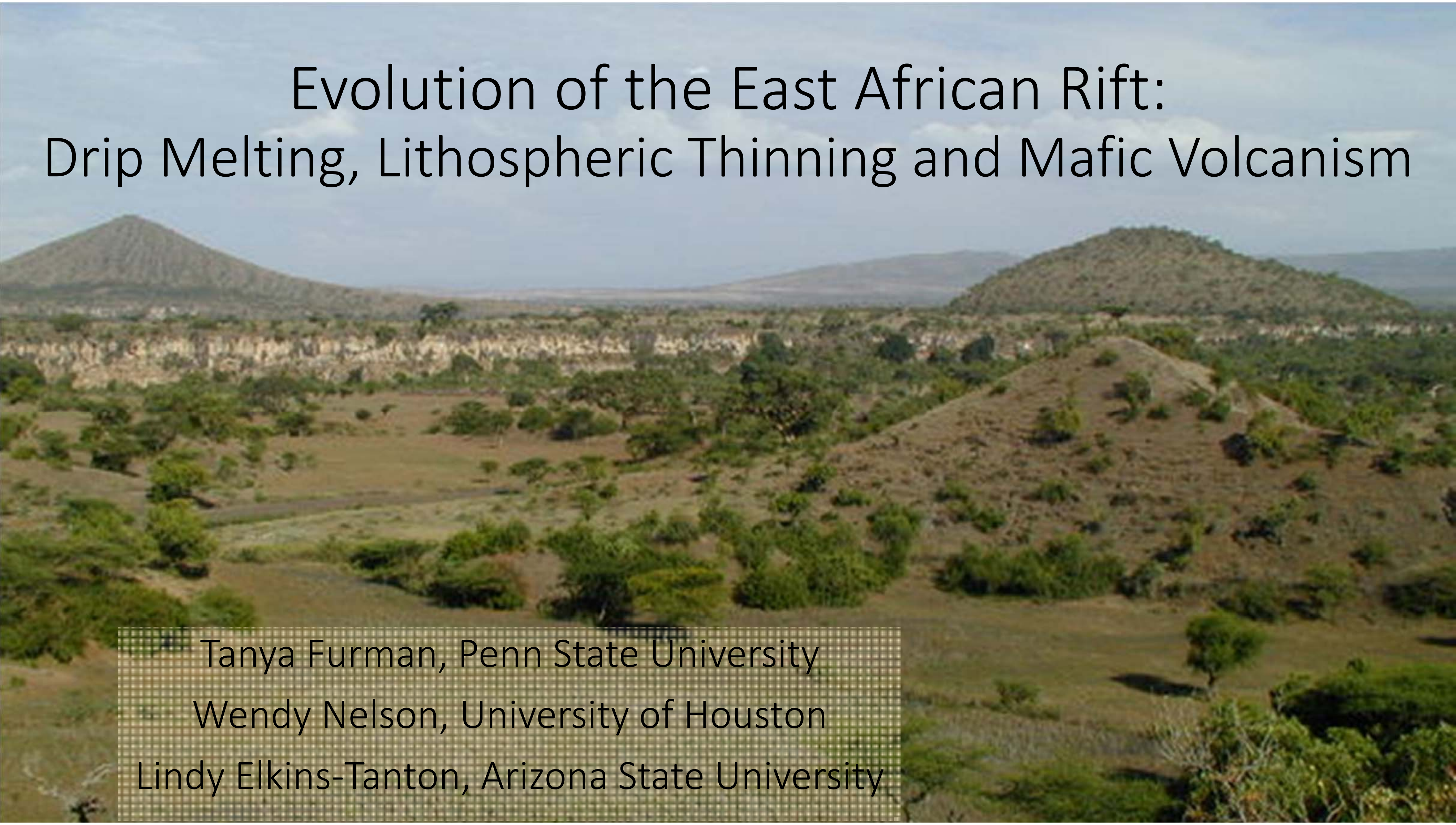
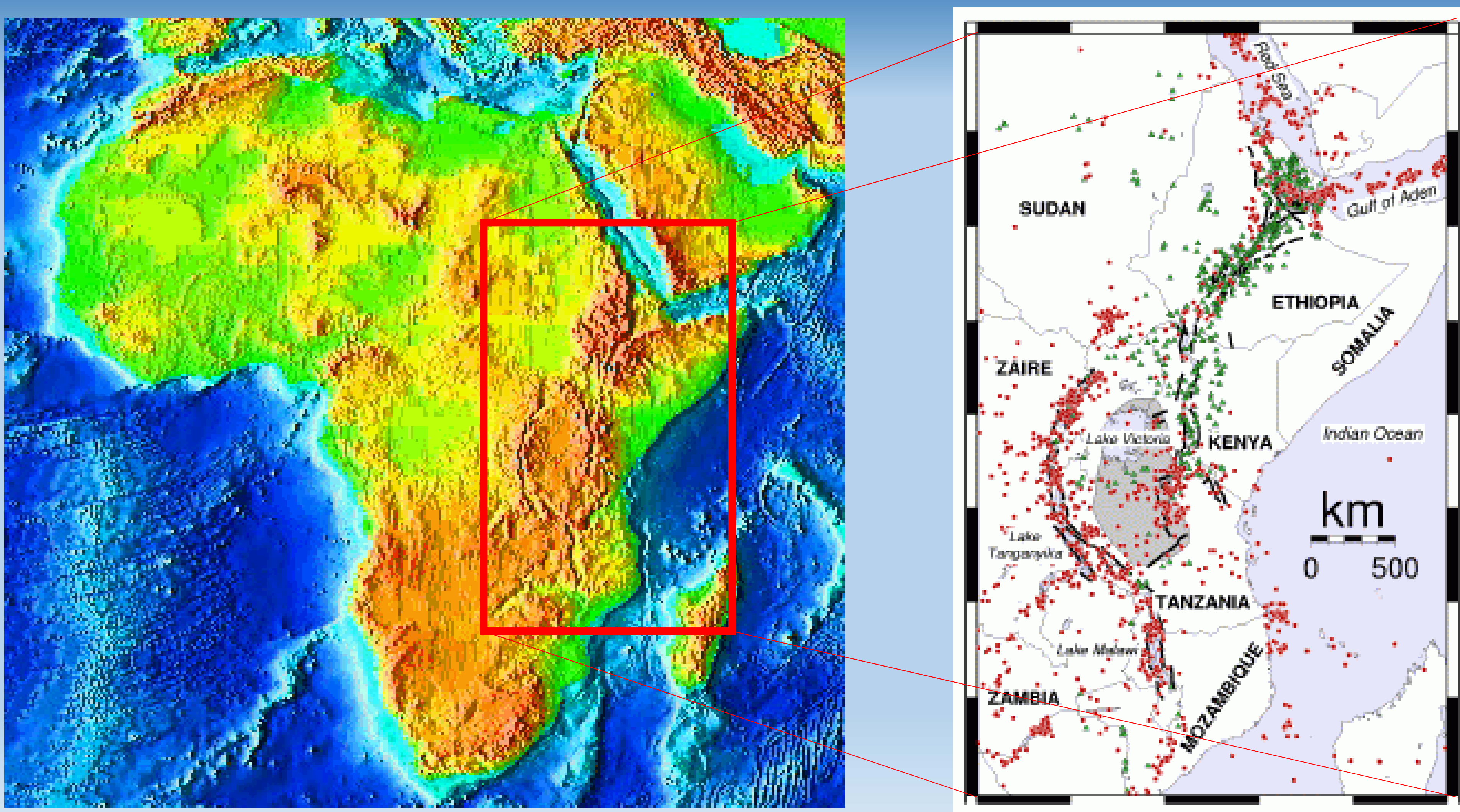
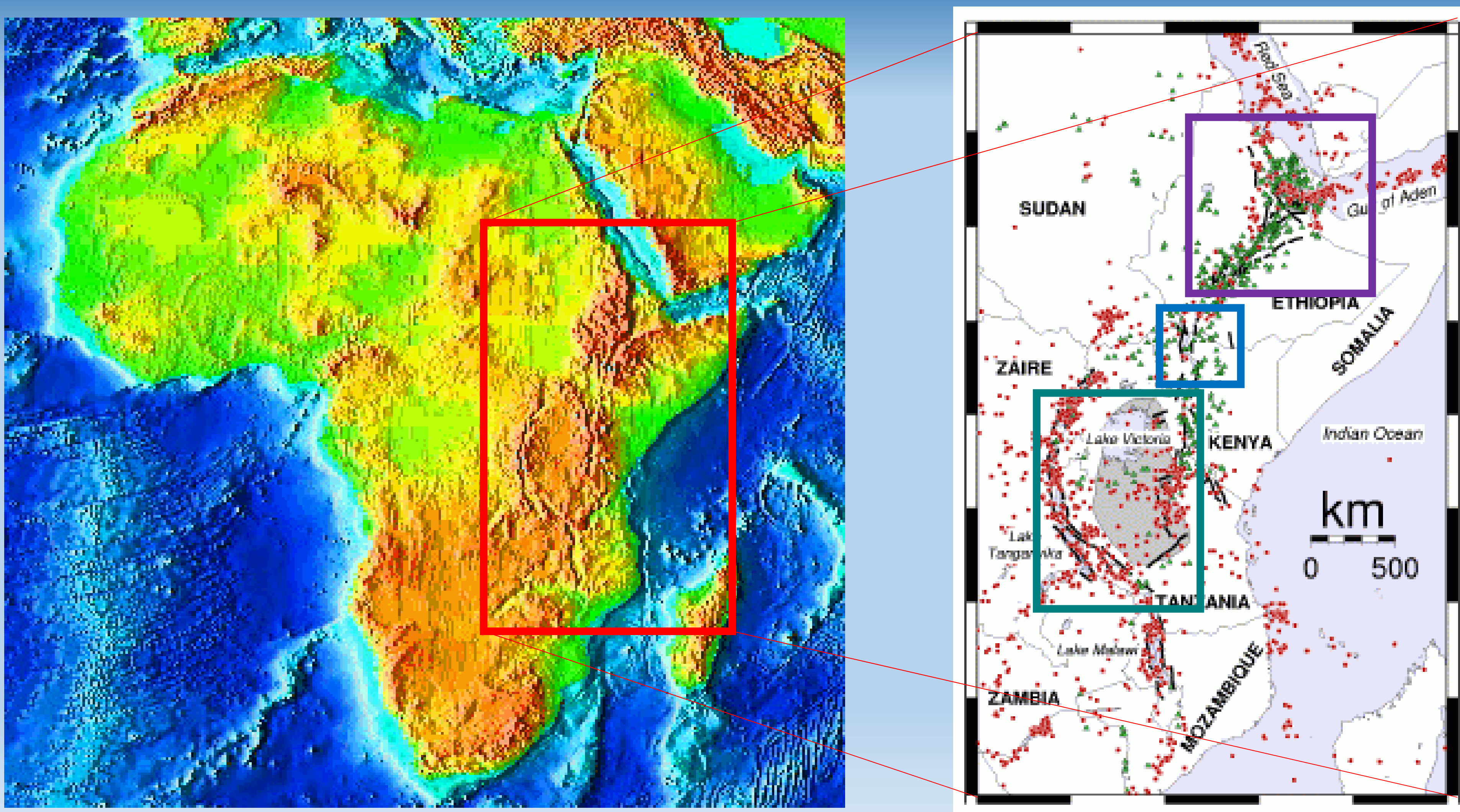


Evolution of the East African Rift:
Drip Melting, Lithospheric Thinning and Mafic Volcanism

Tanya Furman, Penn State University
Wendy Nelson, University of Houston
Lindy Elkins-Tanton, Arizona State University

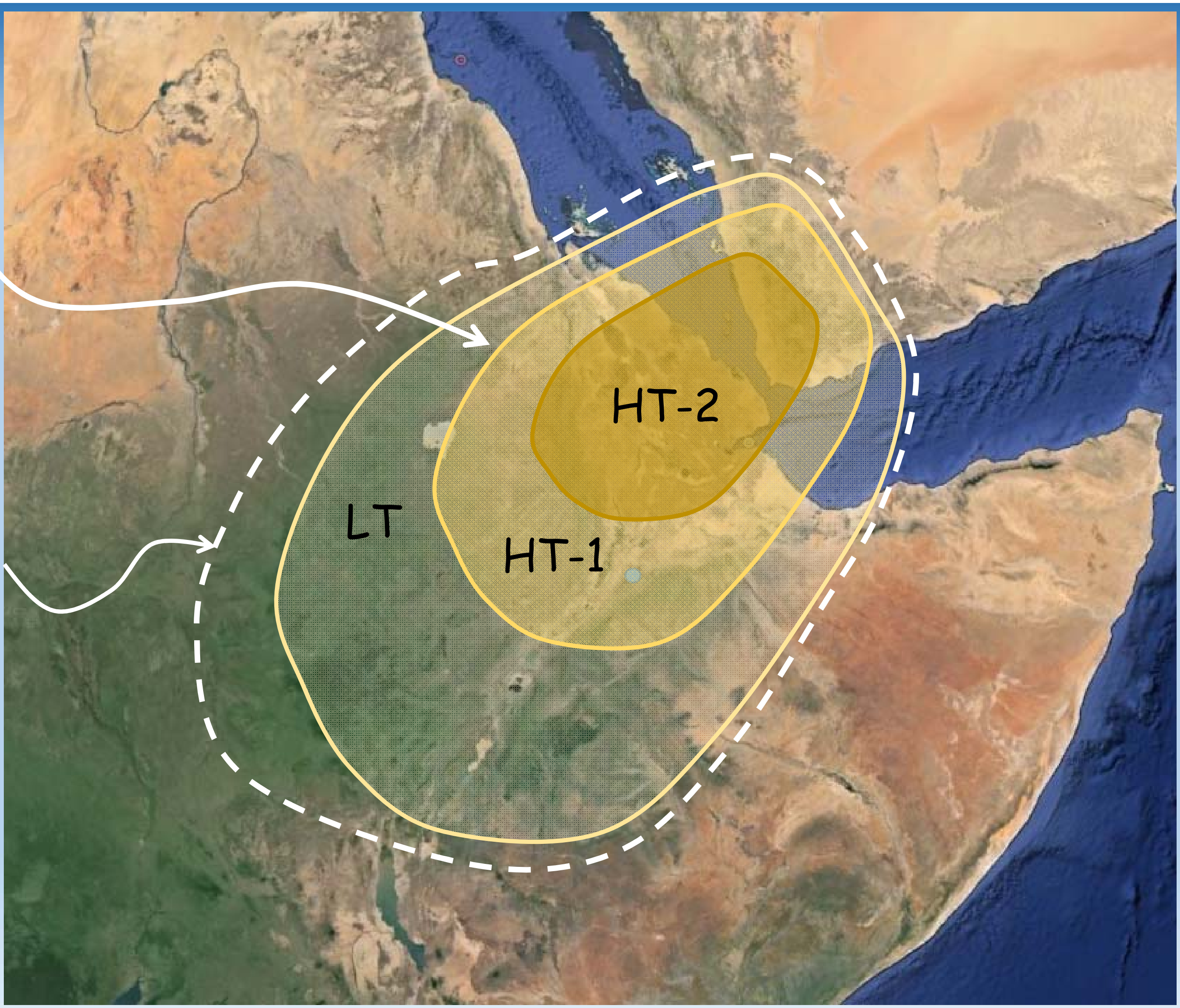

Red Sea
Gulf of Aden
SUDAN
ETHIOPIA
SOMALIA
ZAIRE
Lake Victoria
KENYA
Indian Ocean
km
0
500
Lake Tanganyika
TANZANIA
Lake Malawi
ZAMBIA
MOZAMBIQUE

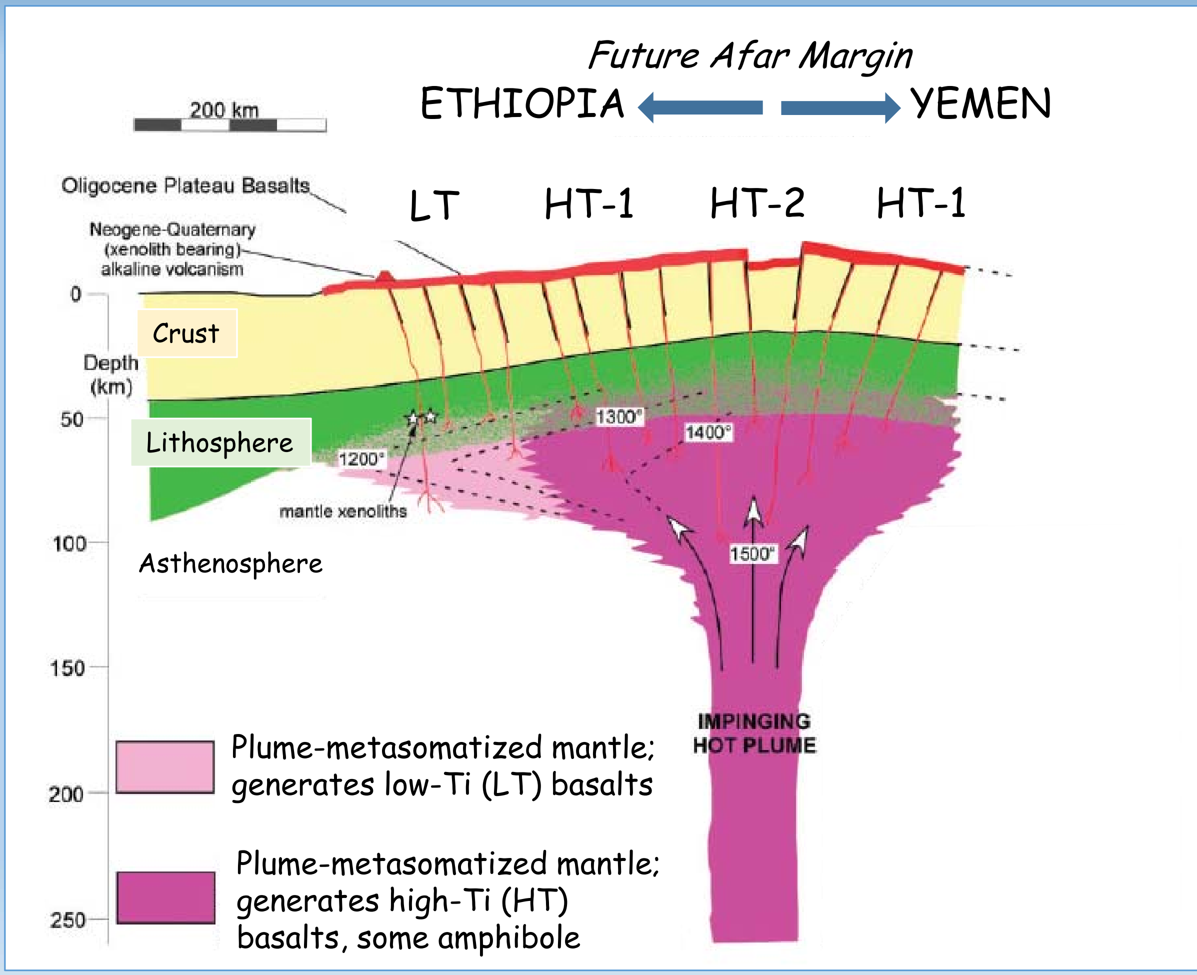


Red Sea
SUDAN
Gulf of Aden
ETHIOPIA
SOMALIA
ZAIRE
Lake Victoria
KENYA
Indian Ocean
km
0
500
TANZANIA
Lake Malawi
ZAMBIA
MOZAMBIQUE

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

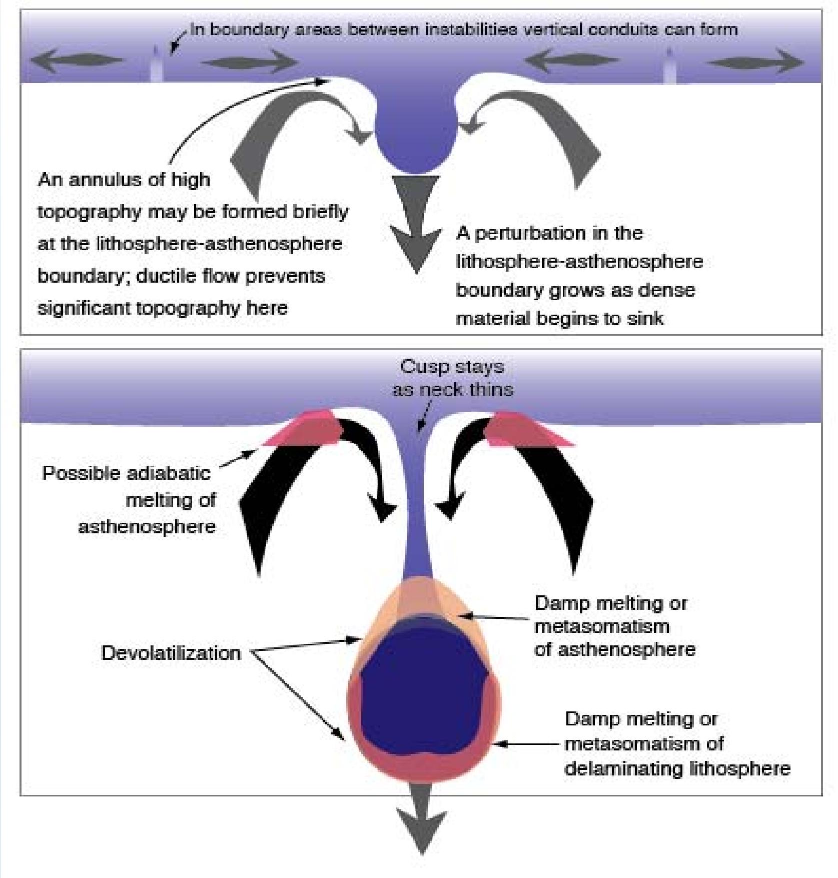
Modified after Beccaluva et al. 2009

Aspects of HT2 basalt genesis are problematic

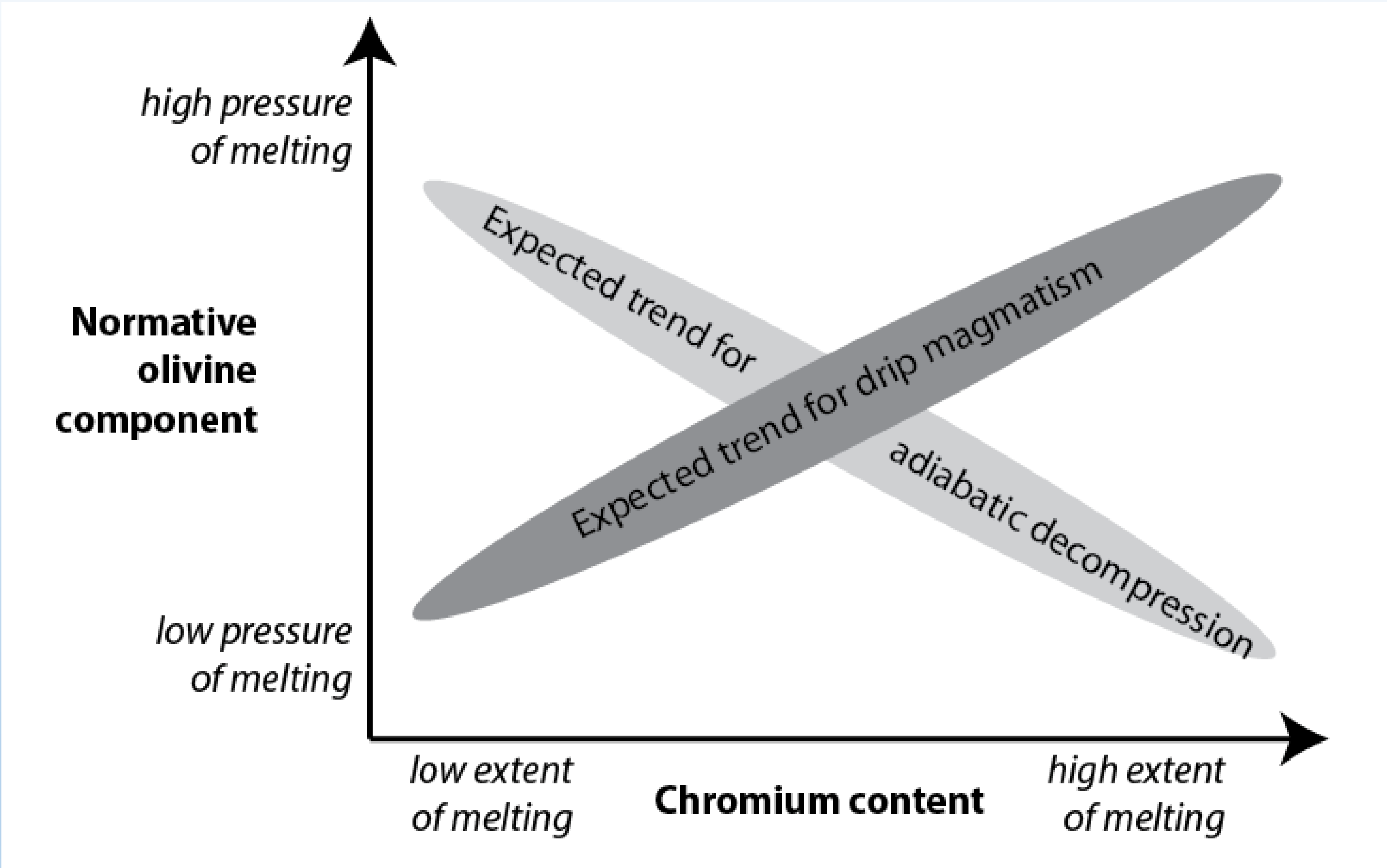
- HT2 lavas and picrites interpreted as melts of Afar plume
- Sr-Nd-Pb values not fully aligned with mantle reservoirs
- ITE abundances not fully aligned with mantle reservoirs
- Some of the samples contain amphibole

- Consider alternative interpretation

Consider process: Lithospheric drip melting

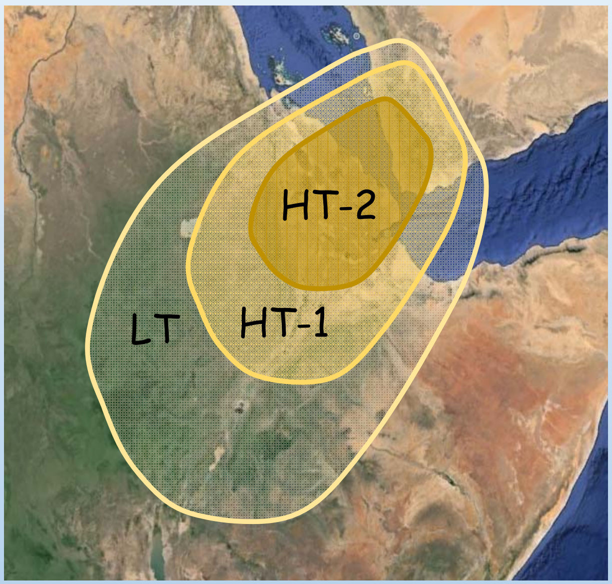


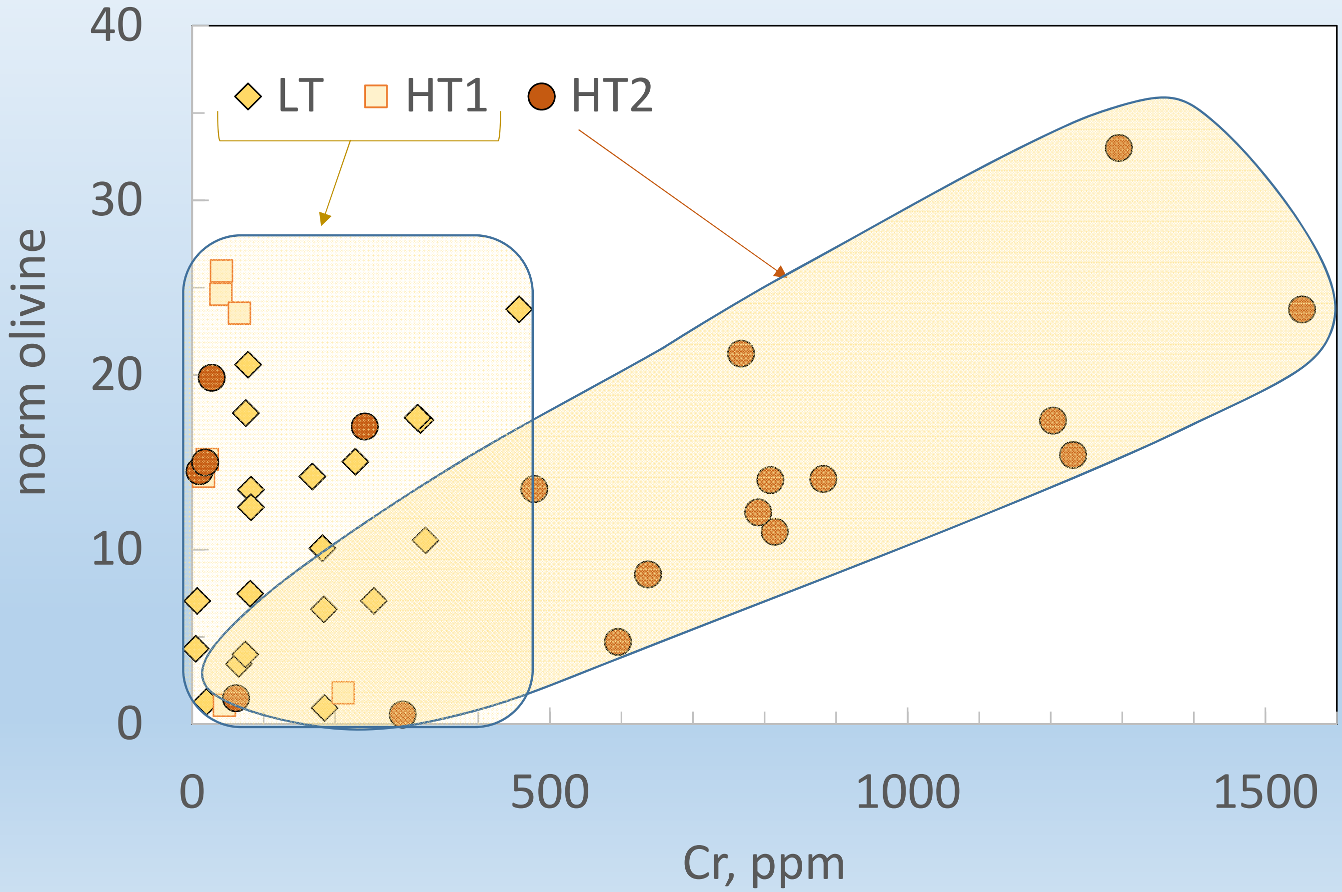
- Density instability in lithosphere
- Warm lithosphere destabilized
- Sinking material devolatilizes, melts
- Melting occurs during descent
- Resulting melts can be identified:
  - Hydrous
  - Melt fraction, depth increase together
  - Geochemical signatures are clear

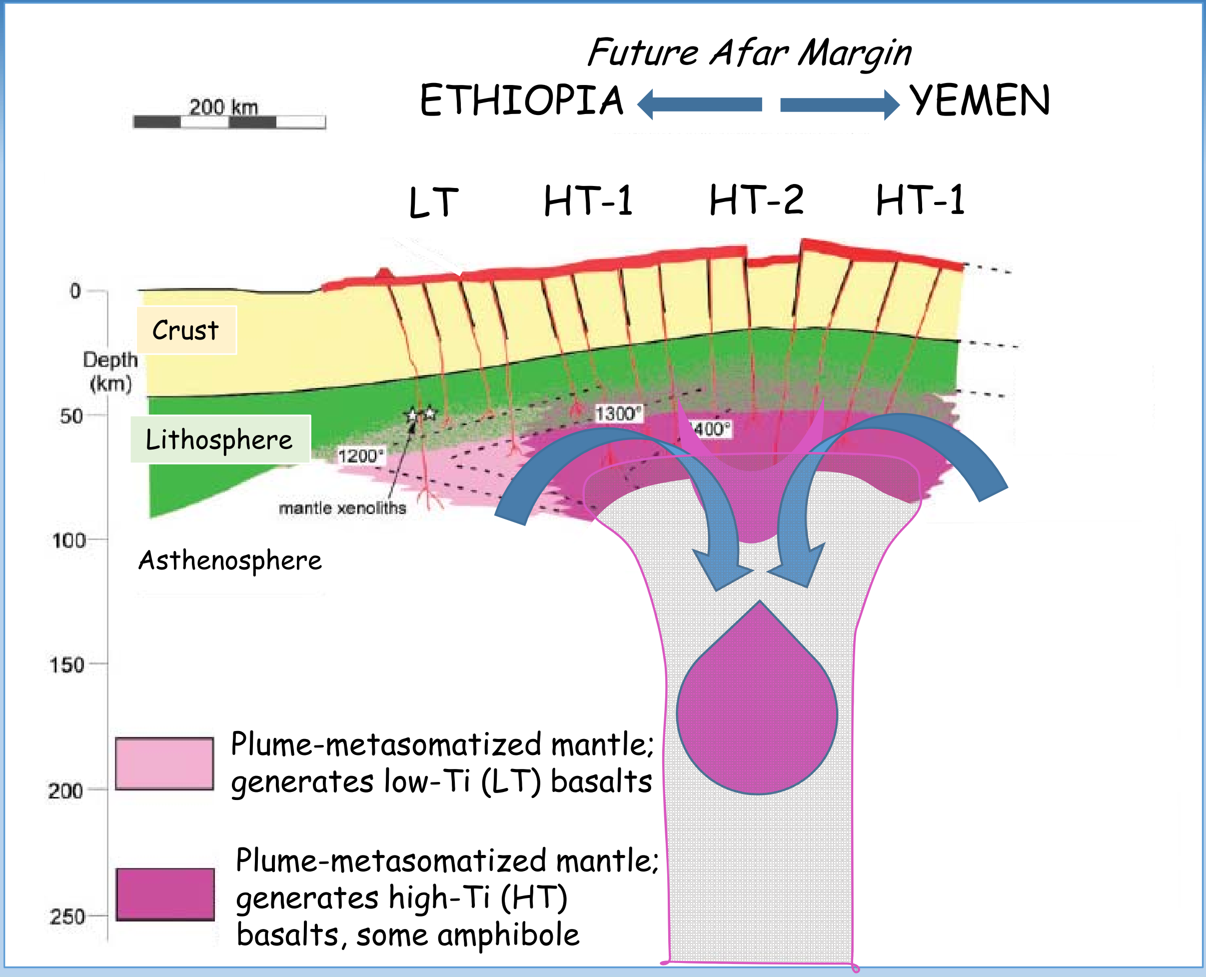


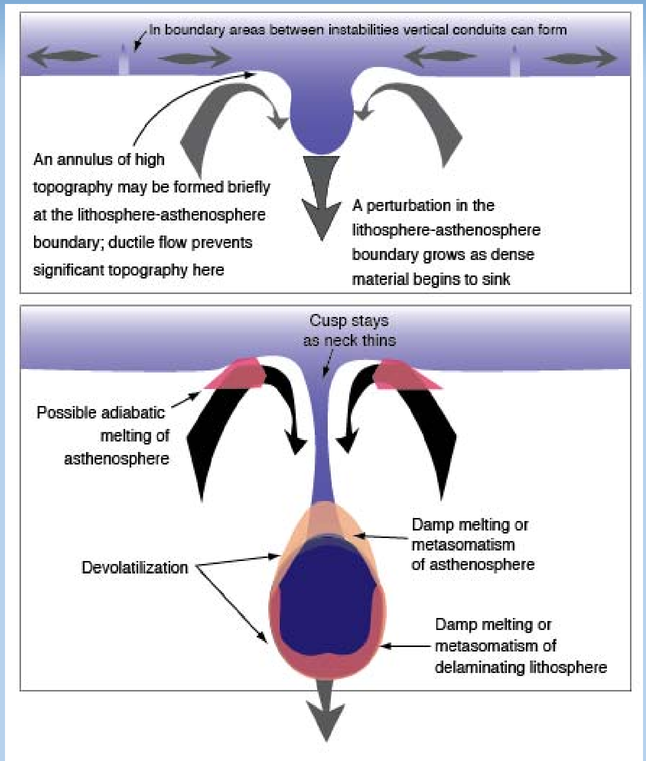
high pressure of melting
Normative olivine component
low pressure of melting
Expected trend for adiabatic decompression
Expected trend for drip magmatism
low extent of melting
Chromium content
high extent of melting

HT2 lavas: signature of lithospheric drip melting



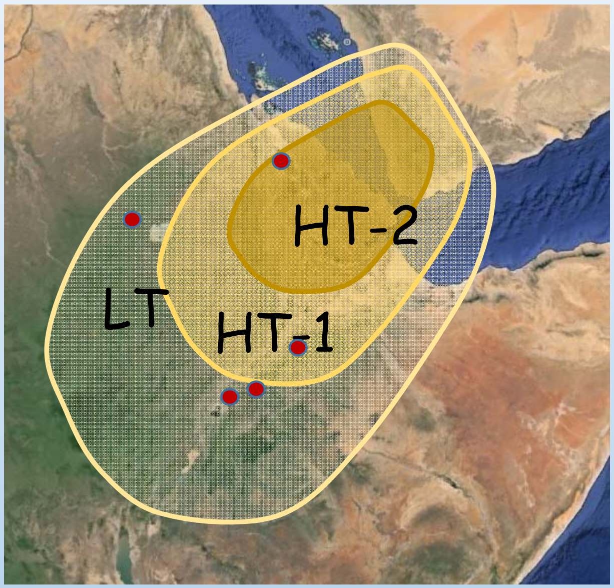




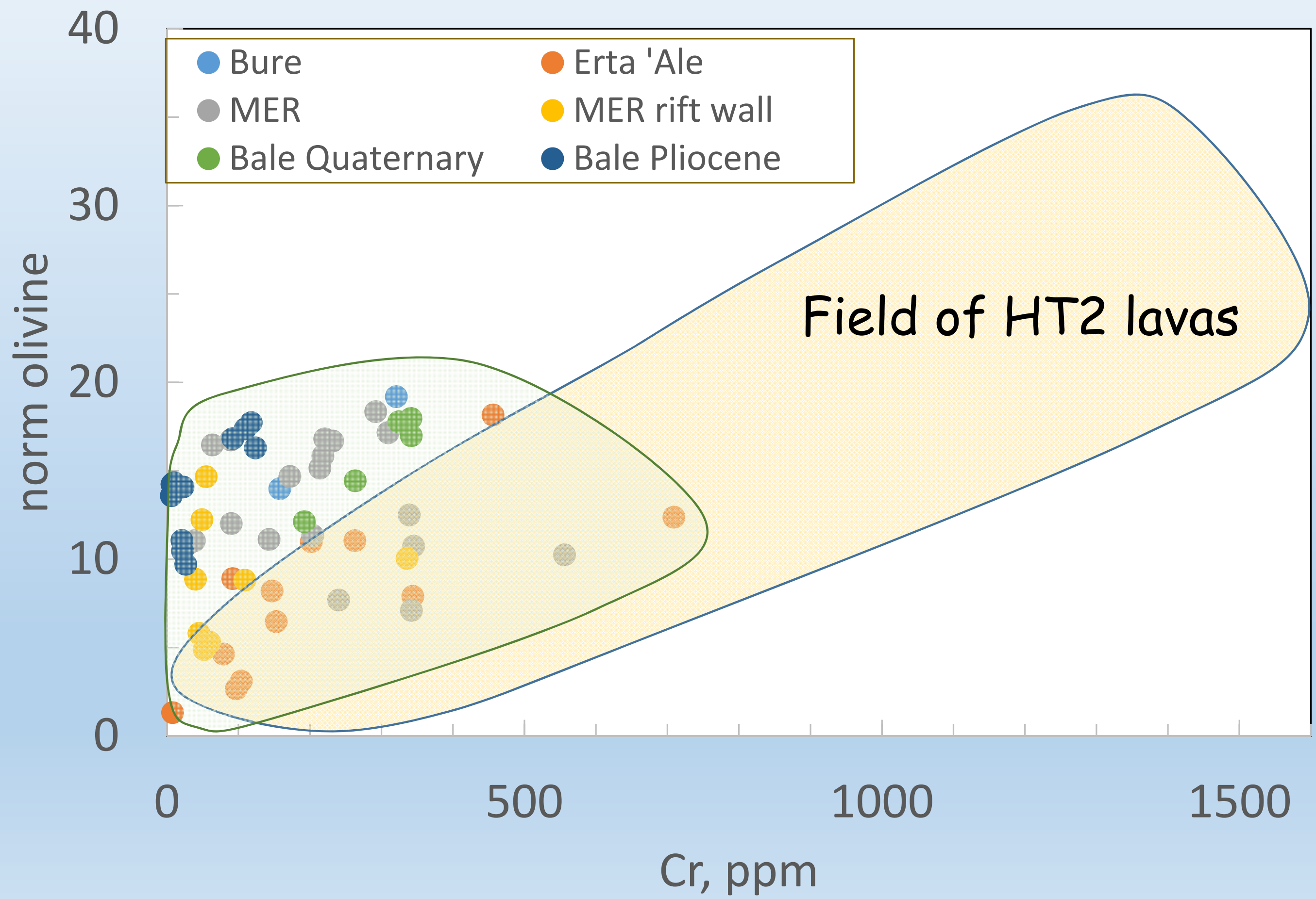


Modified after Beccaluva et al. 2009

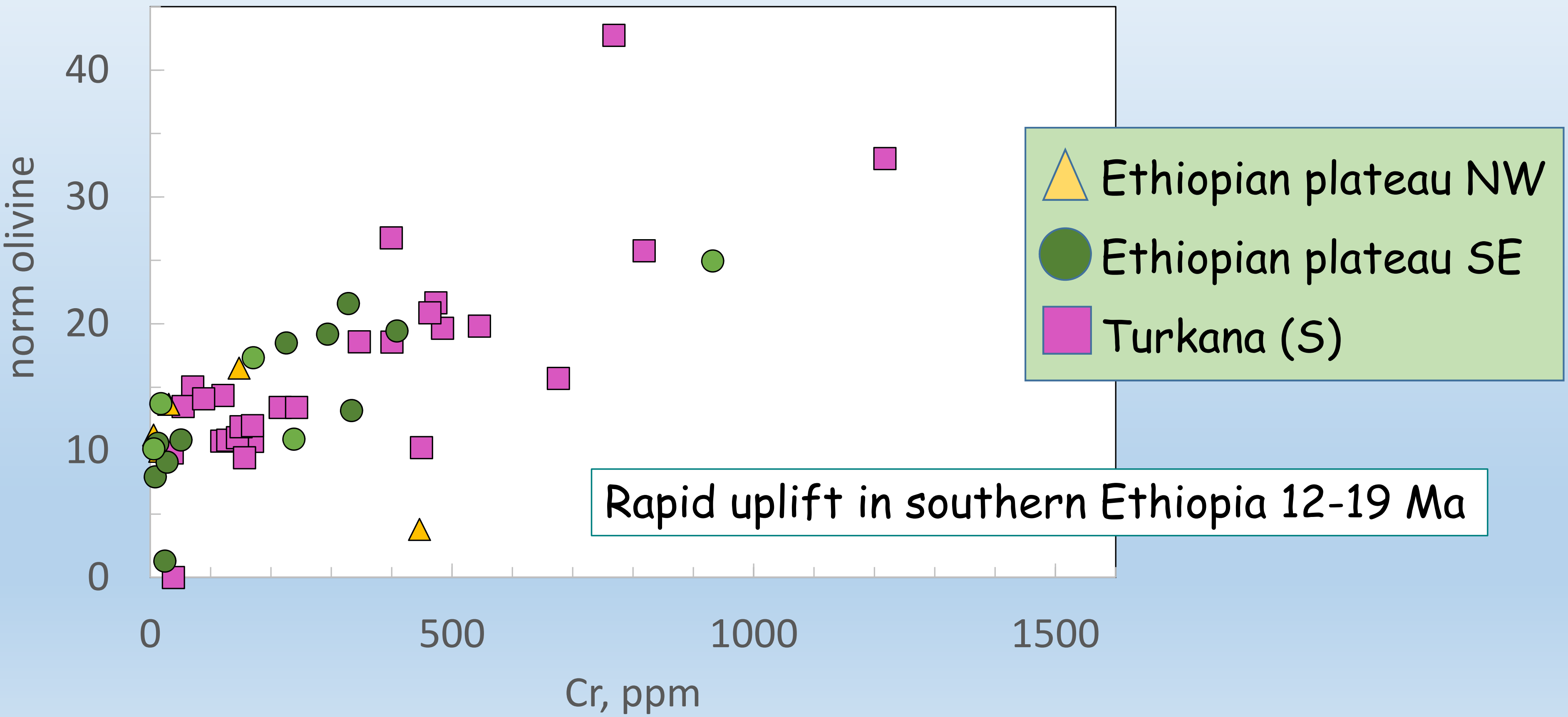
No drip melting signature in young Ethiopian lavas



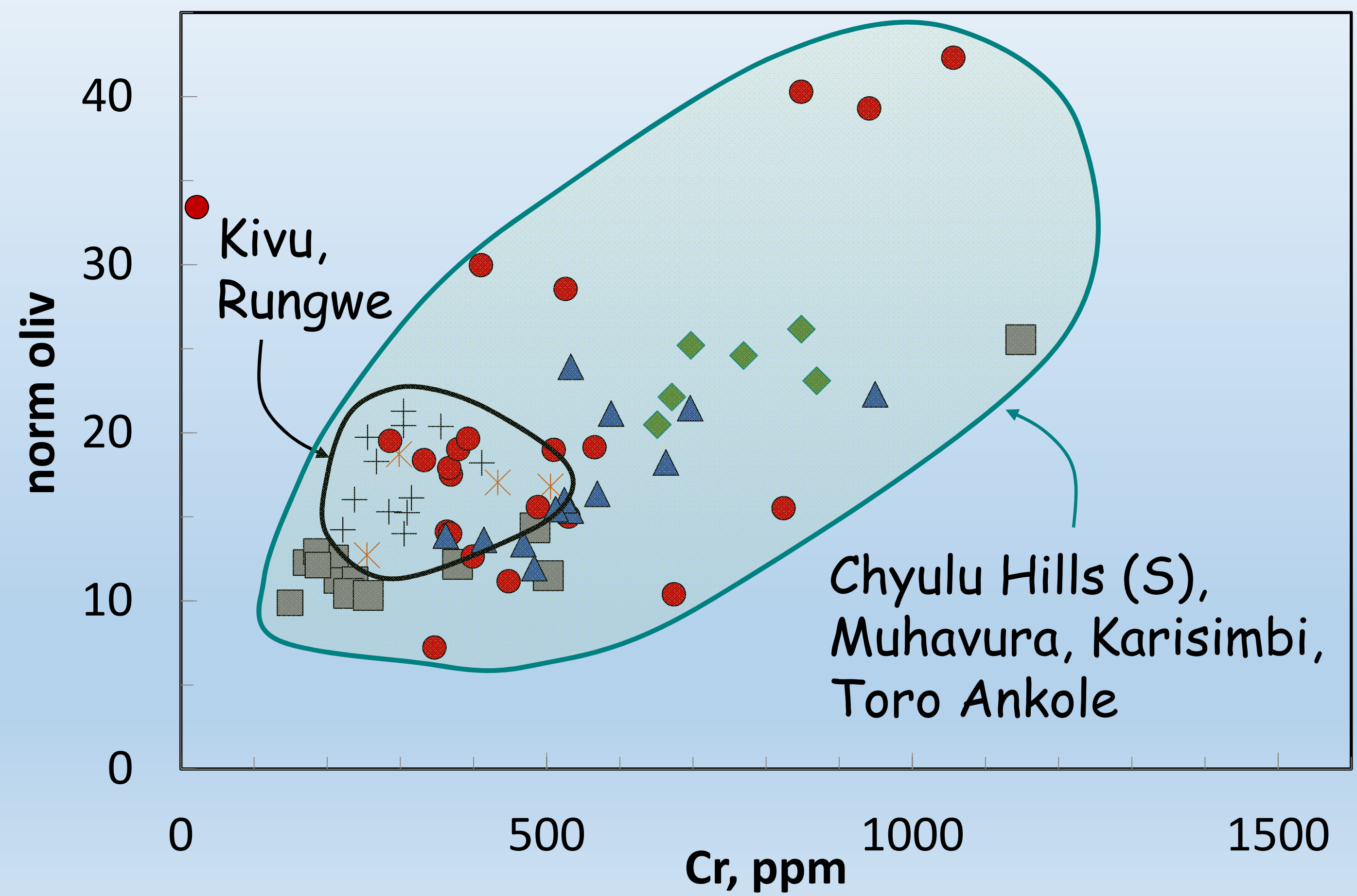
Young Ethiopian lavas :
Bure (Meshesha & Shinjo)
MER (Furman, Rooney)
Bale (Nelson)
Erta 'Ale (Barrat)



Lithospheric drip signature widespread 16-23 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