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Seismic Tomography Structure of the Crust in the Fennoscandian Shield

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A three-dimensional travel time tomography is applied to explosion data in order to derive a crustal velocity model beneath the central Fennoscandian Shield. The observations include first P- and S-wave arrivals from explosions recorded during the DSS (1981, 1982, 1991, 1994), BABEL (1989) and FIRE (2003-2006) experiments and the Europrobe/SVEKALAPKO project (1998-1999). In addition, P- and S-wave arrivals measured from chemical explosions registered at permanent seismic stations are included. In total, 19180 first P-wave and 15146 S-wave crustal travel times from 565 seismic sources inside the study area (59-67N, 18-34E) are used in the inversions. The main objective is to create smooth P- and S-wave velocity models with highest optimal resolution in good agreement with the observed data and error limits. The non-controlled SVEKALAPKO events are relocated using grid search technique using the near-final tomography model. Lateral resolution of the model is estimated to be at least 50 km to the depth of 40 km in the central study area.
The distribution of the P- and S-wave velocities and the Vp/Vs-ratio are varying locally in the whole crust. Especially, in the upper 10 km of the crust, the velocity ratio distribution images a complex mosaic of alternating minima and maxima. The anomalous velocity behaviour reveals several distinct bodies and slanting belts, which can be associated with the main geological units. The border zone between the Archean and the Proterozoic terranes can be distinguished as an upper crustal low anomaly zone to the depth of 10 km. An uppermost crustal velocity minimum (Vp <6.1 km/s, Vs <3.6 km/s, Vp/Vs <1.70) is also observed in the Bothnian Schist Belt covering most of the Gulf of Bothnia. Similar low velocity regions are associated with schist belts in southern and eastern Finland. In the south, Laitila and Vyborg rapakivi batholiths are characterized by high Vp/Vs-values (>1.76). The Central Finland Granitoid Complex expresses higher velocity ratios (Vp/Vs >1.74) in the lower crust than the surrounding regions (Vp/Vs <1.72). Two high velocity ratio (Vp/Vs >1.76) pieces suggest hidden mafic blocks in the lower crust of the Complex.
In summary, the velocity tomography image completes our view of the crust forming processes, the accretion of old micro-continents and island arcs stabilized by extensional processes.