Red Hill: Unveiling the Geochemical and Hydrothermal Evolution of a Granitoid-Hosted Orogenic Gold System in the Yilgarn Craton, Western Australia

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The Red Hill gold deposit, located in the Boorara Domain of the Eastern Goldfields Superterrane, represents an orogenic gold system hosted within the Red Hill granodiorite stock. Gold mineralisation is closely associated with sub-planar quartz-carbonate vein arrays. Geochemically, the granodiorite displays a calc-alkaline affinity and a metaluminous to weakly peraluminous character, with high Sr vs Na_2O + CaO (wt%) ratios characteristic of high-SiO_2 adakites. However, elevated Mg#, Ni, Cr, and incompatible element concentrations (Sr/Y, Cs, Ba, LREE), along with depleted HFSE levels (Nb, Ta, Zr, Hf, Ti), align more closely with a sanukitoid-like granodiorite composition.

The Red Hill granodiorite is hosted within the mafic-ultramafic clast-rich Ballarat Conglomerate and has an elongated geometry along the axis of a SW-plunging regional syncline. The granodiorite and surrounding stratigraphy are transected by NNW- and NE-trending shear zones. The deposit comprises multiple generations of quartz-carbonate veins with different wallrock alteration assemblages and variable gold content. An early barren halo of hematite-carbonate (dolomite to ankerite) alteration is overprinted by an inner albite-quartz-ankerite-sulphide assemblage, manifested as microcrystalline albite and quartz replacement of the groundmass. This later alteration phase is intimately associated with the formation of gold-bearing sulphide stringers and quartz-carbonate veins. In addition to these alteration phases, a white mica–dominated alteration phase is also present.

This study integrates datasets acquired from laser-induced breakdown spectroscopy (LIBS), computed tomography (CT) radiographs, and XRF analyses (Orexplore GeoCore X10) collected on half core, complemented by four-acid digest ICP multi-element analyses on pulverised half core samples. These datasets are used to characterise the mineralogical and geochemical evolution of hydrothermal alteration and vein development, which has implications for a revised genetic model. The results of the study provide a robust mineral system framework to support well-constrained resource and geometallurgical models.