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Slip Variability along Main Marmara Fault

Semih Ergintav (1), Uğur Doğan (2), Ziyadin Çakır (3), Thomas Walter (4), Faqi Diao (5), Rongjiang Wang (4), Seda Özarpaci (2), Hayrullah Karabulut (1), Özgün Konca (1), Michael Floyd (6), Robert King (6), and Robert Reilinger (6)

(1) Boğaziçi University, Kandilli Observatory and Earthquake Research Institute, istanbul, Turkey (semih.ergintav@boun.edu.tr), (2) Yıldız Technical University, Geodesy Department, Istanbul, Turkey, (3) ˙Istanbul Technical University, Geology Department, Istanbul, Turkey, (4) GFZ German Research Centre for Geosciences, Potsdam, Germany, (5) State Key Laboratory of Geodesy and Earth's Dynamics, Institute of Geodesy and Geophysics, Chinese Academy of Sciences, Wuhan430077, China, (6) Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA

The ∼1500 km-long North Anatolian Fault (NAF) zone, the seismically and tectonically most important fault zone in Turkey, has generated nine major earthquakes in the 20th century. It splits into two main branches east of the Marmara Sea; the northern fault branch takes up most of the strike-slip component of Anatolia-Eurasia relative motion while the southern fault system accommodates the oblique extension of the Marmara basins. Based on > 20 years of GPS observations, direct constraints on strain accumulation within the Marmara Sea show that the Princes' Islands fault segment is accumulating strain at rates that are sufficient to produce a slip deficit since the last major earthquake in 1766 capable of generating a M>7 earthquake. In contrast, the offshore Central Marmara Fault (CMF), previously thought to represent the potential source for one or more M>7 earthquakes, shows no observable indication of accumulating strain. This is a challenging section to measure geodetically due to its distance from land but, if verified, the most likely explanation is that the fault is creeping aseismically to shallow levels. Creep on some segments of the NAF on land is known to occur as long-term post-seismic motion, affecting shallow parts of fault segments that slipped co-seismically, with the best observations coming from the 1999 M7.6 Izmit Earthquake. The low, or absence of, interseismic loading, along CMF, is puzzling. Possible explanations involve asymmetry in crustal elastic properties north and south of the fault, the southward dipping fault skewing the locus of surface shear strain to the south, creep at near plate velocity, or a very shallow locked zone (< 5 km). However, the depth distribution of microseismicity supports the notion that some shallow creep occurs in the western Marmara Sea from Ganos to the Central Basin (around the western part of CMF), arguing against shallow locking. Attempts continue to use in situ strategies to directly constrain fault slip rates; however neither the lengths of the possible creeping and locked segment nor the depth distribution of fault coupling are well constrained. Improvements in the classification of the geometrical and rheological features of the NAF in the Marmara could be realized by extending and densifying InSAR and GPS observations along the shores of the Sea and on the Princes' Islands, with direct implications for assessing the earthquake potential of the offshore fault systems in the Marmara Sea.

In this study, we will present our strategies to estimate the variability of creep along NAF's branches in the Marmara Sea using the new spatially and temporally dense geodetic data sets. The results of this study will help constrain the mechanics of strain accumulation and release, and the development of extensional basins along strike-slip fault systems.