

MORB-type spinels in Karoo continental flood basalts, Luenha River, Mozambique

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Olivine-rich tholeiitic lavas exposed along the Luenha River, Tete province, Mozambique, erupted during Karoo flood basalt magmatism ca. 180 Ma ago. They contain translucent, brown aluminous spinel inclusions (20–300 μm) hosted in unaltered, large olivine phenocrysts (0.2–10 mm) and zoned, vermiform-rimmed spinel phenocrysts (50–500 μm). Electron Probe Micro-Analyzer (EPMA) Wavelength Dispersive X-ray Spectroscopy (WDS) analysis shows that the Al-spinel inclusions near the cores of primitive olivine phenocrysts (Fo_{85-87}) and the cores of Al-spinel phenocrysts have low TiO_2 (0.16–0.44 wt.%) and comparatively high Al_2O_3 (23.6–37.5 wt.%) contents identical to MORB spinels. In contrast, opaque spinel inclusions within olivine rims as well as the rims of spinel phenocrysts are relatively high in TiO_2 (1.1–1.8 wt.%) and low in Al_2O_3 (11.7–17.4 wt.%), and classify as Cr-spinel and chromite. The Al-spinel has #Cr of 0.32–0.46 and #Mg of 0.60–0.70, whereas the Cr-spinel and chromite have #Cr and Mg# of 0.45–0.57 and 0.25–0.58, respectively. The Luenha high-Mg lavas exhibit komatiitic (olivine cumulate) to basaltic compositions. Similar to most Karoo flood basalts, their Nd and Sr isotopic as well as incompatible trace element ratios suggest involvement of lithospheric source components.

Given the low diffusion rates of Ti and Al in olivine, the spinel inclusions probably represent compositions in equilibrium, or nearly so, with the parental melt. The Al-spinels found as olivine-hosted inclusions and phenocrysts plot within the same low-Ti, high-Al MORB-affinity field, which suggests crystallization from similar parental melts under the same temperature and pressure conditions. In comparison, previous studies of Karoo picrites have indicated high-Ti and low-Al spinel compositions characteristic of LIP or OIB type magmas. We speculate that the MORB-type liquidus spinel in the Luenha picrites may implicate a previously undocumented low-Ti and high-Al parental magma type for Karoo province.