Geophysical Research Abstracts
Vol. 12, EGU2010-6520, 2010
EGU General Assembly 2010

Dynamic rupture process of the great 1668 Anatolian earthquake

Yuko Kase (1), Hisao Kondo (1), and Ömer Emre (2)

(1) National Institute of Advanced Industrial Science and Technology, Tsukuba, Japan (kasep@ni.aist.go.jp/81-29-861-3803), (2) General Directorate of Mineral Research Exploration of Turkey, Ankara, Turkey

The North Anatolian fault system (NAFS) gives us the well-preserved evidences of multi-segment earthquakes. During the 1939 Erzincan earthquake, surface ruptures extended along the Resadiye segment. The surface ruptures during the 1942 earthquake appeared on two segments, the eastern Niksar and the western Erbaa segments which are to the west of the Resadiye segment. On the other hand, paleoseismological evidences show that the 1668 earthquake was a single multi-segment earthquake including the Resadiye, Niksar, and Erbaa segments (Kondo et al., 2009). The fault geometry, however, does not make us imagine a single multi-segment occurring. The distance along strike and step-over width between the Resadiye and Niksar segments is 17 and 11 km, respectively. This fault discontinuity is much larger than the previously-known threshold of a multi-segment rupture, 5 km, shown in observations of historical earthquakes (Matsuda, 1990; Wesnousky, 2006) and numerical studies (Harris and Day, 1999; Kase and Kuge, 2001). In this study, we construct dynamic rupture models for the North Anatolian earthquakes based on seismological data of the 1939 and 1942 earthquakes and the present stress condition, and then we investigate possibility of a single multi-segment earthquake in agreement with the paleoseismological data of the 1668 earthquake.

A fault model is assumed, based on the surface traces, hypocenter distribution and source mechanisms of the 20th century earthquakes on the NAFS. Using the source mechanism of the 1939 earthquake (McKenzie, 1972) and the stress inversion results along the NAFS (Bellier et al., 1997; Fuenzalida et al., 1997), we adopt a regional stress field that is resolved onto all fault segments. We perform preliminary simulations to determine a hydrostatic stress condition and coefficient of friction producing surface slip distribution consistent with the observed surface slips during the 1939 and 1942 earthquakes (Barka, 1996; Emre et al., 2009; Kondo et al., 2009). We use a finite-difference method with a conventional grid formulated by Kase and Day (2006).

Under the stress condition mentioned in the previous paragraph, a rupture initiating on the Erbaa segment propagates on the Niksar segment, but cannot jump across the 11-km-wide discontinuity between the Niksar and Resadiye segments. The result shows that the discontinuity acts as a geometrical barrier during ‘usual’ earthquakes like ones in the 20th century earthquake sequence. In the Niksar segments, paleoslips of up to 8 m are observed as the 1668 earthquake. The paleoseismological data also show that the last earthquake before the 1668 earthquake was during the 6th century; thus, the interval between these was much longer than the 274 years between the 1942 and 1668 earthquakes. The 1668 earthquake following a long quiescent period had the capability for accumulating large strain. We thus assume larger values of stress drop for the Niksar and Erbaa segments, and simulate dynamic ruptures. When the stress drop is twice as large as in the 1942 earthquake, a rupture can jump across the 11-km-wide discontinuity and propagates onto the Resadiye segment. The maximum surface slip on the Niksar segment is 6.65 m. Although the simulated slip is less than the observed one, the rupture jump succeeds. The numerical result shows the possibility that the 1668 earthquake was a single multi-segment earthquake, therefore, it suggests that the 11 km-width jump in the 1668 earthquake was caused by large stress drop releasing the vast accumulation of strain during the preceding long quiescence.