rock samples*** folder contains the assays and pXRF results for the four whole rock sample obtained from NTGS.
- The ***Run Sheets*** folder contains both the pXRF run sheet for each batch along with scanned copies of the completed run sheets with comments from the operator.
- The ***User Guide*** folder contains the user guides for the pXRF unit.
- The ***23_ALS_Assay_Results.xlsx*** file contains the assay results of the 23 samples selected from the 200 samples assayed at ALS laboratories, Brisbane.
- The ***23_ALS_pXRF_Results.xlsx*** file contains the pXRF results of the 23 samples selected from the 200 samples assayed at ALS laboratories, Brisbane.
- The ***200_ALS_Assay_Results.xlsx*** file contains the laboratory data for the 200 samples assayed at ALS laboratories, Brisbane.
- The ***200_ALS_Assay_Results_Lithologies.xlsx*** file contains the laboratory data for the 200 samples assayed at ALS laboratories, Brisbane, classified by lithology.
- The ***200_ALS_Assay_Sample_Selection.xlsx*** file contains all the working sheets used during the selection of the 200 samples assayed at ALS laboratories, Brisbane.
- The ***679_pXRF_Assay_Comparison.xlsx*** contains the pXRF results for the 679 sample and their corresponding assays from the Nolans Resource Database along with lithology specific comparison plots.
- The ***Lithology_pXRF_Statistics.xlsx*** file contains the tabulated pXRF statistics (mean, maximum value, minimum value and standard deviation) of each element for each lithology
- The ***pXRF_Sample_Selection.xlsx*** file contains all the working sheets used during the selection of the 679 samples to be analysed with the pXRF.

Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
■ E: arafura@arultd.com ■ W: www.arultd.com

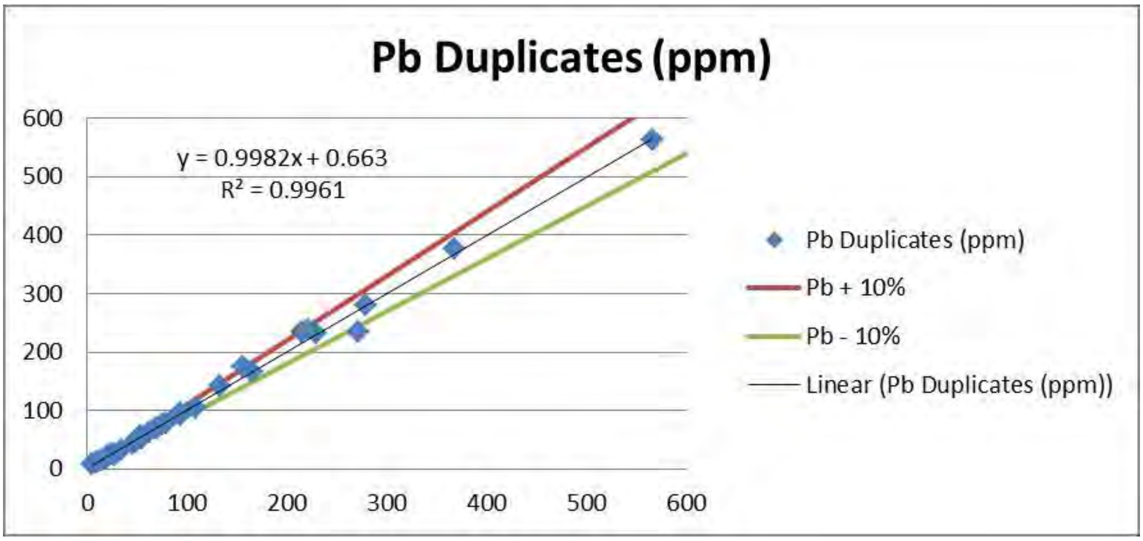

Figure 6 Linear correlation between measured values and duplicate values for lead (Pb).

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Perth Office: Level 3, 263 Adelaide Terrace, Perth WA 6000 ■ PO Box 5773, Adelaide Terrace, Perth WA 6831 ■ T: +618 6210 7666 ■ F: +618 9221 7966
Darwin Office: 18 Menmuir St, Winnellie NT 0820 ■ PO Box 37220, Winnellie NT 0821 ■ T: +618 8947 5588 ■ F: +618 8947 5599
■ E: arafura@arultd.com ■ W: www.arultd.com

Sample_ID	Lithology	Ag	Al	As	Ba	Bi	Cd	Co	*Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	Se	Sn	**Sr	Th	*V	U	Zn
units		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DL		10	10000	5	20	5	10	10	10	10	100	5	5	10	5	200	20	5	20	5	5	5	5	5
pXRF mode		soil	geochem	soil	soil	soil	soil	soil	geochem	soil	geochem	geochem	soil	soil	soil	geochem	soil	soil	soil	soil	soil	geochem	soil	soil
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Sample_ID	Lithology	Ag	Al	As	Ba	Bi	Cd	Co	*Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	Se	Sn	**Sr	Th	*V	U	Zn
units		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DL		10	10000	5	20	5	10	10	10	10	100	5	5	10	5	200	20	5	20	5	5	5	5	5
pXRF mode		soil	geochem	soil	soil	soil	soil	soil	geochem	soil	geochem	geochem	soil	soil	soil	geochem	soil	soil	soil	soil	soil	geochem	soil	soil
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Sample_ID	Lithology	Ag	Al	As	Ba	Bi	Cd	Co	*Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	Se	Sn	**Sr	Th	*V	U	Zn
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Sample_ID	Lithology	Ag	Al	As	Ba	Bi	Cd	Co	*Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	Se	Sn	**Sr	Th	*V	U	Zn
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2108205_2108206	PEG	<10	52360	<5	2408	<5	<10	NR	163	<10	10265	136	<5	<10	95	<200	<20	<5	<20	968	88	78	<5	<5
2108305_2108306	PEG	<10	92374	<5	803	<5	<10	NR	419	<10	9970	298	<5	<10	48	<200	<20	<5	<20	555	173	94	17	<5

Sample_ID	Lithology	Ag	Al	As	Ba	Bi	Cd	Co	*Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	Se	Sn	**Sr	Th	*V	U	Zn
units		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
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pXRF mode		soil	geochem	soil	soil	soil	soil	soil	geochem	soil	geochem	geochem	soil	soil	soil	geochem	soil	soil	soil	soil	soil	geochem	soil	soil
2111710_2111711	PEG	<10	37779	<5	1425	<5	<10	NR	39	51	61518	413	<5	<10	17	<200	<20	<5	<20	323	80	52	6	26
2112698_2112699	PEG	<10	69993	<5	416	<5	<10	NR	491	<10	2590	135	<5	<10	61	<200	<20	<5	<20	43	281	92	6	<5
2113644_2113645	PEG	<10	89322	<5	778	<5	<10	NR	63	<10	<100	<5	5	<10	46	<200	<20	<5	<20	67	79	38	<5	<5
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2134110	SCH	<10	75419	<5	914	<5	<10	NR	<5	33	38136	115	<5	<10	5	<200	<20	<5	<20	127	30	32	<5	<5
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2101216_2101217	SCH	<10	19807	<5	1220	<5	<10	NR	817	<10	43814	532	5	<10	33	<200	<20	<5	<20	537	246	163	11	<5
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2101397_2101398	SCH	<10	38796	<5	1042	<5	<10	NR	231	<10	44939	249	<5	<10	19	<200	<20	<5	<20	404	142	67	<5	<5
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2103163_2103164	SCH	<10	77114	<5	196	<5	<10	NR	<5	<10	2265	<5	<5	<10	6	<200	<20	<5	<20	25	28	<5	20	<5
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2104667_2104668	SCH	<10	49986	<5	849	<5	<10	NR	<5	<10	44866	205	<5	<10	18	<200	<20	<5	<20	218	28	35	5	<5
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Sample_ID	Lithology	Ag	Al	As	Ba	Bi	Cd	Co	*Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	Se	Sn	**Sr	Th	*V	U	Zn
units		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
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pXRF mode		soil	geochem	soil	soil	soil	soil	soil	geochem	soil	geochem	geochem	soil	soil	soil	geochem	soil	soil	soil	soil	soil	geochem	soil	soil
2107637_2107638	SCH	<10	<10000	<5	407	<5	<10	NR	392	<10	76338	459	<5	47	5	<200	<20	<5	<20	284	88	51	<5	6
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2113808_2113809	SCH	<10	22180	<5	461	<5	<10	NR	682	<10	57050	455	<5	<10	10	<200	<20	<5	<20	231	214	117	25	<5
2113854_2113855	SCH	<10	45578	<5	644	<5	<10	NR	21	<10	25759	18	<5	<10	5	<200	<20	<5	<20	195	39	20	<5	<5
2113899_2113900	SCH	<10	60159	<5	546	<5	<10	NR	382	<10	30932	158	<5	<10	15	<200	<20	<5	<20	402	114	86	10	<5
2113912_2113913	SCH	<10	48291	<5	210	<5	<10	NR	343	<10	22544	157	<5	15	13	<200	<20	<5	<20	474	137	68	<5	<5
2113919_2113920	SCH	<10	65924	<5	1285	<5	<10	NR	250	<10	43477	273	<5	<10	8	<200	<20	<5	<20	459	117	89	<5	<5
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2114000_2114001	SCH	<10	61855	<5	860	<5	<10	NR	74	<10	46720	82	<5	<10	5	<200	<20	<5	<20	90	67	39	12	<5
2114038_2114039	SCH	<10	45239	<5	1947	<5	<10	NR	65	12	51617	188	<5	10	26	<200	<20	<5	<20	312	45	53	30	<5
2114044_2114045	SCH	<10	33371	<5	1934	<5	<10	NR	91	11	62258	257	6	30	8	<200	<20	<5	<20	303	36	53	<5	8
2114061_2114062	SCH	<10	130353	<5	3324	<5	<10	NR	192	94	64436	302	<5	24	73	<200	<20	<5	<20	1170	60	89	5	8
2114068_2114069	SCH	<10	131031	10	1830	<5	<10	NR	219	55	100957	739	<5	26	7	<200	<20	<5	<20	335	66	66	<5	115
2114072_2114073	SCH	<10	51004	<5	1175	<5	<10	NR	111	18	63876	753	<5	<10	20	<200	<20	<5	<20	402	62	49	<5	9
2114113_2114114	SCH	<10	58125	<5	545	<5	<10	NR	123	<10	40943	232	<5	<10	17	<200	<20	<5	<20	727	41	49	9	<5
2114154_2114155	SCH	<10	54056	<5	680	<5	<10	NR	<5	<10	30395	11	<5	<10	9	<200	<20	<5	<20	232	26	27	11	<5
2114339_2114340	SCH	<10	101190	<5	1340	<5	<10	NR	33	<10	61084	296	<5	15	8	<200	<20	<5	<20	239	20	38	<5	<5
2114341_2114342	SCH	<10	60159	<5	1338	<5	<10	NR	53	<10	57328	303	<5	10	6	<200	<20	<5	<20	238	19	42	<5	<5
2114343_2114344	SCH	<10	44222	<5	1009	<5	<10	NR	86	<10	57087	448	<5	10	19	<200	<20	<5	<20	535	29	41	<5	<5
2114356_2114357	SCH	<10	52360	<5	1858	<5	<10	NR	66	<10	52303	342	<5	<10	78	<200	<20	<5	<20	454	37	43	9	10
2114769_2114770	SCH	<10	<10000	<5	447	<5	<10	NR	2865	17	29669	1435	<5	<10	208	<200	<20	<5	<20	285	438	447	20	34
2115689_2115690	SCH	<10	83557	<5	613	<5	<10	NR	<5	<10	53222	69	<5	<10	11	<200	<20	<5	<20	82	33	25	<5	<5
2115693_2115694	SCH	<10	41848	<5	626	<5	<10	NR	786	<10	51419	663	<5	<10	25	<200	<20	<5	<20	397	182	139	18	<5
2116308_2116309	SCH	<10	26250	<5	848	<5	<10	NR	45	84	85328	1140	<5	85	33	<200	<20	<5	<20	388	30	42	<5	95
2116423_2116424	SCH	<10	45917	<5	1285	<5	<10	NR	70	<10	22325	124	6	<10	41	<200	<20	<5	<20	262	50	47	<5	<5

Sample_ID	Lithology	Ag	Al	As	Ba	Bi	Cd	Co	*Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	Se	Sn	**Sr	Th	*V	U	Zn
units		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DL		10	10000	5	20	5	10	10	10	10	100	5	5	10	5	200	20	5	20	5	5	5	5	5
pXRF mode		soil	geochem	soil	soil	soil	soil	soil	geochem	soil	geochem	geochem	soil	soil	soil	geochem	soil	soil	soil	soil	soil	geochem	soil	soil
2116473_2116474	SCH	<10	64229	<5	885	<5	<10	NR	342	<10	58726	398	<5	12	53	<200	<20	<5	<20	484	126	80	<5	31
2118285_2118286	SCH	<10	43883	<5	720	<5	<10	NR	<5	13	55705	445	<5	<10	39	<200	<20	<5	<20	197	24	23	10	22
2118486_2118487	SCH	<10	49308	<5	758	<5	<10	NR	<5	<10	40774	25	<5	<10	8	<200	<20	<5	<20	12	16	25	<5	<5
2118515_2118516	SCH	<10	54056	<5	1442	<5	<10	NR	<5	28	41811	159	<5	<10	29	<200	<20	<5	<20	116	27	36	<5	<5
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2118646_2118647	SCH	<10	44561	<5	787	<5	<10	NR	62	77	37395	176	<5	10	13	680	<20	<5	<20	21	22	28	<5	<5
2119725_2119726	SCH	<10	42526	<5	405	<5	<10	NR	118	<10	48138	666	<5	26	10	<200	<20	<5	<20	364	63	40	<5	<5
2119824_2119825	SCH	<10	66263	<5	92	<5	<10	NR	<5	20	79707	1060	<5	68	5	<200	<20	<5	46	47	10	15	13	19
2120320_2120321	SCH	<10	27606	<5	1307	<5	<10	NR	664	13	41734	666	<5	<10	57	<200	<20	<5	<20	504	196	150	39	29
2120324_2120325	SCH	<10	40831	<5	2504	<5	<10	NR	111	36	52859	333	<5	<10	47	<200	<20	<5	<20	586	62	77	11	20
2121349_2121350	SCH	<10	28623	<5	464	<5	<10	NR	398	31	90185	1254	7	79	9	<200	<20	<5	<20	172	143	94	8	52
2121358_2121359	SCH	<10	22180	<5	826	<5	<10	NR	630	10	30926	489	<5	<10	43	<200	<20	<5	<20	400	217	122	9	5
2121673_2121674	SCH	<10	78471	<5	931	<5	<10	NR	25	<10	55697	267	<5	<10	5	<200	<20	<5	<20	50	27	31	<5	<5
2122391_2122392	SCH	<10	85253	<5	733	<5	<10	NR	168	<10	36996	127	<5	<10	13	<200	<20	<5	<20	695	55	48	<5	<5
2122434_2122435	SCH	<10	54734	<5	2500	<5	<10	NR	152	<10	44598	238	<5	<10	5	<200	<20	<5	<20	592	36	93	<5	<5
2122454_2122455	SCH	<10	64568	<5	973	<5	<10	NR	86	<10	29824	98	<5	<10	8	<200	<20	<5	<20	492	74	49	20	<5
2122891_2122892	SCH	<10	76775	<5	792	<5	<10	NR	1050	<10	63633	1349	<5	35	50	2551	<20	<5	<20	430	135	173	10	82
2122893_2122894	SCH	<10	68637	11	1466	<5	<10	NR	453	<10	106787	777	<5	62	29	593	<20	<5	<20	273	72	97	<5	86
2123992_2123993	SCH	<10	47613	<5	2936	<5	<10	NR	142	28	50594	822	<5	13	41	<200	<20	<5	<20	538	50	98	<5	40
2125690_2125691	SCH	<10	54395	<5	2141	<5	<10	NR	140	25	53219	213	<5	17	37	<200	<20	<5	<20	429	29	69	<5	5
2125692_2125693	SCH	<10	59820	<5	1470	<5	<10	NR	195	29	60516	502	<5	11	96	<200	<20	<5	<20	470	73	76	7	34
2125903_2125904	SCH	<10	17433	<5	2233	<5	<10	NR	<5	30	41274	134	<5	<10	13	288	<20	<5	<20	236	25	53	<5	<5
2129871_2129872	SCH	<10	67620	<5	891	<5	<10	NR	29	<10	6592	<5	<5	<10	23	<200	<20	<5	<20	133	33	36	<5	<5

Notes

Complete list of results presented in Dean 2015.

NR: Not reported. The pXRF results could not be accurately calibrated for this element/rock matrix.

* Some reported results may be suspect. Especially those with elevated REE.

** Some results are clearly too high (based on 29,012 exploration results).