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Tracing the fossil lithosphere-asthenosphere boundary beneath the Carpathian-Pannonian region

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Detailed geochemical and deformation analysis of a number of mantle xenoliths from the central part of the Carpathian-Pannonian region revealed that the present lithosphere can be divided into two distinct layers. The shallower layer, from the MOHO at 25-30 km to ∼40 km depth, is characterized mostly by fine grained, equigranular to porphyroclastic xenoliths. The shallower layer generally displays an 'axial [010]' deformation pattern typical for transpressional deformation regime. Mineral constituents from this shallower layer show higher mg# and depleted in basaltic major elements implying that this layer may have undergone considerable depletion. Trace element patterns, however, show enrichment most probably due to subsequent metasomatic enrichment episodes.

The deeper layer is between ∼40 km and the present lithosphere-asthenosphere boundary at ∼60-70 km depth. The xenoliths show mainly coarse grained, protogranular texture with 'A-type' deformation pattern typical for asthenospheric flow. Minerals usually have lower mg# and rich in basaltic major elements. Trace element patterns, on the other hand, do not refer to later refertilization episodes by showing dominantly depleted pattern.

There is also a special group of tabular equigranular xenoliths, which may represent a domain separating these shallower and deeper layers of the present day lithosphere.

In addition to conventional petrologic, geochemical and EBSD observations a sample suite representing each layer was selected for detailed Fourier-transform infrared spectroscopy (FTIR). During FTIR measurements the water content of the nominally anhydrous phases was constrained. The deeper protogranular and coarse-grained lherzolites generally show higher water contents in their NAMs relative to the porphyroclastic to equigranular peridotites. However the tabular equigranular peridotites are also enriched in bulk water concentrations akin to the coarse-granular ones.

We suggest that the deeper, more water rich and less-depleted layer of the present day lithosphere is a juvenile one, which may have added to the lithosphere following the Miocene extension in the thermal relaxation stage. The higher temperature and higher water content of the deeper layer may have added significantly to the lower viscosity of the former asthenosphere. The shallower layer, in contrast, may have undergone several episodes of depletion, deformation and refertilization prior to and during the Miocene extension.

We believe that this complex investigation of mantle xenoliths in young extensional areas following the aforementioned characteristics may assist to trace and locate fossil asthenosphere-lithosphere boundaries worldwide.