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Contrasting melt equilibration conditions across Anatolia

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The widespread mafic volcanism, elevated crustal temperatures, and plateau-type topography in Central Anatolia, Turkey, could collectively be the result of lithospheric delamination, mantle upwelling, and tectonic escape in response to Arabian-Anatolian plate collision. We used the results from basalt geochemistry and a passive-source broadband seismic experiment obtained as part of an international collaborative effort (Continental Dynamics – Central Anatolia Tectonics) to investigate the crust-mantle structure and melting conditions associated with the Quaternary Hasandag Monogenic Cluster (HMC) south and west of Hasandag volcano. The HMC is unusually mafic, not only for Central Anatolia but globally, enabling meaningful comparisons between geochemical and seismic interpretations of mantle conditions.

HMC basalts are characterized by orogenic signatures that could have originated (1) in mantle wedge that, after stagnating because of collision, was remobilized south and upward as a result of rollback of the African slab or, alternatively (2) by piecemeal foundering of residual mantle lithosphere into convecting upper mantle, producing small-scale convection and associated decompression melting. Melt equilibration conditions for the HMC are hot (T_P ~1335-1250˚C, assuming 1-4 wt.% H_2O) and shallow (P = 1.1 to 1.6 GPa), approaching those for MORB. Shear wave velocities are relatively constant at ~4.1 km/s between the Moho and a depth of ~45-50 km (~1.4 GPa; Fig. 6), below which Vs increases with increasing depth. We infer that a melt-perfused mantle lid could be locally present between 40 and 55 km.

In contrast to Central Anatolia, estimated equilibration conditions for Western Anatolia and Eastern Anatolia (east of the Inner Tauride Suture) mantle melts are hotter (by ≥60˚C) and deeper (mostly by 0.6-1.0 GPa). They also have chemical signatures that, unlike Central Anatolia, are similar to those of intraplate basalts. These differences are likely related to the presence of a fragmenting, if quite deep, Cyprus slab beneath Central Anatolia, in contrast to absence of the Arabian slab beneath Eastern Anatolia since at least 10 Ma, and flow of deep-seated asthenosphere through a tear in the African plate under Western Anatolia.

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