Controls on copper mineralising processes in the central McArthur Basin, NT: a progress report on the Coppermine Creek Prospect

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The Proterozoic McArthur Basin is part of the north Australian Carpentaria Zinc Belt; it contains examples of major, stratiform, shale-hosted, zinc-rich base metals deposits (such as McArthur River/HYC and the Teena deposit) in a structurally complex region called the Batten Fault Zone. The central McArthur Basin has long been thought to be a single commodity region; however, there are 'camps' with a significant number of occurrences of copper-rich historical workings located 50 km west and east of the main line of zinc deposits on the Emu Fault (the eastern boundary of the Batten Fault Zone). One camp is the Redbank copper deposits, stratigraphically in the 'Redbank package' of Rawlings (1999), a depositional package dominated by the Tawallah Group (the basal unit of the McArthur Basin). A second camp occurs in the Amelia Dolomite[4] near the base of the younger McArthur Group; examples are here termed 'Amelia-type'. Both Redbank and Amelia-type groups are stratigraphically lower than the host units to the zinc deposits.

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This research, funded by the Northern Territory Geological Survey (NTGS), is focussed on the Amelia-type deposit group. Key prospect examples are Johnstons, Coppermine Creek and Sly Creek (**Figure 1**). Most of these were prospected over the last 100 years, but at least one (Coppermine Creek) has been the subject of more recent (2006 onward) exploration. Drilling at Coppermine Creek has yielded significant intercepts of copper (17 m at 0.5% Cu, with a high of >8% Cu) in a 1.8 km long electrical geophysical target. Prior to this, the site had been drilled by BHP Exploration, producing anomalous copper intercepts. One of the BHP holes, MYD07, transects the entire Amelia Dolomite unit and is the only Coppermine Creek hole that is readily publically accessible within NTGS Core Facility in Darwin. Several samples from more recent drillhole CCD03 have also been made available to this study by current joint venture partners Pacifico Minerals and Sandfire Resources. CCD03 is the most mineralised hole drilled to date in the area (**Figure 1**).

The work in this abstract has focussed on a detailed transect through MYD07 and on a pilot comparison to some more mineralised samples in CCD03. The previous exploration has shown that an east–west line of gossans, ironstones, and workings, located 500 m south of the similar trending Coppermine Creek Fault and long thought to be a separate

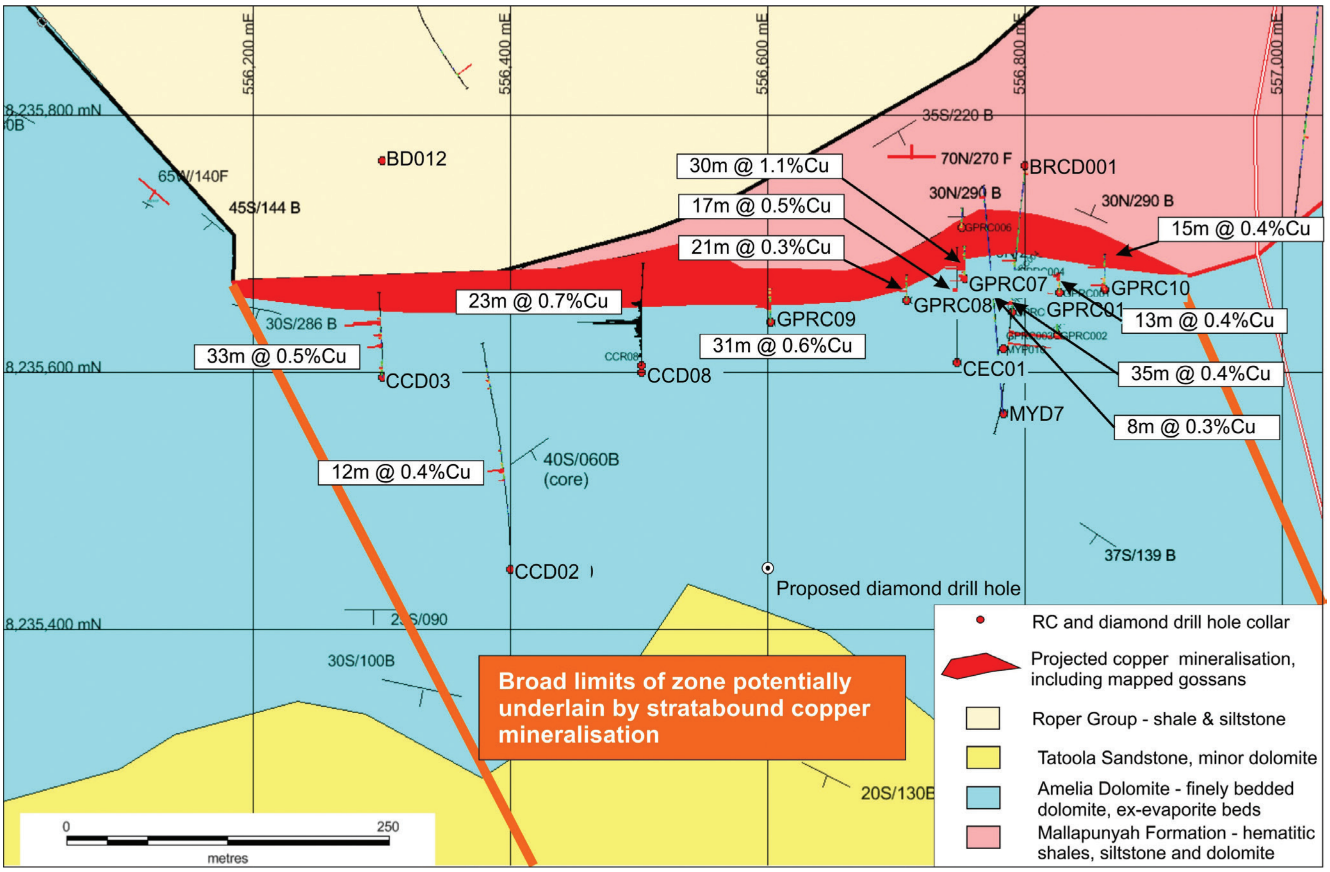

Figure 1. Geological features and drillhole locations at the Coppermine Creek prospect, modified from Pacifico Minerals 23 Nov 2016 announcement.

mineralised fault (Gordons Fault), is in fact a faulted section of mineralised stratigraphy (**Figure 1**). The mineralisation is stratabound and extends down-dip (to the south) of the line of gossans along preferred intervals of the Amelia Dolomite, particularly intervals with sulfate evaporate pseudomorphs. The current Pacifico Minerals strategy is to determine the size and metal grade zonation of this stratabound zone.

The rationale of our research study is that MYD07 is more distal within the mineralised envelope, and CCD03 (which lies further north), more proximal. Carbon, oxygen and sulfur stable isotope results are reported here, together with contextual petrology.

A predominant feature of the mineralised envelope in MYD07 is sparry grey dolomite replacement of primary black carbonaceous dololutite. This dolomite is cut by swarms and networks of 2–20 mm-wide white carbonate veins and veinlets. These are in turn typically cut by a steep generation of stylolites that commonly link with layer-sub-parallel stylolites. The main copper mineral is chalcopyrite, in places including islanded pyrite; small domains of galena and sphalerite also occur. Chalcopyrite has replaced steep sinuous stylolites, giving rise to sinuous sulfide forms; it has also replaced the marginal carbonate in some carbonate veins.

In CCD03, the general paragenesis of the provided samples is similar to MYD07, although the chalcopyrite segments are many centimetres wide. Minor mineralisation occurs in the underlying red Mallapunyah Formation; an intriguing feature of this mineralisation are zones of massive steely hematite that have been replaced by red earthy hematite vein arrays, all testifying to multiple episodes of post-depositional Fe mobility in this unit.

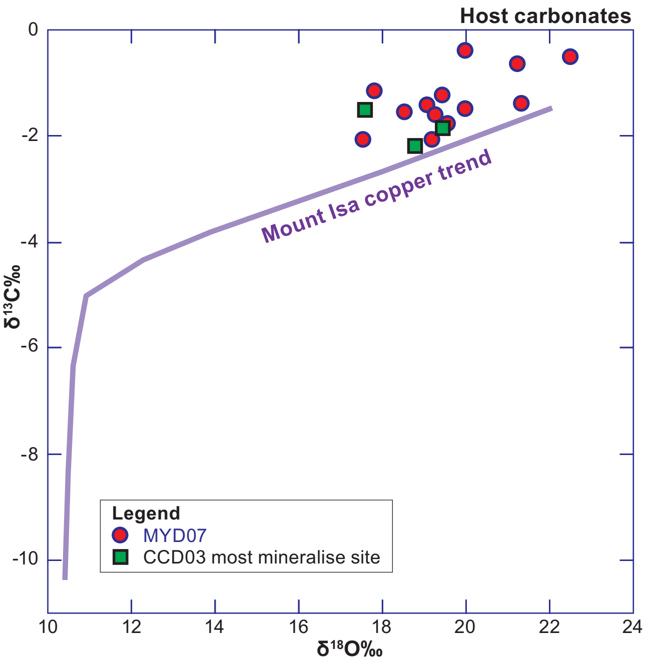

Figure 2. Comparison between host rock carbonate isotopic compositions in the outer stratabound halo (MYD07), pilot samples of the more mineralised material (CCD03) at Coppermine Creek, and the Mount Isa copper trend (Waring *et al* 1998).

Carbonate stable isotopes were sampled at about 10 m intervals through the 150 m thick Amelia Dolomite. Sample types were categorised as carbonate veins or dolomitised host rock. The most interesting response is seen in the host rock bivariate plot of $\delta^{13}C$ ‰ vs $\delta^{18}O$ ‰ (**Figure 2**) where a positive coupled correlation is observed that extends well beyond the expected field of primary to diagenetic carbonates. The most negative isotopic values occur in the carbonates of the most mineralised hole CCD03, providing evidence that this isotopic effect varies with intensity of mineralisation. Surprisingly (given that some organic C is likely to have been sampled in the host rock powders), the veins plot to more negative compositions than the host rock, providing evidence that when these veins crystallised, they were tapping a larger fluid reservoir and were not simply buffered by local host rock compositions. Spatially downhole in MYD07, there is not a strong correlation of isotopic compositions with individual lode positions.

Isotopic depletion is commonly seen in carbonate-hosted hydrothermal systems because of isotopic exchange between hot, isotopically light fluids and local carbonates during wallrock alteration. This is strongly seen in the Mount Isa Cu mineralised system where C-O isotopes have been used to identify the faults that have seen fluid movement during the mineralising event (Waring *et al* 1998). The Coppermine Creek data has strong similarities to the more distal part of the Mount Isa array. A comparison to Mount Isa is also justified because the replacement of gash veins and sub-vertical stylolites by chalcopyrite suggests an epigenetic mineralisation timing. However, far more petrology, logging, and direct dating are required to test this hypothesis. Regardless, our findings to date indicate that C-O isotopes may be useful indicators of active mineralisation conduits and could help to unravel the paleo-fault architecture. Further comparison to C-O signatures of other mineralisation types is warranted at this early stage of the investigation.

Acknowledgements

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