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The late Quaternary slip history of the North Anatolian Fault, Turkey: Implications for the spatial and temporal behaviour of large strike-slip fault belts

Cengiz Zabcı (1), H. Serdar Akyüz (1), Taylan Sançar (2), and Nafiye Güneç Kıyak (3)

(1) Istanbul Teknik Universitesi, Maden Fakultesi, Jeoloji Muhendisligi Bolumu, 34469 Maslak Istanbul, Turkey (zabci@itu.edu.tr), (2) Tunceli Üniversitesi, Aktuluk Yerleşkesi, Mühendislik Fakültesi, Jeoloji Müh. Bölümü 62000 Tunceli, Turkey, (3) Işık Üniversitesi Fen-Edebiyat Fakültesi, Fizik Bölümü, 34980 Şile İstanbul, Turkey

The study of the spatial and temporal behaviour of active faults by estimating the geologic and geodetic slip rates is critical not only for assessing the seismic potential of these tectonic structures, but also for understanding their geodynamics. Geodetic data can provide detailed spatial coverage but represent a short time interval of a single earthquake cycle, while geologic rates are derived as average values for multiple events at spatially limited sites. In the complex tectonic setting of the eastern Mediterranean, the westward extrusion of the Anatolian scholle is mainly accommodated by two major tectonic structures, the North Anatolian (NASZ) and the East Anatolian (EASZ) shear zones, respectively forming the northern and eastern boundaries. The rate of deformation all along the North Anatolian Fault (NAF) is spatially well documented mainly by GPS and InSAR based geodetic studies during the last two decades. Furthermore, the number of the morphochronology-based geologic slip rate studies significantly increased, covering the different sections of this large strike slip fault for various time intervals.

In this study, we do not only compile all previous geologic slip rate estimates, but we also present data for three new and two revised sites from central to the most eastern parts of the NAF in order to understand the spatial and temporal behaviour of this important fault system. The integrated dataset of geologic studies were classified into two groups to represent the central to eastern sections (Model I) and the western part (Model II). The geographical diversion between two models is about at the 31˚E longitude, where the NAF bifurcates into two branches from this point toward west into the Marmara Region. To test any secular variation in fault's slip history, we used the Monte Carlo approach of Gold and Cowgill (2011). After the removal of rates, which do not account the near fault deformation or the existing parallel/sub-parallel faults, the Model I (central-eastern NAF) yield uniform slip rates of about 17 and 19 mm/a for the last 11 and 5 ka, respectively. Although Model II gives a similar uniform rate of about 17 mm/yr for the last 20 ka for the western NAF, the slip history solution shows secular variations in the very long-term offset structures of 100ka time scale within the Sea of Marmara, including eras of deceleration and acceleration during the last 500 ka. The time scale of these changes are remarkably very longer than the earthquake cycle, but shorter than the time-scale characteristics of lithospheric-scale dynamics. The most possible explanation can be the co-dependence between the northern and southern strands of the NASZ that a change on one strand is matched with an equal or opposite change in the rate on the other. In order to have a better understanding on this phenomena or the apparent discrepancy between the geologic and geodetic slip rates, the future studies are mandatory to increase the spatial and temporal resolution especially along the southern strand in the Marmara Region, the splay on the central part and the central-east sections of the NAF.

Keywords: North Anatolian Fault, slip rate, variation in crustal deformation, Turkey

Reference

Gold, R. D., and E. Cowgill (2011), Deriving fault-slip histories to test for secular variation in slip, with examples from the Kunlun and Awatere faults, *Earth and Planetary Science Letters*, 301(1–2), 52-64, doi:10.1016/j.epsl.2010.10.011.