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Chemical Geodynamics of Cenozoic Magmatism in the Turkish-Iranian and Tibetan High Plateaus

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We analyze the chemical geodynamics of Cenozoic magmatism in the Turkish-Iranian and Tibetan high plateaus within the framework of their collisional tectonic evolution. Post-collisional magmatism in both plateaus shows systematic spatial and temporal variations as a direct result of mantle response to plate tectonic events and hence changes in mantle dynamics through time. Continental collision and crustal accretion events along the northern peripheries of the Arabian and Indian plates ∼45 Ma resulted in the detachment of Neotethyan lithospheric slabs (slab breakoff), followed by significant uplift and development of orogen-parallel, curvilinear magmatic belts. Two discrete collisional events within the Neotethyan realm to the west caused the accretion of the Tauride-South Armenian ribbon continent with Eurasia in the north and the accretion of the Bitlis-Pütürge-Sanandaj-Sirjan ribbon continent with Arabia in the south. The resulting slab breakoff-induced magmatism produced the mid to late Eocene calc-alkaline to alkaline volcanic sequences in the Eastern Pontides (Turkey), Lesser Caucasus (Azerbaijan) and the peri-Caspian region (northern Iran), and the coeval shoshonitic volcanic sequences straddling the Bitlis suture zone (Maden Complex) in southern Turkey and in the Urumieh-Dokhtar, Ahar-Arasbaran and Central Iranian magmatic belts in western Iran. The Eocene magmatism following the post-collisional Neotethyan slab breakoff to the east produced extensive shoshonitic to adakitic volcanic units in Central Tibet (between the Jinsha River and Bangong-Nujiang suture zones), and I-type Gangdese granitoids and the Linzizong volcanic suites in the Lhasa terrane north of the Yarlung-Zangbo suture zone. In both plateaus, subsequent magmatism migrated southward through time in the Miocene and produced ultrapotassic and silicic bimodal volcanic sequences with strong asthenospheric signatures; lithospheric delamination was responsible for providing the necessary asthenospheric heat flux, which caused widespread partial melting both in the upwelling and convecting asthenosphere and in the overlying crust. NW-SE-oriented normal faulting in the Turkish-Iranian high plateau and the Lesser Caucasus facilitated the rise and eruption of asthenosphere-derived alkaline olivine basalts with minimal continental contamination in the late Miocene-Pliocene. Ultrapotassic and high-K volcanism accompanied by extensive N-S faulting in the Lhasa terrane, southern Qiangtang and Hoh Xil in Southern Tibet was a result of this delamination-induced magmatic episode. The removal of the Lhasa lithospheric root via delamination facilitated the northward movement of the Indian mantle lithosphere beneath Southern Tibet. This continental underplating terminated the asthenospheric flux and magmatism in Southern Tibet and has provided the support to maintain the high topography in the overlying Southern Tibetan crust. Limited asthenospheric upwelling between the foundering Indian lithosphere and the Kunlun-Qaidam backstop to the north produced potassic volcanism in Northern Tibet since ∼8 Ma. The Plio-Pleistocene and Quaternary volcanism in the Turkish-Iranian plateau has become more alkaline in time and towards the south, indicating the stronger influence and an increased input of melts derived from the upwelling, and enriched asthenospheric mantle through time. However, all alkaline volcanic rocks of this phase still display a subduction zone geochemical fingerprint, suggesting that their magmas were derived from partial melting of subduction-metasomatized continental lithospheric mantle in the spinel lherzolite field. A nearly 60-80-km-thick lithospheric lid and the underlying asthenospheric heat 'buble' collectively support the modern high elevation of the Turkish-Iranian plateau. We infer that the mantle-driven evolution of post-collisional Cenozoic magmatism and topographic buildup has been diachronous across both the Turkish-Iranian and Tibetan plateaus.