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Crystallisation, assimilation and magma mixing in the development of basalts from the Karoo LIP revealed through mineral trace element and Sr- & Nd-isotopic data

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The diverse rocks of the Karoo large igneous province (LIP) have been shown to require contributions from various mantle sources and the continental crust. Picrites and basalts from the Luenha river, Mozambique, represent one end-member of the compositional diversity. Several geochemical characteristics (including εNd_{180Ma} -2.0 to +1.4 and strongly positive δNb) of the Luenha suite suggest derivation from a source of primitive mantle affinity. While olivines from these rocks preserve oxygen isotope and trace element compositions consistent with magma derived from primitive peridotitic mantle with only an minor recycled component, they do not show evidence for assimilation of crustal material during magma ascent and differentiation. In contrast, bulk rock, plagioclase and groundmass Sr isotope analyses show wide variations ($^{87}Sr/^{86}Sr_{180Ma}$ 0.704096-0.71061).

A detailed trace element and isotope study of plagioclase and clinopyroxene probes the evolution of the magmas that produced these rocks, including the timing and extent of assimilation. New trace element data acquired via LA-ICPMS for clinopyroxene (N = 39) and plagioclase (N = 33), combined with MELTS modelling, suggest both phases started crystallising at similar stages in the evolution of this magmatic system (within ~15° of eachother), but the geochemical record of the plagioclase extends into later stages. Isotope analyses of mineral separates supplement existing data to constrain the Sr- and Nd-isotopic evolution of the system. The diverse dataset acquired for these samples reveals a complex interplay between source signatures, crystallisation, magma mixing and crustal assimilation.

Future modelling of the combined bulk rock, groundmass and individual mineral trace element and isotopic datasets using the Magma Chamber Simulator aims to constrain the nature of the assimilant and refine the estimate of parental magma composition. This, in turn, will improve our understanding of the different mantle and crust contributions to the Karoo LIP.