EGU21-5234
https://doi.org/10.5194/egusphere-egu21-5234
EGU General Assembly 2021

Lithospheric mantle beneath the Vogelsberg volcanic field (Central Germany)

Małgorzata Ziobro[1], Jacek Puziewicz[1], Sonja Aulbach[2], Theodoros Ntaflos[3], Magdalena Matusiak-Małek[1], and Michel Grégoire[4]

[1]University of Wroclaw, Institute of Geological Sciences, Wroclaw, Poland (malgorzata.ziobro@uwr.edu.pl)
[2]Institute for Geosciences and Frankfurt Isotope and Element Research Center (FIERCE), Goethe University, Frankfurt am Main, Germany
[3]University of Vienna, Department of Lithospheric Research, Vienna, Austria
[4]Géosciences Environnement Toulouse, Midi-Pyrénées Observatory, Toulouse, France

Vogelsberg is a Cenozoic volcanic field situated at the northern tip of the Upper Rhine Graben. It stretches over two major Variscan basement units: the Rheno-Hercynian Zone in the NW and the Saxo-Thuringian Zone in the SE. We studied peridotite xenoliths from Breitenborn, Nidda and Dreihausen (SE, central and NW part of Vogelsberg, respectively) in order to reveal the evolution of the subcontinental lithospheric mantle (SCLM) rejuvenated during a Cenozoic rifting episode.

The Vogelsberg xenoliths are spinel harzburgites and clinopyroxene-poor spinel lherzolites. Most samples show grain size reduction leading to serial or porphyroclastic texture, or slight to well-defined foliation. All studied sites have similar major elements chemistry: olivine Fo 89.3-91.7%; orthopyroxene (opx) Mg# 0.89-0.92 and 0.06-0.25 atoms of Al pfu (per formula unit); clinopyroxene (cpx) Mg# 0.89-0.93 and 0.10-0.33 atoms of Al pfu. Spinel Cr# is highly variable: 0.18-0.45 for Breitenborn, 0.14-0.57 for Nidda and 0.11-0.61 for Dreihausen.

Vogelsberg peridotites exhibit a diversity of REE patterns:

(1) opx with a sinusoidal pattern, no cpx (Nidda, Dreihausen);

(2) cpx with flat patterns; coexisting opx with strong LREE-depletion, $(La/Lu)_N$ ~0.02 (Nidda, Dreihausen)

(3) cpx with flat, spoon-shaped patterns with La-Ce-enrichment $(La/Pr)_N$ ~4.3; opx similar to (2) but partly spoon-like, $(Nd/Lu)_N$ ~0.02 (Nidda, Breitenborn)

(4) cpx with different degree of LREE-enrichment, $(La/Lu)_N$ of 4-21.4; coexisting opx with mild LREE-depletion, $(La/Lu)_N$ of 0.1-0.3 (Breitenborn, Nidda, Dreihausen)

(5) cpx with flat HREE pattern and strongly LREE-depleted, $(La/Eu)_N$ ~0.03; coexisting opx similar to (2) but with $(Ce/Lu)_N$ ~0.001 (Breitenborn)

Temperatures calculated using REE content (T_{REE}) [1] for the Breitenborn peridotites exhibit two

ranges: 930-990°C and 1050-1130°C, for the Nidda ones: 880-930°C, 1000-1050°C and 1110-1150°C and for Dreihausen ones: 1140-1190°C. Temperatures calculated on the basis of pyroxene major element contents (T_{BKN}) [2] are 40-90°C lower than T_{REE} in Breitenborn and Nidda and lower by 10-55°C in Dreihausen.

The most common pyroxene REE patterns (type 4) are products of two-phase metasomatism: by Vogelsberg alkali basalt followed by a highly LREE-rich melt that further increased LREE contents in cpx, up to observed abundances. Strongly LREE-depleted opx (types 2, 3, 5) and cpx (type 5) patterns could be residues after partial melting of a fertile protolith, or products of metasomatism by melts derived from depleted MORB mantle. Cpx patterns of type 2 and 3 might have been once similar to type 5 but were later affected by the second phase of metasomatism: highly LREE-rich melt that increased chromatographically their LREE contents to variable degrees. The diversity of REE patterns and calculated temperatures shows that the SCLM beneath Vogelsberg is highly heterogeneous, probably due to spatial variability of deformation and percolation of hot melts connected with Cenozoic rifting.

This study was funded by Polish National Science Centre to MZ (UMO-2018/29/N/ST10/00259) and JP (UMO-2014/15/B/ST10/00095). EPMA analyses were done thanks to the Polish-Austrian projects WTZ PL/16 and WTZ PL 08/2018. MZ acknowledges the DAAD fellowship at Goethe University Frankfurt.

References

[1] Liang Y. et al. (2013). GeochimCosmochimActa 102, 246–260.

[2] Brey G. & Köhler T. (1990). JPetrol 31, 1353–1378.