

Mechanisms of Nb and Ta Enrichment in Ferricrete at Mt Weld Carbonatite, Western Australia

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Ferrigenous cap rocks (ferricrete) are important vectors for exploration in weathered terranes, incorporating trace elements (such as REE, Nb, and Ta) released during weathering of the ore deposits at depth. Yet, the processes and mechanisms leading to the accumulation of Nb and Ta are poorly constrained. Here we report mineralogy and geochemistry of a 10 m thick layer of ferricrete formed on the top of Mt Weld carbonatite, a renowned REE deposit in Western Australia. Apart from REE resources, Nb and Ta ore resources were reported at Mt Weld carbonatite. The bedrock comprises a calcite carbonatite outer rim (~4 km) and a ferroan dolomite carbonatite core (~1.5 km). The ferricrete consists of a mixture of clays and ironstone clasts with fine-grained Nb-bearing goethite, Nb-bearing ilmenite, hematite, Nb-bearing rutile, goyazite, columbite, florencite-Ce, quartz, baddeleyite, and zircon.

Whole-rock analysis revealed 1.6% Nb and 613 ppm Ta in ferricrete, indicating an order of magnitude enrichment in Nb and Ta compared to the underlying regolith. The concentrations of homogeneously distributed Nb and Ta in the core of goethite are 4.57wt.% and 0.12wt.%, respectively. The rounded grains of ilmenite contain up to 19.2wt.% Nb and 1.0wt.% Ta in the 500 µm thick rim. The cores contain (average) 12.5wt.% Nb and 0.52wt.% Ta. The Fe-enriched rutile (7.65wt.% Fe) contains 7.17wt.% Nb and 0.09wt.% Ta. TEM observations and EDS analyses of Fe-(hydro)oxides nodules revealed a sharp contact between a polycrystalline core of Nb-rich goethite surrounded by porous Nb-depleted goethite. A nanoporous box-like structure formed in the rims of altered ilmenite during replacement of ilmenite by Nb-depleted rutile and reprecipitation of Nb-enriched nanoparticulate ilmenite. The high-resolution observations document the key role of Fe-(hydro)oxides in the short-range migration of Nb and Ta during the lateritization of carbonatite, making ferricrete a promising tool for Nb and Ta exploration.