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Multi-stage Evolution and REE Mineralization of Wigu Hill Carbonatite, Uluguru Mountains, Tanzania

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The Wigu Hill Carbonatite (WHC) in Uluguru Mountains, Tanzania, is among the REE-endowed carbonatites in Africa. The carbonatite comprises large, fine-grained apatite magnesiocarbonatite that has been locally brecciated and intruded by late-stage carbonatite dike swarms. This work presents the first detailed petro-geochemical and mineralogical characteristics of WHC.

REE mineralization at Wigu Hill is concentrated within late-stage carbonatite dikes, which occur as magnesiocarbonatite to ferrocarbonatites that host pegmatitic, well-preserved REE-bearing hexagonal pseudomorphs after burbankite. Mineralogy of the pseudomorphs varies in space, reflecting the dissolution of primary burbankite through reaction with evolving residual carbothermal fluids. Two major burbankite alteration phases were identified: (1) early alterations are observed in dikes with yellow-colored pseudomorphs typified by an association of synchysite-(Ce), barite, Ca-strontianite, calcite, quartz ± bastnaesite-(Ce), and high synchysite $(La/Ce)_N$ - $(La/Nd)_N$ ratios. (2) The second stage alteration is evident by an assemblage of synchysite-(Ce), barite, Ca-strontianite, fluorite, calcite, quartz, apatite, monazite, Al-REE-phosphates, and low synchysite $(La/Ce)_N$ - $(La/Nd)_N$ ratios. This alteration is recognized in dikes with pink-colored pseudomorphs and has been interpreted as a product of interaction of primary burbankite with highly evolved fluids of elevated HREE.

Stable C, O, and Mg isotopes dolomite signatures across Wigu Hill are of pristine mantle ($\delta^{13}C_{VPDB}$ -4.1‰ to -6.2‰; $\delta^{18}O_{VSMOW}$ +6.5‰ to +7.31‰ and $\delta^{26}Mg$ -0.44 to +0.19‰) and indicate magmatic fractionation is responsible for REE enrichment in the late-stage dikes. $\delta^{26}Mg$ isotopes further suggest that WHC magma may have differentiated by liquid immiscibility from a parental alkaline-rich magma. Our textural, geochemical, and stable isotope findings picture a polygenetic evolution of WHC. The main REE mineralization phase occurred during the end of the magmatic phase, but subsequent reworking by carbothermal fluids has resulted in outstanding REE enrichment.