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Interseismic Locking of the Main Marmara Fault in Northwestern Turkey

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Throughout the last century, the North Anatolian Fault (NAF) produced mostly west migrating sequence of M>7 earthquakes, and in this period of time, the NAF did not break beneath the Marmara Sea. The Main Marmara Fault (MMF), which is the north branch of the North Anatolian Fault in the Marmara Region, is the most active branch in this area. The interseismic behavior of the MMF beneath the Marmara Sea is crucial with regards to assessments for the earthquake risk of the Marmara Region which has a population over 24 million. As a result, the prediction of the locking depth and the fault slip rate have great importance as they provide a comprehension concerning the seismic moment deficit, that can be released at the time of a future event.

In this study, we modeled the interseismic locking of the MMF by making use of the interseismic GPS velocities and implementing a 3D finite-element analysis. Our kinematic model has a realistic 3D fault geometry, in which each and every fault section of MMF is confined to a fault slip rate down below a given locking depth which ranges from 2.5 to 15 km. We improve the fits to GPS velocity data just by changing the interseismic locking depth of each segment and placing more complexity to the locking structure in cases where the data needs. Our preliminary models reveal that a change in locking depth is required in between the Ganos Segment at the western end of the Marmara Sea and Central Segment. A model with a locking depth of 10 km for the Ganos Segment and 2.5 km for the Central Segment fits the GPS velocities well. We outrule the likelihood of similar locking patterns for the two segments. This result is consistent with the earlier work utilizing 1D profiles demonstrating that there is no significant strain accumulation beneath the Central Segment and also seismicity studies show that the background seismicity is very different in these two segments. Under the Princes' Islands Segment, the data is more compatible when we add some shallow creep. For the Izmit Segment, we predict that the locking depth is around 8 km, yet further analysis is needed. Our results show that in most cases, the variation in the seismic behavior of each segment is in accordance with its interseismic behavior in relation to the fault locking.