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Miocene to Recent Magmatism and Geodynamics of Eastern Turkey

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Eastern Turkey has been an active continental collision zone for the last 15 My between the African and Eurasian continents. The collision started at around 15 Ma after the total consumption of oceanic lithosphere of the southern branch of the Neotethys Ocean beneath E Anatolia and is still going on, as Africa still converges to E Anatolia with a velocity of ∼2.5 cm/y. The overriding Anatolian plate, resided below the sea level till the collision, was subjected to a major block uplift event around 10 Ma, emerging as a widespread plateau ∼2 km above the sea level, which has been roughened by later erosion and volcanic activities. The aforementioned plateau is considered as part of a regional dome structure with ∼1000 km diameter extending from E Anatolia up to Azerbaijan. Immediately after the collision, a widespread volcanism emerged on the Eastern Anatolian Plateau, whose products covered almost over half of the region. Characteristically, all these products contain a distinct subduction component. The volcanism in the collision zone continued to the historical times and is considered to be still active. The region includes some of the largest volcanic centers (e.g. Ararat, Nemrut, Tendürek and Süphan volcanoes) and plateaus (e.g. The Erzurum-Kars Plateau) around the circum-Mediterranean region. The collision-related volcanic province is not only confined into Anatolia but also continues into the neighboring countries through Georgia, Armenia, Iran and up to Russia, spanning ∼1000 km.

In contrast, the underthrusting Arabian platform was subjected to both crustal-scale east-west folding close to the thrust front and extensional deformations perpendicular to the suture zone. Along these extensional fractures, within-plate lavas with no subduction component erupted. This intraplate volcanism focused on the Karacadağ volcanic complex, covering an area ∼10,000 km2. Early Stage volcanism of Karacadağ was dominated by magmas derived from a shallower (litospheric) mantle source, while magmas of the later stages were derived from deeper (asthenospheric) sources.

Based on the results of seismic tomography, tectonics and geochemical/isotopic studies of the volcanic successions, it has now been well established that both uplift and widespread volcanism across the region have a common reason: a major "slab-steepening and breakoff event beneath a large accretionary complex". After the collision, being unsupported by the subduction, the slab started to be steepened beneath the region. This possibly resulted in widening, invasion and upwelling of the mantle wedge beneath E Anatolian accretionary complex, followed by a widespread decompressional melting, generating voluminous magmas with an inherited subduction signature. The subducted slab broke off beneath the Bitlis-Pötürge massif ∼10 Ma, causing the enriched asthenospheric mantle with no subduction component beneath the Arabian continent to flow to the north through a slab-window. This resulted in mixing between the subduction-modified E Anatolian and the Arabian asthenospheres. On the basis of the results from our geochemical/ geochronologic/isotopic data and petrologic models, we argue that the temporal and spatial changes in the chemistry of volcanics across the region are the artifacts of these geodynamic events that controlled the movement and interaction of mantle domains with contrasting geochemical, isotopic and mineralogical identities. Compositions of some of the primitive magmas were further modified via interactions with the lithospheric mantle and/or crustal material coupled with fractionation en route to the surface.