Interseismic Behavior of the Active Main Marmara Fault in Western Turkey

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Abstract

The North Anatolian Fault (NAF) caused a sequence of destructive M> 7 earthquakes during the 20th century. The region under the Marmara Sea is the only part of NAF that did not break in this time period. The northern branch, the Main Marmara Fault (MMF) is the most active branch of NAF in this region. The interseismic behavior of the MMF beneath the Marmara Sea is of vital importance in order to evaluate earthquake risk of the region with a total population in excess of 20 million people. The locking depth and the fault slip rate are critical since they provide important clues 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 below a given 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 necessitates it. Our preliminary forward models indicate that a gradient in locking depth is required 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 compatible 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 considerable 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 estimate that the locking depth is about 8 km. Our results reveal that in general the difference in seismicity behavior of each segment is consistent with its interseismic behavior in terms of the fault locking.

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