

Dolocrete as a Tool for Rare Earth Elements Exploration Undercover – A Case Study of Mt Weld Carbonatite, Western Australia

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The 2.06 Ga Mt Weld carbonatite in Western Australia is renowned for its rich, rare earth elements (REE) deposit, comprising 54.3Mt at 5.2% total RE oxide and 37.7Mt at 1.07% Nb₂O₅. It consists of a calcite carbonatite outer rim (~4km) and a ferroan dolomite carbonatite core (FDC) (~1.5km) hosting REE mineralisation. A 20-40m thick layer of sedimentary rocks covers the carbonatite and poses significant challenges for exploration. A lenticular layer of dolocrete (máx. 25m) occurs below the transported sedimentary layer and above the REE-rich saprolite derived from the FDC. Dolocrete has three distinct units: (a) Upper White Dolocrete (UWD), thickness ~8m, characterised by minor palygorskite and traces of quartz, REE-aluminophosphates, rutile, ilmenite, monazite, and pyrite; (b) Middle Pisolite Dolocrete (MPD), 1-10 m thick, containing Fe-oxide nodules allogenic quartz grains, monazite, and Ce-florencite. The pisolites (10µm-4cm) contain iron oxide bands and fragments from the underlying units; (c) Basal Breccia Dolocrete (BBD), <6m thick, comprising clays and ironstone clasts with fine grains of Nb-bearing ilmenite, rutile, quartz, baddeleyite, and zircon. Except for dolomite, the mineralogical composition of these units is consistent with the underlying regolith. Stoichiometric dolomite with a Ca/Mg ratio of 1.01-1.10 is the main constituent of dolocrete. Veinlets of silica crosscut the MPD and BBD, which share some textural features such as coarse regolith-transported grains and porosity. The concentrations of FeO+MnO (in wt.%) in dolomite increase with depth: UWD (0.14%), MPD (0.65%), and BBD (0.89%). Whole-rock analysis revealed a declining (La/Lu)_N ratio from FDC (165.42) upwards: BBD (97.98), MPD (16.31), and UWD (6.62), indicating light REE enrichment in regolith due to carbonatite weathering. The isotopic signature of dolocrete ($\delta^{18}\text{O}_{\text{VSMOW}}=29.1$ to 30.7‰ , $\delta^{13}\text{C}_{\text{VPDB}}=-6.6$ to -5.9‰) is consistent with low-temperature alteration. The REE and Nb mineralisation preserved in dolocrete above the carbonatite ore body makes it a promising tool for REE exploration.