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The lithospheric mantle underlying Northern Hessian Depression – a xenolith study

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Cenozoic alkaline volcanic rocks of Northern Hessian Depression occur in the Rheno-Hercynian Zone of the Variscan orogen close to its contact with Mid-German Crystalline High. Some of them brought to the surface mantle xenolith suites, which are the eastern- and northernmost mantle samples of the Rheno-Hercynian Zone in Europe. We studied the suites from Hirzstein and Baunsberg (both from alkali olivine basalt occurrences in the suburbs of Kassel). This are the only places in the Northern Hessian Depression which currently allow to collect abundant and relatively fresh mantle xenoliths.

The xenoliths are protogranular to porphyroclastic (sensu Mercier and Nicolas 1975). harzburgites and lherzolites. Olivine (1-7 mm) usually forms subhedral crystals with deformation bands. Orthopyroxene (with lamellae of clinopyroxene) and clinopyroxene grains are usually subhedral, up to 4 mm long. Large grains of spinel occur interstitially between primary minerals and in intergranular aggregates.

Forsterite content in olivine defines two groups of xenoliths: A (Fo=89.9-91.4%) and B (Fo=87.6-89.3%). Group A xenoliths plot into OSMA field by Arai (1994). They contain high-Mg and Al orthopyroxene and clinopyroxene (Mg#=0.90-0.92 in both phases; 0.09-0.22 atoms of Al per formula unit, pfu, in opx and 0.13-0.25 atoms Al pfu in cpx). Group B orthopyroxene has Mg# 0.88-0.89 and contains 0.11-0.22 atoms of Al pfu. Clinopyroxene has Mg# 0.87-0.89 and contains 0.17-0.31 atoms of Al pfu. Spinel exhibits significant variation in Cr# (0.12-0.52) and is Mg-rich (Mg#=0.66-0.76).

Hirzstein and Baunsberg clinopyroxene is LREE enriched (La/LuN= 5.54-25.47), trace elements patterns show strong depletion in Nb, Pb, Ce and slight depletion in Zr-Hf and Ti. Orthopyroxene shows LREE depletion (La/LuN=0.12-0.38) and has positive anomalies of Zr, Hf and Ti. These anomalies are especially well-defined in grains rich in fluid inclusions.

The locations of points in the Ti/Eu vs La/LuN diagram suggests that group A of xenoliths were affected by silicate metasomatism. High concentrations of Zr, Hf, Ti in orthopyroxene can be attributed or to asthenosphere-derived mafic alkaline melts or to subducting slab-derived melts (Dobosi et al. 2010; Coltorti et al. 2007). The group B xenoliths are supposedly the result of alkaline silicate melt percolation and metasomatic reaction with mantle peridotite.

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