Controls on Gold Mineralisation in the Braidwood Granodiorite

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Abstract

The Braidwood Granodiorite is an I-type pluton which formed 410 million years ago as part of the Bega Batholith in an extensional environment. The elongate shape of the pluton was influenced by the environment of emplacement, with early structures forming perpendicular to the long axis in an east-west trend.

The structural systems within the Braidwood Granodiorite formed from a combination of ductile and brittle deformation, on east-west, north-east, north-west and north-south orientations. Primary structural features were identified in aeromagnetic data, and were verified using ground based structural analysis. It was determined that early east-west tensional-ductile structures host the primary sulfide rich, gold bearing mineralisation, and are cross-cut by all other structures. Regional deformation formed faults and fractures oriented along north-east and north-west trends, while north-south structures probably formed later as a result of normal faulting in the Palaeogene.

Using a gamma spectrometer, radiation emitted during the decay of caesium (Cs) was measured at the surface, providing a method for mapping alteration and distinguishing it from the surrounding unaltered granodiorite. The radiogenic signature of Cs is persistent in the regolith over Dargue's Reef, and is enriched to several times background in the phyllic alteration zone. Other radiogenic elements that are used in this type of exploration are potassium (K), thorium (Th) and uranium (U). In this instance, K proved inconclusive as a vector to ore while radiation from U and Th were below background levels. This indicates little or no enrichment of these elements in the alteration system, making them inappropriate for use as radiogenic tracers for alteration zones.

Using Pearce Element Ratio (PER) analysis and mineralogy (determined by XRD) it is possible to classify all of the alteration and mineralisation into three types — sodic phyllic and propylitic. Optical characterisation of alteration shows sodic alteration characterised by albite and some sericite mineralisation, which was overprinted by phyllic alteration dominated by sericite-epidote-calcite mineral assemblage. This was seen optically when feldspars in transition mineralisation were sericitised but still maintained their crystal shape. Lastly, propylitic alteration seen as an epidote-chlorite-calcite rich mineralogy extended out from the sodic and phyllic alteration zones. These three alteration types were identified

using X-Ray Diffraction (XRD), and textural relationships show the gold is associated with pyrite in the phyllic alteration zone as it overprints the sodic alteration. Alteration has proceeded via microstructural pathways seen as transgranular fractures that relate to early fracturing prior to brittle deformation.

Chondrite normalised rare earth element (REE) values show a distinct enrichment with respect to the incompatible light rare earth elements in the phyllic alteration, indicating a large fluid volume during the alteration. Together these analyses provide information on elements which are enriched in the different alteration types and allow better identification of potential tracer elements such as Cs, Na, Fe, S, REE's and Mg.

Rhenium-Osmium (Re/Os) dating of molybdenite from Dargue's Reef shows that the ages of pluton formation (410 ± 2Ma) and mineralisation (410.6 ± 1.3Ma) were indistinguishable, suggesting the mineralisation accompanied pluton emplacement.

This study has developed a framework related to the timing of structural events in the pluton, showing an early east west trending systems hosts mineralisation related to gold. A geochemical classification of the Dargue's Reef system as a case study, has better defined potential regional geochemical relationships, such as Cs enrichment in the ore body and regolith, and has identified geophysical (Radiometric analysis) and geochemical methods (PER and GER) which have not previously been used in the region for the identification of alteration and potential vectors to ore in the regolith.

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