Geophysical Research Abstracts
Vol. 14, EGU2012-10045, 2012
EGU General Assembly 2012

Changes in the mantle transition zone from central Europe to the East European Craton as seen by receiver functions

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The depth to which lithospheric roots of cratons influence the surrounding mantle has important consequences for our understanding of the thermal structure of the mantle and its geodynamics. Still, this information is often not well constrained: previous studies of depth variations in mantle transition zone (MTZ) discontinuities beneath cratons led to variable results, depending on the craton under investigation. Here, we present evidence that the influence of the East European Craton extends into the MTZ.

We study teleseismic P-receiver functions recorded at more than 400 stations across central and eastern Europe, from the Netherlands to Estonia. Using P-to-S converted waves, receiver functions yield relative travel times to the 410 km and 660 km discontinuities and are especially useful in mapping variations in MTZ thickness. The main data source in our study is the multinational PASSEQ experiment, which achieved the densest coverage with seismic stations yet in Poland and Lithuania by using about 200 temporary stations installed from 2006 to 2008. These recordings are supplemented by national and regional networks and broad-band data from older temporary deployments. The large data set allows us to image the MTZ across the Trans-European Suture Zone (TESZ), the western boundary of the East European Craton, in high resolution.

We observe significantly advanced onset times, by as much as 2 s compared to standard Earth models and up to 3 s compared to the Central European Platform, for conversions from both MTZ discontinuities for locations within the craton. This effect is expected and due to the higher velocities in the mantle above the MTZ, e.g. the cratonic root. It gets even more pronounced when the opposing effect of variable crustal thickness (50 km and more within the craton in contrast to 30 to 35 km in central Europe) is considered. Additionally, the differential travel time between the two discontinuities is increased by 1 s beneath the craton, most distinctly in north-eastern Poland and Lithuania. This increase in travel time is comparable to observations for the Kaapvaal Craton and suggests a thickening of the transition zone by about 10 km. Attributing this thickening to temperature variations would correspond to a vertical coherent temperature reduction of approximately 80 K in the transition zone of the craton.