What controls high-grade copper mineralisation at Olympic Dam?

JM Clark[1] *and K Ehrig*[3]

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AAusIMM
Senior Geologist, BHP Olympic Dam, Roxby Downs SA 5725.
Email: Jesse.Clark@bhp.com

2.
FAusIMM(CP)
Principal Geometallurgist, BHP Olympic Dam, Adelaide SA 5000. Email: Kathy.Ehrig@bhp.com

ABSTRACT

The IOCG–IOA spectrum of deposits have been researched over the past three decades, largely focused on their classification and definition, character and zonation of iron-oxide- alkali alteration and contentious debates over unified genetic models. However, what specifically controls mineable high-grade copper mineralisation and the importance of preservation, are rarely discussed. This paper documents the key controls to high-grade copper mineralisation (i.e. >2 per cent Cu) at Olympic Dam.

The ca. 1590 Ma Olympic Dam Cu-U-Au-Ag deposit remains the single largest metalliferous iron-oxide deposit, even after over forty years since its discovery. The deposit can be viewed at two scales: i) a disseminated bulk-tonnage, low-grade chalcopyrite dominant deposit largely representing the Mineral Resource, and ii) lower-tonnage, high-grade structurally-focused, discrete bornite-chalcocite zones largely representing the underground Ore Reserve. Nonetheless, the deposit displays a uniform, vertical and lateral mineralogical zonation pattern.

The mappable geological controls on copper grade within the deposit, in order of decreasing importance, are sulphide mineral type and abundance, hematite alteration intensity, protolith/lithology, and structure/geometry.

The ‘first-order’ mineralisation control is the pre- to syn-mineral structural framework, inferred from (and largely obliterated by) high-grade hematite alteration and associated Cu-Au mineralisation. Early intersecting structures were the locus for magmatic intrusion, brecciation and subsequent hydrothermal fluid flow responsible for alteration and mineralisation. The mappable ‘first-order’ mineralisation control, however, is the hypogene sulphide type/abundance intimately controlled by hematite alteration intensity.

Second-order controls are sharp permeability, rheological competency-contrast and/or REDOX boundaries, where high-grade mineralisation wraps around their margins. Examples include texturally-destructive hematite-quartz alteration, intensely sericite-chlorite altered syn-mineral mafic-ultramafic dykes and faulted blocks of an intensely sericite-chlorite altered sedimentary unit.

Fundamentally, the most prospective zones for Cu-U-Au-Ag are preserved within the shallower parts of the system. Therefore, understanding the post-mineral deformation history is important for mapping out the prospectivity and ultimately, relevant high-grade mineralisation.