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Magmatism and Geodynamics of Eastern Turkey

Mehmet Keskin (1), Vural Oyan (2), Evgenii V. Sharkov (3), Andrey V. Chugaev (3), Ş. Can Genç (4), Esin Ünal (5), Namık Aysal (1), Olgun Duru (1), and Orhan Kavak (6)

(1) Istanbul University, Department of Geological Engineering, Faculty of Engineering, Istanbul, Turkey (keskin@istanbul.edu.tr), (2) Van Yuzuncu Yil University, Department of Mining Engineering, Faculty of Engineering and Architecture, 65080, Van, Turkey, (3) Russian Academy of Sciences, Institute of the Ore Deposits Geology, Petrology, Mineralogy and Geochemistry, Staromonetny per., 35, Moscow 119017, Russia, (4) Istanbul Technical University, Faculty of Mines, Dept. of Geol. Engineering, 34469 Maslak, Istanbul, Turkey, (5) Van Yuzuncu Yil University, Faculty of Engineering and Architecture, Dept. of Geol. Engineering, Zeve Campus, Van, Turkey, (6) Department of Mining Engineering, Faculty of Engineering and Architecture, Dicle University, Diyarbakιr, Turkey

Eastern Turkey has been an active collision zone for the last 15 My between the Arabian Plate and Eurasian continent. The collision initiated after the closure of the southern branch of the Neotethys Ocean by northward subduction beneath E Anatolia at ∼15 Ma. The collision-related volcanism started immediately after the closure of the ocean (again at around 15 Ma) in the north of the present day Lake Van with the eruption of mostly intermediate to acid lavas displaying distinct subduction characteristics. Both continental collision and the magmatism are still active, because the Arabian plate still converges to Anatolia with a velocity of ∼2.5 cm/y.

The overriding Anatolian block experienced a major uplift event around 10 Ma. The region once resided below the sea level merged as a widespread plateau ∼2 km above the sea level as part of a regional dome structure with ∼1000 km diameter, extending from Central Anatolia in the West to Azerbaijan in the East. The first alkaline lavas derived from a relatively more enriched source erupted to the surface in the N of Lake Van coeval with the initiation of the uplift at around 10 Ma. The underthrusting Arabian platform, on the other hand, was deformed as a result of both crustal-scale east-west folds adjacent to the major thrust zone and extensional deformations perpendicular to the suture zone. Alkaline within-plate lavas with no subduction component erupted through these extension zones. This intraplate volcanism focused on the Karacadağ volcanic complex that covers an area of ∼10,000 km2. Early Stage volcanism of Karacadağ was dominated by magmas derived from a shallower metasomatized (litospheric) mantle source, while magmas of the later stages were derived from deeper (asthenospheric) sources. The Karacadağ volcanic area of SE Anatolia was sourced by a garnet bearing, deep asthenospheric mantle which is similar to that of Afar in terms of its Pb isotopic ratios. This brings into question whether the mantle material from the Afar plume reached beneath Eastern Anatolian by a mantle convection cell.

We argue that both the uplift and the widespread volcanism across the region share a common reason: a major "slab-steepening and breakoff event beneath the large Eastern Anatolian Accretionary Complex". We argue that the older intermediate calc-alkaline volcanic products displaying a distinct subduction signature were possibly derived from the mantle wedge that opened out due to the steepening of the slab after the continental collision. Being unsupported by the subduction, the slab started to be steepened beneath the region, possibly resulting in widening, invasion and upwelling of the mantle wedge beneath E Anatolian accretionary complex. This possibly created a sucking effect on the asthenosphere, creating a mantle flow from the Pontides in the north to the south. The inferred asthenospheric flow perhaps pulled a portion of the asthenosphere that once had resided beneath the Pontide arc. Therefore, the subduction component was inherited from the previous Pontide arc magmatism. The widespread decompressional melting generated voluminous magmas with the aforementioned inherited subduction signature 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 asthenospheric mantle with no subduction component beneath the Arabian continent to flow to the north through a slab-window. As a result, the subduction-modified E Anatolian and the enriched Arabian asthenospheric mantles started to mix into each other. We interpret 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) as the indication of the formation of the slab-window beneath the region due to tearing of the slab.

The volcanism in the collision zone continued till the historical times. 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 Mediterranean region. Our 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. Our 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.

On the basis of the results from our geochemical data and petrologic models, we argue that the temporal and spatial changes in the chemistry of volcanics across the region are the reflections of the 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.