Lithospheric drip magmatism in NW Saudi Arabia highlights N. Red Sea - Dead Sea Transform interaction

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Widespread Cenozoic volcanism in north Africa and the Mediterranean is associated with arrival of the Afar plume, rifting of the Red Sea and closure of neoTethys. We report new bulk geochemical and mineralogical results on Miocene lavas from Harrat Ash Shaam and reinterpret published data in light of recent models of lithospheric drip melting triggered by these complex interactions. Portions of this lava field were studied in Israel, Jordan and Syria but no geochemical results have been reported for the majority of the basalt field located in Saudi Arabia. The Harrat occupies a key structural position related to diffuse and asymmetrical extension in the northern Red Sea at its intersection with the Dead Sea Transform.

Harrat Ash Shaam volcanism began 28 Ma and continued through 22 Ma; rejuvenated mafic volcanism returned following a hiatus from 22-13 Ma. This younger volcanic episode, which extends to Homs (Syria) and Harrat Hutaymah (central Saudi) is characterized by melts of metasomatized source material (amph$\pm$gt peridotite and pyroxenite; [1,2,3,4]).

Olivine xenocrysts in Harrat basalts display evidence of thermochemical disequilibrium that is also observed in disaggregated xenoliths from neighboring Harrat Urwayid[5]. These crystals display complex Mg-Fe zoning requiring rapid reheating. Most dramatically, the interiors of $Fo_{80\text{-}86}$ crystals are devoid of spinel inclusions but instead have complexly structured spinels surrounding their margins. These spinels are Al, Cr-rich and display zoning suggesting they were exsolved from the olivines during an annealing event. Major and trace element geochemistry of the primitive Harrat basalts indicate increased degree of melting (and decreased involvement of metasomatic phases) with depth, considered the hallmark of drip magmatism. We interpret these features to indicate lithospheric drip and mechanical thinning occurred in response to plate boundary reorganization along the Red Sea – Dead Sea Transform junction.

1 Shaw et al. 2003. J Petrology, 44, 1657-1679.
2 Weinstein et al. 2006. J Petrology, 47, 1017-1050.
3 Ma et al. 2011, J Petrology, 52, 401-430.
4 Duncan et al. 2016. J Volcan Geotherm Res, 313, 1-14.
5 Kaliwoda et al. 2007. Lithos, 99, 105-120.