



## Geodynamic and Magmatic Evolution of the Eastern Anatolian-Arabian Collision Zone, Turkey

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The Eastern Anatolian-Arabian Collision Zone represents a crucial site within the Tethyan domain where a subduction system involving a volcanic arc (i.e. Cretaceous to Oligocene Pontide volcanic arc in the north) associated with a large subduction-accretion complex (i.e. Cretaceous to Oligocene Eastern Anatolian Accretionary Complex i.e. "EAAC" in the south) turned later into a major continental collision zone that experienced a series of geodynamic events including lithospheric delamination, slab-steepening & breakoff, regional domal uplift, widespread volcanism and tectonic escape via strike slip fault systems. The region includes some of the largest volcanic centers (e.g. Karacadağ, Ağırkaya caldera, Ararat, Nemrut, Tendürek and Süphan volcanoes) and plateaus (e.g. The Erzurum-Kars Plateau) as well as the largest transform fault zones in the Mediterranean region. A recent geodynamic modeling study (Faccenna et al., 2013) has suggested that both the closure of the Tethys Ocean and the resultant collision were driven by a large scale and northerly directed asthenospheric mantle flow named the "Tethyan convection cell". This convection cell initiated around 25 Ma by combined effects of mantle upwelling of the Afar super plume located in the south, around 3,000 km away from the collision zone and the slab-pull of the Tethyan oceanic lithosphere beneath Anatolia in the north. The aforementioned mantle flow dragged Arabia to the north towards Eastern Anatolia with an average velocity of 2 cm/y for the last 20 My, twice as fast as the convergence of the African continent (i.e. 1 cm/y) with western and Central Turkey. This 1 cm/y difference resulted in the formation of the left lateral Dead Sea Strike Slip Fault between the African and Arabian plates. Not only did this mantle flow result in the formation of a positive dynamic topography in the west of Arabian block, but also created a dynamic tilting toward the Persian Gulf (Faccenna et al., 2013). Another remarkable indication of the advance of the mantle flow below Arabia is the northward propagation of within-plate alkaline basaltic volcanism which initiated ~30 Ma around the Afar region to SE Turkey in a time period of ~20 My. The northernmost portion of this alkaline basaltic province is represented by the Karacadağ volcanic complex in SE Turkey which covers a footprint area of 10,000 km<sup>2</sup> and consists of lavas ranging in age from ~11 Ma to 100 Ky. The Early Stage volcanism of Karacadağ was dominated by magmas derived from a shallower metasomatized lithospheric mantle source, in contrast to the Late Stage volcanism which was sourced by a garnet-bearing, deep asthenospheric mantle with Sr, Nd and Pb isotopic composition transitional between Red Sea MORB and Afar plume (Keskin et al., 2012).

After the initial contact of the Arabian and Eurasian continents at ~15 Ma, the subducted Tethyan slab steepened beneath the large EAAC, possibly resulting in widening, invasion and upwelling of the mantle wedge beneath E Anatolian accretionary complex. This possibly caused a sucking effect on the asthenosphere, creating a mantle flow from the Pontides in the north to the south (Keskin, 2003). A hot and buoyant asthenosphere emplaced beneath the thinned lithosphere, which is represented mostly by a mélange material, and resulted in the formation of a regional domal uplift. Dehydration of the sunken slab accompanied with decompression of the upwelling asthenospheric mantle generated magmas with a subduction signature which was imprinted on a relatively enriched source chemistry across E Anatolia in a period from 15 to 10 Ma. The slab broke off beneath the region, creating a slab window at around 10 Ma. This caused the enriched Afar-type asthenospheric mantle to flow to the north through the slab-window. As a result, the subduction-modified (i.e. due to slab dehydration) E Anatolian and the enriched Arabian asthenospheric mantles started to mix into each other. The eruption of the first alkaline lavas in the region at around 10 Ma (e.g. tephrites and alkaline basalts in the N of Lake Van) can be interpreted as the indication of the formation of the slab-window beneath the region due to tearing of the slab. I also argue that spatial and temporal presence of a variable subduction signature can be linked to the persistent dehydration from the deep lying slab below the region.

Melting models indicate that there is a temporal change in source characteristics across the collision zone from a garnet-dominated deeper mantle-source during the Miocene to a spinel-dominated shallower source during the Quaternary. I argue that this notable change can either be linked to the derivation of variable fractions of magmas from a newly formed lithospheric mantle by cooling of the asthenosphere along the contacts with the crust (i.e.

reformation of lithospheric mantle), or to the mineral phase transformations in the mantle from garnet to spinel in response to decompression. AFC and EC-AFC models reveal that the importance of the AFC process decreased broadly in time while each volcano experienced a unique replenishment and fractionation history in the crustal magma chambers.

#### REFERENCES

Faccenna, C., Becker, T.W., Jolivet, L. and Keskin, M. (2013). Mantle convection in the Middle East: Reconciling Afar upwelling, Arabia indentation and Aegean trench rollback, *Earth and Planetary Science Letters*, 375, 254–269, doi: 10.1016/j.epsl.2013.05.043

Keskin, M. (2003). Magma generation by slab steepening and breakoff beneath a subduction-accretion complex: An alternative model for collision-related volcanism in Eastern Anatolia, Turkey, *Geophysical Research Letters*, 30(24), 8046, doi:10.1029/2003GL018019

Keskin M., Chugaev A.V., Lebedev V.A., Sharkov E.V., Oyan V. and Kavak O. (2012). The Geochronology and Origin of Mantle Sources for Late Cenozoic Intraplate Volcanism in the Frontal Part of the Arabian Plate in the Karacada Neovolcanic Area of Turkey. Part 2. The Results of Geochemical and Isotope (Sr–Nd–Pb) Studies. *Journal of Volcanology and Seismology*, 6(6), 361–382, doi: 10.1134/S0742046312060048