Evolution of the East African Rift: Drip Melting, Lithospheric Thinning and Mafic Volcanism

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Generalized outcrop areas of distinctive basalt types

Approximate extent of the Ethiopian dome
Oligocene flood basalts: Upwelling plume "bull’s eye" model relates basalt type to temperature, composition of rising asthenosphere.

Modified after Beccaluva et al. 2009
Aspects of HT2 basalt genesis are problematic

- HT2 lavas and picrites interpreted as melts of Afar plume
- Sr-Nd-Pb values not fully aligned with mantle reservoirs
- ITE abundances not fully aligned with mantle reservoirs
- Some of the samples contain amphibole

- Consider alternative interpretation
Consider process: Lithospheric drip melting

- Density instability in lithosphere
- Warm lithosphere destabilized
- Sinking material devolatilizes, melts
- Melting occurs during descent
- Resulting melts can be identified:
  - Hydrous
  - Melt fraction, depth increase together
  - Geochemical signatures are clear
HT2 lavas: signature of lithospheric drip melting
Modified after Beccaluva et al. 2009
No drip melting signature in young Ethiopian lavas

Field of HT2 lavas

Young Ethiopian lavas:
Bure (Meshesha & Shinjo)
MER (Furman, Rooney)
Bale (Nelson)
Ertar 'Ale (Barrat)
Lithospheric drip signature widespread 16-23 Ma

Rapid uplift in southern Ethiopia 12-19 Ma
Kenya, Western Rifts also show lithospheric drip
Lithospheric drip melting is significant in EARS

- Oligocene: Ethiopian flood basalts - HT2 lavas
- Miocene: Widespread from Turkana north through Ethiopia
  - Associated with period of rapid uplift in S. Ethiopia
  - Melts of pyroxenite, particularly in E. Ethiopia but also Turkana
- Pliocene: Eastern Ethiopian plateau, Kenya & Western Rifts
- Quaternary: locally within Kenya and Western Rifts

- Melting regions are localized (individual volcano / volcanic field)
- Drips not exclusively associated w/ rift faulting, edge convection