EGU22-5475
https://doi.org/10.5194/egusphere-egu22-5475
EGU General Assembly 2022

Insights into the 3D lithospheric structure below the Sea of Marmara region from seismic tomography and forward gravity modeling

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The North Anatolian Fault Zone (NAFZ) extends for about 1500 km in the Eastern Mediterranean region, from eastern Anatolia to the northern Aegean. The NAFZ is characterized by strong and frequent seismic activity, increasing the seismic hazard in the region. In the Sea of Marmara area (NW Turkey), the North Anatolian Fault splits into three main branches. The northern branch of the fault, the Main Marmara Fault (MMF), has produced several major earthquakes (M7+) in the past, with a recurrence time of about 250 years. At present, there is a 150 km seismic gap along the MMF which has not ruptured since 1766. The observed fault segmentation, with creeping and locked segments, is indicative of along-strike variability in the fault strength along the seismic gap.

Previous modeling studies in the Sea of Marmara have revealed how crustal heterogeneities effectively affect the thermal and mechanical states of the lithosphere and can likely explain the observed fault segmentation in the area. Therefore, constraining the 3D structure of the deeper crust and upper mantle below the Sea of Marmara is crucial to better assess the mechanical stability of the fault and the possible seismic hazards in the area. In this study, we make use of seismic tomography models and forward gravity modelling to gain insights into the 3D lithospheric structure below the Sea of Marmara. Two tomographic models are used to compute a 3D density model of the area relying on two distinct approaches for the crust and the lithospheric mantle. The results showcase a heterogeneous and rather complex crustal density distribution in the study area[m1] . The 3D density distributions are used in a second step to forward model the gravity response. The results from this new tomography-constrained 3D gravity modelling are then compared to published gravity data and iteratively corrected to fit the overall gravity signals. The final 3D lithospheric-scale density model of the study area will be the basis for thermo-mechanical modeling experiments aimed at improving our current understanding of the present-day geomechanical state of the Sea of Marmara and the MMF and its implications for the seismic hazard of the region.