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Geodynamic Evolution of Subduction to Collision to Escape in Central Anatolia From Surface to Mantle - Results From the CD-CAT Project

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Despite significant progress toward understanding the kinematics of modern tectonic escape in Anatolia, considerable uncertainty remains regarding the dynamics of the transition from collision to escape. Because of the relatively small size of the Anatolia microplate, regional-scale studies spanning the plate margins and interior are well-suited to investigate the driving forces and space-time evolution of this unique tectonic transition in collisional orogens. CD-CAT (Continental Dynamics-Central Anatolia Tectonics) is a five-year (2011–2016) project funded by the National Science Foundation (USA) designed to explore the surface-to-mantle dynamics of Anatolia during the Cenozoic subduction-collision-escape transition in central Anatolia. Our approach integrates results from a diversity of methods including: structural, stratigraphic, and geomorphic analyses; magnetostratigraphy; low-temperature thermochronometry; Ar/Ar geochronology; geochemistry; passive seismic experiments (71 stations over two years); magnetotellurics; and numerical modeling.

The principal results from this project include: recognition of a margin-wide magmatic lull from ∼40–20 Ma, followed by a southwestward migration of the initiation of magmatism toward and within the Central Anatolia Volcanic Province (CAVP); an early Miocene switch from contraction/transpression to extension/transtension in the Kırşehir and Niğde Massifs, while contraction changed to late Miocene strike-slip deformation east of the Central Anatolian fault zone (CAFZ); rain shadow development due to uplift of the central Taurides ∼11–5 Ma; thin to absent lithospheric mantle beneath central Anatolia; the lack of an Arabia slab shallower than 800 km depth; and a change in the Cyprus slab from horizontal beneath the central Taurides and apparently fragmented beneath the CAVP, to very steeply dipping beneath the eastern Isparta Angle. The CAFZ lies along part of the Inner Tauride Suture (ITS) and represents a fundamental inherited lithosphere-scale structure that has accommodated contrasting magnitudes and styles of deformation to the east and west since Arabia collision. The coincidence of a similarly NNE-oriented lower plate boundary (Africa COB) or STEP fault between the Cyprus and Arabia slabs may have amplified the role of the CAFZ in controlling differential upper plate deformation.

These findings support the following tectonic scenario: the first stage involved late Eocene to early Miocene horizontal subduction of the Afro-Arabia slab from central Anatolia to the Zagros, culminating in the final suturing of the Taurides and Pontides in Anatolia. The second stage occurred during the Miocene and involved the segmentation of the downgoing slab at the longitude of the CAFZ to form the Arabia slab in the east and the Cyprus slab in the west. North of Arabia, early Miocene rollback and foundering of the Arabia slab resulted in widespread volcanism, slab delamination beneath the eastern Taurides and eventual break-off and rapid sinking into the lower mantle starting at ∼15–10 Ma. North of Cyprus, initial rollback, steepening and breakup of the Cyprus slab are recorded by early Miocene upper plate extension and exhumation, followed by middle Miocene voluminous CAVP magmatism and uplift of the southern Taurides margin. The final stage involved a transition from diffuse to localized strain along transcurrent structures that have facilitated the westward escape of Anatolia since the latest Miocene-Pliocene.