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

Anderson Santos¹, Artur Deditius¹, Hans Oskierski¹, Arthur Oliveira², Denis Fougereuse², Pete Kinny², Ganesh Bhat³, Malcolm Roberts⁴

1. Murdoch University, Perth, WA, Australia, 2. Curtin University, Perth, WA, Australia, 3. Lynas Rare Earths Ltd, Perth, WA, Australia, 4. University of Western Australia, Perth, WA, Australia

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.