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Deep structure bordering the Alps - upper mantle seismic models for Variscan Europe

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We examine deep structure adjacent to the Alps from both a north and west direction. The study volume is part of the Palaeozoic Variscan orogen, structure resulting from processes similar to those of the Mesozoic-Cenozoic Alpine orogen.

2-D P-wave velocity models of the upper mantle beneath the Variscan units of Central Europe have been derived. Our modelling is based on ray-tracing in a cylindrical coordinate system. Travel time data from shallow crustal earthquakes clustered within epicentral areas small enough to justify superposition of different events, have been derived for distances up to 3000 km. The epicentres were chosen to ensure that there was broadband station coverage at offsets between 900 and 2800 km, enabling the detection of appropriate upper mantle phases over an azimuthal span embracing the studied Variscan structures.

There is a scatter in the travel times over the epicentral distance range from 8 to 15 degrees, however, the scattering does not indicate significant thickening of the LVZ as is the case for events whose ray-paths intersect the Alpine orogen, the object of previous study. The termination of Lehmann phases does not exceed 200 km depth. Also, in contrast to what was observed beneath the Alps, we do not detect high-velocity phases emerging from a discontinuity at 300 km depth. This fact supports our contention that the 300 km discontinuity is a regional feature ascribed to the subduction environment beneath the younger orogen. Within the study volume, the 20 degree discontinuity appears to be the only first-order boundary beneath the 8 degree discontinuity in the Variscan upper mantle. For all azimuths from which structures beneath the Alps are illuminated, we clearly observe both the refraction as well as the reflection branch from the 410 km discontinuity.

The study volume reveals geological features that are different from those typical in the upper mantle beneath young orogens. In contrast to the Alps, the trace of subduction responsible for the creation of the Variscan orogen appears to have disappeared. The upper mantle seems to be in thermal equilibrium, there being no evidence for the presence of cool subducted slab.