

### **Geology and Genesis of the REE-Bearing Ironstones of the Yin Complex, Gascoyne Province, Western Australia**

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Part of the larger Gifford Creek Carbonatite Complex (Capricorn Orogen, Western Australia), the Yin dykes feature over 43km of rare earth element (REE)-rich ferrocarnatite.

Mineralogically, the dykes are dominated by Fe-carbonates (siderite and/or ankerite) at depth, transitioning to goethite-dominated “ironstones” near the surface, interpreted as forming via the supergene alteration of the underlying ferrocarnatite by oxidised meteoric waters. While superficially similar along strike, there are distinct differences in the REE-bearing mineralogy between different sections of the dyke, with the ferrocarnatite at Yin Central being bastnäsite-(Ce)-rich, and the Yin North ferrocarnatite being monazite-(Ce)-rich. This study investigates the Yin Complex ironstones, their REE-bearing mineral assemblages and genesis via near surface weathering.

At Yin Central, weathering fluids caused replacement of Fe-carbonates by goethite and dissolution of other primary carbonates, fluorapatite and barite; with accompanying loss of soluble components (CO<sub>3</sub><sup>2-</sup>, Ca, Mg, lesser F, Sr and S). The key primary REE-bearing mineral, bastnäsite-(Ce), was replaced in-situ by rhabdophane-(Ce) following reaction with PO<sub>4</sub><sup>3-</sup> released by fluorapatite dissolution. In contrast, at Yin North, primary monazite-(Ce) resisted alteration, and remnant primary monazite is the principal REE phase in the ironstones.

Bulk geochemistry and porosity, as summarised in a weathering isocon, suggest that the light REE (LREEs) are immobile on a deposit-scale during weathering and are enriched only due to mass loss of other elements, in contrast to other styles of supergene mineralisation. Total mass loss during ferrocarnatite weathering (~20%, as estimated from porosity) was limited by the high concentration and immobility of Fe. LREE enrichment during weathering was correspondingly low (~1.19x) compared to the extreme enrichments observed at supergene calcio- or magnesiocarnatites elsewhere in Australia and globally (2x to 10x enrichment).