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Unlocking of the North Anatolian Fault prior to the 2014 M 6.9 North Aegean Earthquake: Evidence from seismological and geodetic observations

Fatih Bulut (1), Haluk Ozener (1), Asli Dogru (1), and Bahadir Aktug (2)

(1) Kandilli Observatory and Earthquake Research Institute, Geodesy Department, Bogazici University, 34680 Cengelkoy, Istanbul - Turkey (bulutf@boun.edu.tr), (2) Ankara University, Geophysics Department, 06830 Golbaşı, Ankara - Turkey

We integrated long-term microseismicity and near-fault GPS measurements to elaborate on generation process of the 2014 M 6.9 Aegean Earthquake. The mainshock ruptured part of the westernmost segments of the North Anatolian Fault (NAF), Turkey. We observed that the 2014 M 6.9 Aegean earthquakes were preceded by almost a decade-long period of enhanced microearthquake activity representing a front-edge fracturing process preparing the failure. Microseismicity-derived pre-seismic low-slip patches are interpreted to represent locked fault sections rather than a pure a-seismic creep. The nucleation of the mainshock occurred at low-slip patches where the lowest pre-slip has been accommodated along the ruptured fault section. For the time period of 2006-2014, acceleration in microseismicity delays for one year with respect to the increase in GPS-derived tectonic motion. This verifies that the tectonic loading drives the acceleration in microseismicity. The direction of GPS-derived velocity field rotates systematically from $\sim$234° to $\sim$244° clockwise, which tends smoothly to be sub-parallel to the local fault strike. This rotation corresponds to upward migration of locking depth from $\sim$13.0 km to $\sim$8.0 km within a time period of eight years suggesting unlocking of the NAF prior to the 2014 M 6.9 North Aegean Earthquake.