GRANITE-ASSOCIATED MINERALISATION IN NEW SOUTH WALES: DATA, MODELS AND OPPORTUNITIES FOR THE FUTURE

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Granites (*sensu lato*) and related rocks are important mineralisers for a wide range of elements including Sn, W, Mo, Au, Cu, Ag, Pb, Zn, Bi, As U, Th, F, Li, Nb, Ta and the REE. They are also the vehicles by which substantial vertical redistributions of fluids and heat occur within the crust. Granites are also important in the supply of dimension stone, aggregate, silica, feldspar, mica and even artificial sand.

Granite-related mineral deposits are important ongoing contributors to mineral production and potential in New South Wales. Tin is associated with both I-types in the New England Orogen (NEO) and with S-types in the Lachlan Orogen (LO). Substantial Sn resources are also associated with the I-type Midway Granite near Bourke, which is one of the most evolved granites in NSW. Molybdenum is well represented by deposits associated with various combinations with W, Bi and Au in the NEO and LO. Tungsten occurs as wolframite and scheelite in both Sn-W and W-Mo combinations determined by granite compositions and oxidation state.

"Intrusion Related Gold Deposits" (IRGDs) have been recently added to the granite menagerie. These were initially defined in the Alaska-Yukon region (the Tintina Gold Province) for a range of deposit types with a general Au±As,Bi,Te,Sb metal chemistry. An important difference is that Australian IRGDs are essentially polymetallic in character and show intimate hydrothermal and magmatic associations with their associated granitic igneous suites.

Gold-rich, Cu-poor systems associated with felsic I-types in eastern Australia are associated with W-Mo mineralised suites with Au occurring within a predictable metallogenic zonation. Gold mineralised I-types comprise weakly to moderately oxidised, high-K granitoid suites that, at least in the east Australian context, have low K/Rb ratios and show strong fractionation trends. Compositionally, they are not oxidised enough and are too evolved and/or felsic to be associated with Cu. They are too oxidised to be associated with significant Sn production. They occur in the redox-fractionation compositional range normally associated with minor W-Mo±Sn occurrences and W-scheelite mineralisation. The Tintina Gold Province granites are more reduced and less compositionally evolved than their Australian equivalents.

Given then polymetallic nature of IRGD mineralisation in eastern Australia and the compositional diversity of granite compositions with which they are associated, the definition of Au-rich granite-related deposits needs to be broadened or redefined. Deposits at Burraga and Browns Creek (in addition to Dargues Reef) fit such an expanded classification.

Gold is readily removed from granitic magmas through the early precipitation of sulfides, or to a lesser extent by magnetite. Crystallisation of Fe-poor, silica-rich granitic magmas in a relatively narrow oxidation window between the FMQ and NNO buffers may provide conditions where retention of Au in magmas in felsic granitic magmas is optimised.

New Studies

The granites of New South Wales will be the subject of a major synthesis and strategic assessment in order to recognise prospective tracts within the state for the full range of granite

related deposit types and metal associations. Preliminary work in this regard has already recognised the need for a major reclassification of the mineralised granites of the NEO. In addition, in the south east of the LO, reinterpretation of the granite petrology and geochemistry on the Goulburn 250k sheet has lead to the recognition of a prominent eastwards change in granite compositions from low Na intermediate S-types in the west to high Na, felsic and weakly peraluminous granites of intermediate I-S character in the east. Some of these latter granites have (Mn-) garnet and allanite. The most extensive example is the problematic Wologorong Batholith. The Davies Creek granite on the Bathurst 250k sheet is now also included as an equivalent of the Wologorong Batholith. Further south, granites of similar intermediate character are also present down through the Canberra 250k sheet and includes the Sutton, Tinderry, Watchbox and Shannons Flat Granites, through to the magnetic, weakly peraluminous Dalgety Granite, Murrumbucka Tonalite and the (Mn-) garnet-bearing 500 Acre Granite. This belt may represent a broad zone of variably contaminated or transitional I-S granites located immediately to the west of the “I-S Line” and as such, represents the first recognition of systematic E-W changes in the composition of LO granites as the I-S Line is approached from the west. Westwards changes have previously recognised in the Bega Batholith located to the east of this line.

These east west compositional gradients also mirror a general shift from Sn in the west (Koetong/Bullenbalong Supersuites), through W (associated with the Wyangala Supersuite), to Mo in the east. Gold is associated with the Braidwood Granodiorite in the Bega Batholith but IRGD type systems may be also associated with the W dominant portion of this overall zonation. Interestingly, the Carboniferous Rossdhu and Au-mineralised Burraga Granites in the Oberon region of the Bathurst 250k sheet (immediately to the north of the Wologorong Batholith) are also garnet bearing I-types or weakly peraluminous character.