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A shear-wave velocity model of the European upper mantle from automated inversion of seismic shear and surface waveforms

C. Legendre (1), T. Meier (2), S. Lebedev (3), W. Friederich (1), and L. Viereck-Götte (4)

(1) Ruhr-Universtity Bochum, Institute for Mineralogy, Geology, and Geophysics, Bochum, Germany, (2) Christian-Albrechts University Kiel, Institute of Geosciences, Kiel, Germany, (3) Dublin Institute for Advanced Studies, Geophysics Section, Dublin, Ireland, (4) Friedrich-Schiller University Jena, Institute for Geosciences, Jena, Germany

Broadband waveforms recorded at stations in Europe and surrounding regions were inverted for shear-wave velocity of the European upper mantle. For events between 1995 and 2007 seismograms were collected from all permanent stations for which data are available via the data centers ORFEUS, GEOFON, ReNaSs and IRIS. In addition, we incorporated data from temporary experiments, including SVEKALAPKO, TOR, Eifel Plume, EGELADOS and other projects. Automated Multimode Inversion of surface and S-wave forms was applied to extract structural information from the seismograms, in the form of linear equations with uncorrelated uncertainties. Successful waveform fits for about 70,000 seismograms yielded over 300,000 independent linear equations that were solved together for a three-dimensional tomographic model.

Resolution of the imaging is particularly high in the mantle lithosphere and asthenosphere. The highest velocities in the mantle lithosphere of the East European Craton are found at about 150 km depth. There are no indications for a large scale deep cratonic root below about 330 km depth. Lateral variations within the cratonic mantle lithosphere are resolved by our model as well. The locations of diamond bearing kimberlites correlate with reduced S-wave velocities in the cratonic mantle lithosphere. This anomaly is present in regions of both Proterozoic and Archean crust, pointing to an alteration of the mantle lithosphere after the formation of the craton. Strong lateral changes in S-wave velocity are found at the western margin of the East European Craton and hint to erosion of cratonic mantle lithosphere beneath the Scandes by hot asthenosphere. The mantle lithosphere beneath Western Europe and between the Tornquist-Teyissere Zone and the Elbe Line shows moderately high velocities and is of an intermediate character, between cratonic lithosphere and the thin lithosphere of central Europe. In central Europe, Caledonian and Variscian sutures are not associated with strong lateral changes in the lithosphere-asthenosphere system. Cenozoic anorogenic intraplate volcanism in central Europe and the Circum Mediterranean is found in regions of shallow asthenosphere and close to sharp gradients in the depth of the lithosphere-asthenosphere boundary. Low-velocity anomalies extending vertically from shallow upper mantle down to the transition zone are found beneath the Massive Central, Sinai, Canary Islands and Iceland.