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Lithospheric mantle beneath Northern Phyllite Zone – Nidda case study (Vogelsberg, Central Germany)

Małgorzata Ziobro (1), Jacek Puziewicz (1), Theodoros Ntaflos (2), Michel Grégoire (3), and Magdalena Matusiak-Małek (1)

(1) University of Wroclaw, Institute of Geological Sciences, Wroclaw, Poland (malgorzata.ziobro@uwr.edu.pl), (2) Univeristy of Vienna, Department of Lithospheric Research, Vienna, Austria, (3) Géosciences Environnement Toulouse, Midi-Pyrénées Observatory, Toulouse, France

The Cenozoic Vogelsberg volcanic field (Central Germany), part of the CEVP, is situated at the northern end of the Upper Rhine Graben. The NW, central and SE Vogelsberg are underlain by Rheno-Hercynian Variscan basement, the Northern Phyllite Zone and the Mid-German Crystalline High, respectively. Here, we describe peridotite xenoliths from the Nidda basanite in the SW and compare them with those from Dreihausen in the north [3], with the aim to estimate spatial variability of lithospheric mantle beneath different Variscan basement units.

The Nidda xenoliths are clinopyroxene (cpx)-poor in part strongly foliated spinel lherzolites and spinel harzburgites with dominantly porphyroclastic texture [2] and chemically homogeneous minerals. Forsterite content in olivine defines two xenoliths groups: A (Fo 90.4-91.7%) and B (Fo ∼89.5%), the latter characterised by more Al-rich orthopyroxene (opx) and cpx. Trace element compositions show no correlation with major element compositions or textures. Two main groups of peridotites can be distinguished in terms of REE: (1) cpx with relatively flat, spoon-shaped patterns with enrichment in La-Ce and opx with relatively steeply decreasing abundances from HREE to LREE, also partly spoon-like; (2) cpx with LREE-enrichment relative to HREE and opx with moderate depletion in LREE relative to HREE. Some peridotites contain cpx with strong negative HFSE anomalies. In contrast to these main groups, two of the most magnesian (ca. 91.5% Fo) and least aluminous harzburgites (Al content in pyroxenes ca. 0.10 atoms pfu, spinel Cr# ca. 0.57) contain opx with a sinusoidal REE pattern (sample 3896) or pyroxenes with U-shaped REE patterns (sample 3894).

Taken together, the petrographic and compositional data for the Nidda and Dreihausen xenoliths suites bear on the origin and evolution of the lithospheric mantle beneath the different basement units. Group A includes a depleted harzburgite (sample 3896) only slightly affected by metasomatism and a set of peridotites exhibiting increasing degree of metasomatic alteration, manifested by a gradual increase in Al content in pyroxenes and spinel and varying REE characteristics. Negative HFSE anomalies in clinopyroxene from some xenoliths cannot be explained by melt percolation [1] and may indicate that metasomatic agents contained a carbonatitic component. Group B peridotites were strongly affected by reactive silicate melt percolation. Importantly, harzburgite 3896 is compositionally similar to harzburgite from Dreihausen [3], which suggests that the lithosphere initially stabilised during the Variscan orogeny (or earlier) was similar across the two basement domains. In contrast, the subsequent metasomatic processes accompanying rifting and eventual host basalt emplacement appear to have been different: only the Nidda suite contains xenoliths with strongly LREE-depleted opx and cpx with spoon-shaped REE patterns.

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