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Re-evaluation of fault geometry and slip distribution of surface ruptures associated with the large earthquakes in the 20th century along the central and eastern part of the North Anatolian fault system

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The North Anatolian Fault System (NAFS) which is a seismically active continental plate boundary transform system ruptured in a westward-migrating sequence of large earthquakes between 1939 and 1999. 1939, 1942 and 1943 earthquakes occurred on the eastern and central NAFS in this sequence. The 1939 (M:7.9) and 1943 (M7.6) earthqaukes which are largest two events in the sequence produced multi-segment surface ruptures 380 and 280 km-long, respectively. The 1942 (M7.0) earthquake generated from Erbaa-Niksar fault located between these two multi-segment ruptures formed a 48 km-long surface rupture. We have performed a serial study on the fault geometry and revision of slip data associated with these earthquakes based on detailed field mapping of the ruptures and interview to local eyewitness.

The 1939 Erzincan earthquake which is the largest event in the sequence nucleated on a restraining bend close the eastern end. The rupture extended along the master strand of the NAFS between Erzincan and Niksar basins. However, a part of 65 km-long western portion of the rupture directed towards on the Ezinepazarı splay fault. Along the 1939 rupture, on going studies reveal that the slip is not uniform along fault strike and the amount of slip varies between 1 to 8 m. The 1943 earthquake which is second largest event along the NAFS in 20th century nucleated on the western end of the rupture and unilaterally propagated eastward contrary to the 1939 event. The 1943 rupture is divided into nine sub-segments based on slip distribution and fault jogs. The amount of average slip along the entire rupture zone is 3.6 m. and the maximum slip of 6.0 m. These newly measured amounts of slip are larger than previously reported. A 48-km-long surface rupture was formed in the 1942 earthquake. The surface rupture associated with this earthquake is divided into two main sections by a 12 km-long restraining stepover which is characterized with a push-up structure bounding reverse faults. The event nucleated below this restraining stepover and bilaterally propagated. The amount of the maximum slip riches up 2.5 m along the rupture zone.

The data conclude that: 1) the 1939 and 1943 multi-segment earthqaukes on the central and eastern NAFS nucleated on the large restraining bends and propagated unilaterally, 2) not only Niksar releasing stepover but also structural complexity in the Erbaa-Niksar region played a significant role on the deviating of the 1939 rupture from the master strand to the Ezinepazarı splay, 3) in general, the direction of the fault along each multi-segment rupture changes near or on the restraining bends or stepovers as well as along the entirety of the fault zone 4) the average slip along multi-segment ruptures is not uniform, and the amounts of the measured slip in this study along the central and eastern NAFS is larger than that of previous study, 5) In comparison with the slip distribution on the surface ruptures between the 1939 and 1999 earthquakes, the average slip along the entire NAFS is rather uniform and diminish gradually westward except for eastern portion of the 1939 rupture.