2019 Mw5.8 Silivri Earthquake Reveals the Complexity of the Main Marmara Shear Zone

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The North Anatolian Fault (NAF) is a 1600 km dextral transform fault accommodating the motion between Anatolia and Eurasia Plates. The segments beneath the Marmara Sea, are the only part of the NAF that did not break since the 20\textsuperscript{th} century. Recent studies show that this 150 km seismic gap is characterized by heterogeneous interseismic behavior and significantly high background seismicity with respect to the other parts of the NAF.

On September 24 2019, an activity started north of the Main Marmara Fault (MMF) including a M\textsubscript{w}4.7 earthquake, which led to the Mw5.8 mainshock several days later. The 2019 M\textsubscript{w}5.8 Silivri earthquake is the largest since 1963 M\textsubscript{w}6.3 Cinarcik earthquake in the Marmara Sea. This sequence occurred at a location that is immediate north west of the Central Basin; between a zone that is possibly partially creeping (Central Basin) to the west and a possibly locked segment to the east (Kumburgaz Basin).

In this study we used template search for detection of earthquakes, relocated the earthquakes, obtained focal mechanism solutions of earthquakes that are M>4 and obtained a finite-fault slip model of the M\textsubscript{w}5.8 mainshock. Using template cross-correlation, a total of 400 earthquakes were detected in this sequence. The activity started in a relatively narrow zone and spread to larger distances following the M\textsubscript{w}4.7 mainshock. The depth distribution shows that the earthquakes are confined to a narrow zone between the depths of 9-13 km. The focal mechanisms show that there are two clusters; the cluster to the northwest show a ~70°north dipping fault with rake angles about ~160°, while the activity toward east converges to the Main Marmara Fault and dip angle is close to ~70°with rake angles of ~140°. The finite-fault model shows a bilateral rupture that propagated down-dip from the hypocenter.

We conclude that the seismic activity occurred on a fault that is within the Main Marmara Shear Zone beneath the sedimentary basin. This secondary fault possibly connects to the Main Marmara Fault to the east. There is no evidence that the causative fault continues up-dip into the basin.
Another characteristic of this sequence is that all of the focal mechanisms show significant thrust component in addition to the expected right-lateral motion. The January 2020 M$_{w}$4.7 earthquake that occurred in the same zone between the two clusters have predominantly thrust mechanism, confirming that this zone is under local compression. The observed thrust component is possibly related to change of the width of the shear zone with narrowing from Central Basin to the west to Central High to the east and/or the change of the interseismic behavior of the fault from partially creeping Central Basin and locked Kumburgaz Basin segments.