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Interseismic Behavior of the Main Marmara Fault in the Marmara Region of Turkey

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The North Anatolian Fault (NAF) generated series of M>7 earthquakes during the 20th century. The only part of NAF that did not break in this time period is beneath the Marmara Sea. The most active branch of NAF in this region is the northern branch, the Main Marmara Fault (MMF). With a population exceeding 20 million, the interseismic behavior of the MMF beneath the Marmara Sea is of critical importance in order to assess earthquake risk of the region. The locking depth and the fault slip rate are critical since they give an understanding about the seismic moment that can be generated during a forthcoming earthquake and thus help make an assessment of the seismic hazard of the region.

In this study, we modeled the interseismic locking of the MMF by modeling the interseismic GPS velocities using a 3D finite-element approach. Our kinematic model is based on an elastic, homogeneous medium with realistic 3D fault geometry, where each fault segment of MMF is constrained by a fault slip rate beneath a specified locking depth ranging from 2.5 to 20 km. We optimize the fits to GPS velocity data by varying the interseismic locking depth of each segment and adding more complexity to the locking pattern if the data requires it. Our preliminary forward models show that a gradient in locking depth is necessary between the Ganos Segment and Central Segment. A model with locking depth of 10 km for the Ganos Segment and 2.5 km for the Central Segment is consistent with the GPS data. We outrule the possibility of similar locking patterns for both segments. This result is consistent with previous work using 1D profiles showing that there is no significant strain accumulation beneath the Central Segment. To the east, beneath Princes' Islands Segment, the data is best-fit if we add some shallow creep. For the Izmit Segment, we predict that the locking depth is about 8 km. Our results show that in general the difference in seismicity behavior of each segment is consistent with their interseismic behavior in terms of the fault locking.