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Late Cenozoic extension in Anatolia and its implication for the tectonic escape model

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The westward motion of Anatolia is often used as a classic example of indentation-escape tectonics. In this model, the collision between Arabia and Eurasia is responsible for lateral extrusion of Anatolia toward the Aegean basin forming a free boundary. Anatolia is considered a rigid lithospheric block guided by the active right-lateral North Anatolian Fault (NAF) in the north and by the left-lateral East Anatolian Fault (EAF) in the southeast. Available GPS data show that the present-day movement of Anatolia can be described as a coherent counterclockwise rotation, favoring the model of a rigid westward tectonic extrusion of the Anatolian plate at a first approximation. However, the velocity field increases from East Anatolia to the Aegean region, which seems contradictory with the hypotheses that (1) Anatolia as a whole behaves as a rigid block and (2) the engine for Anatolian westward motion is indentation of Arabia.

From our interpretation of remote sensing data and structural analysis in the field, we show that during the late Cenozoic Anatolia has been in large part subjected to extensional tectonics involving separate crustal blocks. Deformation is not localized along the NAF but distributed in triangular wedges bounded by the NAF and NE-trending adjacent fault systems cutting the Anatolian block. The eastern boundary of Anatolia seems to have migrated by successive jumps from west to east, creating fault zones parallel to the EAF. Compression is limited to the eastern Taurus belt and to a north-south elongate region running from the northern tip of the Amanos mountain belt to the Sivas basin, in relation with forced subduction of the African plate south of the Africa-Arabia-Anatolia triple junction.

Here we develop the idea that crustal thickening and related uplift of the Anatolian orogen are not related to the Arabia-Eurasia collision. We propose that the Anatolian crustal thickness increased during a major shortening event that occurred in the Eocene. Continuous shortening would have permitted the storage of crustal gravitational potential energy, which has been released since the Oligocene, when the Aegean basin opened. Extensional collapse of a thickened crust produced the extension that progressively migrated eastward across Anatolia during the Neogene-Quaternary. Migration of the extensional deformation is related to progressive jumps of NE-trending transtensional faults forming the eastern boundary of Anatolia at a given time. This tectonics can necessarily be understood admitting a low-angle detachment surface within the crust, where high-angle brittle faults connect. Eastward propagation of the extension is accompanied by thinning of the crust and of the lithospheric mantle.