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3-D Crustal Structure along the North Anatolian Fault Zone in North Central Anatolia from local earthquake tomography

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The North Anatolian Fault is a seismically active dextral strike-slip fault zone extending for about 1500 km from Karliova in eastern Turkey to the Gulf of Saros in the Aegean Sea. Three-dimensional P-wave velocity structure and Vp/Vs variation in the crust along the North Anatolian Fault Zone in north central Anatolia was investigated by the inversion of local P- and S-wave travel times in order to gain a better understanding of the seismological characteristics of the region. We used the damped least-squares iterative inverse code SIMULPS14, which includes a standard approximate pseudo-bending ray tracer (ART) and a full 3-D shooting ray tracer algorithm (RKP) to invert for the 3-D velocity models. The data used in the 3-D local earthquake tomography inversions include 5444 P- and 3200 S- wave readings obtained from 168 well-located earthquakes between January 2006 and May 2008 recorded by 47 broad-band seismic stations. Dense ray coverage yields good resolution, particularly in the central part of the study area. The 3-D Vp and Vp/Vs tomographic images reveal good correlations with the surface geology and important tectonic units in the region. Resolution control parameters reveal the well-resolved regions of the tomography area with a reliable solution and in particular represent the interdependence of the predicted model parameters. For our case, it can be seen that most of the rays are sub-vertical for the uppermost layers (0 - 5 km), which means that good resolution is only constrained below the seismic stations at these shallow depths. The number of rays (KHIT) for each node, DWS, RDE values and thus the resolution at deeper layers (5 - 30 km) increases in the central part of the study area, consisting of several important tectonic structures such as the North Anatolian Fault Zone and its well-developed splays and the Cankiri basin.

We observed the lower limit of the seismogenic zone for North Central Anatolia at 15 km depth. Final earthquake locations display a distributed pattern throughout the study area with most of the earthquakes occurring on the major splays of the North Anatolian Fault Zone, rather than its master strand. The scarcity of earthquakes along the central part of the North Anatolian Fault indicates that this part of the fault is in a general inter-seismic stage following the destructive 1939, 1942, 1943, 1944 and 1951 earthquakes. We also identified three major high velocity blocks separated from each other by the Izmir-Ankara-Erzincan Suture and interpret these blocks to be continental basement fragments that were accreted onto the margin following the closure of Neo-Tethyan Ocean. These basement blocks may have in part helped to control the rupture propagations of the historical 1939, 1942 and 1943 earthquakes. In addition, large variations in the Vp/Vs ratio in the mid-crust were observed and correlated with varying fluid contents of the existing lithologies and related tectonic structures.