Geochemical inferences from bimodal Afar volcanism

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The Afar Triple junction, Ethiopia is fed by the youngest lower mantle-sourced plume in a cratonic setting. Bimodal volcanism that started with thick eruption of flood basalts ca. ~31 Ma continues to this day, with basaltic (B) and silicic (S) volcanism. Major and trace elements and Nd, Sr, Pb and O isotopic data from a suite of 55 well-dated bimodal volcanic rocks from the Dabbahu-Manda-Harraro (DMH)[1], Gona[2,3] and the Southern Red Sea Rift (SRSR)[4] margin provide a spatial and temporal analysis of the mechanism of bimodal magma generation and evolution in time. The radiogenic isotopes and trace elements indicate a lower mantle plume-derived basaltic magma generating silicic lava without continental crustal contamination.

PRIMELT3 and rhyolite MELTS modeling give the average T^0C, B-1450 and S-1020 (DMH) and 1150 for B and S (Gona and SRSR). These T are consistent with our dynamic melting inverse modeling, implying formation of primitive Afar basalts by 3-9% partial melting of a LREE-enriched mantle source. The REE of the rhyolites is modelled by 35% partial melting of this hydrothermally altered basalt, followed by 20-70% fractional crystallization of plagioclase and clinopyroxene. The $\delta^{18}O$ values are decoupled from Sr and Nd isotopes. The heterogeneity of the $\delta^{18}O$ of whole rocks and included crystals is inconsistent with simple fractional crystallization supporting a partial melting/assimilation of the altered basaltic rocks for the origin of the silicic rocks.

We propose that the mechanism for generation of significant volumes, 35% in this case, of silicic crust without subduction or the assimilation of pre-existing crust can be applied for origin of Hadean continental crust.

[1]Ebinger et al. (2008), Geophys. J Int. **174(3)**, 1138-1152; [2]Quade et al. (2008), GSA Special Paper **446**, 1-31; [3]Kleinsasser et al. (2008), GSA Special Paper **446**, 33-65; [4]Wolfenden et al. (2005), GSA Bulletin **117**, 846-864