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Report prepared by
INTERNATIONAL GEOSCIENCE LTD

On behalf of
USI NT PTY LTD
FINAL REPORT: EL 27805, RELINQUISHED BLOCKS

5 July 2015

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EXECUTIVE SUMMARY

USI NT (USI) hold exploration license EL 27805; one of five ELs collectively referred to as the Amadeus project area. In July 2015 EL 27805 was reduced. The relinquished area is located in the northern portion of the tenement.

Several field investigations have been undertaken on the relinquished blocks of EL 27805 but unfortunately no mineralisation was identified.

The reason for selecting the Amadeus tenements was the close proximity to known manganese occurrences and USI NT’s recent success (USI NT Manganese occurrences: Tardis, Dalek, Dalek West, The Doctor, Ivan, Ivan West, Ethan).

The selected blocks for relinquishment were chosen due to the lack of mineralisation observed in field investigations.

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Figure 6: Dissolved Mn²⁺ (left) and dissolved Fe²⁺ relative to salinity (modified after Van Cappellen et al., 1998).

Figure 7: Historical and recently discovered manganese in the Amadeus (Left) correlated with the Amadeus Basin stratigraphy (right) (after Edgoose, 2012).
1 OVERVIEW

USI NT (USI) hold exploration license EL 27805; one of five ELs collectively referred to as the Amadeus project area. In July 2015 EL 27805 was reduced. The relinquished area is located in the northern portion of the tenement.

No field investigations have been undertaken on the relinquished blocks of EL 27805 due to poor access to outcropping geology.

The reason for selecting the Amadeus tenements was the close proximity to known manganese occurrences and USI NT’s recent success (USI NT Manganese occurrences: Tardis, Dalek, Dalek West, The Doctor, Ivan, Ivan West, Ethan).

The selected blocks for relinquishment were chosen due to the lack of mineralisation observed in field investigations.

![Figure 1: Location of the original outline for USI NT’s EL27805 and the relinquished blocks.](image)

1.1 Local Geology

EL 27800, 27801 and 27805 are completely within the Amadeus Basin and consist of a significant amount of Quaternary and Tertiary cover material (Figure 3) 27800 is approximately 80-90% covered in aeolian sand and alluvium. ELs 27801 and 27805 are approximately 60-70% covered by aeolian sand and alluvium.

The EL’s appear to be dominated by east-west trending folding and apparent block faulting. Due to the limited amount outcrop the complete geological setting and deformation within the EL’s is
difficult to grasp. The available airborne magnetic data shows significantly more detail than provided by the outcrop geology. If these EL’s prove to be prospective it is recommended that a full magnetic interpretation be undertaken to build and improve the current geological understanding of the region.
Figure 2: Geology map for the southern tenements in USI NT’s Amadeus Project area from NTGS 250k Henbury digital data.
2 EXPLORATION ACTIVITY OF REPORTING PERIOD

2.1 Field work

Several field trips have been made to the relinquished blocks over the period USI held the tenement but no samples have been collected and no mineralisation has been identified.
3 MANGANESE MODEL IN THE AMADEUS BASIN

The Amadeus is an intracratonic Proterozoic basin covering 117,000km² (Edgoose, 2012 and Shaw et al., 1991). It overlies the Palaeo-Mesoproterozoic basement of the Musgrave Province to the south and the Arunta Region to the north (Edgoose, 2012) (Figure 4).

Lindsay (1987) has identified that the Late Proterozoic basin appears to have consisted of two major poorly circulated anoxic sub-basins, which perhaps opened to the ocean in the south. Because of this disconnection to the ocean the salinity of the basin waters were often high and on occasion hypersaline. During at least two periods the salinity was high enough to form thick evaporate units. Both oxygen availability in the sea and salinity have important roles to play the formation of manganese deposits.

Manganese is a widely abundant element in the earth’s crust but only large high grade deposits are economically viable. A sound understanding of the potential source rock(s) and the mechanisms for transportation/deposition are required in order to explore on a regional scale with the expectation of discovering a new manganese province.

3.1 Source Rock

The two main potential source rocks for the manganese in the Amadeus come from the Arunta Region (North) and from the Musgrave Province (South). A significant portion of the two regions have been eroded since the formation of the Amadeus, and hence the original source may be absent. However, the bulk lithologies provide an indication of the potential sources of manganese.
The Arunta consists of various high grade metamorphic and igneous rocks varying in composition from ultramafic to felsic. In particular, the large mafic intrusive complexes in the Arunta block contain >0.15% Mn based on rock samples reported in the NTGS database (Figure 5).

The Musgrave Province is dominated by various gneisses, granites and quartzites and to a lesser degree a series of late Mesoproterozoic dyke swarms (Alcurra Dyke Swarm ~1080Ma). Several historical rock samples have been reported in the NTGS database to contain >2.75% Mn from granite-gneisses (Figure 5). These rocks make for a good source of manganese in the Amadeus.

The main source of sedimentation into the Amadeus Basin came from both the Arunta Block to the north and Musgrave province to the south. It is considered that the Mn in these rocks could have provided sufficient material for Mn mineralisation to develop in the Amadeus Basin.
Figure 4: Location of manganese mineralisation in the Amadeus Basin. Potential source rocks for manganese have been included with %Mn values from the NTGS database.
3.2 Transportation and Deposition

At the earth’s surface manganese is carried by meteoric waters (surface and subsurface) to the coastal areas. If the coastal waters are anoxic (i.e. black shale seas) the manganese continues to concentrate in the seawater. During periods of increased oxygenation the manganese precipitates and is deposited on the sea floor. Oxygenation commonly occurs in two ways, during regressive (when sea levels retreat) events and during periodic influx of oxygenated sea water into anoxic inland seas (Figure 6). Both of these mechanisms can be active simultaneously in a transgressive/regressive cycle.

Regressive events tend to not only precipitate manganese but also remove it from the marine cycle and hence can ‘lock’ the manganese with sedimentary strata. The most active environments of manganese precipitation are along palaeo-shorelines and therefore deposits of this nature can be very extensive (Figure 6 A).

Periodic flooding of an inland sea, like the Amadeus Basin, can allow for the precipitation of manganese within various parts of the sea floor. In a relatively deep basin the zone of mixing between the manganese rich anoxic basin water would result in the precipitation of manganese along a zone between the manganese poor oxygenated water and the poorly mixed anoxic bottom water (Figure 6 B). The manganese precipitated in this zone may be re-dissolved when the basin returns to being anoxic and as salinity increases.

If the inland sea is relatively shallow than an influx of oxygenated water could result in the precipitation of manganese throughout the sea floor (Figure 6 C). Deposition of manganese in this manner may result in laterally extensive deposits. In order to preserve this manganese in the stratigraphic column the basin would be required to remain oxygenated, possibly as a result of maintaining its connection to the ocean and/or sufficient burial of the manganese beds.

**Figure 5:** Manganese precipitation model during regressive cycles (A) after Frankes and Bolton (1992), and within an inland sea during sea level incursion (B) and (C)
Manganese behaves similarly to iron as it is soluble in acid and reduced conditions. Although manganese is chemically weathered in slightly reducing conditions and iron is precipitated in slightly oxidizing solutions. These variations in chemical behaviour can lead to a ten-fold or more increase of manganese relative to iron (Frankes and Bolton, 1991). Salinity also influences the dissolution rate of manganese and iron. Assuming limited oxygen is available, in hypersaline waters iron does not significantly dissolve into solution until extreme salinities are reached (>240‰). Manganese on the other hand has a much more variable dissolution rate with respect to salinity. At moderate salinities (50-150 ‰) manganese dissolution increases with salinity, but between >150 ‰ manganese dissolution decreases and therefore precipitation can occur (Figure 7, Van Cappellen et al., 1998).

![Figure 6: Dissolved Mn²⁺ (left) and dissolved Fe²⁺ relative to salinity (modified after Van Cappellen et al., 1998).](image)

3.3 Discussion

Several manganese occurrences have been discovered on USI NT’s tenements. Comparison of these occurrences with previously discovered manganese in the Amadeus Basin provides a picture of the extent in both time and location of manganese in this region (Figure 5 and Figure 8). To date sedimentary manganese has been shown to be deposited in the Neoproterozoic (Bitter Springs Formation and Inindia Beds), early Cambrian (Winnall Beds), late Cambrian-Ordovician (Pacoota Sandstone) and the Devonian-Carboniferous (Pertnjara Group). This wide spread distribution is likely reflecting a cyclic nature of manganese deposition in the Amadeus. The main cycle which is ultimately responsible for the majority of manganese deposition is sea-level change. A relative rise and fall of sea-level explains the transgressive-regressive depositional model as well as the periodic influx of oxygenated water into an inland sea. The relative change in sea-level in the Amadeus is probably not only a result of global sea-level changes but local changes due to tectonic changes within the basin.
Figure 7: Historical and recently discovered manganese in the Amadeus (Left) correlated with the Amadeus Basin stratigraphy (right) (after Edgoose, 2012).
4 RECOMMENDATIONS

The following recommendations are suggested in order to evaluate the mineral prospectivity of the surrendered blocks:

- Geophysical survey to explore under cover
- Full background study of historical exploration in the region
- Reconnaissance field investigation of any outcropping areas
5 REFERENCES


