

Characteristic and non-characteristic behavior on the North Anatolian fault, Turkey

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We revealed characteristic behavior on the 1944 Bolu-Gerede earthquake ruptures along the North Anatolian fault (NAF). The 1944 Bolu-Gerede earthquake (M_s 7.3) occurred along the central portion of NAF and the surface rupture associated with the earthquake can be divided into main five fault segments based on slip distribution and geometric features. Along the Gerede segment, which slipped 3 to 6 m in 1944 and they exhibited multiple offsets of the 1944 event. We measured a few to several tens meters right-lateral offsets of geomorphic features such as channels, gullies and terrace risers. Additionally, we performed three-dimensional trenching at Demir Tepe site. These offsets are double, triple and quadruple multiples of the 1944 slip within the errors of measurements. These data imply that a similar slip distribution during the four most recent large earthquakes along this segment and support the concept of characteristic slip. Furthermore, the total rupture length including the Gerede segment varied greatly during the last four earthquake cycles, according to historical records. Our interviews to local people revealed the 1944 surface rupture extended for ca. 180 km. On the other hand, the penultimate gigantic 1668 event accompanied the 600 km-long or further long surface ruptures. Additionally, the event prior to the antepenultimate event can be correlated with the above-mentioned 1035 earthquake, that accompanied the several tens km-long surface ruptures. On the other hand, we found some evidences of non-characteristic earthquakes occurred along the surface rupture associated with the 1942 Niksar-Erbaa earthquake (M 6.9) as short-lived temporal clusters, based on the mapping of detailed fault geometry and interview to local people. Total length of surface rupture associated with the 1942 earthquake is for ca. 50 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 (M 7.9). 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 NAF 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.