

**Copper bearing hydrothermal breccia infilling a linear dilatant Las Minerale mineralized channelway, Rocklands Project, Cloncurry District, Proterozoic Mt Isa Inlier, North West Queensland.**

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Today, I and my co author Malcolm Carson will be talking about an exciting discovery of copper bearing hydrothermal breccia in the Eastern Mt Isa block made by Cudeco a little over 12 months ago. Cudeco Directors led by Chairman Wayne Macrae and fellow Director Tim Koitka made the discovery. The Directors role in the discovery and continual guidance of the exploration is gratefully acknowledged, as is the permission of the board to deliver this paper. Cudeco is an Australian Stock Exchange (ASX) listed company, its market capitalization prior to the Rocklands discovery was \$30M, its current market capitalization is ~\$400M

***The Rocklands discovery has been truly a company maker for Cudeco. It is worth noting that breccias not only generate geological interest : they also can generate wealth !***

This paper will focus on the geological understanding of the mineralization at Rocklands. A major exploration program is currently underway at the Rocklands project, involving 5 drill rigs and several tens of thousands of metres of drilling. Obviously this amount of drilling generates an enormous amount of data that needs to be analysed and incorporated in any geological model of the deposit. The geological interpretation presented here is therefore preliminary in nature. In keeping with the subject matter of the symposium this paper emphasizes the breccia characteristics of the mineralized host rocks. It will be descriptive in content.

As a requirement of ASX Disclosure Rules, the text of this technical paper has been released to the ASX and the full presentation with figures, will be posted on Cudeco's web site [www.cudeco.com.au](http://www.cudeco.com.au) to which conference participants are referred should they require additional information. The yellow highlighted references in the text refer to Figures posted with the full presentation on the web site.

The Rocklands project is located 17 km west of Cloncurry, north west Queensland. *Location Maps*

In terms of regional geology, the prospect area occurs in the Eastern Succession of the highly mineralized Proterozoic, Mt Isa Inlier; located in the nose area of the major north plunging Duck Creek Anticline. The current detailed published geology of the area is the Geoscience Australia 1:100,000 geological sheet of Marraba (#6956). Mapping was completed in 1978 by the Bureau of Mineral Resources/Geological Survey Queensland. *Geological Location Maps.*

On the Marraba sheet, the Rocklands area is shown to be underlain by Middle Proterozoic units of the Overhang Jaspilite and Mitakoodi Quartzite intruded by some patches of Proterozoic dolerite. The Overhang Jaspilite is shown to have a broad east south east strike and contains interlayered units of jaspilite, calc silicate, limestone, sandstone, quartzite. Surficial deposits of Tertiary to Recent alluvium and colluvium cover the Proterozoic basement in places.

The Cloncurry district is a famous historical copper field. In the early 20<sup>th</sup> century, the Cloncurry district was the premier copper field in the British Empire. There are many old copper showings and workings scattered through the district, which numerous geologists have inspected and walked over in the past. The Rocklands area is no exception, with historical open pit and underground production from the Double Oxide Mine and several other smaller copper

occurrences. A gossanous lode containing secondary copper minerals and native copper, with some supergene and primary copper sulphides was mined at Double Oxide until 1994. Some copper stained siliceous outcrops occur as isolated occurrences in broadly sub-parallel trends to the Double Oxide Mine. *Photos Double Oxide, Alex No2.*

In April, 2006 Cudoco Limited tested underneath surface copper mineralization at Alex No 2 and discovered the Las Minerale mineralization which intersecting 78m @ 2.31% Cu from 34-112m in hole DORC079. Intensive drilling has occurred since then, with the drilling of some 45,000m of mostly reverse circulation percussion and subordinate diamond drill core. A model of the mineralization is being developed, consistent with geological knowledge to date on the shape of the mineralized system, lithological, metamorphic and weathering relationships and the stratigraphy. The geological model is evolving as more drill data becomes available from the major drilling program currently underway. *Figure Plan view of drill pattern.*

*Figure Plan view of surface geology.* The mineralized lodes occur within a metamorphosed sedimentary sequence of fine quartz and quartz magnetite sandstone, siltstone, quartzite, limestone and calcareous units including scapolitic siltstone. Some features of the calcareous and quartz magnetite units suggest a stromalitic origin. Medium grained, intrusive dolerite is very prominent in the area and appears generally conformable with the sediments. In places the Proterozoic basement rocks are overlain by recent thin 1-10m alluvium and colluvium. *Photos host and cover rock sequence, general view of area.*

The overall attitude of the sedimentary sequence is generally striking east south east with a sheet dip to the north. *See Map.* Structural information has been obtained from surface outcrops and oriented drill core. Dips in the south of the prospect area appear to be shallower, in the 10 to 40 degree range, dipping to the north east, whereas steeper dips in the 40 to 60 degree range are present north of the Las Minerale structure. *Photos dips obtained from outcrop and core orienting frame developed at JCU.*

Copper mineralization over the Rocklands project area is hosted in a series of sub parallel, west north west trending, linear zones. Las Minerale and Rocklands South are the most prominent mineralized structures identified to date. The distribution of copper in drilling is shown on the accompanying plan, overlain on geology. Examples of selected copper drilling intercepts are also shown. *Map geology with Mineralized Structures and copper distribution. Selected copper intercepts.*

- At Las Minerale primary chalcopyrite mineralization occurs within a steeply dipping, through-going, west north west trending, clearly defined and persistent linear, structure that cuts the dipping sediment-dolerite package at a high angle. Surface expression of the mineralization consists of oxidized siliceous breccias (often copper stained). *Photos outcropping Las Minerale quartz breccia.*
- There is widespread evidence across the prospect area of planar joints and fractures that have acted as dilatant channelways to fluids that have altered and mineralized the rock. Typical mineral infill includes calcite, red feldspar (probably both albite and K feldspar), quartz, actinolite, pyrite, chalcopyrite, with biotite and magnetite. *Photos mineralized and brecciated fluid channelways.*
- Where there is oriented core and good correlation between drill holes, eg 11400E, The Las Minerale structure has been observed to be striking east south east (125 degrees) and steeply dipping either sub vertical or 70 to 80 degrees to the south west. The Rocklands Central Structure is steeply dipping to the north east in outcrop. *Figure drill section 11400E, photo steep structure. Outcrop Rockland Central.*
- Total true thickness of the structure is 30m up to 50m in places. This thickness includes all material infilling the structure : hydrothermal breccia, calcite and quartz vein material,

together with slivers of apparently in situ shattered and altered wall rock. Infill material within the structure is not necessarily all mineralized. An evolutionary sequence is evident from hydraulically fractured wall rock, mantled by secondary biotite, and actinolite which is infilled and broken up by calcite, pyrite, chalcopyrite and quartz. Large patches of granular magnetite are often present. As more mineralized fluid is pumped into the structure, jigsaw type breccias, with little evidence of rotation are replaced by milled matrix supported breccias with rounded clasts. Coarse unbrecciated sparry calcite appears to be a late infill phase. Primary copper mineralization is evident as coarse splashes of irregular chalcopyrite with coarse well formed pyrite, particularly associated with the calcite, quartz, vein and breccia infill. *Total sulphide content within the mineralized Las Minerale structure is variable from 1-2% up to 10-20%.*

- *Photos of evolving textures from clast supported jigsaw to matrix supported milled breccias of hydrothermal origin,*
- Alteration associated with the mineralization is a moderate to high temperature assemblage of biotite, actinolitic amphibole, red feldspar (probably both potassium feldspar and albite), magnetite, calcite, silica. Spotting after scapolite apparently forms an alteration envelope in the wallrocks of the mineralized structure.
- Polymict breccia is prominent in the central part of Las Minerale, where sub-rounded clasts are supported in a rock flour matrix dominated by green clay after comminuted dolerite and possibly altered biotite and actinolite. The geometry and extent of the polymict breccia is yet to be delineated. *Figure drill section 11300E, photos polymict breccia. and native copper.*
- Base of oxidation in unmineralized rocks within the project area is a relatively shallow 10-20m. However, oxidation of the sulphidic mineralized structures at Las Minerale and Double Oxide have generated acid fluids which have resulted in leaching, deep oxidation and supergene enrichment of copper. Within the oxidized zone, copper has been leached from near surface areas and re-deposited as coarse nuggets of native copper. Coarse nuggets of native copper are particularly associated with the oxidized versions of the polymict breccia. Copper carried in solution downwards to below the base of oxidation, replaces existing sulphides with strongly copper enriched minerals chalcocite. This leaching and reprecipitation is responsible for some of the spectacular high copper grades. Oxidation at Las Minerale has been observed at vertical depths in excess of 100m. *Photos polymict breccia. and native copper, chalcocite*
- At Las Minerale the structure has been shown by drilling to be strongly mineralized over a strike length of at least 700m (from 10900E to 11600E). The carbonate lode and oxidized breccia extends along strike, mineralized extensions to the east and west are currently being drill tested. *Figure Map with assays.*
- There is little strongly conductive country rock at Rocklands in the form of carbonaceous or graphitic sediments or conductive overburden. The high sulphides present in the project area allow the mineralized structures to be tracked with electrical geophysics. Cudoco has had some success to date, drill testing conductivity anomalies delineated by Sub Audio Magnetic geophysical surveying. *Further targeting of electrical geophysical anomalies is planned. Figure RTP and SAM images.*
- Cudoco's exploration to date has shown that the Las Minerale and Rocklands South structures contain ore grade and thickness copper mineralization over strike lengths of hundreds of metres. Within the Cudoco tenements there are several other promising sub parallel linear breccia and alteration zones. Given the fairly subtle surface expressions of the known drilled mineralization, all zones require careful evaluation with geological, geochemical, geophysical surveys and drill testing. *Photos outcrops of oxidized breccia.*