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Doug Kirwan

Merlin - The World's First Primary Rhenium Mine?

Sydney Rugby Club, Thursday, 27th August, 2009

The Merlin Mo-Re Zone, a New Discovery in the Cloncurry District, Australia

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Abstract. The Merlin Molybdenum-Rhenium (Mo-Re) Zone was discovered in 2008 during the drill out of the Mount Dore secondary Cu deposit. Much of the Mo-Re mineralisation at Merlin, and the overlying Cu mineralisation at Mount Dore, remain concealed under an extensive granite intrusive. The high-grade, northeast-trending and east-dipping molybdenite mineralisation occurs at the footwall of the secondary Cu zone. Evidence from drilling suggests an overlap of the two mineralisation phases. The host stratigraphy is a package of metasediments that exhibit earlier regional scale sodic-calcic alteration and albitisation. The albitisation is cut by K-feldspar and quartz veining and succeeded by brecciation which hosts the earliest episode of primary Cu mineralisation. A second phase of brecciation was followed by a hydrothermal event that deposited mainly dolomite with chalcopyrite, pyrite, sphalerite, cobaltite, bornite and trace galena, arsenopyrite and molybdenite. The late molybdenite mineralisation, accompanied by silica-albite alteration with interstitial clay, was emplaced along reactivated fractures and shears zones and replaced the matrix of fault breccias that developed in carbonaceous shale and meta-siltstone. The host metasediments are bounded to the west by a footwall of massive silicified unit and over-thrust to the east by the Mount Dore granite.

Keywords. Molybdenum. Rhenium. Merlin. Mount Dore. Cloncurry.

1 Introduction

High grade surface-enriched Cu was mined from Mount Dore in the early 1900's. However the total recorded production to 1961 was only 5.9 tonnes of Cu. The first drilling in 1957 indicated that the Cu mineralisation extended at depth, with the only hole drilled into the deposit intersecting 8.8 metres at 1.3% Cu from 49.7 metres. Exploration recommenced in 1975 and extended the Cu mineralised zone. The project changed ownership several times from 1978 to 2003 with drilling undertaken at some stages. Ivanhoe Australia acquired the tenement in 2003. On September 9, 2008, the company announced a Cu resource of 80 Mt at 0.6% Cu for Mount Dore.

In the course of an RC drilling campaign to identify other near surface Cu occurrences to the north of the project area, one hole encountered strong molybdenite mineralisation. This prompted a review of the drilling data to determine the potential of further Mo mineralisation and led to the identification of a 700m zone trending NNE, with molybdenite occurring in the NE end, and Mo oxide occurring in the SW end.

2 Geology of the Mount Dore Project Area

2.1 Host Rock

The Merlin Mo-Re Zone lies in the northern part of the Mount Dore Copper Project in the Cloncurry District. Both Mo and Cu mineralisation are hosted within a tectonised sequence of metashale, metasiltstone, schist and phyllite belonging to the Proterozoic Kuridala Formation that was variably silica-albite and K-feldspar altered (Fig. 1). This stratigraphy lies to the west of the Mount Dore Granite and extends north-south along strike for several kilometres and dips eastward underneath the granite.

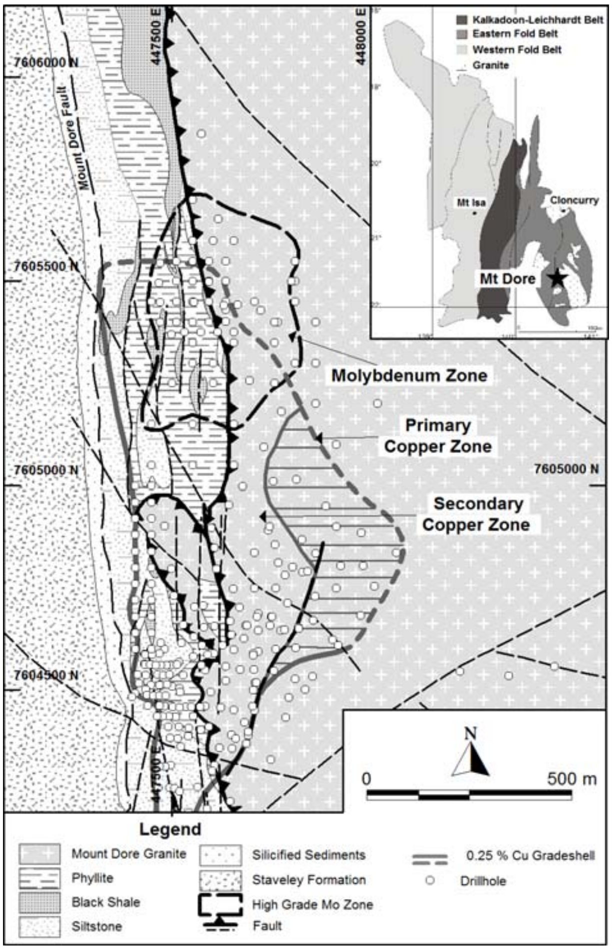

Figure 1. Geology of the Mount Dore Project showing the extent of molybdenite mineralisation in the drill holes.

In the host stratigraphy, variable proportions of interfingered black carbonaceous and grey micaceous siltstone and grey shale alternate with thicker beds of phyllite and schist.

These metasedimentary units exhibit recrystallisation textures but retain relict sedimentary features such as bedding and folding in outcrop. The carbonaceous shale consists of extremely fine-grained oriented muscovite (sericite) and the dark colour is attributed to the presence of abundant ultrafine graphite along laminations (generally <5% of rock), with petrology suggesting that much, if not all, of this rock type is actually carbonaceous slate (Pontifex, 1990 and Corlett, 2008: unpublished reports). The meta-siltstone consists of recrystallised quartz grains with a micromosaic texture with occasional incipient K-feldspar grain of hydrothermal origin. Another variety of the metasiltstone appear to have a slightly silky sheen due to fine muscovite (sericite) and is probably derived from clayey or muddy protolith. Regional metamorphism has led to the development of andalusite and scapolite within the host sequence. Strongly fractured and brecciated portions of the carbonaceous shales and siltstone outcrop as narrow elongate ridges. Brecciation has also been focussed along the axes of overturned and assymetrical folds.

The schists (with associated phyllites) are the coarsest-grained metasediments with abundant mica, quartz and accessory metasomatic K-feldspar commonly-oriented to produce distinct schistosity or foliation. Large lenses of massive quartz are common in this more foliated unit. Some foliated bands display isoclinal or curvilinear folding of finer-grained bands and lenses and commonly contain lenses or grains of milky translucent to clear quartz.

2.2 Hangingwall Granite and Footwall Quartzite

The Mount Dore Granite, dominating the eastern section of the project area, forms part of the extensive Williams Batholith and postdates the main period of compressional deformation in the metasedimentary rocks (Blake, 1987). This intrusion forms the unmineralised hanging wall to the Cu and Mo mineralisation and conceals the greater part of the Cu and Mo orebody. In outcrop and drill cores, this non-foliated intrusive is coarse-grained to porphyritic and commonly hosts black tourmaline veins. Pyrite is commonly observed in interstices and fracture zones, with minor chlorite. Several granitic aplite dikes, intersected in drillholes and mapped on the surface, cut the coarser granite and probably brought the K-feldspar.

The emplacement of the granite appears to be controlled by faulting, resulting in brecciation along the east-dipping base of the granite and intruded metasediments. Near this contact, the granite exhibits crackle to intense brecciation, often with slightly clayey matrix. The fault contact is characterised by a narrow gougy, chloritic to graphitic shear zone that contains mixed fragments of altered metasediments, schist, granite and common pyritic aggregates.

The footwall to the mineralisation forms a narrow linear and north-south trending ridge west of the project area. This massive, intensely silicified 'quartzite' ridge, with hardly any internal texture, dips east and is less than 40m in true thickness. This zone defines the Mount Dore Fault and serves as the boundary between the host metasedimentary package of the Kuridala Formation and the underlying siltstone and shale units of the Staveley Formation. The contact between this relatively unmineralised massive, clean, footwall 'quartzite' and the overlying host metasediments is marked by a silty friable unit interpreted as milled breccia with abundant micaceous material interspersed with fragments of silica-altered metasediments.

2.3 Alteration

The host rock in the project area has been affected by regionally extensive Na-Ca alteration (de Jong and Williams 1995) with localised hematite-stained albite, actinolite and pyroxene. Scapolite and andalusite are also observed within the black shale, siltstone and schist. The Na-Ca alteration is most evident in the metasiltstone units and less developed in the foliated phyllite, schist and the black carbonaceous shale. This early alteration is overprinted by K-feldspar-quartz veinlets and matrix infill within the massive to brecciated black shale, siltstone, phyllite and schist. The fine-grained pinkish to pale cream K-feldspar also occurs as pervasive replacements, and lighter hues can be difficult to distinguish from silicification in the core. Biotite and tourmaline occur locally, with the biotite showing partial or total alteration to chlorite. The K-feldspar alteration is associated with an episode of Cu mineralisation in Mount Dore.

Silicification and tourmaline alteration of the sediments and their brecciated equivalents occurs close to the granite. The hanging wall schists have been disrupted by schist breccia with much quartz and K-feldspar matrix breccia above the main body of Cu mineralisation. This unmineralised breccia contains only patchy pyrite.

2.4 Mineralisation

Similar to the Cu-dominant mineralisation, the Mo mineralisation strikes north-northeast and dips east under the Mount Dore Granite (Fig. 2). As the Mo mineralisation overprints the earlier Cu zone, it is necessary to describe the character and geologic setting of the Cu mineralisation.

The bulk of the currently known Cu mineralisation in the project area consists of secondary Cu oxides and carbonates (chrysocolla, cuprite, chalcotrichite, pseudomalachite, minor to trace azurite and malachite) and native Cu after chalcocite, that grades with depth into a transition zone dominated by chalcocite (replacing pyrite, chalcopyrite, and sphalerite) and trace covellite. The oxides and native Cu penetrate deeper into the transition zone within major shears and fault zones. Primary Cu mineralisation was emplaced in breccias and fractures that were best developed in the metasiltstones and black shales and are only weakly developed in the schists and phyllites. Two major episodes of Cu mineralisation have been recognised: an earlier chalcopyrite-pyrite-sphalerite-bornite assemblage emplaced into brecciated metasiltstone and black shale with associated K-feldspar ± quartz, and a later dolomite-hosted breccia with chalcopyrite-pyrite-sphalerite. Trace to minor galena, cobaltite, arsenopyrite and molybdenite are noted in the primary sulphide zone. Both types of primary Cu sulphide became the source of the secondary enrichment zones for Cu by weathering, after the unroofing of the granite cover by erosion. Very little gossan is developed.

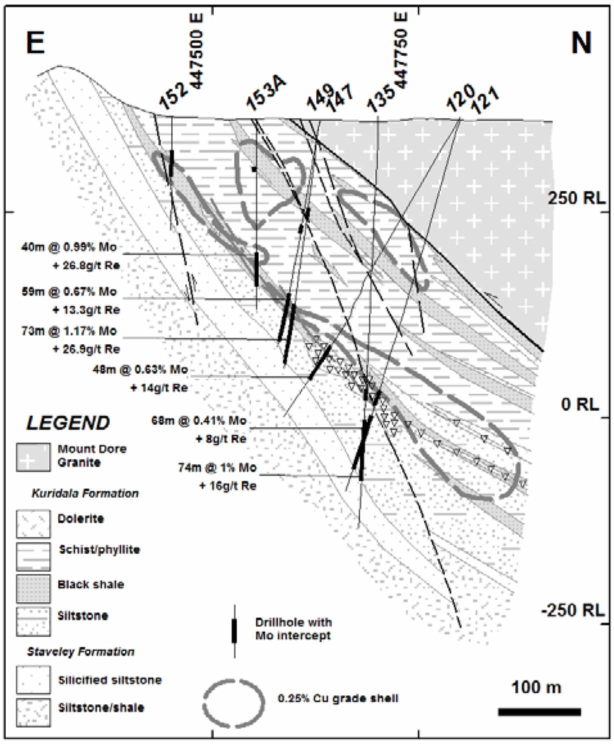

Figure 2. Interpreted geology of the Mount Dore Copper Project showing the extent of molybdenite mineralisation in the drill holes.

Several drillholes north of Mount Dore display the convergence of the early Cu and late Mo episode with good cross-cutting features. Fracture-controlled and breccia-matrix molybdenite mineralisation is hosted within K-feldspar-altered and albitised black shales and siltstones, which lie above and below the foliated schist and phyllite. The footwall structure at the base of the foliated phyllite and schist appears to have the strongest Mo and is inferred to have developed good open structures due to competency contrast. This basal contact also appears to have acted as good barrier for the Mo-rich fluids, thus resulting in ponding of the metals in the favourable structures just below the contact. The mineralised matrix-breccias contain sub-rounded clasts of K-feldspar and clay-altered siltstone with very minor clay, with molybdenite partially to completely replacing the breccia matrix. Minor patchy pyrite and chalcopyrite within the matrix are commonly enveloped by molybdenite. Molybdenite also occurs as stylolitic fracture fill, disseminations and preferential infill of folded bedding planes. Narrow patchy clay zones (illite, montmorillonite) are noted in some of the fractures infilled by molybdenite.

The excellent correlation between Mo and Re assay values indicate co-eval emplacement and intimate association of the two metals (Fig. 3). The Mo-Re ratio is about 550:1 at a 0.1% Mo and 0.1ppm Re cut-off. Other than the occasional overlap of mineralised zones of Cu, Ag, Au, Pb and Zn, no other metal analysed comes close to the strong affinity between Mo and Re.

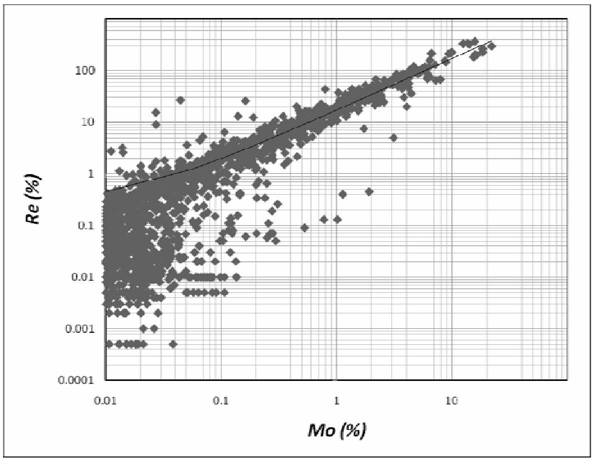

Figure 3. Plot of Mo versus Re assay values from drill cores. A very good correlation exists indicating an intimate association of the two metals in the ore.

3 Conclusion

The Mo mineralisation of the Merlin Zone in the Mount Dore Copper Project overprinted the earlier Cu mineralisation and much of this economic deposit lies beneath a granite cover. Rheology and competency contrast of the member units of the Kuridala formation has created a favourable environment for the development of host structures and trapping of hydrothermal fluids for both early Cu and late Mo mineralisation.

Acknowledgements

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