Refined Slip History of the North Anatolian Fault at Gerede on the 1944 rupture

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We excavated four new fault crossing trenches and a complex of fault parallel trenches at Ardicli, 15 km east of Gerede on the 1944 Bolu-Gerede segment of the North Anatolian fault to resolve timing and slip in past earthquakes. A unique large gravel-filled channel (unit 10) was determined to be offset 17 to 20 m. Preliminary age control on the gravel shows it dates to the 6th or 7th century AD. Fault crossing trenches show evidence for 5 events after deposition of unit 10. Preliminary 14C dates place the earlier 3 of 5 events at AD 643-918 (EV5), AD 943-1298 (EV4), and AD 1171-1668 (EV3). These 3 events are recorded in 3 clayey units (8, 6, and 4). EV3 is the best represented with disruption into the base of unit 4 and on the main and subsidiary faults. The two most recent events are the 1944 (E1) and presumably the great 1668 earthquake (E2). Based on the offset of small channels cutting into the unit 4 surface at the site, slip in 1944 and 1668 was 5 +/- 1 m in each event. This suggests that the prior 3 events collectively produced 7 to 10 m slip, slightly less than that which occurred in the most recent events. EV4 may be correlated with 1050 earthquake, but no catalog has mentioned about EV5 and EV3, indicating that historic records of the large North Anatolian fault earthquakes are incomplete for this period. The finding of EV3 is important for the analysis of earthquake cycles. According to the catalogs, the interval of 618 years between 1050 and 1668 was much longer than the 1668-1944 interval and that around the Marmara Sea. With EV3, the recurrence may be much more periodic. Our detailed studies on the repeated slips along the 1944 segment indicate the slips during past 5 earthquakes are similar. The 1944 segment, especially in its central portion around Gerede is quite unique and straight. The refined slip history here will help to define regularity and irregularity of earthquake recurrence.

First set of 20 radiocarbon dates suggest following interpretations. Six faulting events had occurred between 500+/-50 AD and 1944. The lower limit is based on the date of the outermost ring of a large trunk near the bottom of the trench. The oldest event (EV6) is well defind after 500+/-50 AD and before about 700 AD. Next event (EV5) occurred around 700 AD with uncertainty of +/- 50 years or less. The sediments below and above EV5 contain a lot of pine cones and twigs of between 600 and 800 AD. Two younger events of EV4 and EV3 are correlated to after 700 and before 900 AD, given all dates represent the age of the stratigraphic position of the samples. In this case. the interval between EV3 and EV2 (historic 1668) is over 700 years and historic 1035 event is missing. Three events in a 300 year period followed by over 700 year quiescence indicate very distinct temporal clustering. However, if we assume intense reworking of EV5 horizon wood fragments into EV4 and EV3 horizons, the ages of EV4 and EV3 are to be 10th-12th century and 11-13th century respectively, and the age of EV4 coincides with the historic 1035 event. The recurrence time in this case still ranges 100 to 500 years, temporal clustering is less distinctive. We are conducting more dating carefully to rule out the effects of reworking and contamination. Recent detailed studies on the past slips in each event by our group have revealed that similar amount of coseismic slips (5 +/- 1 m) had been repeated in EV4 through EV1 thought the rupture length differed greatly. The timing of these regular slip events is a key to understand the fault behavior.