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Uplift of the northern margin of the Central Anatolian Plateau: lateral plateau growth by combined strike-slip and reverse faulting associated with the North Anatolian Fault, Turkey

Cengiz YILDIRIM (1,2), Taylor F. Schildgen (2), Helmut Echtler (1), Daniel Melnick (2), and Manfred R. Strecker (2)

(1) GeoForschungsZentrum, Potsdam, Germany (cengiz@gfz-potsdam.de), (2) Institut für Erd- und Umweltwissenschaften, Universität Potsdam, Germany

Located between the Taurides in the south and the Pontide mountains in the north the Central Anatolian Plateau constitutes a highland at an average elevation of 1.5 km in the transition between the Aegean extensional province to the west and the Bitlis-Zagros collision zone to the east. These morphotectonic provinces define the relatively rigid Anatolian plate, which has been extruding westward along the dextral North Anatolian Fault (NAF) and sinistral East Anatolian Fault since Miocene time as a result of the collision between the African and Arabian plates with Eurasia. While these first-order features are well known, the mode and rates of plateau uplift remain controversial. Mechanisms causing plateau uplift in this region may span lithospheric mantle delamination to distributed crustal shortening. The northern margin of the plateau is tectonically active and is closely associated with the NAF. Here, folded and uplifted Miocene to Quaternary strata, disturbed bedrock rivers and deeply incised gorges indicating ongoing tectonic uplift define the northern flanks of the plateau. This provides a promising setting for exploring the spatiotemporal patterns surface uplift and deformation that may help decipher possible mechanisms for uplift and lateral growth of the plateau.

We present structural and geomorphic field observations, morphometric data and interpret published geodetic and seismic reflection data in the context of the evolution of the northern plateau margin. Our regional morphometric analysis reveals regional topographic anomalies, steep channel gradients, and local high relief areas as proxies for ongoing surface uplift. Using the pole reconstruction of Reilinger et al. (2006) we analyze velocity vectors obtained from GPS measurements. We calculated the horizontal plate-motion slip vectors along the NAF, and by using the local fault strike, deconvolved the absolute vector into fault-normal and fault-parallel components. Taken together these assessments suggest that differential surface uplift is active between the NAF and the Black Sea. The distribution of surface uplift inferred from the highest topographic relief and channel gradients is focused mostly on the western part of the plateau margin, which correlates with the highest magnitude of NAF-normal motion revealed from geodetic results. This area furthermore coincides with the area of uplifted Black Sea shorelines (0.5-0.7 m) during the 03.09.1968 Bartın earthquake.

Importantly, the boundaries of the modern topographic highs of the margin are controlled by regionally active thrust faults, which were active first in the Paleogene, but reveal unequivocal evidence for Quaternary activity. Structural and geomorphic field observations combined with onshore and offshore seismic reflection data reveal that the northern margin of the plateau forms an active bivergent wedge with out-of-sequence thrusting. Although topographic boundaries are controlled by active reverse/thrust faults, none of the faults apparently accommodate large magnitudes of upper crustal shortening. Due to the lack of significant crustal shortening despite recent surface uplift and relief development, we conclude that the restraining-bend geometry of the NAF, potentially combined with a deeper structural detachment horizon which creates a wedge or positive flower structure geometry, is responsible for lateral growth of the northern plateau margin. This interpretation implies that onset of dextral movement along the NAF was critical for the development of the northern plateau margin. Rather than wholesale plateau uplift, this setting rather suggests piecemeal plateau growth through a complex interaction of strike-slip faulting and lateraly advanced thrust and reverse faults.