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Orogenic plateau magmatism of the Arabia-Eurasia collision zone

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Magmatism is a common feature of high plateaux created during continental collision, but the causes remain enigmatic. Here we study Pliocene-Quaternary volcanics from the active Arabia-Eurasia collision zone, to determine the chemistry of these rocks and their relations to faulting and deeper lithospheric structure. The great majority of the centres lie within the overriding Eurasian plate in Iran, eastern Turkey and Armenia , implying that mantle fertilised by pre-collision subduction processes plays a significant role in magma generation. The composition of the Pliocene-Quaternary centres is extremely variable, ranging from OIB-like alkali basalts, to intermediate types resembling mature continental arc lavas, to potassic and even ultrapotassic lavas. These centres are erupted across a mosaic of pre-Cenozoic suture zones and heterogeneous lithospheric blocks. The chemical diversity implies a range of partial melting conditions operating on lithospheric and perhaps sub-lithospheric sources. Published data show a thick (>200 km) lithospheric keel beneath the Arabia-Eurasia suture, thinning to near normal thicknesses ($\sim$120 km) across much of central and northern Iran. Thin mantle lithosphere under eastern Turkey (max. $\sim$30 km) may relate to the region's juvenile, accretionary lithosphere. These variable thicknesses are constraints on the cause of the melting in each area, and the degree of variation suggests that no one mechanism applies across the plateau. Various melting models have been suggested. Break-off of the subducted Neo-Tethyan oceanic slab is supported by tomographic data, which may have permitted melting related to adiabatic ascent of hot asthenosphere under areas where the lithosphere is thin. This seems a less plausible mechanism where the lithosphere is at normal or greater than normal thickness. The same problem applies to postulated lower lithosphere delamination. Isolated pull-aparts may account for the location of some centres, but are not generally applicable as melt triggers. Enigmatic lavas are erupted over the thick lithosphere of Kurdistan Province, Iran. These alkali basalts and basanites have the chemical characteristics of small degree (<1%) melts in the garnet stability field. Most possess supra-subduction zone chemistry (La/Nb = 1-3), but this signature is highly variable. Similar La/Nb variability occurs in the basic lavas of Damavand volcano in the Alborz Mountains of northern Iran. Modelling suggests the depletion of residual amphibole during the progression of partial melting can explain the observed La/Nb range. This melting may occur as the result of lithospheric thickening. At depths of $\sim$90 km, amphibole-bearing peridotite crosses an experimentally-determined "backbend" in its solidus. Melting can continue while the source remains hydrated. Such "compression" melting may apply to parts of other orogenic plateaux, including Tibet.