Geophysical Research Abstracts
Vol. 19, EGU2017-6883, 2017
EGU General Assembly 2017

Upper crustal structure of the North Anatolian Fault Zone from ambient seismic noise Rayleigh and Love wave tomography

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By utilising short period surface waves present in the noise field, we can construct images of shallow structure in the Earth's upper crust: a region that is usually poorly resolved in earthquake tomography. Here, we use data from a dense seismic array (Dense Array for Northern Anatolia - DANA) deployed across the North Anatolian Fault Zone (NAFZ) in the region of the 1999 magnitude 7.6 Izmit earthquake in western Turkey. The NAFZ is a major strike-slip system that extends ∼1200 km across northern Turkey and continues to pose a high level of seismic hazard, in particular to the mega-city of Istanbul. We obtain maps of group velocity variation using surface wave tomography applied to short period (1- 6 s) Rayleigh and Love waves to construct high-resolution images of the upper 5 km of a 70 km x 35 km region centred on the eastern end of the fault segment that ruptured in the 1999 Izmit earthquake. The average Rayleigh wave group velocities in the region vary between 1.8 km/s at 1.5 s period, to 2.2 km/s at 6 s period. The NAFZ bifurcates into northern and southern strands in this region; both are active but only the northern strand moved in the 1999 event. The signatures of both the northern and southern branches of the NAFZ are clearly associated with strong gradients in surface wave group velocity. To the north of the NAFZ, we observe low Rayleigh wave group velocities (∼ 1.2 km/s) associated with the unconsolidated sediments of the Adapazari basin, and blocks of weathered terrigenous clastic sediments. To the south of the northern branch of the NAFZ, we detect high velocities (∼ 2.5 km/s) associated with a shallow crystalline basement, in particular a block of metamorphosed schists and marbles that bound the northern branch of the NAFZ.