

Nature and timing of gold mineralisation in Tin-Tungsten provinces, insights from the Lachlan Orogen, Tasmanides, Australia

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Tin (Sn)-Tungsten (W) provinces are well-known to include gold occurrences typically interpreted as intrusion-related. However, the occurrence of orogenic gold alongside widespread granitic intrusions in these provinces complicates the distinction between deposit types. Resolving this is crucial to improve mineral exploration targeting and project evaluation in those regions. To address these challenges, we revisit eight gold prospects in the Western Lachlan Orogen (WLO) of southeast Australia utilising a macro- to micro-scale approach, integrating micro-XRF MAIA mapping, automated mineralogy, EPMA-CL mapping/microanalysis, and apatite chronochemistry.

Gold mineralisation is hosted as free gold in quartz veins at prospects close to the I-type Sn and W-bearing Beechworth Granite. These veins host Bi, Te, lollingite and hydrothermal apatite coeval to the emplacement of the Devonian granite suggesting an intrusion-related style. Additionally, high Ti-in-quartz and U-Pb reset of detrital apatite reveal temperatures above 375°C. In contrast, at Haunted Stream, the abundance of sulfide, gold locked in pyrite and a lack of Bi and Te indicate orogenic style mineralisation. Hydrothermal apatite in gold prospects near Beechworth are distinct from those at Bendigo, Happy Valley and Haunted Stream. The latter are enriched in Sr, LREE/HREE, Th/U and display a flat to positive Eu anomaly. U-Pb chronochemistry reveal two generations of hydrothermal apatite in several gold prospects. Overall, new ages indicate 1) a Jurassic age for Haunted Stream suggesting reactivation of the nearby Haunted Stream Fault during the breakup of Gondwana; 2) a Triassic age for Happy Valley negating a genetic link with the nearby Devonian Yackandandah Granite and 3) a Carboniferous age at Gill Reef likely originating from late stage magmatic-related activity of the Upper Devonian Harcourt Granodiorite. Applying U-Pb chronometry of apatite together with mineralogical observations is crucial to unravelling the cryptic gold metallogeny of the WLO and its association with Devonian granitic magmatism and Sn-W mineralisation.