Analysis of the complexity of the Mw 5.8, 26 September 2019 Silivri Eq. in the Sea of Marmara, Turkey, constrained from geodetic datasets


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Based on >20 years of GPS observations and seismological works, direct constraints on the strain accumulation along the Main Marmara Fault (MMF) show different characteristics from Princess Islands to Ganos Fault. Ganos and Princess Island segments identified as locked based on GPS and seismological observations while the part of the Central Marmara segment show partially creeping behaviour. Moreover, around the Kumburgaz Basin, GPS data could be explained by creep models in contrast to fully locked seismic models. Clearly, there are many puzzling questions on the nature of strain accumulation on the MMF, under the constrain of various data sets. In order to contribute to a better understanding of this fault the observation capacity of geodesic network has been increased along the northern coast of the Marmara Sea and supported by seismological stations as well as Marine Geodesy.

In September, 2019, an intense earthquake activity started between Central Marmara and Kumburgaz Basin. The mainshock occurred on 26 September 2019 (Mw5.8) as a largest earthquake, since 1963 Mw6.3 Cinarcik earthquake, in the Marmara Sea. A foreshock activity started 4 days before the mainshock and the largest one (Mw4.7) observed on September 24, close to the mainshock. The mechanisms of the mainshock and the large aftershocks as well as foreshocks are dominantly strike-slip with a significant reverse component. The aftershocks are located on the north of the MMF trace.

Here we investigate the geodetic data related to this event, with the aim to shed some light on the complexly segmented MMF. We observed co-seismic offsets at the nearest 6 GPS stations (~12-20 km far to the epicenter) along the northern coastline of the Sea of Marmara. The estimated offsets are not big and change between 1-3 mm on horizontal and 1-10 mm on vertical components. All of the stations are located on the northern part of the hypocenter and exhibit predominant NS-direction movement, which is inconsistent with a primarily E-W right lateral transform system. Instead, the co-seismic pattern can be explained with a complex earthquake
mechanism which has a dominant reverse component while the strike-slip component is relatively insignificant, based on Okada-type elastic models and geodetic moment magnitude obtained as ~6.2. The total cumulative moment using geodesy is much higher than the total seismic cumulative moment of earthquake activity (~M5.9), and the thrust component is also more dominant in comparison the focal mechanisms from regional data. Obviously, geodetic co-seismic offsets estimated from daily-based data and they include pre-and post-earthquake deformations. In addition, the tide-gauge data (station distance is 25 km far to epicenter) was analyzed and it shows the strong variations after Mw 4.7 and they faded out after Mw5.8. This sea level change, which temporally correlates with the seismic activity, gives important evidence about the possibilities of pre-earthquake activity. Using GPS time series, we intend to explore the pre-earthquake anomalies and, to reduce the discrepancy between seismological and geodetic models. (This study is supported by TUBITAK 1001 Project no: 117Y278).