Linking Orogenic Gold and Orthomagmatic PGE-Ni-Cu Deposits in the Archean Yilgarn Craton

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The Archean Yilgarn Craton hosts both the world class orogenic gold deposits of the Kalgoorlie–Kurnalpi Rift and the recently discovered orthomagmatic Gonneville PGE-Ni-Cu deposit, Australia's largest PGE resource. Traditionally these separate deposit types are viewed as products of distinct metallogenic processes. However, new observations suggest a deeper connection. This study highlights the remarkable coincidence of gold and orthomagmatic PGE-Ni-Cu mineralisation forming synchronously at ~2.65 Ga on opposite margins of the craton. Despite their differing deposit styles, both systems share four key features: enrichment in semi-metals (Bi–Te), consistent positive mass-independent sulfur isotope ($\Delta^{33}S$) signatures, and geochemical indicators of hydrous, metasomatised mantle sources.

These shared traits challenge prevailing models that treat orthomagmatic and orogenic systems as isolated. Instead, we propose they reflect a common lithospheric control: the presence of a fertile mantle reservoir enriched in volatiles and sulfur, generated through crustal recycling. In this framework, local geology acts as a secondary control, while primary fertility is inherited from mantle-scale processes.

We further suggest that $\Delta^{33}S$ anomalies provide a powerful tool to map these enriched domains across both time and space. Recognising deep-seated controls reframes how Archean mineral systems are explored, advocating a unified view of metallogenesis and integrating models that span different deposit styles. By recognising the importance of metasomatised mantle and its sulfur signatures, we offer a new prospective for targeting Archean mineral systems globally.