# Mapping of mantle heterogeneity in Karoo basalts using Nb-Zr-Ti-Y ratios

A.V. LUTTINEN*

Finnish Museum of Natural History, P.O. Box 44, 00014 University of Helsinki, Finland (*correspondence: arto.luttinen@helsinki.fi)

The study of mantle sources of continental flood basalt provinces is often compromised by crustal contamination overprinting of the incompatible element and isotopic ratios of the predominant rock types. Mantle source components can be only characterised for rare picrites that preserve primary magma compositions. Geochemical tracers which are only mildly affected by contamination help to (i) identify co-genetic types of flood basalts, (ii) establish parent-daughter relationships between flood basalt types and rare uncontaminated picrites, and (iii) constrain mantle source heterogeneity even when picrite types are unknown. Identification of such tracers has turned out to be difficult, however.

I have examined variations of Nb/Y, Nb/Zr, and Nb/Ti at given Zr/Y (quantified using $\Delta Nb_Y$[1], $\Delta Nb_{Zr}$ and $\Delta Nb_{Ti}$) in geochemically diverse flood basalts of the Mid-Jurassic Karoo province. Importantly, the delta-Nb values are only mildly affected by melting and crystallisation processes, and their variability during contamination is limited by the Nb-depleted composition of continental crust.

In the Karoo province, the variations in $\Delta Nb_Y$, $\Delta Nb_{Zr}$, and $\Delta Nb_{Ti}$ and initial Nd and Sr isotopic ratios call for at least three mantle source end-members: Two have Nb-depleted compositions relative to primitive mantle, but markedly different depleted and enriched isotopic compositions. The third end-member is Nb-undepleted and shows isotopic affinity to bulk silicate Earth. Importantly, three Karoo picrite suites can be associated with these end-members, whereas other picrites probably represent subordinate mantle components.

In the Karoo province, the delta-Nb tracers facilitate provincial scale mapping of mantle heterogeneity using variably contaminated flood basalts and help to identify picrites best suited for geochemical characterisation of the major mantle components [2].

[1] Fitton *et al.* (1997) *EPSL* **153**, 197-208. [2] Luttinen (2018) *Sci. Rep.* **8**, 5223 doi:10.1038/s41598-018-23661-3.