Geophysics and Drilling Collaborations Final Report
Deep Diamond Drilling Proposal
Carrara Project -EL 30665

Map Sheet: Mount Drummond (1:250,000)

Mitchiebo (1:100,000)

Tenure holder & Operator: Teck Australia Pty Ltd, Level 2/35 Ventnor Avenue, West Perth WA 6005, Australia

Compiled by: Michael Cawood (Michael.Cawood@teck.com)

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Teck Australia

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Declaration

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Summary

Teck Australia completed a single diamond drill hole into an interpreted sub-basin within the Carrara Project (EL30665) with the objective of detecting sulphidic Paleoproterozoic stratigraphy, believed to be prospective for Shale-Hosted Massive Sulphide Zn-Pb-Ag mineralization, interpreted at a depth of 500m to 750m defined by a conductive horizon identified in an extensive AMT survey completed in 2015. The interpreted 4th order sub-basin was identified from magnetics, gravity, and proximal outcrop and was placed proximal to the NE trending Little Range Fault, considered a major basin bounding extensional fault, and a NW trending 'transform' structure.

The drill hole, CRDD001, was drilled between the 10th and 26th October 2016, and was completed to a depth of 800.42m terminating within South Nicholson Group sediments after encountering difficult drilling conditions. The target Paleoproterozoic sediments were not intersected, indicating the identified NW trending structure was likely reactivated post Cambrian. The AMT conductive horizon is likely coincident with a large saline aquifer within a porous sandstone host.

CRDD001 was the only effective drill hole within the prospective covered Lawn Hill Platform immediately south of the Carrara Range, and has aided the geological understanding of the area.

Contents

Figures

Tables

Ammendments

A core review held during April 2017 under the supervision of Dr. Tim Munson has resulted in the revision of some of the stratigraphic units identified in the originally submitted report. Amendments to this document are detailed below.

Section	Amendment
Results and Interpretation	Removed inclusion of Narpa Group (pp. 17)
	Amended interpreted stratigraphic column (Figure 7; pp. 17)
	Amended interpreted boundaries (pp. 18)
	Amended Camooweal Dolostone lithological description (pp. 18 – 19)
	Amended contact relationships and stratigraphic column, and updated stratigraphic descriptions (Figure. 9; pp. 20)
	Updated stratigraphic description (Table 3; pp. 20)
	Amended stratigraphic unit from Current Bush to Ranken Limestone (pp.21)
	Updated figure description (Figure 10; pp. 22)
	Removed description of Qld geological corollary to Narpa Group (pp. 23)
	Updated and amended Wonarah Formation description (pp. 23)
	Amended and updated stratigraphic description interpretation (Table 5; pp. 26 - 27)

Introduction

Partial funding was provided by the Northern Territory – Geophysics and Drilling Collaborations program to complete a single drill hole into an interpreted 4th sub-basin within the Carrara region of the greater McArthur basin. The target was Paleoproterozoic sediments considered prospective for SHMS Zn-Pb mineralization, such as the McArthur River deposit, developed at the intersection of an interpreted major growth fault and transform fault.

Teck Australia's Carrara project is located 300km northwest of Mt Isa, Queensland, in the Mt Drummond 250K map sheet. The nearest sizeable township is Camooweal, which is located approximately 150km to the south-southeast of the project in Queensland (**Figure 1**). Access is via Camooweal, north to Gallipoli Station, then west to Mittiebah Station. Land use in the region is predominantly cattle grazing on large pastoral holdings. The Carrara Project straddles the Mittiebah and Alexandria stations which are both owned by North Australian Pastoral Company Pty Ltd. The drill hole is located at 740425E, 7921000N (MGA53) within EL30665 and was drilled to a depth of 800.42m.

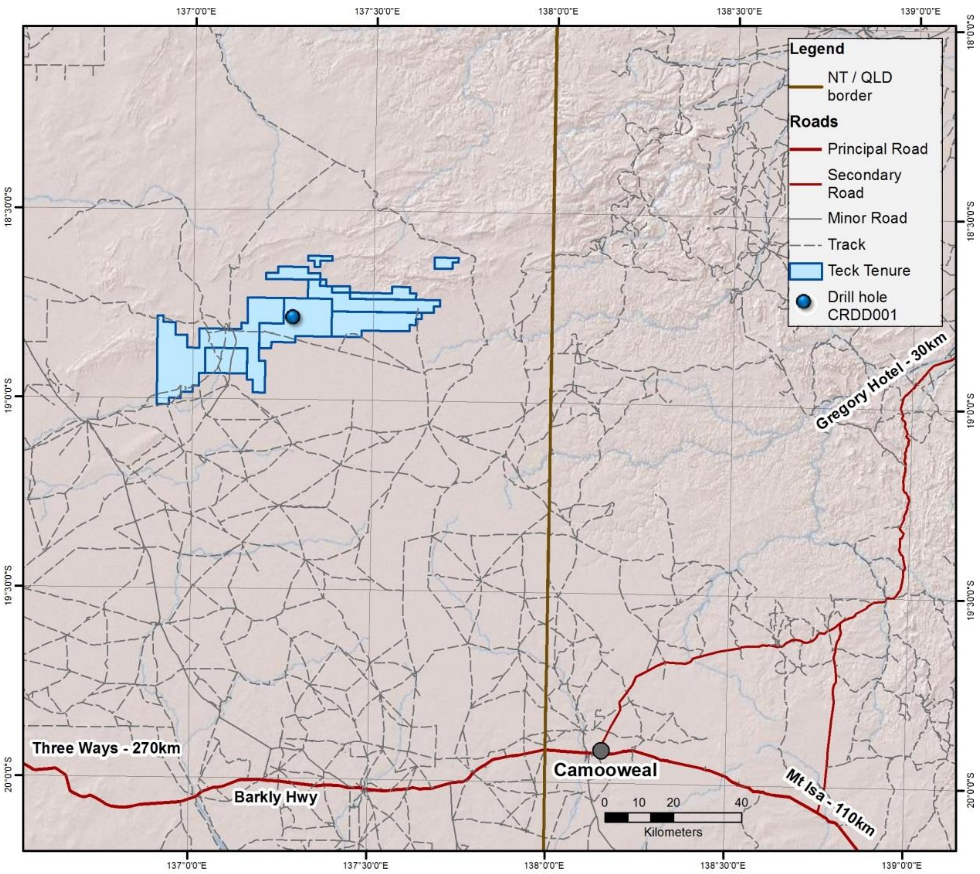

Figure 1: Carrara tenure location plan

Regional Context

The Carrara Project lies within the MOUNT DRUMMOND 250K map sheet, at the southern margin of the Paleo to Mesoproterozoic South Nicholson Basin; belonging to the greater McArthur Basin, and considered a western extension of the Northern Lawn Hill Platform (Figure 2). The Mount Isa Inlier, of which the Lawn Hill Platform is a member, hosts a number of world class sediment hosted massive sulfide (SHMS) zinc-lead-silver deposits, including Century and Mt Isa. Within the MOUNT DRUMMOND sheet, three Paleoproterozoic Formations that are considered prospective for SHMS deposits are recognized. These units are “grouped” into stratigraphy code L7 in Figure 3.

Based on chrono-stratigraphic correlations between the McArthur River Group (NT nomenclature) and the McNamara Group (QLD nomenclature) these recognized prospective formations are correlated as such: (1) the Lawn Hill Formation (MRG) with the Wide and Doom Supersequences (which host the Century mine); (2) the Plain Creek Formation (MRG), which is the equivalent to the Barney Creek Formation and the River Supersequence (host to the McArthur River, Walford Creek and Bluebush occurrences; and, (3) the Upper Brumby Formation, which is considered equivalent to the Lady Loretta Formation (host of the Lady Loretta deposit)

Structural Framework

Architecture of the Lawn Hill Platform is generally manifested by east-northeast extensional faults, northwest transfer zones and moderately steep folding related to north-south and east-west compression respectively (Andrews, 1998). Similarly a number of easterly to east-northeasterly faults are mapped in the south eastern quadrant of MOUNT DRUMMOND, and this dominant structural fabric is most abundant in the Carrara Ranges where inversion (thrusting) is extensively developed in comparison to the rest of the Lawn Hill Platform. Stratal growth is documented on the main easterly faults, the Little Range and Mitchiebo. Measured sections of Carrara Ranges stratigraphy (Rawlings 2004) indicates that the basin was deepening to the south, towards the Little Range fault, at Lawn Hill and Plain Creek formation deposition times. The Little Range Fault is interpreted to mark the southern boundary of the Lawn Hill Platform/South Nicholson basin in the MOUNT DRUMMOND, consequently it is considered a highly prospective corridor for SHMS Zn-Pb-Ag exploration.

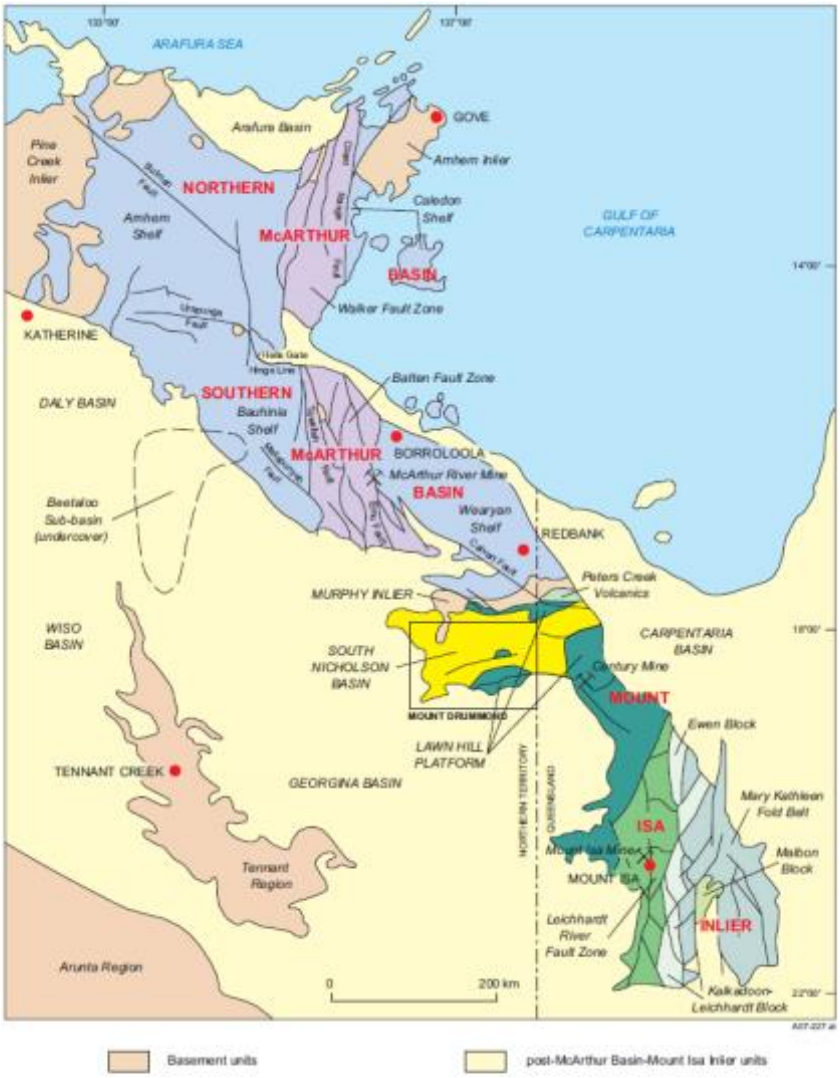

Figure 2: Regional tectonic framework for the North Australian Paleoproterozoic Basins (Source: Rawlings et al. 2004, page 7)

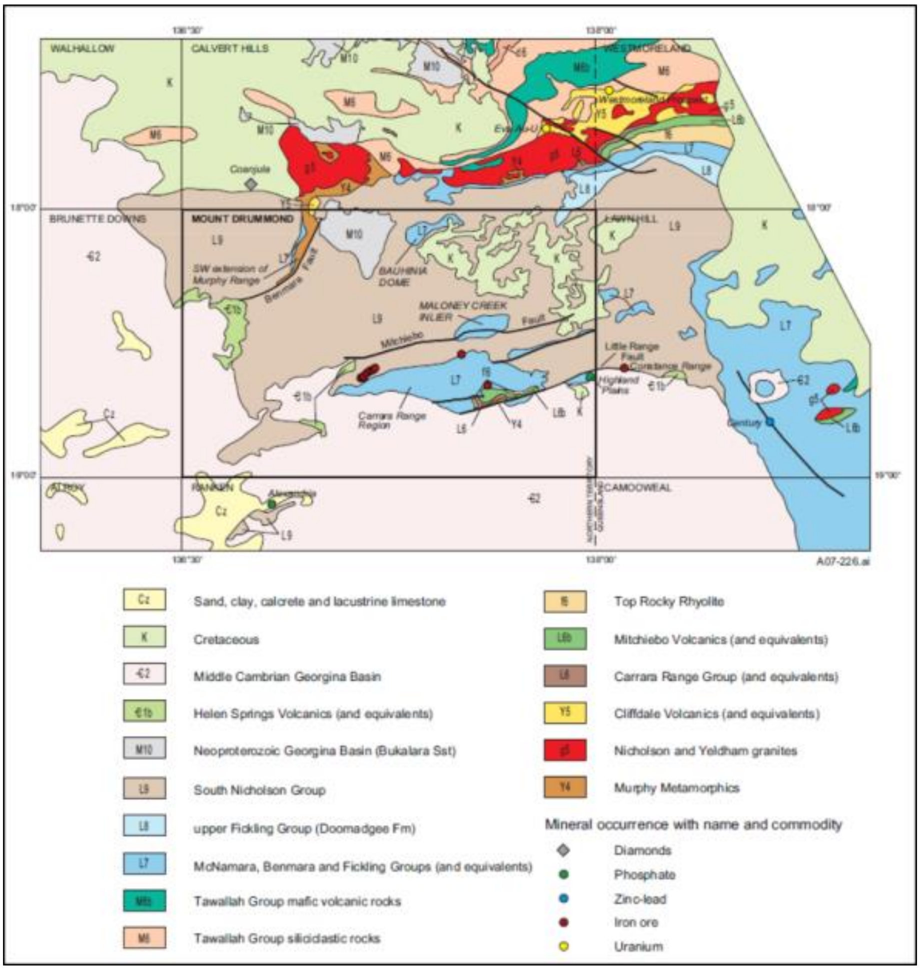

Figure 3: Regional geological setting, showing the Carrara Range, bound by the Little Range Fault. Note the location of Century and the Termite Range Fault to the east (Source: Rawlings et al. 2004, page 6)

Previous Exploration

Historical Mining/Exploration

Most tenements within the Carrara Project have had limited historical exploration. Drill holes reported in the NTGS database west of the Carrara Ranges are shallow water bores with limited information. Historical mineral exploration in the MOUNT DRUMMOND 250K map sheet targeted base metals, phosphate, diamonds and iron ore over time. Historical base metal exploration focused on the eastern portion of the southern part of MOUNT DRUMMOND in the eastern Carrara Ranges targeting Zn-Pb mineralisation.

CRA explored in the Carrara area from 1991 to 1996, conducting extensive surficial geochemistry surveys over the Carrara Ranges and defined a number of areas with minor to moderate Pb and Cu anomalies. Two targets defined from GEOTEM surveys were tested with eight reverse circulation drill holes and returned poor results.

Rio Tinto explored the area from 2000 to 2002 conducting an extensive RAB drilling program over sub-cropping Lawn Hill Formation. A separate blind target area bound by a fault intersection of interest was tested with an IP survey but it was deemed that the moderate response did not warrant drill testing.

Anglo American explored the area south east of the Carrara Ranges from 2003 to 2004, and drill tested a discrete combined EM and magnetic anomaly with one diamond and one RC drill hole. Basement lithologies were intersected and tenure was subsequently relinquished.

Teck's focus has been in the area of cover to the west of previous exploration, completing AMT and gravity surveys, in 2015. The results of the two surveys allowed for the broad resolution of basin architecture and identified conductive material at depth. A drill hole is proposed for 2016 to determine the nature of the conductive stratigraphy and is the subject of this proposal

Historical exploration reports covering SHMS Zn-Pb exploration in the Carrara Ranges include:

Anglo American: CR20030283, CR20030410, CR20040232, CR20040233.

Rio Tinto: CR20000282, CR20010179

CRA: CR19910168, CR19910179, CR19910180, CR19920156, CR19920164, CR19920264, CR19920370, CR199300262, CR19930336, CR19930337, CR19940319, CR19940452, CR19950316, CR19950323, CR19960149.

Teck: EL29557_2015_C_01_FinalReportf.pdf

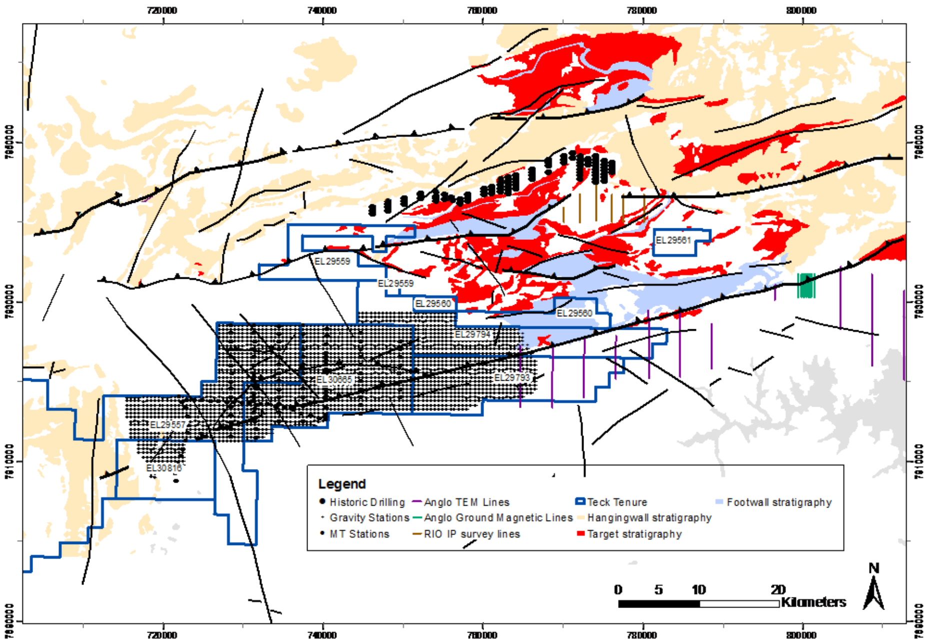

Figure 4: Map of target stratigraphies showing interpreted structural framework, historical drill holes and geophysical survey lines

Exploration Concept

The exploration model for the Carrara Project is based on the world class McArthur River Zn-Pb deposit. It is proposed that the Carrara Project has the potential to host analogous sub-basins, controlled by the extensional Little Range Fault, as the major basin bounding fault, and a north-northwest striking transform faults to create 3rd and 4th order sub-basins (i.e. **Figure 5**).

West of the Carrara Ranges the Little Range Fault can be weakly traced under Mesoproterozoic and Cambrian cover through its magnetic signature. A total of 50 kilometres strike length of this key structural corridor is controlled by the project tenure. Surface dip measurements in the Ranges show that key target lithologies dip west under Cambrian Georgina Basin sediments. Additionally it is inferred from surface mapping that target stratigraphy generally thickens south towards the Little Range Fault, again implying enhanced prospectivity as the SHMS model requires basin active deepening at time of sulphide deposition into anoxic waters.

Depth of cover is variable and largely unconstrained (it is estimated at greater than 100m based on water bore logs from the western side of the project). Currently the regional aeromagnetic survey offers limited insight into the Proterozoic target stratigraphy rocks, although the gravity is potentially useful in differentiating the denser dolomitic stratigraphy from the siltstone and sandstone dominated units.

The AMT survey completed in 2015 highlights a conductive zone which potentially correlates with one of more pyritic shale unit, inferred to be either Plain Creek Formation, or Lawn Hill Formation or both (Figure 6). Both are considered prospective for SHMS mineralisation. While a conductive unit within the Georgina Basin, or South Nicholson Group could not be ruled out, although descriptions from the MT DRUMMOND 250k explanatory notes suggest this is less likely. The depths to the conductors (400m to 1250m) supports the interpretation of lower McNamara stratigraphy (which is mapped on the eastern edge of the Teck tenements) occurring at deeper levels within the potential sub-basins (**Figure 6**), hence preserving the prospective overlying Plain Creek and Lawn Hill Formation stratigraphy.

A 1200m deep diamond drill hole was proposed to test the shallowest portion of the AMT conductive horizon, establish the presence of the target stratigraphy and yield insights into the prospectivity of the 3rd order sub-basin developed proximal to the Little Range Fault (**Figure 6**). Should prospective stratigraphy be intersected with geochemical indications of mineralization and alteration then future exploration would be focused along the length of the 3rd order sub-basin.

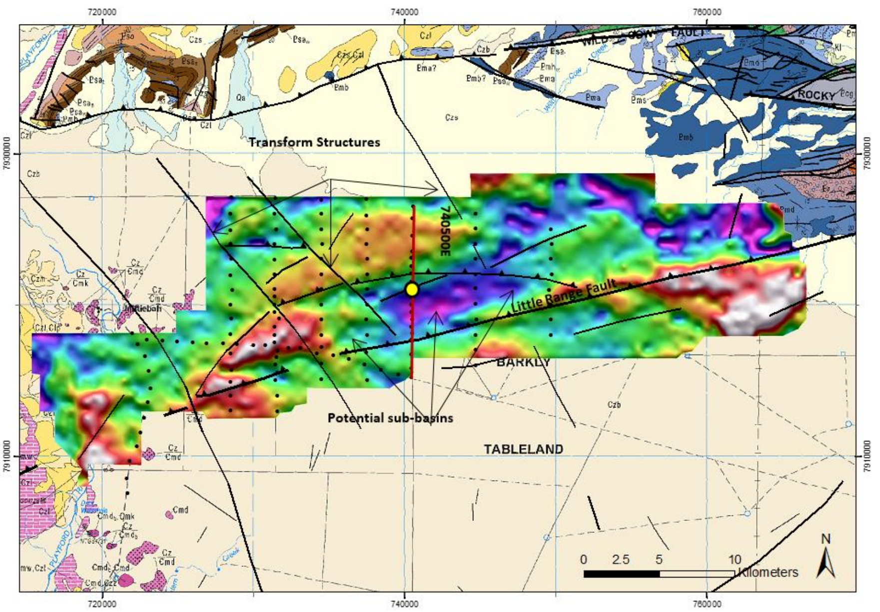

Figure 5: Structural interpretation on Bouguer gravity and government mapping. Little Range Fault is interpreted as an inverted growth fault and the NNW trending structures as transform faults. Stratigraphy is interpreted to be progressively downthrown from east to west, preserving the Lawn Hill Platform sediments and coeval mineralisation. The proposed drill hole (yellow dot) is located in a portion of the interpreted sub-basin which is proximal to the Little Range Fault and the western transform structure

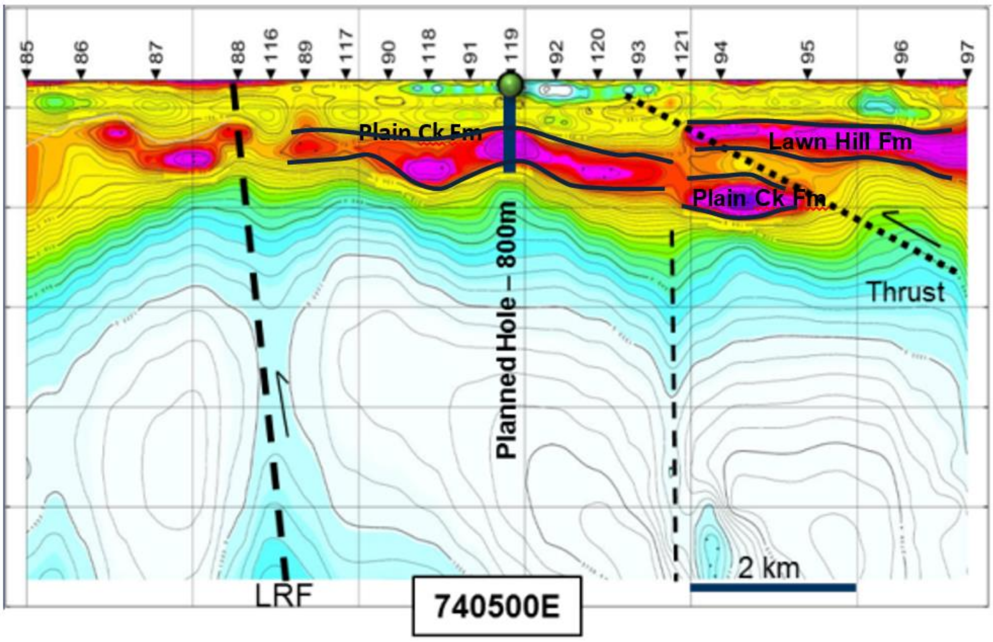

Figure 6: AMT section 740500E. Conductive units interpreted to be pyritic shales within Plain Creek and L

Details of the Collaborative Program

Specification	Diamond drill hole
Hole Number	CRDD001
Coordinates	740425E, 7921000N, 275mRL (GDA 1994, zone 53)
Depth	800.42m.
Dip	80 degrees
Azimuth	0
Drill method	HWT 0-9.4m, HQ 9.4m-259.2m, NQ 259.2-800.42m
Drill Contractor / Drill rig	Titeline Drilling Pty Ltd / UDR1200HC
Final data delivery	3 months from drill hole completion

Geochemical Sampling

Sampling protocols for CRDD001 consisted of one metre samples of geologically representative material approximately once every 30 metres. Where a duplicate sample was required, the sample was re-cut to quarter core and both quarters will be submitted as separate samples.

Samples were crushed to a nominal 20mm and then re-crushed to 85% passing 2mm. Samples were then split in a rotary splitter to approximately 500g. They were then reduced to 90% passing. These samples were used for all further analysis.

All samples were analysed for major elements and a selected suite of trace metals. The XF100, LA101 and TC001 package at Bureau Veritas was used. This is an oxidative fusion of the sample and analysis by XRF. The fused bead is then analysed for a trace element suite by LA-ICPMS. The list of elements and detection limits are shown in **Table 1**.

A number of standards, blanks and duplicates were inserted into each block of sixty samples as shown below. This process is randomized by the Acquire Database Object used routinely by Teck for core sampling.

- Field duplicates: 2
- Pulp duplicates: 1
- Crush duplicates: 1
- Fine blank: 1
- Coarse blank: 2
- Standards: 3

Element/ Oxide	Unit	Method	Detect Limit		Element/ Oxide	Unit	Method	Detect Limit
Fe	PPM	XF100	100		Ba	PPM	XF100	10
SiO2	PPM	XF100	100		V	PPM	XF100	10
Al2O3	PPM	XF100	100		Cl	PPB	XF100	10
MnO	PPM	XF100	10	L	LOI	%	XF100	0.01
TiO2	PPM	XF100	10		Ag	PPM	LA101	0.1
CaO	PPM	XF100	100		As	PPM	LA101	0.2
MgO	PPM	XF100	100		Ba	PPM	LA101	0.5
K2O	PPM	XF100	10		Be	PPM	LA101	0.2
P	PPM	XF100	10		Bi	PPM	LA101	0.2
S	PPM	XF100	10		Cd	PPM	LA101	0.1
Na2O	PPM	XF100	100		Ce	PPM	LA101	0.02
Cu	PPM	XF100	10		Co	PPM	LA101	0.1
Ni	PPM	XF100	10		Cr	PPM	LA101	1
Co	PPM	XF100	0.01		Cs	PPM	LA101	0.01
Cr	PPM	XF100	10		Cu	PPM	LA101	2
Pb	PPM	XF100	10		Dy	PPM	LA101	0.01

Zn	PPM	XF100	10	Er	PPM	LA101	0.01
As	PPM	XF100	10	Eu	PPM	LA101	0.01
Sn	PPM	XF100	10	Ga	PPM	LA101	0.1
Sr	PPM	XF100	10	Gd	PPM	LA101	0.01
Zr	PPM	XF100	10	Ge	PPM	LA101	0.05
Hf	PPM	LA101	0.01	Sm	PPM	LA101	0.01
Ho	PPM	LA101	0.01	Sn	PPM	LA101	0.2
In	PPM	LA101	0.05	Sr	PPM	LA101	0.1
La	PPM	LA101	0.01	Ta	PPM	LA101	0.01
Lu	PPM	LA101	0.01	Tb	PPM	LA101	0.01
Mn	PPM	LA101	1	Te	PPM	LA101	0.2
Mo	PPM	LA101	0.2	Th	PPM	LA101	0.01
Nb	PPM	LA101	0.01	Ti	PPM	LA101	1
Nd	PPM	LA101	0.01	Tl	PPM	LA101	0.2
Ni	PPM	LA101	2	Tm	PPM	LA101	0.01
Pb	PPM	LA101	1	U	PPM	LA101	0.01
Pr	PPM	LA101	0.01	V	PPM	LA101	0.1
Rb	PPM	LA101	0.05	W	PPM	LA101	0.05
Re	PPM	LA101	0.01	Y	PPM	LA101	0.02
Sb	PPM	LA101	0.1	Yb	PPM	LA101	0.01
Sc	PPM	LA101	0.1	Zn	PPM	LA101	5
Se	PPM	LA101	5	Zr	PPM	LA101	0.5

Table 1: Assayed elements and detection limits

Physical Property Sampling

Physical property measurements comprising magnetic susceptibility, specific gravity, and conductivity were collected routinely throughout the core drill hole (HQ – 9.4m to 259.2m, NQ – 259.2 to 800.42m EOH). A summary of the collection parameters is listed below;

Magnetic Susceptibility

The KT-10SC instrument utilizing a round coil was used to take one measurement per metre, in straight SI units, as reported in attachment *EL30665_2017_C_09_MagsuscConductivity.txt*. The measurement was taken from near the metre mark and the settings in the KT-10 were adjusted for core, and core size. The instrument was used in non-pin mode and no reference pads or standards were used to check the acquired results.

Specific Gravity

SG readings, using the Archimedes method, were taken from one sample per core tray, which is typically at two to five metre intervals. The data are presented in EL30665_2017_C_10_SG.txt. The samples were taken directly from the core tray and were not dried, or soaked prior to weighing.

Conductivity

Conductivity measurements were taken using the KT-10SC instrument at the same location as the magnetic susceptibility readings. The data, in S/m units, are reported in *EL30665_2017_C_09_MagsuscConductivity.txt*. As with the magnetic susceptibility readings, no reference pads or standards were used to check the results. The results from the KT-10SC tend to be unreliable at low conductivity values, hence should be used with caution.

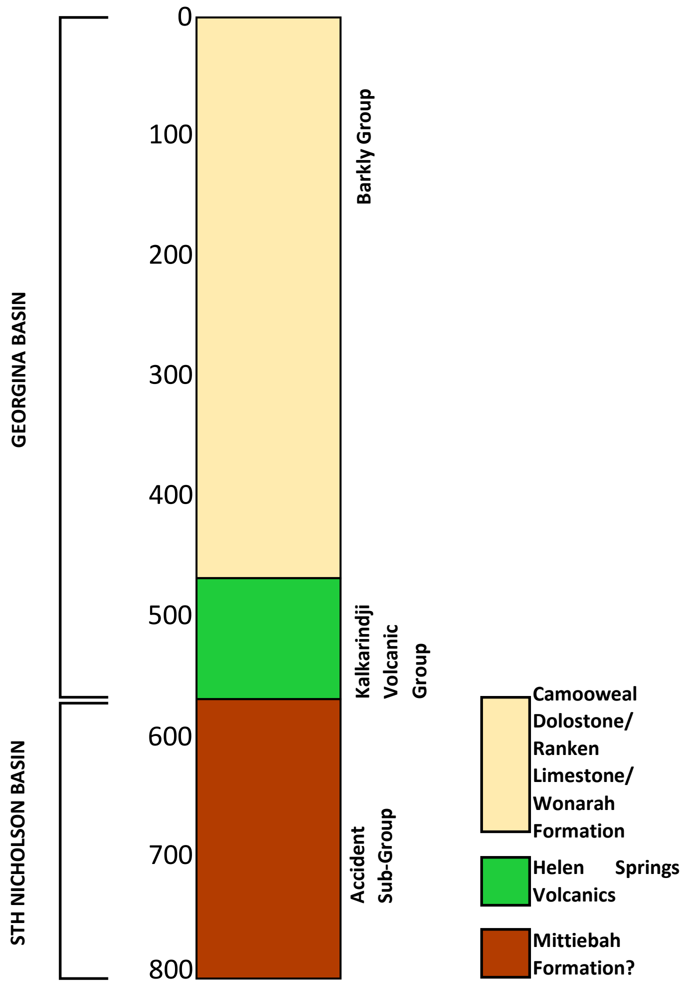

Figure 7: Interpreted stratigraphic units of CRDD001

Results and Interpretation

Collared in Camooweal Dolostone, CRDD001 intersected ~569m of the Cambrian Georgina Basin, including 467m of Barkly Group, and 101m of underlying Helen Springs Volcanics, before terminating in South Nicholson sandstones at 800.42m. No significant assay results were received, or significant conductor intersected. All data collected are attached as digital files.

Stratigraphic units (Figure 7) were identified using lithological characteristics and contact relationships detailed in Mount Drummond, Northern Territory. 1:250,000 geological map series explanatory notes, SE 53-12 (Rawlings et al., 2008 – referred hence forth as Mount Drummond SE 53-12).

Initial interpretations incorrectly identified Current Bush Limestone/Border Waterhole (Narpa Group) between 213.9 – 312.75m, and 312.75 – 467.2m respectively, and Mullera Formation between 568.76 – 800.24m.

Barkly Group

<u>Camooweal Dolostone</u>

Unit, Thickness	Lithology	Depositional Environment	Stratigraphic relationships
Camooweal Dolostone, 167m+ in RANKEN	Pale microbial dololaminite with nodular chert, dolosparstone; minor peloid and ooid dolostone, conglomerate, dolomitic limestone, marl; lower high-energy interval of quartzic, intraclast and ooid dolograinstone and quartz sandstone	Peritidal to restricted and open shallow subtidal marine	Conformably overlies Currant Bush Limestone; unconformably overlain by Cretaceous rocks in sheet area

Table 2: Description of Camooweal Dolostone as detailed in Mount Drummond SE 53-12 (Rawlings et al., 2008)

CRDD001 intersected 213.90m of Camooweal Dolostone, a variably leached/weathered unit composed of vuggy, massive, crystalline limestone +/- low relief domal stromatolites (8B). Vugs have rare chalk infill, and may be associated with low relief domal stromatolites. Intervals of yellow-cream carbonate sandstones up to granular-pebbly sized grains, and fine cream-yellow carbonate mud-silts with grey silica replaced “nodules” (may actually be remnant primary lith) with internal laminations (8A). Bedding textures may be destroyed – likely due to weathering – but sediments are generally irregular and v thin lam to thin-med beds, with limestone more massive/thicker. Between ~140 – 213.90m the unit was observed as having a more siliclastic nature, with dark grey shales and siltstones between ~140m to 170m.

Sedimentary textures include cross cutting beds, scour marks and what looks like ‘dune building’. Rare stromatolites both columnar more columnar (8C) and domal – despite Cambrian age, there is little evidence of fossils, particularly in the upper part of the unit.

The base of the unit is marked by thick (~20m) interval of increasingly oidial dominated grainstone (8D) consistent with observations from Rawlings et al, 2008 of the unit- “Oncoid dolorudstone, ooid dolograinstone, quartzic dolostone and quartz sandstone also contribute to the basal interval of this tract, which *extends into southwestern MOUNT DRUMMOND as far a Mittiebah homestead* ”

The high degree of ooid grainstones in the base of the interval combined with the evidence of above storm wave basin (SWB) sedimentary structures seen in peritidal to open tidal (stratification, tempestites etc.) is consistent with Camooweal Dolostone.

Figure 8: Rock types identified within Camooweal Dolostone include carbonate mud-silts with rounded to irregular silica replaced nodules (?) with internal lams [A]; variably coarse, crystalline and vuggy limestone +/- stylolites [B]; example of conical stromatolites [C]; basal ooidal dolograinstone

The units underlying Camooweal Dolostone has been interpreted as Ranken Limestone and Wonarah Formation which is consistent with contact relationships (re: overlying Helen Springs Volcanics) identified in Mount Drummond SE 53 – 12 (Rawlings et al., 2008).

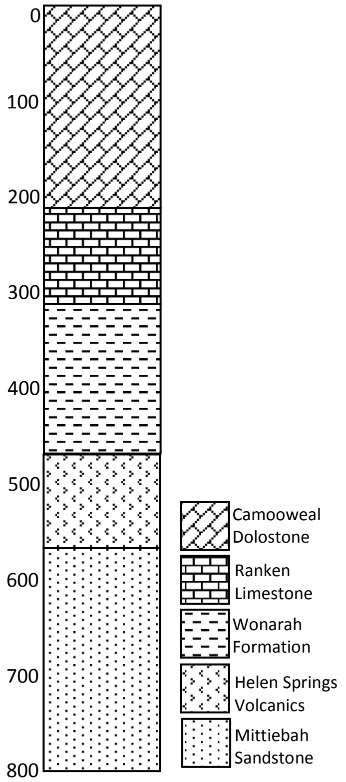

Figure 9: The revised stratigraphic column based off the Mount Drummond SE 53-12 guide (Rawlings et al., 2008)

The lithological descriptions for Ranken Limestone and Wonarah Formation from Mount Drummond SE 53-12 are included in Table 3 (Rawlings et al., 2008).

Although separate units, the contact between Ranken Limestone and Wonarah Formation is conformable, with subtle, rather than significant changes in lithology demarking the boundary at 312.75m. Complicating this is the interpreted depositional environment both these formations show evidence of; namely the high energy shelf margin. This is interpreted as representing a period of seawater level stability in a High Stand System Track in which transgression in the overall HSST is simply not recognisable.

Despite this subtlety, there is some evidence for two separate units as per Rawlins et al., 2008 with variations including;

a) Increased nodular cheritified limestone observed in the lower portion of the package;

b) Presence of grainstones, floatstones, and rudstones in the underlying Wonarah Formation, and

c) Granule to pebble conglomerates at the base of Wonarah Formation.

Unit, Thickness	Lithology	Depositional Environment	Stratigraphic relationships
Ranken Limestone Notionally 80m	Pervasively certified fossiliferous bioclast and bioclast-ooid rudstone	High – energy shallow subtidal marine	Discontinuous within lower high-energy interval of Camooweal Dolostone
Wonarah Formation, 36+ m; 146m in RANKEN	Pervasively chertified fossiliferous limestone, shale and siltstone; minor phosphorite; basal sandstone.	Shallow marine	Disconformable on Helen Springs Volcanics; conformably overlain by Camooweal Dolostone

Table 3: Lithology descriptions of Ranken Limestone and Wonarah Formation, as detailed in Mount Drummond SE 53-12 (Rawlings et al., 2008)

Ranken Limestone

CRDD001 intersected Ranken Limestone between 213.9 – 312.75m (98.85m). The unit is composed of very thinly laminated carbonate silts/shales with irregular or bedding parallel nodules. These may appear bed-like and increase in frequency downhole to a predominantly carbonate (more massive) lithology. Very thin to medium beds of bioclastic +/-ooid carbonate packstone/grainstone (Figure 10A) are common. Limestone is observed both as fossiliferous "ribbons" associated with very thinly laminated muds, and more massive and vuggy, often coarse intervals.

The unit is variably altered – both by meteoric water, and what appears to be patchy dolomite alteration. Fossil types were not identified, with the exception of interpreted worm fossils at the upper contact (pers. Comm., Cawood). There is a minor wet clay interval within the unit. The depositional environment is interpreted as a high energy shelf margin.

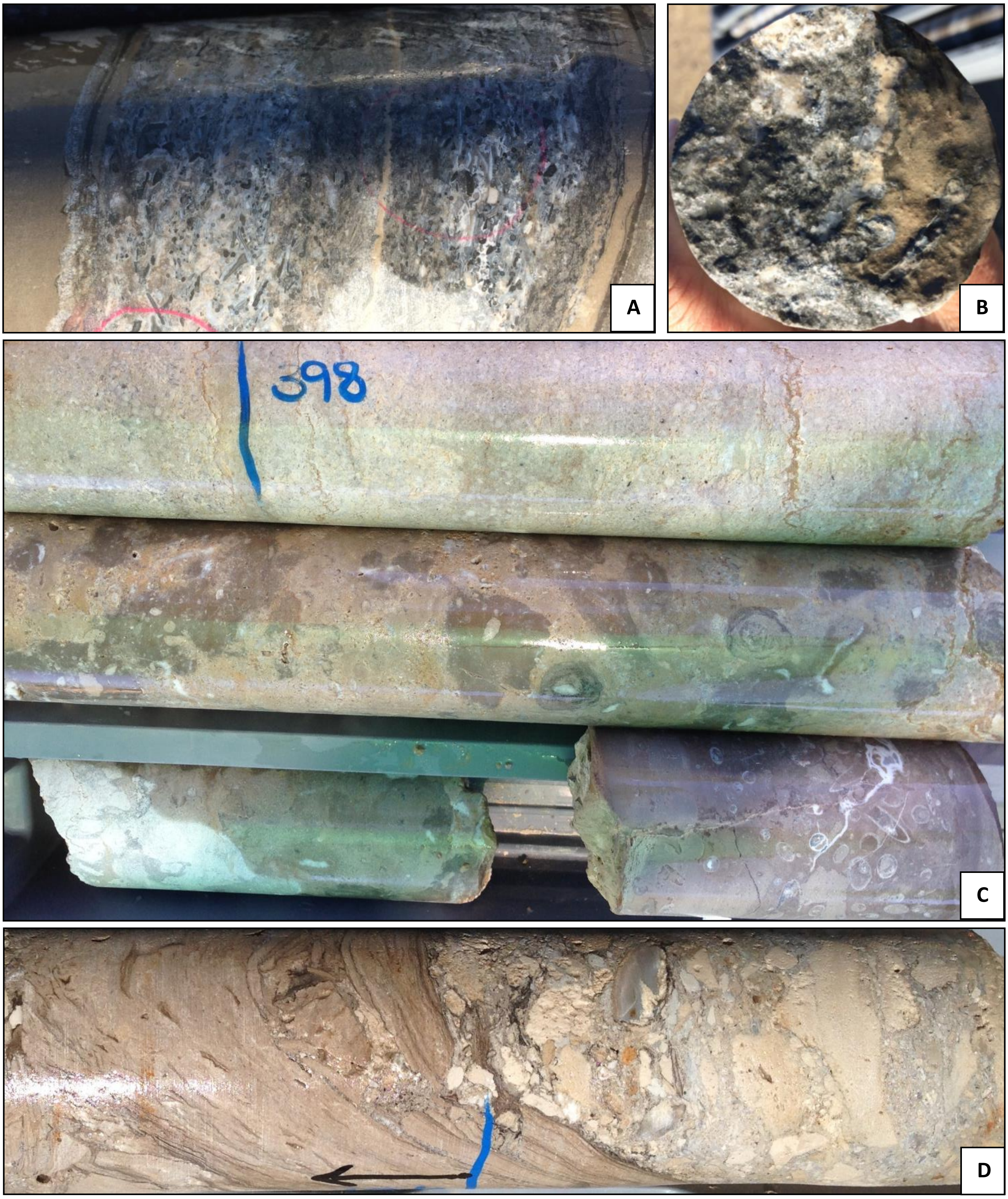

Figure 10: Examples of bioclast grainstone (A, B); rudstone progressing to floatstone (C); and the basal Wonara Formation pebble conglomerate (D)

Wonarah Formation

Intersected at 312.75m the Wonarah Formation is similar to the overlying Ranken Limestone, composed of massive vuggy crystalline and floatstone limestone, laminated siltstones with rounded and irregular nodules or “ribbon” limestone which may increase downhole to a more massive carbonate unit. Bioclast +/- ooid packstone/grainstones are common, and floatstones – rudstones are also observed (Figure 10).

The unit is variably weathered with minor intervals of clay, and patchy dolomite alteration textures. The contact zone (6m thick) overlying the Helen Springs Volcanics is variably broken and very porous showing strong oxidation from ground water. Beds of siltstone, conglomerate and bioclastics over the lower 30m of the interval have degraded, developing as clay horizons that have been “washed-out” during drilling, resulting in core loss. Where these clay zones remain there is evidence of minor disseminated pyrite. Upwards of 50% over a 5m interval has been lost.

Kalkarindji Volcanic Group

Helen Springs Volcanics

Helen Springs Volcanics marks the basal unit of the Georgina basin, and was intersected by CRDD001 at 467.2m. Despite only 40m being observed in the western portion of the Mount Drummond SE 53-12 map sheet (Rawlins et al., 2008), CRDD001 intersected 101.56m of Helen Springs Volcanics, which may indicate either a general thickening trend to the east, or that the sub-basin was more active at this time. Alternatively, it may simply reflect how data poor the area is, given the lack of outcrop in the area.

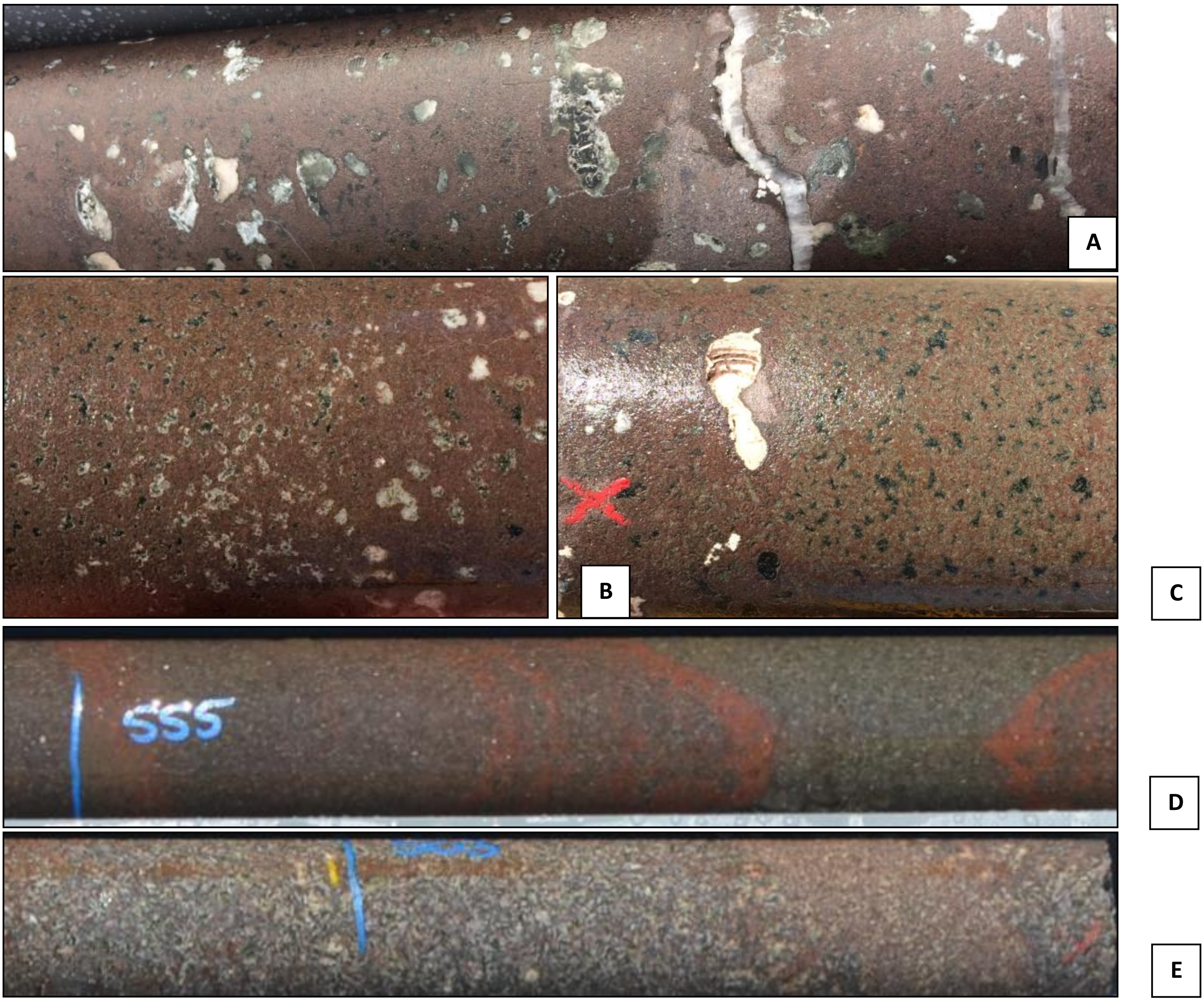

Figure 11: Helen Springs Volcanics. Coarse filled amygdaloids with fine aphanitic groundmass (A); pitted texture (B); amygdaloids with coarser groundmass (C); red hematite banding observed within the unit (D); coarser crystalline structure in the mid to mid-lower portion of the unit.

Unit, Thickness	Lithology	Depositional Environment	Stratigraphic relationships
Helen Springs Volcanics, 156m	Variably altered, locally amygdaloidal basalt and microdolerite; thin basal pebbly sandstone and conglomerate.	Subaerial lava flows and invasive flows.	Unconformable on South Nicholson Group; relationship with Bukalara Sandstone unknown; disconformably overlain by Wonarah Formation.

Table 4: Lithology description of the Helen Springs Volcanics as detailed in Mount Drummond SE 53-12 (Rawlings et al., 2008)

Generally, the Helen Springs Volcanics are consistent with the lithological description in Mount Drummond SE 53-12 (Rawlings et al., 2008; **Table 4**) – a variably altered, locally amygdaloidal basal. The majority of the amygdaloids are infilled with chlorite, caledonite, gypsum and chalk (Figure 11A, C), and concentrated at the top of the unit. The top of the unit is also defined by deep brick red hematite discolouration, which may be interpreted as evidence of weathering.

Below this is a narrow zone where the less resistant infill minerals have been removed resulting in a pitted appearance (Figure 11B). In this zone there is evidence of haematite alteration of feldspars and biotite clots of >2mm are easily observed. Toward the mid-base interval of the unit, red hematite bands are observed (Figure 11D).

Initial hand held magnetic susceptibility readings would indicate that magnetite values bookend the unit – that is are greater in the upper and lower margins, rather than remain consistent. Crystalline structure tends to grow coarser and more needle-like in the mid to mid-lower portions of the unit (Figure 11E), with a lower 'chilled margin' observed. The thin basal pebbly sandstones and conglomerates noted by Rawlings et al., (2008) were not observed.

South Nicholson Group

Mittiebah Sandstone?

Unit, Thickness	Lithology	Depositional Environment	Stratigraphic relationships
Mittiebah Sandstone 450 – 2200m	Fine- to coarse-grained, quartzose to lithic sandstone; minor interbeds of pebble or cobble conglomerate and siltstone	Alternating shallow storm-influenced marine and braided fluvial.	Conformable to disconformable on Crow Formation; top not exposed but probably conformably overlain by Mullera Formation

Table 5: Lithology description of Mittiebah Sandstone as detailed in Mount Drummond SE 53-12 (Rawlings et al., 2008)

CRDD001 intersected what has been interpreted as the South Nicholson Group at 568.76m. Unfortunately, the dominance of sandstone within the South Nicholson Group, combined with the lithological consistency of the drilled interval, it is difficult to definitively identify the stratigraphic unit intercepted. While contact relationships from Mount Drummond SE 53-12 (Rawlings et al., 2008) would suggest that it is the Mullera Formation, based on the description it is more likely to represent Mittiebah Sandstone. Although the unit is up to 2200m thick, the presence of rare pebble- cobble-conglomerates are consistent with the identified Psi_3 (*pebbly facies*)and/or Psi_4 (*mixed facies*) sub units. Significantly it would indicate that Mullera Formation is missing from the sequence.

Overall the unit is dominated by fine to coarse grained (rare granule) quartz dominated and mica-rich +/- lithic sandstones. Between 568m – 621m the majority of the unit is a hematite cemented? micaceous siltstone to sandstone lithic to quartzose sandstone (Figure 12A), while between 621m – 738m the unit changes in composition to an overall white fine to medium grained sandstone with rare angular glauconitic mud-clasts (Figure 12D). In this zone tabular to planar cross bedding is common diagnostic of shallow marine /shoreline facies. Mud drapes on the foresets and the occurrence of herringbone cross stratifications is very indicative of a tidal environment. Hummocky stratification although hard to determine in core was observed in places suggesting further evidence of an above storm wave base (SWB) shoreface environment. Within this zone the presence of mud drapped cross stratification and channel fill course sandstone (Figure 5) confirms the shore face to foreshore position to perhaps even deltaic at times.

The hematite or 'red-bed' character and blotchy/bleaching overprint, seen in Figure 12A dominates the unit. It is likely due to a combination of iron deposition, with later saline brines dissolving out iron manganese species, forming the blotchy bleached sandstone unit. This is consistent with observed dissolution fronts which appear to move down from between bedding layers.

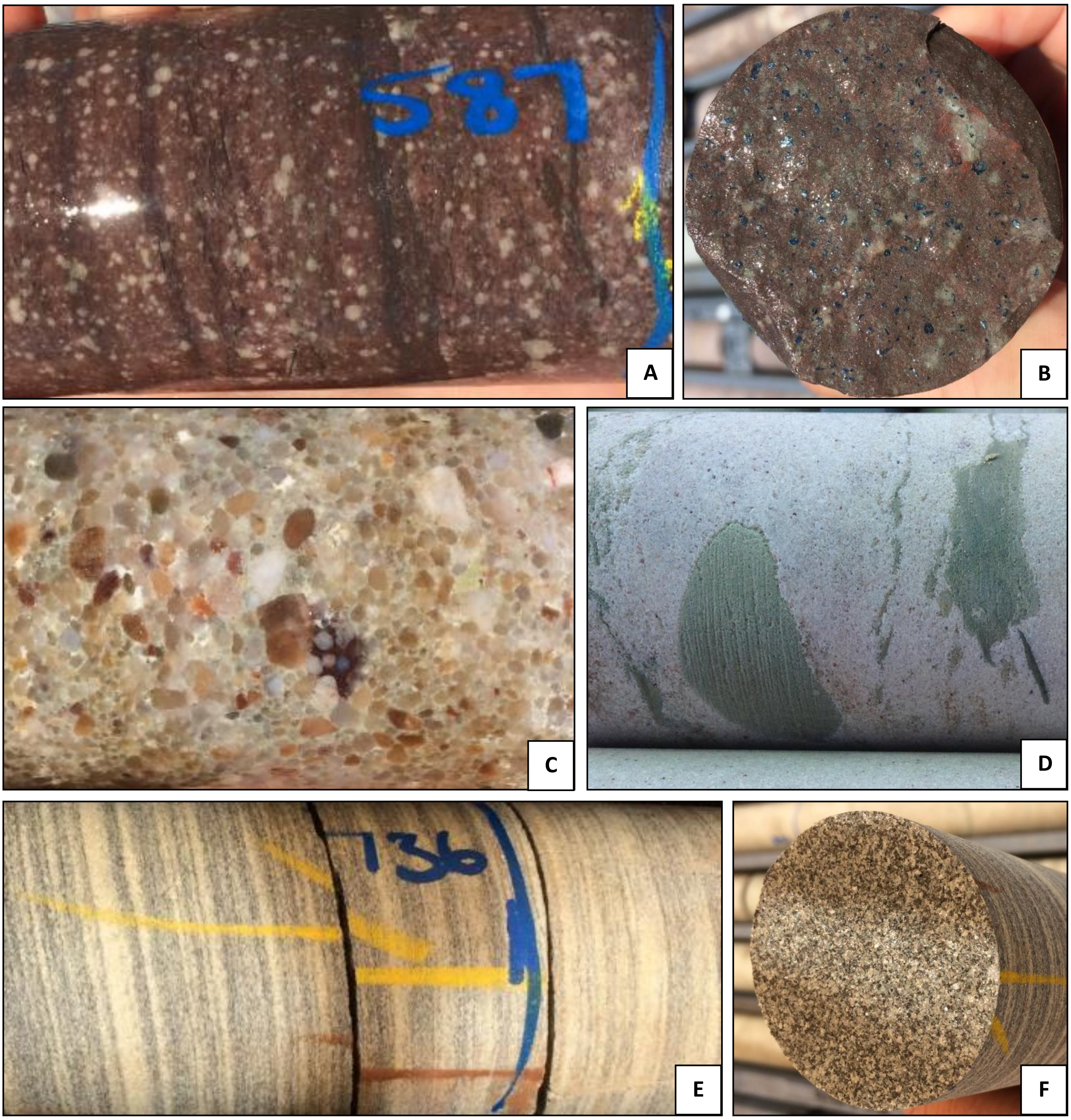

Figure 12: The unit is dominated by red/purple/pink and spotty/blotchy alteration textures (A); coarse biotite flecks are common in the upper portion of the unit (B); rare coarse, rounded, polymictic conglomerates (C); fine to med grained sandstone with angular glauconitic mud clasts (D); very thin grey-green laminations (E) are often micaceous (biotite) rich bands.

Of note, the unit contains 2 minor (<2m) intervals of granule to pebble conglomerates (**Figure 12**C). Clasts appear well rounded and polymictic, with no obvious grading. Although a minor interval, they may prove to be a marker unit. Overall the evidence from this and the surrounding sandstone is highly suggestive of a shallow marine - tempestite environment rather than a shallow marine to deeper shelf environments – an interpretation consistent with Mittiebah Sandstone.

Conclusion

The diamond drill hole, CRDD001, was completed at 800.42m within the South Nicholson Group, failing to intersect the underlying Paleoproterozic Lawn Hill and Plain Creek stratigraphies which are deemed potentially prospective for SHMS mineralisation. The lack of local existing drilling through the South Nicholson Group, into the Paleoproterozic, makes it difficult to estimate the expected depth of the Paleoproterozoic stratigraphy but it is expected to be greater than 1300m based on the logged South Nicholson stratigraphy.

It is concluded that the NW trending transform structures, delineating the eastern and western edges of the targeted sub-basin, were reactivated post Cambrian preserving Paleoprotozoic stratigraphy and greater depth than interpreted. The AMT conductive horizon targeted is now considered coincident with a saline aquifer developed within a porous sandstone host. The lack of conductive rocks measured from petrophysical sampling, but the presence of salt in the lithology correlating with the level of the AMT conductor, provide confidence to this interpretation (Conductivity data for the drill hole is provided in the attached EL30665_2017_C_08_MagsuscConductivity.txt).

Multielement analysis of samples collected downhole we completed to provide further guidance on lithological relations and provide any indications of potentially economic accumulations (i.e Phosphate and replacement Zn-Pb). No significant results were returned, including phosphate, which may be associated with Wonarah Formation. . Further correlation of these results to confirm additional relations with the South Nicholson was not completed.

CRDD001 is the only deep drill hole within the prospective but ‘covered’ greater McArthur Basin (Lawn Hill Extension) immediately southwest of the Carrara Range, and has aided the geological understanding of the area.

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