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Upper mantle structure across the Trans-European Suture Zone from S-receiver functions

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We use more than 15,000 S-receiver functions collected at 347 stations, including those of the PASSEQ 2006-2008 experiment, to study the lithosphere structure of Central Europe across the Trans-European Suture Zone in Poland and into the East European Craton in high resolution. A pronounced velocity reduction with depth interpreted as lithosphere-asthenosphere boundary (LAB) is found at an average depth of 90 km beneath Phanerozoic Europe. Deviations from this average value are associated with regions of the most recent tectonic activity, e.g. lithospheric thinning beneath areas of Cenozoic volcanism, and thickening beneath the central Alps. In contrast, no distinct variations in lithospheric thickness associated with the Caledonian and Variscan sutures are apparent, indicating that the base of the lithosphere is probably younger than Variscan. However, we image a preserved lithospheric root beneath the central parts of the Bohemian Massif.

Structure within and along the Trans-European Suture Zone is characterized by strong heterogeneity. Its northern parts are underlain by slightly thickened lithosphere up to 150 km. An eastward-inclined structure as well as a vertical drop in LAB depth cannot be ruled out based on the data. The LAB then drops sharply to more than 200 km beneath the East European Craton.

Beneath the craton, the LAB conversion is much weaker and less continuous than in the west. Sub-horizontal negative conversions are found at depths between 200 and 270 km along individual profiles. The low amplitude of the LAB conversion either indicates a weaker velocity contrast than in the west, on the order of 1.5-2.5%, or a more gradual velocity decrease in keeping with a purely thermal boundary. Instead of a clear, pronounced LAB phase, a distinct velocity reduction within the lithosphere, at 80–120 km depth, is observed, though with a generally smaller amplitude than the Central European LAB. This mid-lithospheric discontinuity (MLD) is attributed to a compositional boundary between depleted and more fertile lithosphere created by late Proterozoic metasomatism. While there are variations in MLD depth beneath different regions of the craton, the discontinuity is flat without a pronounced dip within these regions.

At larger depths, a positive conversion associated with the lower boundary of the asthenosphere is imaged at 210-250 km depth beneath Phanerozoic Europe, continuing down to 300 km depth beneath the craton. Conversions from both 410 km and 660 km discontinuity are found at their nominal depth beneath Phanerozoic Europe, and the 410 can also be traced into the craton. An increased depth of the 410 beneath the TESZ is in keeping with a thinner mantle transition zone beneath the boundary of the craton. A potential negative conversion on top of the 410 found in migrated images is analyzed by modeling and attributed to interference with other converted phases.