Softening of sub-continental lithosphere prior rifting: Evidence from clinopyroxene chemistry in peridotite xenoliths from Natash volcanic province, SE Egypt

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Abstract:

Major and trace element compositions were determined for well-preserved diopside relics in highly altered mantle xenoliths from Natash volcanic province, south Eastern Desert of Egypt, to unravel the major magmatic processes that occurred within the lithospheric mantle long time before the Red Sea rift. The diopside shows a limited compositional range as for mg# (0.89–0.92), Al2O3 (3.52–5.60 wt%), and TiO2 (0.15–0.35 wt%), whereas it is characterised by a larger variability as for Na2O (0.23–1.83 wt%) and, in particular the trace elements. The latter identify two main diopside types: 1) CPX-I has low abundances of incompatible elements, spoon-like REE patterns, small negative anomalies in Ti and Zr and a positive anomaly in Sr; and 2) CPX-II has high abundances in incompatible elements, REE patterns with steady enrichment from HREE to LREE patterns and marked negative anomalies in Ti and Zr. The range of REE patterns in the mantle section can be explained by 7–22% batch melting of the primitive mantle followed by varying degrees of trace element chromatographic exchange. CPX-I underwent only small-scale reactive porous flow metasomatism at the percolation front, whereas CPX-II resulted from large-scale rock–melt interaction close to the melt source. Trace element abundances of CPX-II suggest equilibration with carbonatite-like melts that bear close similarities with the carbonatites that enriched the lithosphere in the southern part of the Arabian plate. The similarity of the P-T gradients recorded by the Natash and southern part of Arabian lithospheres, as well as their re-fertilisation by similar, carbonatite-like agents, is consistent with the presence of a mantle plume at the base of the lithosphere after accretion of the Arabian-Nubian Shield in Late Precambrian. The plume material was fossilized due to secular cooling and became part of the lithospheric mantle before the eruption of the Natash volcanic in Late Cretaceous.

Keywords:

Sub-continental lithosphere Carbonatite metasomatism Chromatographic enrichment Thermal gradient Mantle plumes

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