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Short-term and long-term slip rate estimations along the Ganos Fault using stream offsets and paleo-climatic changes (North Anatolian Fault, Turkey)

M. Ersen Aksoy (1,2,*), Mustapha Meghraoui (1), Matthieu Ferry (3), Ziyadin Çakır (4), and Gülsen Uçarkuş (2)

(1) Institut de Physique du Globe (UMR 7516), Strasbourg, France, (2) Istanbul Technical University, Eurasia Institute of Earth Sciences, Istanbul, Turkey, (3) Universidade de Évora, Centro de Geofísica, Évora, Portugal, (4) Istanbul Technical University, Dept. of Geological Sciences, Istanbul, Turkey, (*) Now at Instituto Dom Luiz, Universidade de Lisboa, Lisboa, Portugal (ersenma@fc.ul.pt)

The Ganos fault, is the westernmost segment of the right-lateral North Anatolian Fault (NAF) located west of the highly populated Istanbul and Marmara region of Turkey. This fault generated a large and destructive earthquake (Ms=7.3) in 1912 and hence plays a significant role in the hazard of the region. Recent crustal deformation along the Ganos fault is expressed by typical structures of strike-slip faulting; i.e. step-overs, pull-aparts, bends, pressure ridges, sag-ponds, offset ridges, shutter ridges and stream displacement. We use DEM, aerial photography and DGPS field investigations to document the fault zone and infer the long-term and short-term active deformation in the Marmara region. Our observations describes 69 right lateral cumulative displacements ranging from 8 to 575 m and include streams, ridges and partly ancient roads. The classification of stream offsets shows 5 distinct classes of cumulative slip that can be correlated to different episodes of stream formation due to climatic fluctuations and hence to periods of high precipitation. The sea level change and paleoclimatic fluctuation curves of the Black Sea allow us to constrain the timing of high rainfall periods and determine 5 subsequent sea level rise episodes at 4 ka, 10.2 ka, 12.5 ka, 14.5 ka and 17.5 ka. The slip rate estimations provide 17.9 mm/yr constant slip rate during the last 20.000 years and a variable slip rate of 17.7 mm/yr, 17.7 mm/yr, 17.9 mm/yr and 18.9 mm/yr for the last 10.2 ka, 12.5 ka, 14.5 ka and 17.5 ka, respectively. This indirect dating method provides an average slip rate for the Ganos fault which is similar to slip rates obtained from paleoseismic trenching sites (17 - 27 mm/yr) of the region and other studies along the NAF (15 to 25 mm/yr). We notice that geodetic methods applied over the whole NAF suggest slightly higher strain accumulation values (22 - 26 mm/yr), but they represent the deformation over a significantly larger area. The discrepancy between geodetic and geological results can be due to the complex lithospheric structure and earthquake rupture characteristics along the NAF.