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Deformation of Central Anatolia through GPS Observations

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Taking place between North Anatolian and East Anatolian mega shear zones, neotectonics of seismically less active Central Anatolia is often regarded as tectonic escape or extrusion tectonics. Although previous published GPS studies dating back to early 1990's report coherent rotation, they were mostly focused on seismically more active and more populated Western Anatolia and lack spatial resolution in quantifying second-order tectonic structures within the central area, such as Tuz Gölü Fault Zone, Central Anatolia Fault Zone comprising Ecemiş Fault and Erciyes Fault, Ezinepazarı Fault, related basins and associated processes. However, new dense GPS velocity field of Central Anatolia exhibits systematic local patterns of internal deformation inconsistent with either coherent rotation or translation. Velocity gradients computed along rotation profiles of Central Anatolia show nearly smooth westward increments which can not be explained through a simple rotation/translation of Central Anatolia Basin. Moreover, estimating and removing a rigid-body rotation represented by an Euler Pole computed from sites lying in the middle absorbs the velocity discrepancies between the Eastern and Western part of Central Anatolia down to a few millimetres leaving out systematic residuals. Upon completion of Turkish National Fundamental GPS Network (TNFGN) in 2002, further observations were carried out in Central Anatolia which result in a velocity field of unprecedented spatial density with average inter-station distance of 30-50 km. Also, the data from particular stations of Turkish National Permanent GPS Network (TNPGN) contributed to the analyses. We computed horizontal velocity field with respect to ITRF2000, to Eurasia, and to a computed Anatolia Euler Pole as well. Two distinct models of Anatolia neotectonics, microplate and continuum deformation were tested through rigid-body Euler rotations and strain analysis, respectively. Results show that decomposition of the Eurasia-fixed velocity field into rigid rotations and residuals reveals systematic residuals up to 5 mm/yr with respect to a computed best-fit Euler Pole located at 31.6820N$\pm$0.05, 31.6130E$\pm$0.02 with 1.3800/Myr $\pm$0.01 rate. Relative velocities computed along rotation paths exhibit westward increasing linear gradients of 0.7 mm to 1.3 mm per 100 km depending on the latitude which is mechanically inconsistent with the assumptions of a coherent transport or rotation due to an extrusion in the east. Moreover, strain analysis results show that up to 100 nanostrain/yr E-W extension rates are observed along approximately N-S striking faults within the region from west of Karliova to Isparta Angle which is another indication of partitioned extensional strain across the Central Anatolia. On the other hand, compressional strains were obtained near eastern branch of Isparta Angle, Tuz Gölü and southern Anatolia. In this study, we provide new quantitative results about the fact that deformation in Central Anatolia is not uniform and possible driven by extension through slab pull and/or suction in west-southwest and compression in the south rather than coherent rotation and/or translation/transport of Anatolia driven by an extrusion process in the east.

Keywords: GPS, Central Anatolia, Deformation, Euler Pole Parameters, Rigid Block Rotation, Translation