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# Origin of Sr-enriched picrites from the Karoo Large Igneous Province

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The magmatic products of several continental Large Igneous Provinces (LIPs) can be divided into distinct low- and high-Ti types. In the Karoo LIP, the high-Ti type is volumetrically subordinate, geographically restricted, compositionally diverse (basalts, picrites, nephelinites, lamproites, etc.) and markedly enriched in incompatible elements relative to the vast volumes of uniform low-Ti tholeiites. High-Ti picrites contain up to 1600 ppm Sr, which seems unusual for olivine-enriched mafic rocks. In order to understand the nature and origin of this Sr enrichment, 6 picritic samples from the Letaba Formation near the South Africa – Zimbabwe border were selected to determine the phase(s) in which Sr resides in these rocks. The studied samples have Sr = 826–1526 ppm, MgO = 11.5–21.3 wt. %, and consist of 10–30% euhedral olivine phenocrysts (Fo83-91), in a groundmass with varying abundances of brown glass, augite and feldspar, with accessory ilmenite and apatite. Small equant grains of Cr-rich spinel occur both as inclusions in olivine phenocrysts and in the groundmass. Glasses are mainly trachytic, with up to 67 wt. % $SiO_2$ and 13 wt. % Na2O+K2O. X-ray intensity maps for Sr and other elements demonstrate that olivine, apatite, ilmenite and spinel are devoid of Sr, and augite contains very little. Rather, most of the Sr resides in the glass phase, and to a lesser extent, in feldspars, if present. The highest Sr (up to 3570 ppm) occurs in glasses immediately adjacent to edges of euhedral olivines, suggesting that the phenocrysts are genetically related to the evolved liquids that are represented by surrounding matrices. Spinels entirely enclosed in olivine were shielded from interaction with evolving residual liquids, and preserve their early, primary high Cr, Mg and Al compositions, whereas grains protruding into groundmass are strongly zoned, with Fe-Ti rich outer regions that reflect spinel evolution toward Ti-magnetite. These features suggest that the picrites are 2-component mixtures of accumulated olivine phenocrysts and variable amounts of evolving residual liquids represented by bulk groundmasses. As such, compositional arrays formed by WRs, olivines and bulk groundmasses (calculated as WRs minus phenocrysts) represent liquid lines of descent, and parental melt compositions should lie on extensions of these arrays. Fractional crystallization modelling using PELE gives encouraging results for a parent melt with $SiO_2$ ~47%, MgO ~28%, Na2O+K2O ~2.2% and Sr = 700 ppm. Such unusual melt compositions imply derivation from SCLM mantle sources enriched in Sr and other incompatibles, and suggest a possible petrogenetic link between the high-Ti Karoo magmas and carbonatites & kimberlites.