APPENDIX A

Helen Springs Project, Northern Territory

Summary of exploration activities for 2006-2007, preliminary geological model and proposed exploration strategy

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Exploration License: EL23698

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1 Introduction

OM (Manganese) Ltd (OMM) explores for manganese and base-metals within four project areas, as part of the Bootu Creek Operation, over sedimentary basins within the Ashburton Province of the Tennant Inlier in the Northern Territory.

The Helen Springs Project is located approximately 135 km north of Tennant Creek along the Stuart Highway and about 27 km northwest of the Bootu Creek Project area (Figure 1).

A thorough multidisciplinary exploration study is being undertaken over exploration license EL23698 held by OMM and is part of the area of interest.

1.1 Tenement Details

Tenement No.	Grant Date	Anniversary Date	Area	
			Blocks	km^2(ha)
EL23698	6 August 2003	5 August 2007	19	61.68

1.2 Project Location and Access

The Helen Springs Project is located about 25 km southeast of the Renner Springs roadhouse (Stuart Highway) and about 9 km southeast of the Helen Springs Station. The area is accessible via several dirt roads infrequently maintained by the Helen Springs Station (Figure 1).

From the Stuart Highway turn off to the Helen Springs Station, a 12 km dirt track runs east past the Station complex to the northern portion of the Project area. A second dirt track, 7.5 km south from the Stuart Highway turn off to the Station leads eastwards to the south-western edge of the project area.

Access within the Project area is difficult. Two Old tracks within the rugged terrain are overgrown and in places washed away restricting access by vehicle.

1.3 Previous Exploration Activities and Strategy

The Helen Springs area was never explored for manganese. Bootu Creek Resources targeted the area based on favourable geology as mapped by the NT Geological Survey identifying Shilinglaw Formation stratigraphy, which hosts Mn mineralisation at the Renner Springs Project area.

The limited outcrop mapping alongside the main access track did not identify Mn mineralisation occurrences within the sedimentary Namerrini Group, which is about 100 Ma younger than the Bootu Creek Area stratigraphy. The Project area is still prospective as the main portion of the Project area was never examined due to the lack of a N-S access track through the rugged terrain.

OM Manganese after negotiations with a third party is now in the process of acquiring the exploration rights over the more prospective EL23495 and EL24052 to the NE were Mn mineralisation has been proven. These new concessions together with the application EL23699 consolidate a potentially stand alone economically viable project area which merits higher expenditure and further structured exploration.

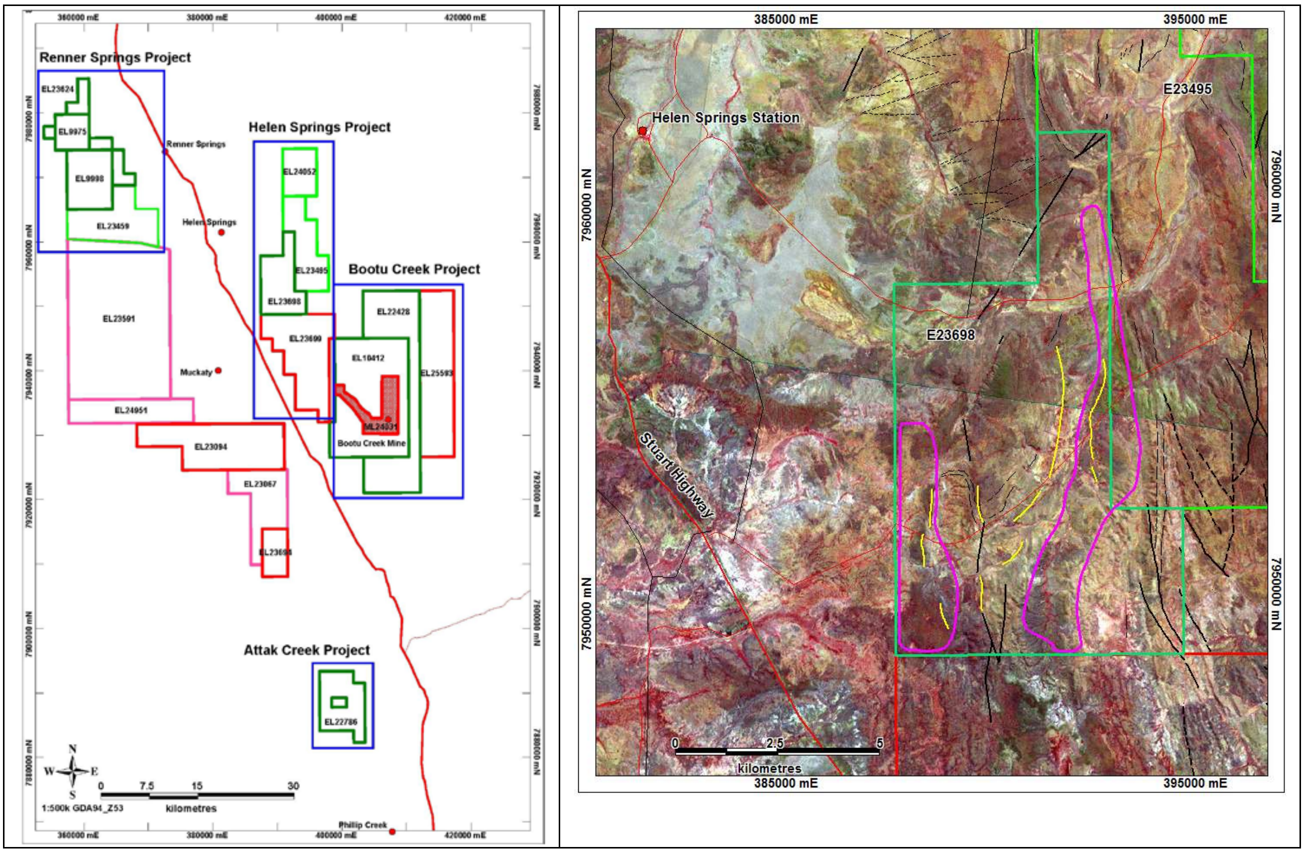

Figure 1. OM Manganese tenement holdings and exploration Projects areas within the Bootu Creek Operation, Northern Territory. On the right, location of E23698 over new ASTER spectral analysis study image taken by OM Manganese over the project area showing preliminary targeting for Renner style Mn mineralisation. ASTER scene true colour bands 321 at 15m pixel resolution.

2 Geological Settings

Three distinct informal provinces are recognised in the Tennant Inlier. These are, from north to south, the Ashburton, Tennant Creek and Davenport provinces. The stratigraphy and the generalized interpreted geological map (Figure 2) are taken from Ferenczi 2001.

2.1 Palaeoproterozoic Basement

A poly-deformed succession of greywacke, siltstone and mudstone with inter-bedded felsic and hematitic shale comprises the Warramunga Formation (1860 Ma), and intruded by syn-orogenic granite and granodiorite as well as by felsic porphyry sills, represents the oldest rocks exposed. This package is overlain by felsic volcanics and volcaniclastics of the Flynn Group (1845-1820 Ma), and is intruded by anorogenic felsic intrusives (granite and porphyry) and lamprophyre. Deformation of the Warramunga Formation during the Barramundi Orogeny produced moderate to tight upright folds with a pervasive, sub-vertical east-west slaty cleavage and was accompanied by lower greenschist facies metamorphism (from Ferenczi 2001).

I-type granodioritic melts and granitic differentiates (Tennant Creek Suite) intruded the Warramunga Formation and lower parts of the Flynn Group between 1850 Ma and 1840 Ma during the Barramundi Orogeny. Deposition of the volcano-sedimentary Flynn Group and emplacement of the Treasure suite (1830-1825 Ma) followed the Barramundi Orogeny. These mainly volcanic rocks are characterised by predominantly high-K rhyolitic to rhyodacitic lava, felsic tuff and ignimbrites.

2.2 Palaeoproterozoic Sedimentary Basin

Three unconformity-bounded, predominantly cyclic fluvial to shallow marine sandstone, siltstone and carbonate successions (Tomkinson, Namerinni and Renner Groups) overlie the Flynn Group and comprise the Ashburton province (Hussey et al 2001).

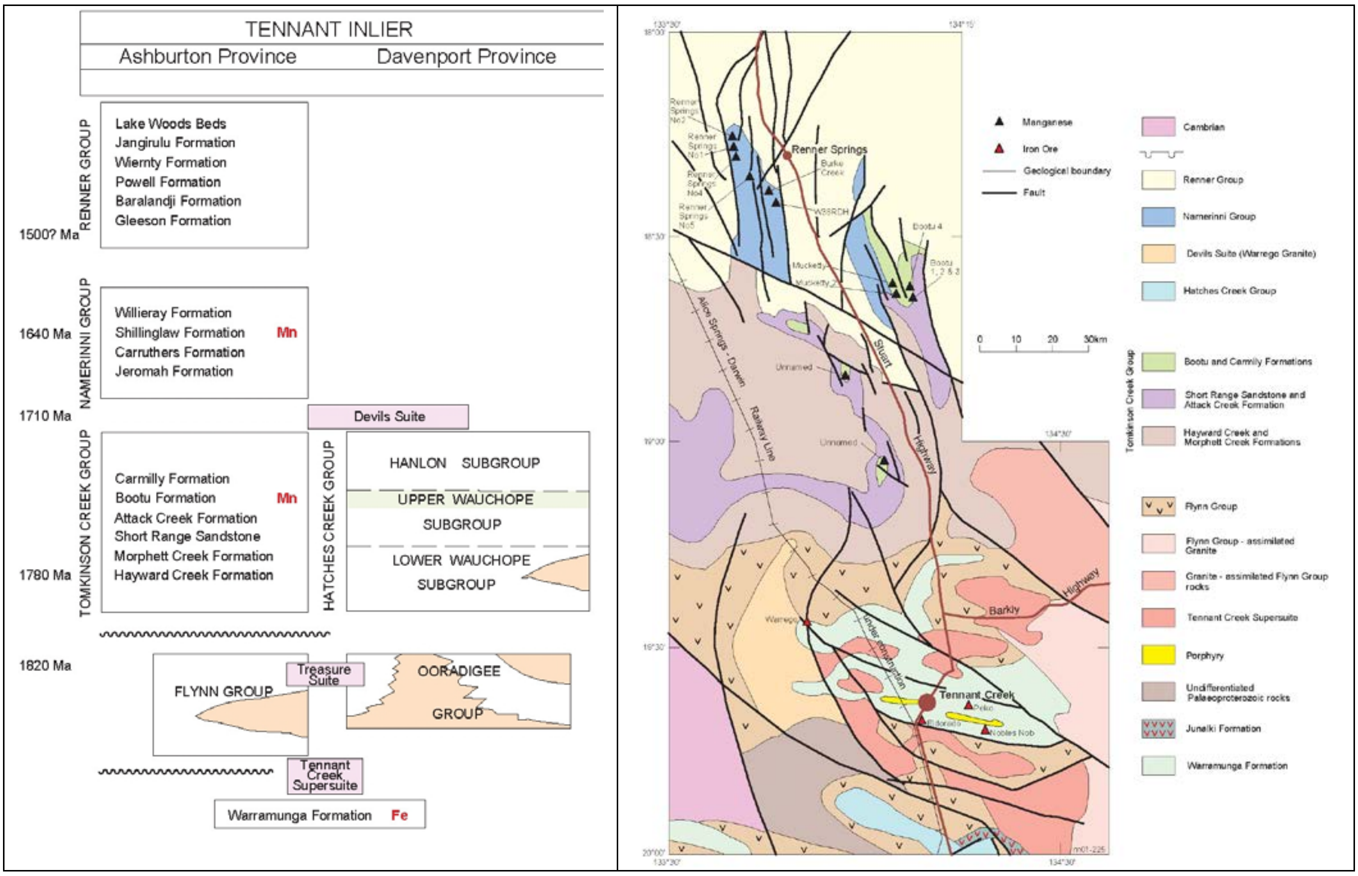

Figure 2. Stratigraphy and interpreted geological map of the Ashburton Province within the Tennant Inlier. Note the increasing distance to north of stratigraphic groups away from basement edges to south.

2.2.1 Tomkinson Group (modified after Ferenczi 2001)

Continental flood basalts are present in the lower part of the Tomkinson Group. The Tomkinson Creek Group is dominated by thick siliciclastic units that alternate with six mixed siliciclastic-carbonate intervals. A recessive sequence of calcareous siltstone and stromatolitic dololutite (Attack Creek Formation, 1730 Ma) is present in the upper part of the group. Along the contact with the overlying predominantly ridge-forming sandstone sequence (Bootu Formation) is an extensive manganese horizon within dolomitic siltstone, sandstone and stromatolitic dololutite.

2.2.2 Namerinni Group (from Hussey et al 2001)

The Helen Springs Project area like the Renner Springs area comprises mainly of stratigraphical units of the Namerinni Group (Figure 3). OMM exploration study suggests that Renner Style Mn mineralisation is stratigraphically controlled and bound to the lower units of the lower lithofacies of the Shillinglaw Formation close to the contact with the Carruthers Formation and to the upper units of the upper lithofacies of the Shillinglaw Formation close to the contact with the Willieray Formation (Figure 2). An understanding of the host stratigraphy is highly important for the development of an exploration model.

The Namerinni Group is an alternating sandstone, siltstone and carbonate succession with a maximum total thickness of about 2800 m. This Group is divided into, in ascending order, the Jeromah, Carruthers, Shillinglaw and Willieray Formations (Figure 2).

The Mesoproterozoic Renner Group unconformably overlies all formations of the Namerinni Group. A subtle angular unconformity with the underlying Tomkinson Creek Group is recognised where Namerinni Group rocks are in general finer and the sandstones are less mature and more lithoclast-rich than those in the upper Tomkinson Creek Group.

2.2.2.1 Carruthers Formation

The Carruthers Formation, with a minimum thickness of approximately 1100 m, comprises interbedded dolostone (including silicified dolostone or chert, dolomitic mudstone, quartzic dolostone, and laminated stromatolitic dolostone), shale, mudstone and sandstone. Evaporite pseudomorphs are common and include: nodular chert and moulds after anhydrite; hopper and cube casts and moulds after halite; and rare bladed or disc shapes probably after gypsum. This formation is also characterised by abundant stromatolites with diverse geometries, intense surface silicification of carbonate rocks, and a distinct upstanding sandstone interval in the uppermost part.

The upper lithofacies of the Carruthers Formation is predominantly sandstone, which contains some interbedded mudstone and minor chertified and, in places, stromatolitic dolostone. It is between 40-120 m thick in the Renner Springs Project area. Outcrops are typically resistant and upstanding. Some sandstone contains evaporite pseudomorphs after anhydrite and/or halite. Ferricrete is commonly developed on mudstone rich intervals. This lithofacies is a coarsening-upward unit. It can be divided into a lower 0-30 m thick, very thinly to thinly bedded, fine sandstone and mudstone interval, and an upper, thinly to medium bedded, slightly coarser and more competent sandstone interval, which forms the majority of the lithofacies.

The upper interval of this upper lithofacies consists of resistant (silicified), light pink to purple or tan sandstone and minor red-brown or maroon mudstone. Sandstone is fine to very coarse and is predominantly thinly to medium bedded. It has bidirectional, low angle, tabular or trough cross-beds and may have lenticular bed sets that in places exhibit a pinch and swell geometry. Some intervals contain abundant intraformational mud clasts, mud galls, desiccation cracks, pseudomorphs after halite (casts and moulds), flaser bedding, normally graded beds, synaeresis cracks and scattered quartzite pebbles. Sandstone beds may have scoured bases infilled by discontinuous intraformational siltstone breccia. Ripple marks are prolific and include symmetric, asymmetric and less common interference and linguoid varieties. Nodular chert or moulds after nodular chert are also diagnostic. These are usually round or elliptical, up to 4 cm in diameter, and some exhibit rosette-like structures.

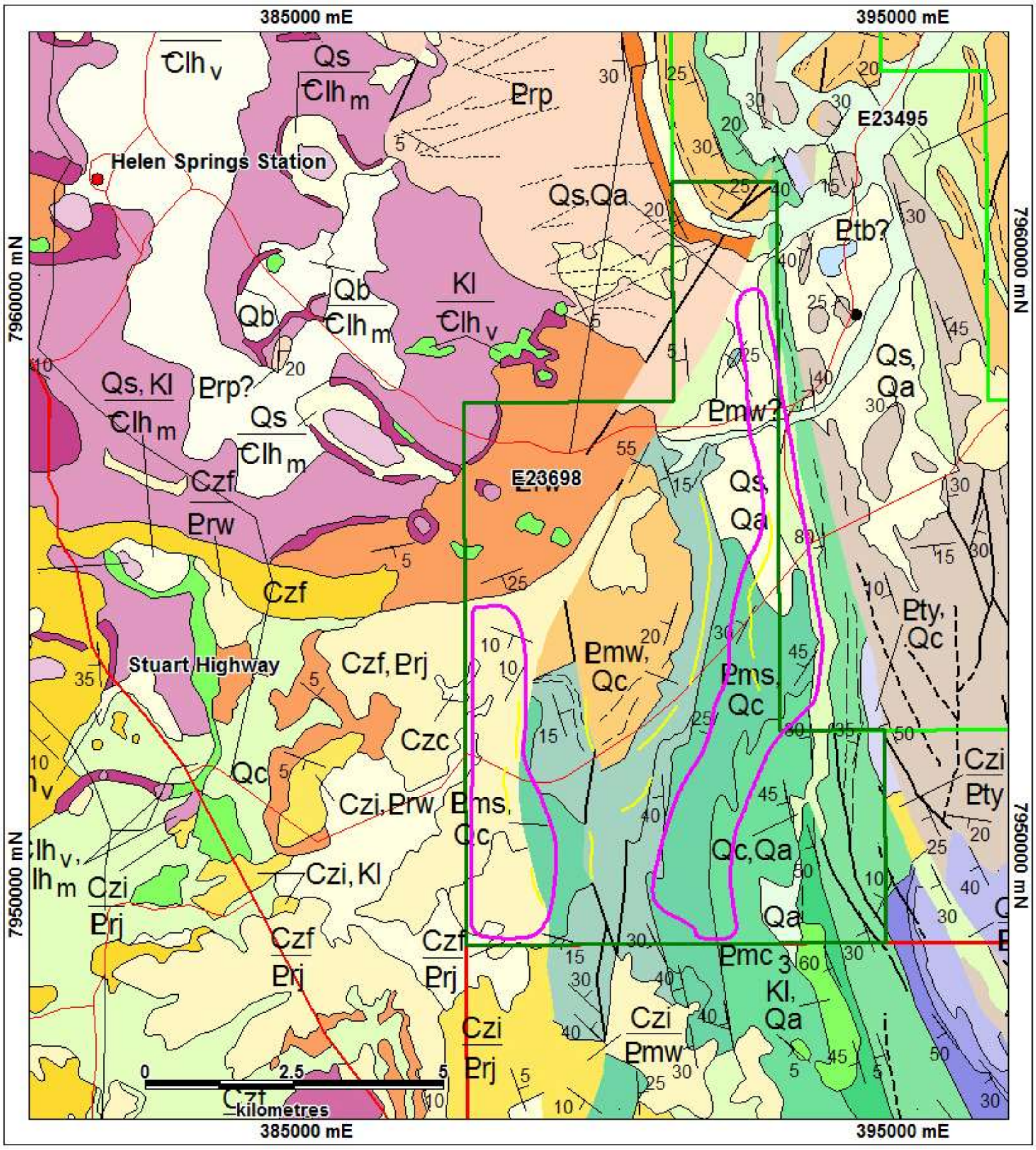

*Figure 3. Geological map of the Helen Springs Project area extracted from Helen Springs 1:250k SE53-10 geological map (Hussey et al 2001). **Legend:** Stratigraphical contacts and areas prospective for Renner Type Mn mineralisation in chert breccia are marked by purple polygons. New targets for Mn mineralisation identified from the new Aster spectral study infers a correlation with previously mapped geology and are marked in purple polygons and yellow lines. For further information refer to text on proposed geological model and exploration strategy in this report.*

2.2.2.2 Shillinglaw Formation

The Shillinglaw Formation is 550-700 m thick, mixed siliciclastic-carbonate unit (Figure 2). This formation is divided into two subunits, informally referred to as the lower and upper lithofacies. The lower lithofacies is typically intensely silicified in the type section and forms an upstanding strike ridge with a high point at Mount Shillinglaw. To the east and northeast of that ridge, outcrop is leached and less silicified, and forms dominantly recessive undulose hills of low to moderate relief.

Leached units are commonly tabular or blocky whereas silicified units are blocky in outcrop. Lateritic profiles are often developed on leached rock types (eg in northwestern Muckaty) whereas manganiferous or ferruginous deposits tend to develop on more silicified units (eg near Mount Shillinglaw). Silcrete is common to both silicified and leached units.

The contact with the underlying Carruthers Formation is conformable and transitional, and is placed at the base of a succession of very thin to medium interbedded sandstone (containing pseudomorphs after halite), mudstone, microbial doloboundstone (containing aggregations of bulbous stromatolites), and red to maroon chertified dololaminite. This succession contains a variety of facies that may vary considerably along strike but generally become more arenaceous up-section.

Sandstone of the Shillinglaw Formation is mostly of well sorted quartz arenite or sublitharenite, which contains subangular to subrounded, very fine to medium grains of monocrystalline quartz, minor polycrystalline quartz, chert, sedimentary lithic grains and accessory muscovite, zircon and tourmaline. Quartz overgrowths and cement are common, although a muddy ferruginous matrix is in places evident where quartz cement is absent. Less mature sandstone is of a similar composition but has a larger matrix component and may contain accessory ooid clasts.

Quartzic dolostone in the Shillinglaw Formation is composed mainly of subangular to subrounded monocrystalline quartz. It also contains minor chert, polycrystalline quartz (some sutured varieties), plagioclase, and silicified, fine, rounded, dolomitic lithoclasts. Accessories include muscovite, tourmaline and zircon. Most grains have low sphericities and are set in a dolomitic and less common microcrystalline calcite matrix/cement that is variably iron stained and contains microstylolites.

Laminations and dissolution textures are common in microcrystalline calcite varieties and are possibly replacing evaporite minerals. The composition of the sedimentary rocks indicates that they were dominantly reworked from previously deposited sediments, possibly from chertified underlying units and intraformational sources.

The dominance of undeformed monocrystalline quartz and less common feldspar throughout this formation may indicate a predominantly plutonic or volcanic provenance whereas tourmaline may indicate a pegmatitic source. Greenish chert units are interpreted to have a felsic volcanic component from the presence of clear quartz and euhedral, magmatically zoned zircon.

2.2.2.2.1 Lower Lithofacies

The lower lithofacies of the Shillinglaw Formation is about 250-350 m thick, comprises interbedded sandstone, mudstone and dolostone and is often characterised by distinct cream to rusty-tan and less common red tonal variations on aerial photos.

Several greenish chert horizons occur near the top of this unit and are interpreted to be tuffaceous units. Zircons from one of these units have yielded a rather poorly constrained SHRIMP U-Pb date of 1639 +/- 27 Ma (Nunn 1997) and this provides a maximum depositional age.

Cream to red or mauve, chertified, domical and columnar stromatolitic boundstone and dololaminite is diagnostic of the lower lithofacies (eg northern parts of Mount Shillinglaw). Silicified, evaporite pseudomorph-bearing dolostone, quartzic dolostone and sandstone are also characteristic rock types.
Fine to medium, slightly micaceous sandstone occurs intermittently throughout this lithofacies and outcrops as laterally continuous units up to 10 m thick, but usually less than 2 m thick.

Sandstone units are usually thinly to medium bedded, display low angle, bidirectional, simple or tabular cross-bedding, and contain current ripple marks and ripple cross-laminations. Desiccation cracks, rare scoured bases, angular to rounded mud clasts, chert and ferruginous mud flake intraclasts are also present.

Some lenses contain medium bedded, fine to very coarse, poorly sorted quartz arenite, discontinuous granular lags and silicified sedimentary pebble lithoclasts. These probably represent palaeochannel deposits.

Sandstone units in the lower lithofacies commonly grade upward to mudstone or very thinly to thinly bedded dolomitic mudstone and dololaminite. Sandstone and mudstone are commonly inter-bedded and form streaky, lenticular, wavy and flaser laminations and beds.

Other sedimentary structures in sandstone include scoured bases, intraclastic flat pebble breccias, mud clast impressions and rip-up clasts (mud galls and chert clasts), load structures, graded beds, diagenetic chert nodules, mud drapes, ripple cross-laminations, ripple marks with both rounded and truncated crests (asymmetric, symmetric, linguoid, interference, linear to bifurcating), desiccation cracks and rare fluid escape and convolute bedding structures.

Pseudomorphs after halite are present but mainly occur in the basal parts. Interbedded, very thinly to thickly bedded, laminated dolomitic units are both stromatolitic and non-stromatolitic and are variably micaceous. Stromatolitic units comprise domical, columnar, conical (up to 1 m high), bulbous and planar forms, as well as 'sausage-like' stromatolites that occur between large probable mudcracks.

Sedimentary structures common to this facies include tepees, ripple cross-lamination, cryptomicrobial lamination, fenestrae, intraclast breccias and rare elliptical, laminated, diagenetic nodules (found as float only). Solution breccia is common and is associated with possible slump folding of beds. It is also common near faults.

The poorly exposed uppermost intervals of the lower lithofacies near Mount Shillinglaw are composed of interbedded, locally calcareous quartzic dolostone, dolostone, sandstone and siltstone. These strata also contain thinly bedded dolostone with radiating acicular crystal clusters (some of which are vertically stacked or intergrown) orientated approximately perpendicular to bedding.

The lower lithofacies of the Shillinglaw Formation lithologically resembles the lower and middle lithofacies of the Carruthers Formation and was probably deposited in a similar marginal marine to continental sabkha environment. Stromatolitic dolostone and interbedded sandstone and mudstone units, interpreted as tidal rhythmites, indicate shallow water deposition in the photic zone throughout the lower lithofacies. Evaporitic pseudomorphs, intraformational breccia, ripple marks and desiccation cracks also indicate periodic emergent or supratidal settings. Solution breccias may have formed by dissolution of evaporite-rich facies, causing the collapse and fragmentation of overlying beds.

2.2.2.2.2 Upper Lithofacies

The upper lithofacies is predominantly a succession of calcareous and quartzic dolostone. It contains minor thinly to medium bedded dolostone, dololaminite, dolomitic mudstone, breccia, sandstone, conglomerate and mudstone, and becomes progressively coarser and more siliciclastic upsection.

A type section has a minimum thickness of 300-400 m and outcrops as low to moderate relief undulose hills with subtle benching. The upper lithofacies has characteristic red to dark purple aerial phototones that highlight gentle folding and distinguish it from other mixed siliciclastic-carbonate lithofacies.

The contact with the lower lithofacies is sharp and conformable to possibly discomformable. It separates thinly bedded, chertified, laminated dolostone and mudstone of the lower lithofacies from thinly to medium bedded quartz arenite and sublithic arenite containing metasedimentary lithic clasts, and is placed at the base of the first thin sandstone unit. The basal sandstone unit is thin, laterally persistent, micaceous in part, silicified, medium to course, thinly to medium bedded and faintly laminated. It contains low angle cross-beds, some localized small trough cross-beds, desiccation cracks, tabular mudclast impressions (up to 2 cm) and occasional pebble clasts of laminated dolostone.

A red to purple and light grey intercalated lithofacies of quartzic dolostone, dolomitic mudstone, dolostone, sandstone, siltstone and rare conglomerate overlies the basal sandstone. The thin interbedded rock types are laminated (discontinuous, wavy and undulose) and contain ripple cross-laminations and rip-up clasts. Some beds are graded.

Quartzic dolostone is the dominant rock type and is thinly to massively bedded, fine to coarse and in places intensely fractured and fissile. Locally, these units contain detrital muscovite and some frosted, well rounded quartz grains, indicating a possible aeolian contribution. Granules and small pebble clasts occur in thinly to thickly bedded fine dolostone.

Sandstone, including the basal facies, is poorly to well sorted, fine to coarse, and contains some discontinuous granular laminations and pebbles (mainly quartzite and chert) up to 5 cm in diameter. It forms light cream to tan, thin to medium beds that are low angle bidirectionally cross stratified.

Sedimentary structures include ripple cross-laminations, scoured bases, tabular mudclast impressions, and rare fluid escape structures. Some beds are lenticular, and laminations or very thin interbeds of dolomitic mudstone and dololaminite may be present. Dolostone and quartzic dolostone have karstic weathering surfaces and are thinly to thickly bedded. They are variably calcareous and silicified and may contain discontinuous, undulose and sandy ripple cross-laminations. Locally, these rock types contain secondary barite, subangular quartz and lithic pebbles, granular laminations, possible desiccation cracks and solution seams.

Pebble to cobble conglomerate is clast supported, cross-stratified and medium to thickly bedded. It contains imbricated, subangular to sub rounded quartzite clasts and minor tabular dolomitic mudstone clasts in an arenaceous matrix. Conglomerate is interbedded with red to purple, medium bedded, micaceous quartzic dolostone containing silicified dolostone rip-up clasts.

The upper lithofacies depositional environment is somewhat equivocal but is interpreted to be dominantly shallow to subtidal marine. The relatively higher energy basal sandstone interval is indicative of a shallow water environment whereas the overlying units were deposited in dominantly quiescent conditions. The lack of evaporites and stromatolites suggests a deeper water environment to that of the lower lithofacies, but the red to dark purple colour of these rocks could also indicate lacustrine redbed facies. The transitional relationship with overlying sandstone of the Willieray Formation favours a shallow water environment, at least for the upper parts of the Shillinglaw Formation.

2.2.2.3 Willieray Formation

The Willieray Formation forms the uppermost part of the Namerinni Group conformably overlies the Shillinglaw Formation and is predominantly a siliciclastic unit with subordinate carbonate rocks (Figure 3). The Willieray Formation typically forms discontinuous low to high relief hills, in which benched outcrop typically weathers to tabular or blocky rubble and commonly has a characteristic red-brown to orange-tan colour. Outcrops are usually leached and silicified, and are locally covered by laterite, ferricrete or undifferentiated Cretaceous rocks.

The preserved thickness of this formation varies considerably beneath an angular unconformity with the overlying Gleeson Formation of the Renner Group, and locally, the unit is completely removed by erosion. The formation is up to 120 m thick in the Renner Springs Project area and up to at least 400 m thick in the eastern succession, where most exposed sections are incomplete and structurally complicated.

The basal unit of the Willieray Formation is typically less than 20 m thick and consists of an overall coarsening- and thickening-upward package of interbedded dolomitic mudstone, quartzic dolostone and sandstone in thin to medium beds. It is commonly poorly exposed and is possibly absent in places. Bedding is typically planar or wavy and some sandstone beds pinch out.

Sedimentary structures include parallel, wavy and streaky lamination, ripple marks and ripple cross-lamination, desiccation cracks, mudclast impressions and mud galls. Some low angle tabular cross-bedded sandstone within this basal interval has an off-white matrix and is notably micaceous.

The basal unit is overlain by typically fine to medium (less commonly up to very coarse) red-brown to purple and tan sandstone and minor mudstone. This constitutes the majority of the Willieray Formation although some recessive, more mudstone dominated intervals are apparent. Minor pebbly sandstone and conglomerate form thin to thick crossbeds and lags throughout.

Sandstone is predominantly of thinly to medium bedded quartz arenite or sublitharenite with low angle cross-beds and in places, discontinuous coarse laminations that contain higher proportions of muscovite and rare quartzite pebble clasts.

Other sedimentary structures include abundant ripple marks (symmetric and asymmetric, parallel-crested to bifurcated, and linguoid and interference ripples), planar and ripple cross-laminations, rare graded beds, undulose bedding, mudclast impressions (up to 5 cm), white dolostone rip-up clasts, reactivation surfaces, desiccation cracks, scour and fill structures and rare pseudomorphs after halite.

Sandstone contains subangular to subrounded, poorly to well-sorted grains that consist predominantly of monocrystalline quartz with minor polycrystalline quartz, chert, and metamorphic and sedimentary lithoclasts (some laminated). Detrital muscovite, blue-green tourmaline and rounded zircon are common accessory grains. Authigenic quartz, haematite, clays and sericite constitute varying proportions of the cement and matrix. Monocrystalline and polycrystalline quartz probably indicate a plutonic and less significant metamorphic provenance whereas sedimentary lithoclasts indicate the intraformational reworking of quartz-rich sedimentary rocks.

The Willieray Formation is a transgressive, sandstone-dominated unit that was probably deposited in an intertidal to supratidal environment. The close association of localized high energy channels, prolifically ripple marked sandstone intervals, evaporite pseudomorphs and desiccation features, and intervals of interbedded sandstone and mudstone that appear to be analogous to tidal rhythmites favours a marginal shallow marine environment and suggests either a tidal flat or deltaic setting.

2.3 Structural Deformation (from Hussey et al 2001)

The structure of the Ashburton province is dominated by north-northwesterly, north-northeasterly and northeasterly trending faults, and by less significant northwesterly trending faults. These tend to form elongate fault block geometries. Most of the faults appear to be subvertical and both normal and reverse senses of movement are documented, although some faults are rotational. Moderate to low angle faults have been identified, but these are rare.

The Proterozoic rocks of the Ashburton province typically show low to moderate bedding attitude, although beds can range from subhorizontal to subvertical and rarely may even be locally overturned adjacent to faults. In general, most folds display open to moderate interlimb angles and lack pervasive axial planar cleavages, although associated conjugate fracture cleavages are sometimes evident. Tight to isoclinal folds are present but these tend to be developed in or adjacent to major fault zones.

The earliest major period of folding produced regional northwest trending map-scale anticlines and synclines that are restricted to the Tomkinson Creek Group. Regional aeromagnetic data suggest that these folds continue beneath the Georgina Basin in east.

It is proposed that this earliest folding event generally produced more open fold styles and that the tight, northwesterly trending folds have been enhanced by northwesterly faults. The open fold geometry is evident in the general distribution of Short Range Sandstone outcrop as well as in several mappable synclines within the region. The absence of a well developed axial planar cleavage also suggests that this folding event was not intense and occurred at a relatively high crustal level.

These major northwest trending folds clearly predate the prominent faults in the region. North-northwesterly trending faulted synclines and anticlines are superimposed on earlier folds in the Tomkinson Creek Group, whereas anticlines, synclines, homoclines and asymmetric folds are present in the Namerinni and Renner Groups. These latter folds have notably shorter wavelengths, are often more intensely developed locally, and are clearly related to faulting rather than regional folding. There is often a dramatic steepening in bedding attitudes towards the northerly trending faults. Fold geometries and localized cleavage development (typically on the western side of major north-northwesterly trending faults) generally suggest reverse movement on steeply easterly dipping faults. Quartz dissolution and white mica growth are common in these high strain zones within a dominantly brittle regime. Quartz veins are not a common feature in the region, but do occur in these zones. Open folds are present in the Renner Group. These may likewise be related to fault block movements. Outcrops of Renner Group show conjugate sets of fracture orientations that suggest horizontal east-west compression orthogonal to the major faults.

Significant structuring of the Ashburton province is evident prior to the deposition of the Renner Group. Minor tilting also appears to have occurred before deposition of the Namerinni Group but the limited exposure of this contact precludes an adequate understanding. Apparent shifts in palaeocurrent directions and variations in unit thicknesses suggest that there has been variable subsidence and extension throughout the Ashburton province during this interval.

3 Summary of exploration Activities Taken during 2006 and 2007

3.1 Satellite-Borne Spectral Study

3.1.1 Introduction

OM Manganese commenced a satellite-borne ASTER spectral study over the area in an attempt to identify possible Mn mineralisation targets, Fe-rich zones, prospective stratigraphical units and contacts, and prospective structures.

The Advanced Thermal Emission and Reflection Radiometer (ASTER) can be considered to be the geological successor to Landsat TM. The ASTER satellite is onboard one of NASA's Earth Observing Satellite systems, Terra, which was launched in 1999.

The ASTER instrument collects data in 14 bands (Table 1) together with one stereo, backward-looking band. The ASTER instrument consists of three separate instrument subsystems, with each subsystem operating in a different spectral region and having its own telescope(s): the visible and near infrared (VNIR), the SWIR, and the TIR. It has a mixture of spatial resolutions, ranging from 15 m in the visible part of the spectrum to 30 m in the SWIR, to 90 m in the TIR. Like SPOT it has a 60 × 60 km swath width, but is on the same orbit as Landsat TM, but with a half-hour delay.

ASTER wavelength bands

Band number	*Wavelength (µm)*	*Resolution (m)*
Band 1	0.52 to 0.60 (visible green)	15
Band 2	0.63 to 0.69 (visible red)	15
Band 3	0.76 to 0.86 (near infrared)	15
Band 4	1.60 to 1.700 (shortwave infrared)	30
Band 5	2.145 to 2.185 (shortwave infrared)	30
Band 6	2.185 to 2.225 (shortwave infrared)	30
Band 7	2.235 to 2.285 (shortwave infrared)	30
Band 8	2.295 to 2.365 (shortwave infrared)	30
Band 9	2.360 to 2.430 (shortwave infrared)	30
Band 10	8.125 to 8.475 (thermal infrared)	90
Band 11	8.475 to 8.825 (thermal infrared)	90
Band 12	8.925 to 9.275 (thermal infrared)	90
Band 13	10.25 to 10.95 (thermal infrared)	90
Band 14	10.95 to 11.65 (thermal infrared)	90

Table 1. ASTER wavelength bands (from Gozzard, 2006)

Because of its higher spectral resolution and configuration when compared to Landsat TM for example, especially in the SWIR and TIR parts of the spectrum, ASTER is able to map a range of minerals. In the SWIR it is able to discriminate alunite, pyrophyllite, kaolinite, illite–muscovite–sericite, and MgOH–carbonate minerals (Figure 4).

In the TIR it can discriminate feldspar, quartz, carbonate, amphibole, and clay. However, the discrimination of these mineral assemblages requires sophisticated processing to remove temperature and atmospheric effects from the data.

At 15 m resolution the VNIR data are currently the best resolution multispectral data available commercially from a satellite, with the exception of the 4 m resolution IKONOS data and the 70 cm resolution DigitalGlobe image products. Compared to the single panchromatic 15 m band of Landsat TM ETM+, the ASTER VNIR data have a better spectral resolution.

The SWIR data consists of six bands. Band 4 has a similar wavelength to Landsat TM band 5 and is located where most types of materials have maximum reflectivity. Bands 5 to 9 cover a region where many OH-bearing minerals and carbonate minerals have absorption features. Bands 5 to 8 approximately cover the wavelength limits of Landsat TM band 7.

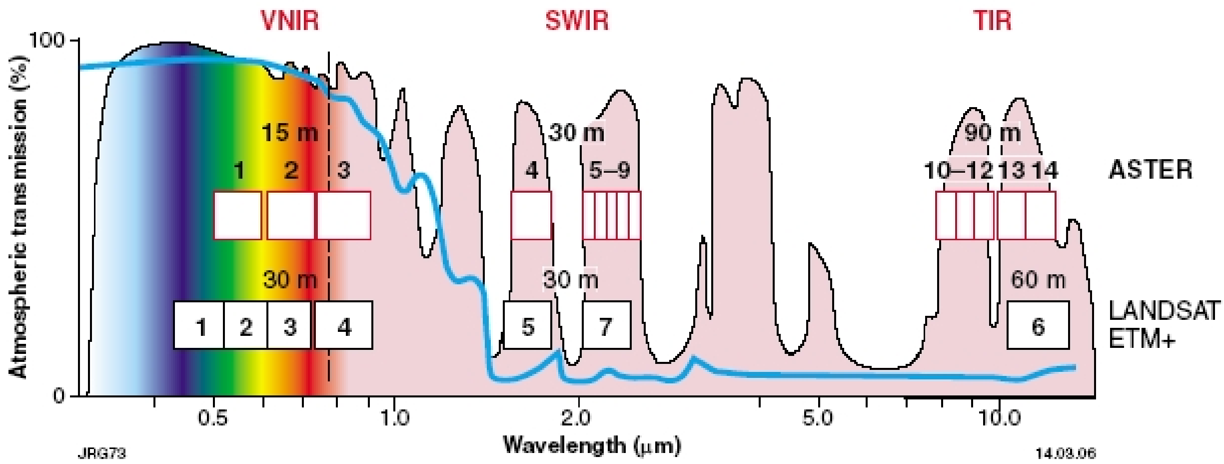

Figure 4. Distribution of ASTER and Landsat bands (from Gozzard, 2006)

Minerals of interest to the exploration of hydrothermal Mn and base-metals mineralisation within the Helen Springs Project area that can be identified in the SWIR region include:

- Mg-OH minerals and carbonates — major components of lithological units associated with mineralisation. Landsat TM cannot discriminate these minerals
- alunite–pyrophyllite — significant because they can define areas of argillic alteration. Landsat TM cannot discriminate these minerals
- kaolin-group minerals — also significant because they are useful in helping to define argillic alteration and in mapping regolith
- illite–muscovite–smectite — common minerals in the surficial environment and useful for mapping regolith. They are also associated with both phyllic and argillic alteration

ASTER TIR bands, which measure radiance in the 8.1 – 11.7 µm wavelength region, are the only available multispectral thermal-imaging data available, apart from airborne systems, and although they only have a resolution of 90 m, are useful for identifying surface silicification, siliclastic units and possibly chert breccia units.

3.1.2 Work Completed

Two ASTER scenes, collected on September 2000 and September 2004, covering the entire extent of the Helen Springs Project area were sourced out for OMM by GeoImage Pty Ltd, an imagery specialist consultancy based in WA.

Product processing included:

- VNIR and SWIR data merged and orthorectified to SRTM DEM and MDA satellite base at 15m resolution
- TIR data orthorectified to same base but at 90 m resolution
- Calibration for local crosstalk by estimating a spectral end member for the crosstalk contamination and then removing it

- Atmospheric calibration by estimating gains for each ASTER band to make data values compatible with the expected theoretical atmospheric spectrum in the case of VNIR and SWIR data and with the expected blackbody response, in the case of ASTER TIR data
- Data-driven atmospheric effects correction by finding a water vapour spectrum in an image and then unmixing it

Data supplied by GeoImage:

- Raw original Aster data (zipped HDF Format)
- 9 band VNIR and SWIR merged orthorectified data (zipped ERMapper format)
- 5 band TIR orthorectified data (zipped ERMapper format)
- Data supplied as UTM Zone 53, WGS84 Datum (equivalent to GDA94)
- Various ECW enhancements (MapInfo format)

Unfortunately the product supplied by GeoImage is poor and does not meet our standards and expectations. The raw and processed datasets were passed to Resource Potentials, a Perth based geophysical and geological consultants, for assessment reprocessing, recalibration and re-enhancement.

Identified issues with the GeoImage product:

- Processing the raw dataset from Level 1A to Level 1B by GeoImage using in-house software was incorrect and unnecessary as Level 1B is readily available commercially to purchase.
- Atmospheric calibration and crosstalk correction had to be preformed by Resource Potential using their software
- The orthorectified product shows an offset of 130 m compared with GPS waypoints collected on the ground. Registration is expected to have no more than 30 m offset
- Scene selected has high coverage of fire burnt area including a live fire locally dispersing heavy smoke. It is impossible to conduct spectral analysis over area covered with fresh days-old burnt vegetation
- TIR dataset is unusable, as area covered by this dataset does not match area covered by VNIR an SWIR dataset. This is possibly due to originally corrupted raw dataset or corruptions occurred during GeoImage processing.

Data supplied from Resource Potentials:

- Processed and calibrated VNIR and SWIR dataset
- Standard band ratio enhanced images as GeoTIFs and MapInfo TAB files (in order of their proven exploration value):
    - Vegetation masked true colours
    - Ferrous iron
    - Mg (OH) abundance
    - RGB image of ferric iron (red), Al (OH) abundance (green), Mg (OH) abundance (Blue), and band 2 (greyscale) as background
    - Ferrous silicate
    - Dolomite
    - Al (OH) abundance
    - Landsat equivalent to TM 742
    - Landsat equivalent to TM 541
    - Ferric iron

As GeoImage did not deliver a usable TIR dataset, which was identified as highly important for mapping in a silica-rich environment (siliclastic rocks) and as first order processing was poorly done, OMM decided to complete the spectral study by contracting Resource Potentials to acquire three new ASTER scenes and properly complete a full study (Appendix A). This study was to include classified mapping based on spectral signature of known Mn outcrops both of the Bootu and Renner mineralisation styles as sampled directly from the ASTER datasets.

3.1.3 Results of spectral study

The spectral study provided mixed results (Table 2). Unfortunately Resource Potentials specialist did not get to complete the study and at the moment OMM holds the first pass over the data, still missing an adjustment phase to correlate between field geology and image enhancements.

Highlights:

- True colour band 321 at a high pixel resolution of 15m provided a useful base map for regional orientation and mapping (Figure 5).
- The most useful product for the identification of Fe-rich and Mn-rich units is still the ferrous-iron enhancement produced by Resource Potentials over the first ASTER dataset (Figure.6)
- The TIR dataset was too coarse to differentiate variations in silica content within the silica-rich units and also between siliclastic and carbonatic rocks (Figure 7).

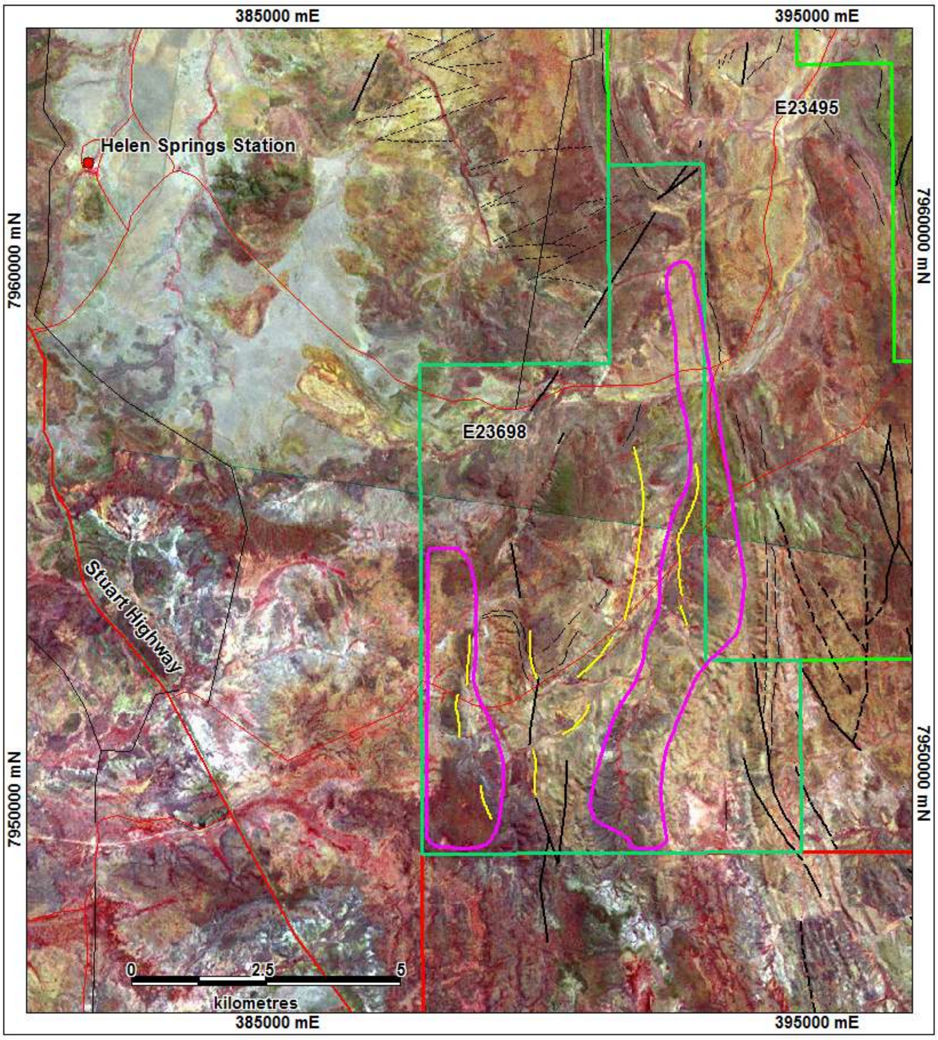

Figure 5. A true-colour ASTER image at 15m pixel resolution highlights favourable geological units and contacts (purple). Yellow lines are targets for Mn mineralisation delineated using ASTER ferrous iron enhancement.

Image Name	Usability	Remarks	Features	Red band	Green band	Blue band	Pseudo Colour
AST_L1B_RGB_321_m53 AST_L1B_RGB_321_vegmask_m53 AST_L1B_RGB_321_15m_m53	Average Average Good	Should be 15m resolution Should be 15m resolution. Too much masking All Known Mn occurrences identified. Some stratigraphic differentiation. Some topographic enhancement. Missing some veg masking, contrasting and smoothing.	Vegetation and visible bands True colours	3	2	1	
AST_L1B_CYMK_123_vegmask*_m53 AST_L1B_CYMK_123_m53	Average Good	Low contrast. Some correlation with stratigraphy Good contrast. Possibly highlighting dissolution of carbonate-rich silicified stratigraphy and alteration.	Convert CMYK colour to RGB, map visible bands	1/4	2/4)	3/4	
AST_L1B_RGB_eqL742_m53 AST_L1B_RGB_eqL742_clip_m53	Good Average	Discriminates stratigraphy and structural offsets. Too dark at Renner. All Known Mn occurrences identified. Homogenic. Too green. Better around Renner mine.	Enhanced structural features	6	3	1	
AST_L1B_decorellation_m53	Average	Low resolution. Highlights silicified stratigraphy	Decorellation (envi)	13	12	10	
AST_L1B_discriminationformapping_m53 AST_L1B_discrimination_m53	Average Good	Poor contrast. Low resolution Poor contrast. High potential for mapping	Discrimination for mapping	4/1 4/1	3/1 3/1	12/14 3/5	
AST_L1B_ferric_iron_m53	Poor	No correlation with stratigraphy	Ferric oxide				4/3 2/1
AST_L1B__AlOH_ab_m53	Poor	Some correlation with stratigraphy. Low resolution. Clipped too low.	Al(OH) abundance				5+7/6
AST_L1B_ep_ch_amph_m53	Average	Some correlation with stratigraphy. Low resolution. Needs further study of regional scale alteration	Epidot/chlorite/amphibole				(6+9)/(7+8)
AST_L1B_sio2_m53	Poor	Inverse highlighting. Course grained	Sio2				12/13
AST_L1B_ferrous_silica_m53 AST_L1B_ferrous_silica_clip_m53	Average Average	Some correlation with stratigraphy. Clipped too low	Ferrous silicates (biot,chl,amph)				5/4
AST_L1B_ferrous_iron_m53 AST_L1B_ferrous_iron_clip_m53	Poor Poor	Clipped too low. Old product is better Clipped too low. Not contrasty enough	Ferrous Iron				5/3+1/2
AST_L1B_mgoh_ab_m53	Good	Highlights dolomitic stratigraphy. Clipped too low.	MgOH/Amphibole				6+9/8
AST_L1B_mn_opaque	Average	All known Mn occurrences identified. Clipped too low. Should be 15m resolution. High potential.	Enhancing b1				2/1
AST_L1B_class_mn_veg_m53	Poor	Sampled Renner near old mine. No uniqueness to Mn outcrop. Poor pixel sampling. High potential.	Classification of darkest pixels at Renner (66-67)				1
AST_L1B_bootu_mnclass_m53	Good	Sampled Shekuma Hill. All Mn occurrences identified. Should be applied to other two scenes.	Classification of darkest pixels at Shekuma (52-66)				1

Table 1. Preliminary assessment of spectral processing of three satellite-borne ASTER scenes over the Bootu Creek, Renner Springs and Attack Creek prospect areas completed by Resource Potentials (May 2007).

Mapping for ferrous iron spectral signature proved very useful in identifying Bootu Creek Style Mn outcrops due to Fe-rich hangingwall and Fe-rich upper portion of exposed Mn strata. The Renner Springs mineralisation style has a different spectral signature as the mineralised strata is chert-rich and Fe-poor. The main western outcrops at Renner Springs do not carry this signature and could not be identified using this image. On the other hand, the central flat laying outcrop having the same mineralisation style can be detected and enhanced using the ferrous iron spectral signature (Figure 6). This is probably due to the level of weathering of iron oxides within clay-rich dissolution zones. This enhancement can be used to map Fe-rich weathered dissolution zones.

Mapping for Mg (OH) abundance and to lesser success for dolomite spectral signature identified thick dolomitic units of the upper Shillinglaw Formation and in places even thin inter-layered dolomitic beds within more siliclastic stratigraphic sequences (Figure 7).

The Landsat equivalent 742 was used successfully to highlight outcropping structures and many lithological contacts (Figure 8).

Spectral mapping using digital sampling of known Mn outcrop of both Bootu and Renner mineralisation styles does not discriminate well between Mn strata and Fe-rich units. Further classification is recommended using PIMA or ASD instruments.

Overall results from the preliminary standard ASTER spectral study are very promising and have already made voluble contributions to the Renner Springs Project exploration efforts. It is highly recommended to incorporate advanced level interpretations into this study.

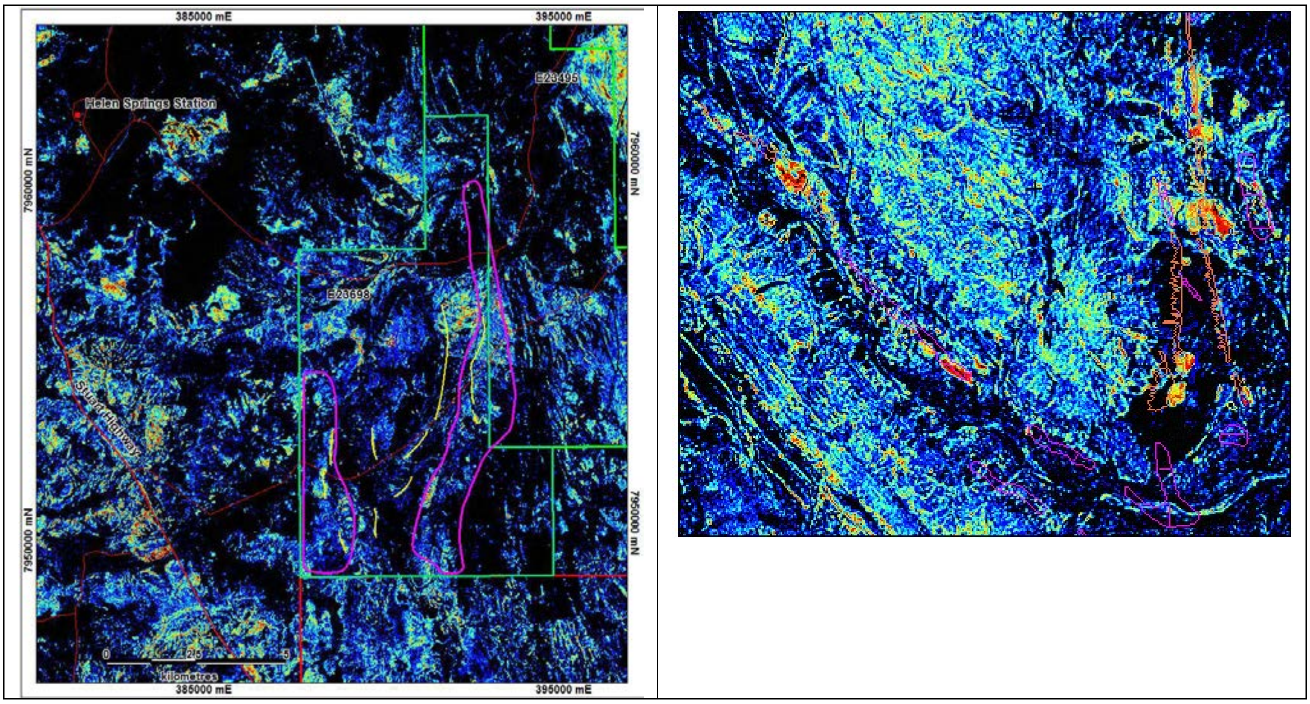

Figure 6. The ferrous-iron enhanced ASTER image on the right covering a portion of the Bootu Creek Project area west and north of the mine site, highlights (red) known Mn-rich ironstone outcrops. For comparison, the same product on the left highlights targets within the Helen Springs Project area with similar spectral signature. Yellow lines are marking delineated targets within E23698 to be followed by ground proofing fieldwork.

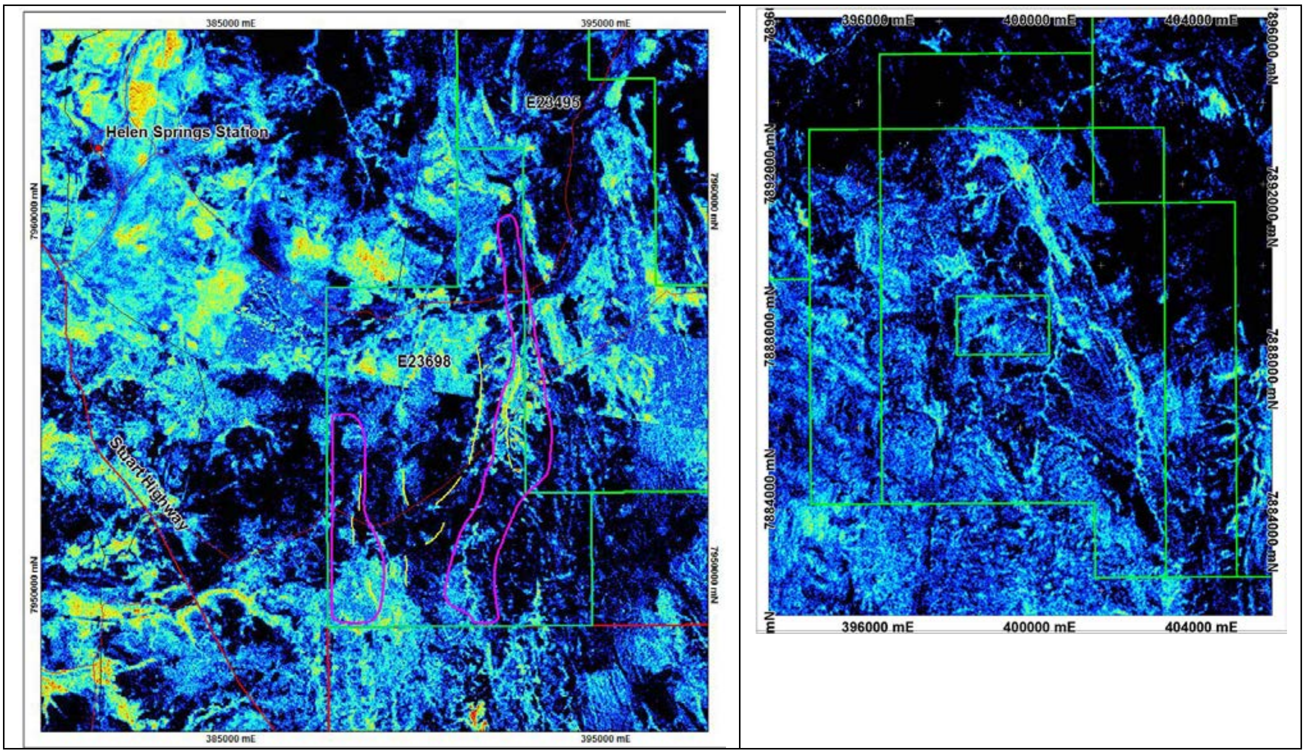

Figure 7. Mg(OH) enhanced ASTER image on the left highlighting dolomitic units within the Carruthers and Shillinglaw Formations. For comparison on the right, Attack Creek Formation dolomite beds are highlighted at the northern portion of the image within the Attack Creek Project area

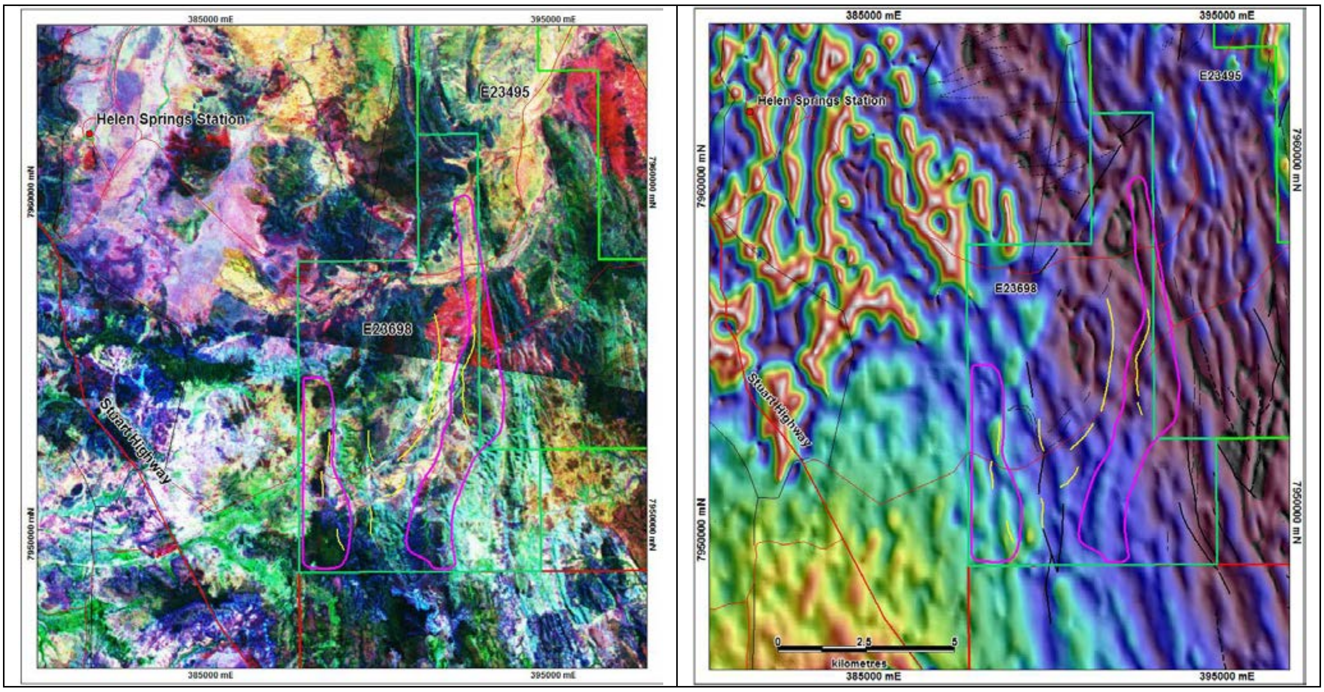

Figure 8. Landsat 742 equivalent ASTER enhancement on the left highlights geological contacts and structural contacts within the Helen Springs Project area. For comparison, on the right, a newly-processed re-grided regional magnetic image (RTP tilt) of the same area showing NE-SW structural contacts within the Renner Group along the Northern portions of the License and a lithological contact to the northwest with younger basaltic flows.

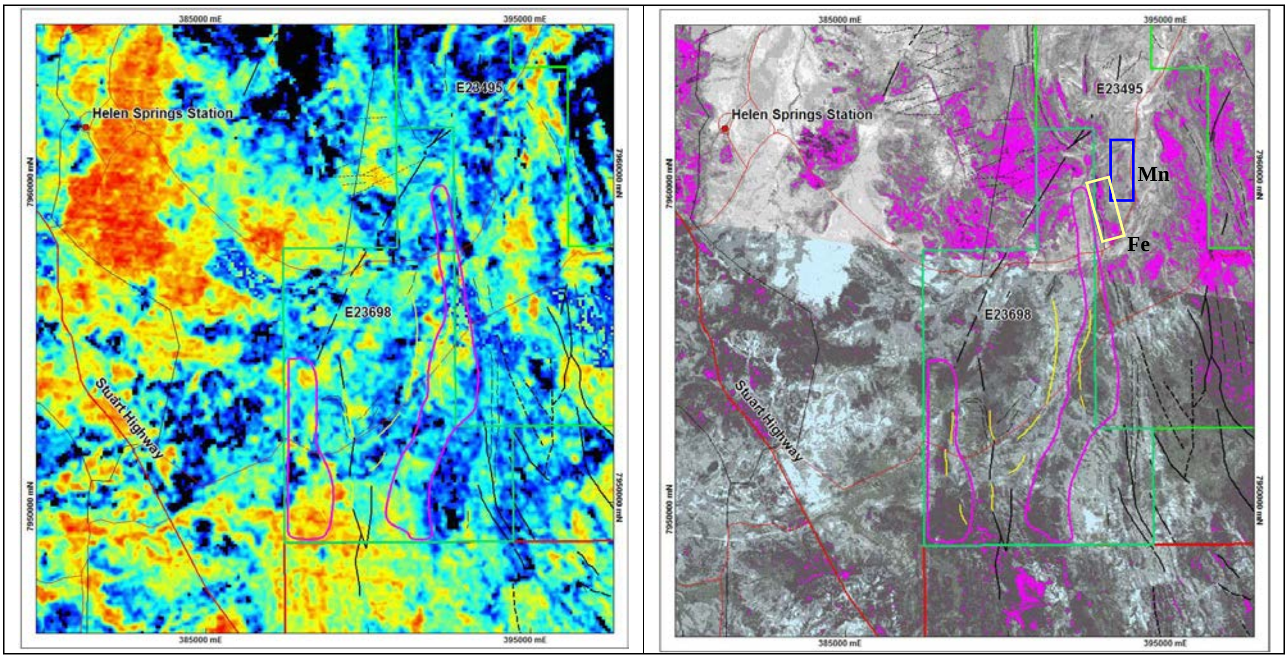

Figure 9. SiO_2 enhanced ASTER image on the left using TIR bands showing some lithological and structural correlation as presented in higher resolution within other ASTER enhancements. On the right, classified mapping using spectral signature of Mn-rich outcrop of the Bootu Style identified Mn strata and ironstone within E23495 which is of the Bootu Formation. Results within E23698 are not as definitive.

3.1.4 Recommendations for advanced interpretations

- Obtain spectral signature from ASTER dataset of Fe-Mn-rich mineralised outcrops of both mineralisation styles, dolomite, ironstone, dissolution zones, marker beds and chert breccia, and apply ASTER classified mapping over entire dataset. These targets can now be identified and sampled directly from the dataset using accurate GPS located field observation waypoint.
- Obtain spectral signature from GPS located rock samples collected in the field and apply ASTER classified mapping over entire dataset. The spectral signature can be obtained through CSIRO using preferably the ASD system if it is available or, if not, the PIMA mobile devise.
- Adjust thresholds values to standard and advanced enhancements according to field mapping and observations

3.2 Field Work

Three site visits were conducted over EL23698 between November 2006 and June 2007 by the Author.

The first site visit conducted on November 12 2006 aimed at traversing across the License from SW to NE along the gazetted fence line entering the Project area at 387500Em 7951900Nm. Unfortunately the track along the fence is only cleared to 388254Em 7951511Nm ending in a sharp cliff at the edge of a canyon. Geological logs of the country rocks identified siliclastic bedded stratigraphy striking generally N-S. The potential of the area was not fully tested.

A second field visit conducted on November 24 2006 accessed the northern portion of the License along Helen Springs Station track aiming at traversing the License from NE to SW along the gazetted fence line. From this end, after a difficult creek crossing to the south, the track was found to be completely overgrown with low trees and dense bushes. Geological observations of northern traverse recorded a change from basalts to siliclastic stratigraphy of the Shilinglaw Formation. The full potential of the area was not tested as some portions are under cover and outcrops to the south were inaccessible.

The third site visit conducted in June 13 2007 aimed primarily to test exploration activities taken over E23495. During a previous flyover conducted on one of the routine Bootu Creek crew-change flights a clearing was identified west of the old overgrown connecting N-S track. A second attempt to reach the gazetted fence line through the inferred clearing failed again due to terrain conditions.

4 Geological Model

4.1 Introduction

The proposed geological model for Mn mineralisation within the Namerinni Group covered by the Helen Springs Project area is based on preliminary study of observations and data collected in the field from the Renner Springs Project area combined with OMM proposed geological model for Mn and base-metals mineralisation within the Ashburton Province of the Tennant Inlier.

The geological model for the region identifies massive regional-scale hydrothermal systems within paleoproterozoic sedimentary basins over an area of approximately 11,000 km^2 within the Ashburton Province. Characterising these hydrothermal systems is a work in progress, crucial for the understanding and further development of the exploration efforts and interpretation of collected data.

Based on field observations and preliminary mineralogical, geochemical, and geophysical evidence the genetic models for mineralisation are suggested to be subtypes of Sedimentary Exhalative (SEDEX) Mineralisation Style

Subtypes of SEDEX deposits include those that formed below but near the seafloor. These deposits, either individually or collectively (district-wide), may show characteristics of both seafloor deposition and epigenetic features typical of Mississippi Valley-type (MVT) deposits (Goodfellow et al 2006).

SEDEX deposits are typically tabular bodies composed predominantly by combinations of Zn, Pb Ag, with several subtype variations of which Sedimentary Mn and Sedimentry Cu best match the Bootu Creek Mn and Cu mineralisation styles respectively. The Renner Springs Mn Mineralisation Styles share many characteristics with MVT mineralisation style.

4.2 Mn Mineralisation Styles

Two Mn mineralisation styles are identified within the Namerinni Group:

- The first is massive to disseminated Mn within chert breccia beds or hydraulic dykes (further study is required to resolve this). It is suggested that manganiferous fluids dissolved and replaced, to various degrees, existing chert breccias forming 1-3 m thick completely-mineralised to matrix-only-mineralised to highly-dissolved but partially-mineralised 3-4 chert breccia beds. These beds are best exposed within; (a) the western portion of the Renner Springs Area where they can be visually traced almost continuously for approximately 6 km along strike dipping steeply probably to the east, and (b) flat laying within the central portion of the area. This style of mineralisation is hosted within the lower lithofacies of the Shillinglaw FM (Pms_1) close by to the more prominent ridge forming silicified sandstones of the upper lithofacies of the Carruthers FM (Pmc_3), recognised as a pathfinder for the mineralised horizons.

- A second, not as common, Mn mineralisation style is disseminated to podi-semi-massive Mn oxides within dissolution zones hosted within successions of dolomite and quartzic dolostone of the upper lithofacies of the Shillinglaw FM (Pms_2). It is suggested that reactive fluids dissolved these carbonate-siliclastic rocks to form stratiform and podi-form dissolution zones, which, in places, were favourable for the precipitation of Mn oxides. This style of mineralisation is structurally controlled and at this preliminary stage of exploration may potentially be found anywhere within this 300-400 m thick lithofacies and within the interbeded dolomitic mudstone and quartzic dolostone basal unit of the Willieray FM.

The Helen Springs Project area lacks comprehensive structural interpretation towards a possible reconstruction of paleoproterozoic surfaces and understanding the structural controls over mineralisation.

4.3 Recommendations for further work

- Structural interpretation of newly re-grided regional magnetic datasets
- Field Structural mapping
- Mapping lithologies using spectral mapping of ASTER datasets and newly re-grided regional radiometric datasets
- Field geological mapping for Mn-mineralised chert breccia, Mn-mineralised dissolution zones, un-mineralised dissolution zones, dolomitic lithologies and main structures.
- Hoist-EM survey to identify conductive bodies under cover, potential structures related to mineralisation and lateral offsetting of conductive bodies, and to model for bedding dips, unit repetitions due to possible thrusting and folding, and possible hidden poorly conductive vertical limbs

5 Exploration Strategy

The exploration strategy for the next two years is based on the proposed geological model and collective experience from previous exploration work conducted both over the Renner Springs Project area and the Bootu Creek Project area.

5.1 Main objectives

- Identify potential targets for Mn mineralisation through geological mapping and interpretation of EM dataset
- Ground proof EM targets
- Drill test Mn mineralisation targets

5.2 Define new drill targets

In order to upgrade known Mn mineralisation occurrences to drilling targets level and to generate new drilling targets a comprehensive mapping effort is to be conducted using remote sensing and field mapping methods.

5.3 Advanced spectral mapping

- Obtain spectral signature from ASTER dataset of Fe-Mn-rich mineralised outcrops of both mineralisation styles, dolomite, ironstone, dissolution zones, marker beds and chert breccia, and apply ASTER classified mapping over entire dataset. These targets can now be identified and sampled directly from the dataset using accurate GPS located field observation waypoint.
- Obtain spectral signature from GPS located rock samples collected in the field and apply ASTER classified mapping over entire dataset. The spectral signature can be obtained through CSIRO, preferably using the ASD system if it is available or, if not, the PIMA mobile devise.

5.3.1 Estimated costs for spectral study

- Obtaining spectral signature from rock samples at CSIRO: 1day * $125/day = $125
- Processing and enhancement of dataset: 3 days * $600/day = $1,800
- Total for spectral study (06/08): $1,925

5.4 Magnetic and radiometric regional study

- Conduct a regional structural and alteration study over the Helen Springs region targeting for hydrothermal fluid conducts possibly associated with Renner Springs and Bootu Creek Mn-Mineralisation Styles, and general MVT, SEDEX, Sedimentary Cu and Sedimentary Mn deposits

5.5 Field mapping

- To commence at the beginning of the dry season after EM data has been interpreted
- Map Helen Springs Area for Mn-mineralised chert breccia, Mn-mineralised dissolution zones, un-mineralised dissolution zones, dolomitic lithologies and main structures.
- 21 fieldwork days targeted geological mapping at 1:20k scale over stereo aerial photos (if available from NT) or purchased archived IKONOS images

5.5.1 Estimated costs for field mapping

- Geologist: 21 days * $700/day = $14,700
- Field assistant 21 days * $450/day = $9,450
- Vehicle and gear hire: 21 days * $120 = $2,520
- Accommodation: Bootu Creek Camp and camping
- Food: provided by Bootu Creek Camp
- Total for field mapping (05/08): $26,670

5.5.2 Acquisition of IKONOS scenes

- Archive data available through Geoimage with some cloud in the NW part
- Costs for 751 sq km of archive 1-metre colourised data plus processing:
  - Data: $8,544
  - Freight from USA: $198
  - Orthorectification: $4,206
  - ECW compression & reprojection (usually not required): $827
  - ECW compression only: $330
  - **Total for IKONOS scenes (compression only): $13,278**

5.6 EM surveys

- Airborne EM survey over the Helen Springs Project area covering E23698 and E23495 no later than November 2007 to identify conductive bodies under cover, potential structures related to mineralisation and lateral offsetting of conductive bodies, and to model for bedding dips, unit repetitions due to possible thrusting and folding, and possible hidden poorly conductive vertical limbs.
- Delineate new drilling targets from subsequent interpretations of EM data

5.6.1 Estimated costs for EM surveys

- Helicopter borne SKYTEM survey through Geoforce at $127/line-km over approximately 160 km^2 for an estimated 1,100 line-km at 200 m line spacing allowing for 30% increase in line-km to 100m spacing over areas targeted in real-time (Figure 10).
- Total cost as quoted by Geoforce is estimated at $160,000 including mobilisation.

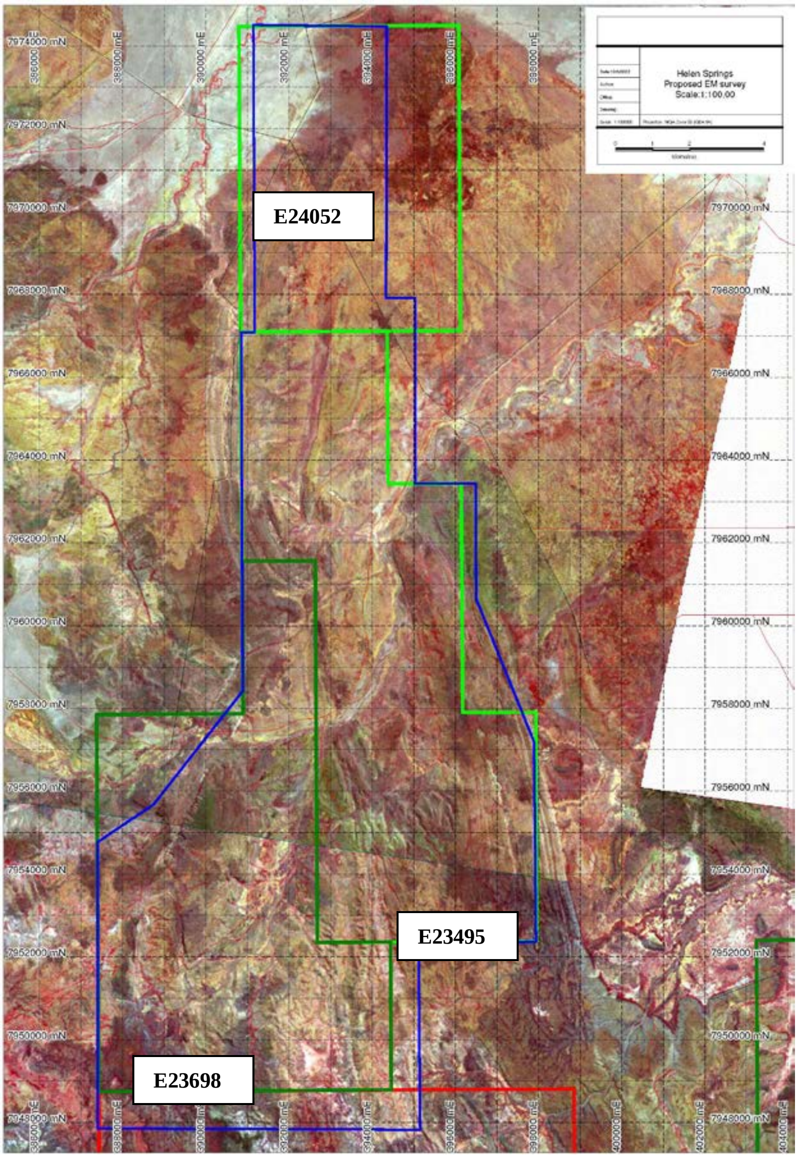

Figure 10. Proposed coverage for an airborne EM survey over the Helen Springs Project area (blue polygons). Survey is to include E23698, potential for hosting shallow massive Mn mineralisation in chert breccia within poorly exposed units of the Lower Shillinglaw Formation and E23495 and E24052, which are potential for hosting stratiform possibly unconformity related Mn mineralisation along the contact of the Bootu FM and the Attach FM.

6 Reference

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