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Deformation and fluid-enhanced annealing in subcontinental lithospheric mantle beneath the Pannonian Basin (Styrian Basin, Eastern Austria)

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In the Carpathian-Pannonian region, xenolith-bearing Neogene alkali basaltic volcanism occurred in five volcanic fields [1], from which the Styrian Basin Volcanic Field (SBVF) is the westernmost one. In this study, we present new petrographic and crystal preferred orientation (CPO) data, and structural hydroxyl ("water") contents of upper mantle xenoliths from 12 volcanic outcrops across the SBVF.
The studied xenoliths are mostly coarse granular hydrous spinel lherzolites. Amphiboles, replacing pyroxenes and spinels, are present in almost every sample. The peridotites are highly annealed, olivines and pyroxenes show no significant amount of intragranular deformation. Despite the annealed texture of the peridotites, olivine CPO is unambiguous and varies between [010]-fiber, orthogonal and [100]-fiber symmetry. The CPO of pyroxenes is coherent with coeval deformation with olivine. The fabric and CPO of amphiboles suggest postkinematic epitaxial overgrowth on the precursor pyroxenes. The structural hydroxyl content of the studied xenoliths exhibits rather high, equilibrium values, up to 10, 290 and 675 ppm in olivine, ortho- and clinopyroxene, respectively. The olivines contain more structural hydroxyl in the annealed xenoliths than in the more deformed ones.
The xenoliths show equilibrium temperatures from 850 to 1100 °C, which corresponds to lithospheric mantle depths between 30 and 60 km. Equilibrium temperatures show correlation with the varying CPO symmetries and grain size: coarser grained xenoliths with [100]-fiber and orthorhombic symmetry appear in the high temperature (>1000 °C) xenoliths, which is characteristic for asthenospheric environments [2]. Most of the samples display transitional CPO symmetry between [010]-fiber and orthogonal, which indicate lithospheric deformation under varying stress field from transtensional to transpressional settings [3], probably related to the Miocene evolution of the Pannonian Basin, during which varying compressive and extensive deformational regimes controlled the evolution of the basin. We suggest that the source of the fluids and melts, caused extensive annealing in the subcontinental lithospheric mantle, was the subducted Penninic-slab (e.g. [4]) below the Styrian Basin. The source of the high structural hydroxyl contents could be also this slab, which provided high H_2O activity environment in the SCLM of the Styrian basin in a mantle-wedge-like setting.

References:
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