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Surface ruptures associated with the 1942 and 1951 earthquakes along the North Anatolian fault system -Implications for non-characteristic earthquakes and macroscopic barrier segments

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We found new evidences of non-characteristic earthquakes occurred along the North Anatolian fault system (NAFS), which are the 1942 Niksar-Erbaa earthquake (M6.9) and the 1951 Kursunlu earthquake (M6.9) as short-lived temporal clusters, based on the mapping of detailed fault geometry and interview to local people. Each fault segment ruptured twice during the migrating earthquake sequence in the 20th century along the NAFS at the recurrence interval of three years and seven years. Total length of surface rupture associated with the 1942 earthquake is for 47 km. The rupture is geometrically divided into two main fault sections by a restraining step-over, which is characterized 12-km-long push-up structure. Compiling the 1942 rupture information of eyewitness, the eastern fault section of 26 km, including several normal faults bound on northern margin of Niksar releasing step-over, had also ruptured during the 1939 Erzincan earthquake (M7.9). Some eyewitness pointed out that the surface ruptures of the 1939 and 1942 events appeared at the exactly same locations on their field. Even though the maximum right-lateral slip of the 1942 event has been considered as 2.0 m, offsets of ca. 1.5 m on the 1942 segment were interestingly witnessed just after the 1939 event. Additionally, revisited fault geometry between the 1939 and 1942 ruptures around Niksar basin indicates that several normal faults connected up the ca. 11-km-width releasing step-over, the largest one along the whole NAFS on land. These data suggest that the 1939 earthquake probably ruptured through the Niksar releasing step-over at some and extended up to the push-up structure on the 1942 segment for 26 km long, although the accumulated seismic moment on the 1942 segment was not totally released during the 1939 event. Then, the 1942 event seems to have occurred so as

to release the rest of accumulated moment on the 1942 segment. Similarly, the 1951 earthquake re-ruptured for the two easternmost fault segments of the 1944 earthquake rupture. According to previous works, the seismogenic fault of 1951 event has been considered as the easternmost portion of the 1944 rupture, or as a reverse fault which is located in Cerkes-Kursunlu region, 10 km southeast of the eastern tip of the 1944 rupture. Judging from our field data, epicenter and focal mechanism, the former portion of NAFS seems to re-rupture during the 1951 event. We could not obtain precise surface slip data associated with both of earthquakes, however, these fault segments may have played an important role to arrest multi-segment ruptures as macroscopic barrier segments.