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Gold provenance fingerprinting and prospectivity in Western Australia

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Australia is the world's third largest gold producer, and Western Australia contributes about 60% of Australia's gold resources. The Geological Survey of Western Australia (GSWA) is evaluating the gold prospectivity of Archaean and Proterozoic terranes in Western Australia, hence the potential for the presence of significant undiscovered gold resources, by undertaking a systematic study of the physical and chemical characteristics of placer and bedrock-hosted gold.

The morphology, internal crystal structure, silver and trace element contents of gold grains, and associated inclusion and gangue mineralogy, can provide important information on mineralizing fluid composition, proximity to primary source(s), primary mineral deposit type(s), and post mineralization events, and studies of such have been successfully used in exploration for gold for more than a half century [1; 2; 3]. GSWA is examining the characteristics of gold grains (>0.1 mm) from the Proterozoic Capricorn Orogen [4; 5; 6], and the Archean Kurnalpi goldfield in Western Australia, using visual morphometry, acid etching, reflectance microscopy, scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDX), and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS).

Results to date reveal: (i) terrane-specific trace-element signatures in gold e.g. elevated Cu and Sb at the Paulsens and Mount Olympus deposits (northern Capricorn Orogen) and Egerton and Bangemall Mining centres (central Capricorn Orogen); elevated Pd in the Glenburgh deposit (southwestern Capricorn Orogen); (ii) the occurrence of two distinct mineralizing environments in the central Capricorn Orogen – a deeper, high pressure and high temperature setting (e.g. Egerton Mining Centre) and a shallower, lower pressure and temperature setting (Bangemall Mining Centre); (iii) lode gold from Paulsens and Mount Olympus was precipitated at low temperature, and has subsequently experienced only weak, low pressure and low temperature, post-depositional alteration, suggesting that primary mineralization post-dates the regionally significant c. 2.2–2.15 Ga Ophthalmian and c. 1.8 Ga Capricorn Orogenies; (iv) the Glenburgh deposit appears to have formed prior to regional deformation and metamorphism of the c. 1991 Ma Glenburgh Orogeny; (v) hypogene gold from the Capricorn Orogen has been partially recrystallized and depleted in Ag during post-depositional deformation and/or metamorphism; and (vi) placer gold nuggets from paleochannels in the Kurnalpi goldfield are not far removed from at least two distinct primary hypogene mineralization types or sources.

As part of this work, we have developed a technique for **quantitative** LA-ICP-MS analysis of gold, employing certified gold standards and well-established gold-fingerprinting methodology [7].

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