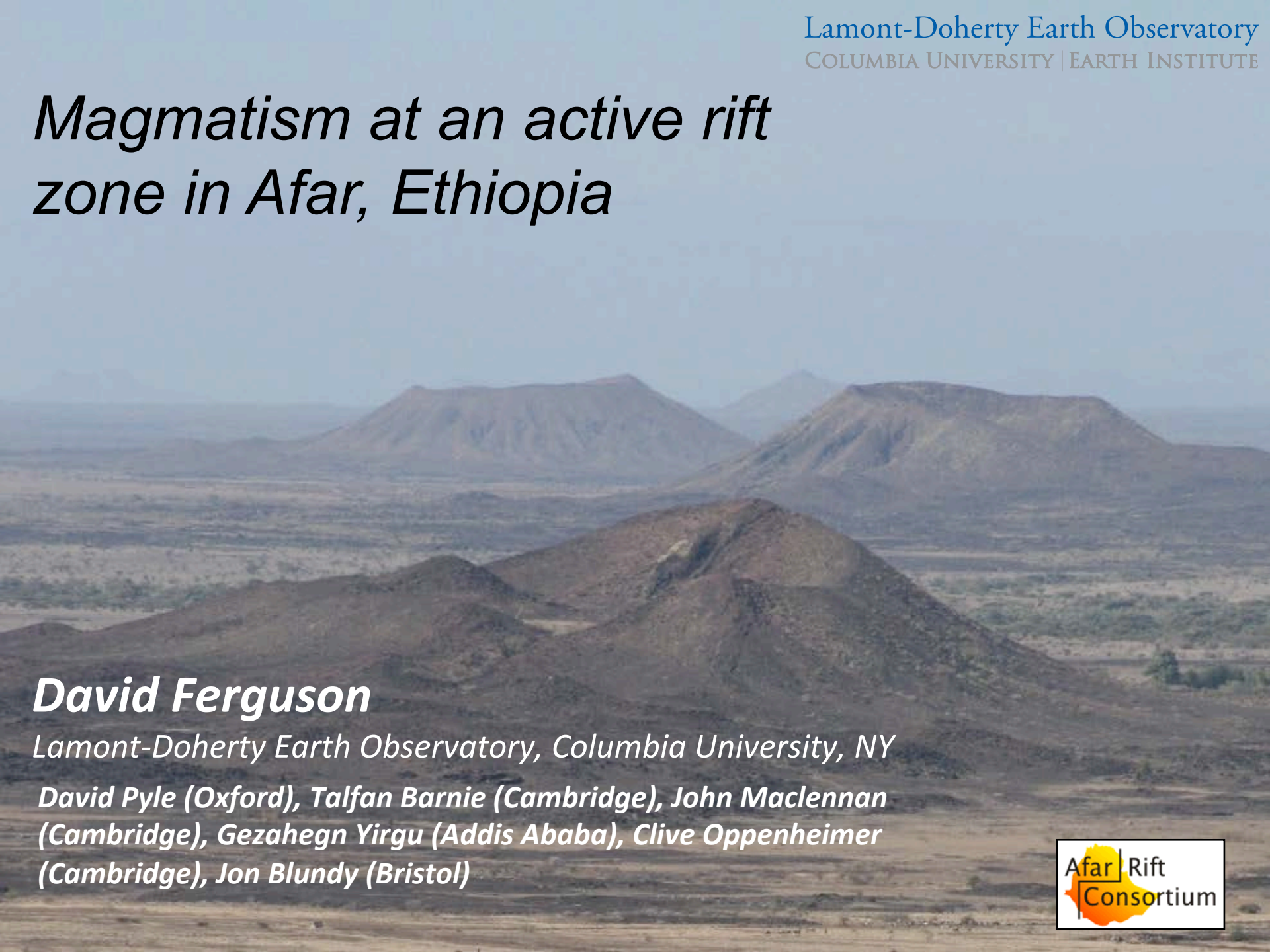
Lamont-Doherty Earth Observatory
Columbia University | Earth Institute

Magmatism at an active rift zone in Afar, Ethiopia



David Ferguson

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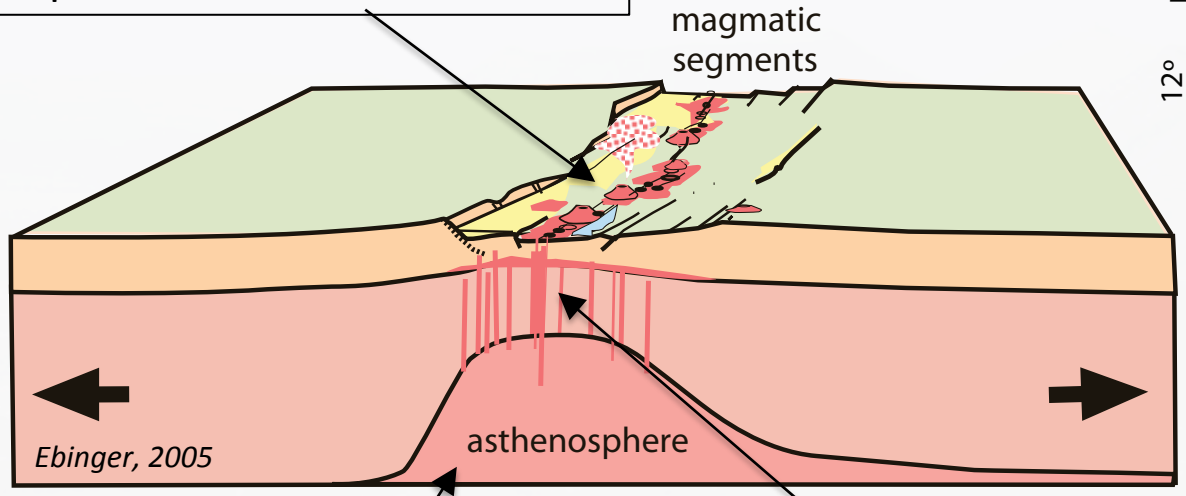
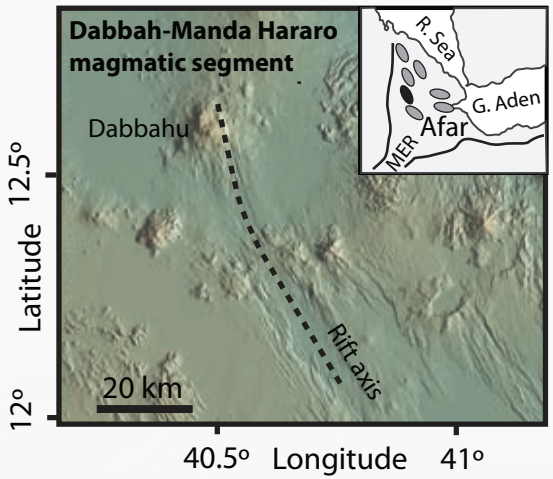
Afar Rift Consortium

Overview: source to surface magmatism at Quaternary rift zones

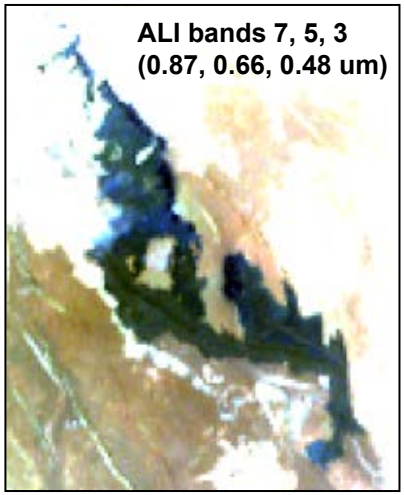
Timescales, volumes and physical mechanisms of melt emplacement at the rift surface

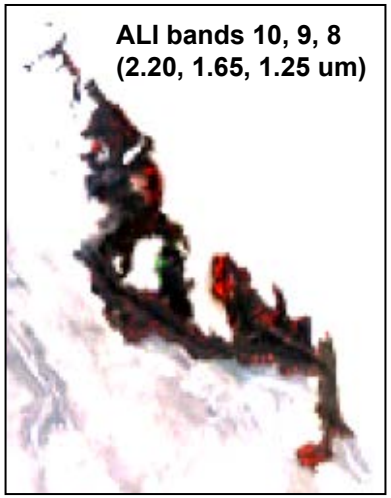


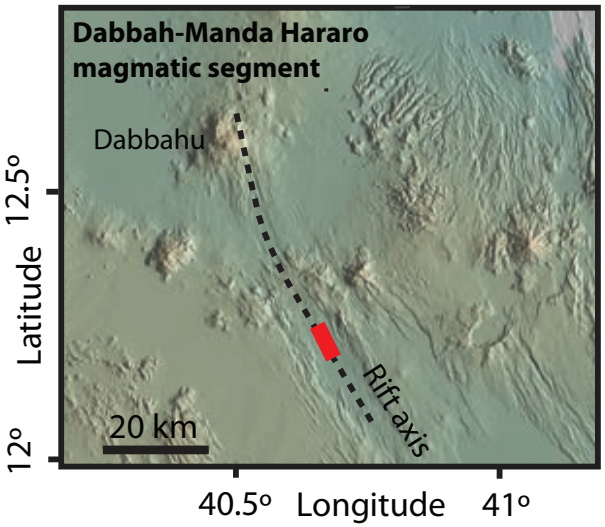


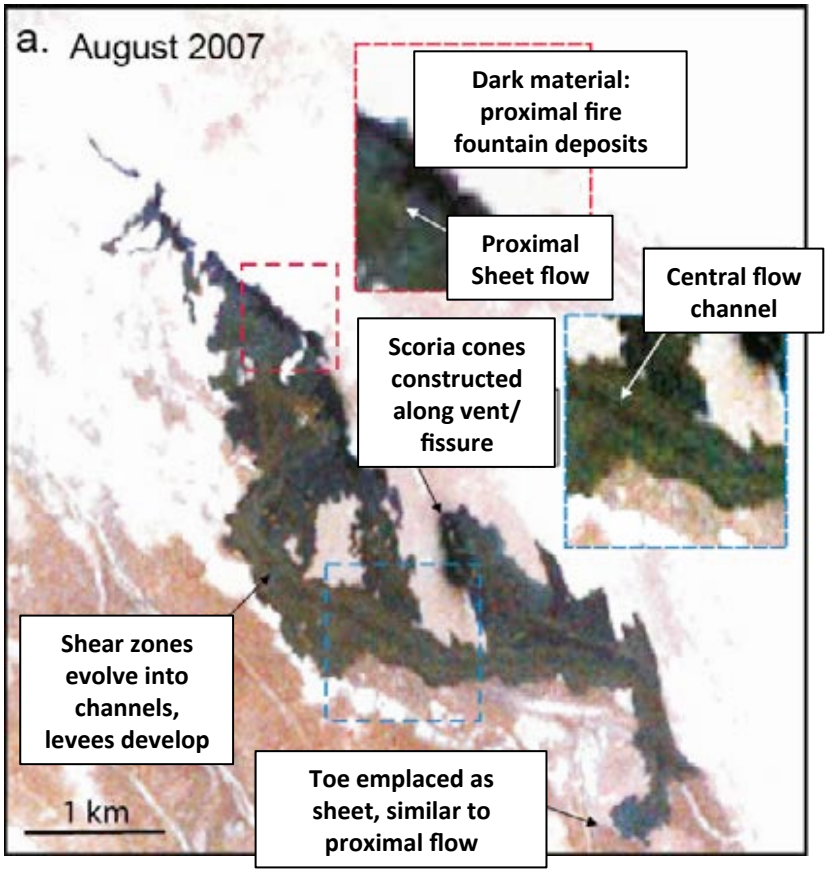
Links between melt production/ thermomechanical state of the mantle and recent magmatic rift zones/rift development?

Melt ascent processes / lithospheric plumbing systems

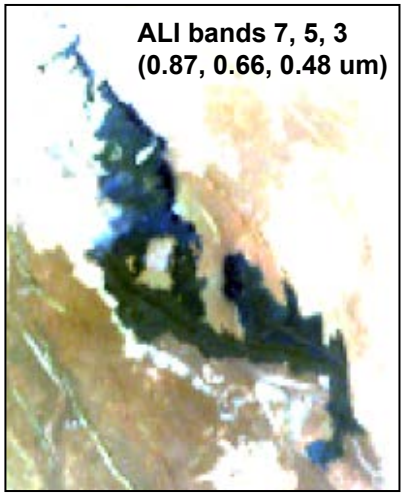


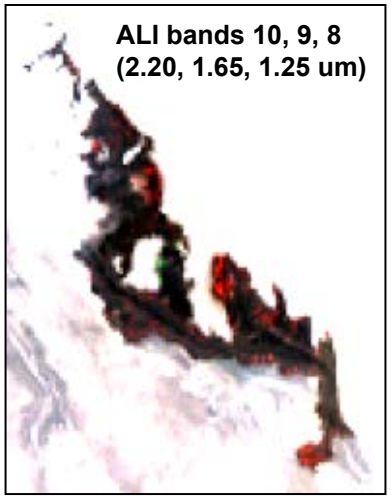


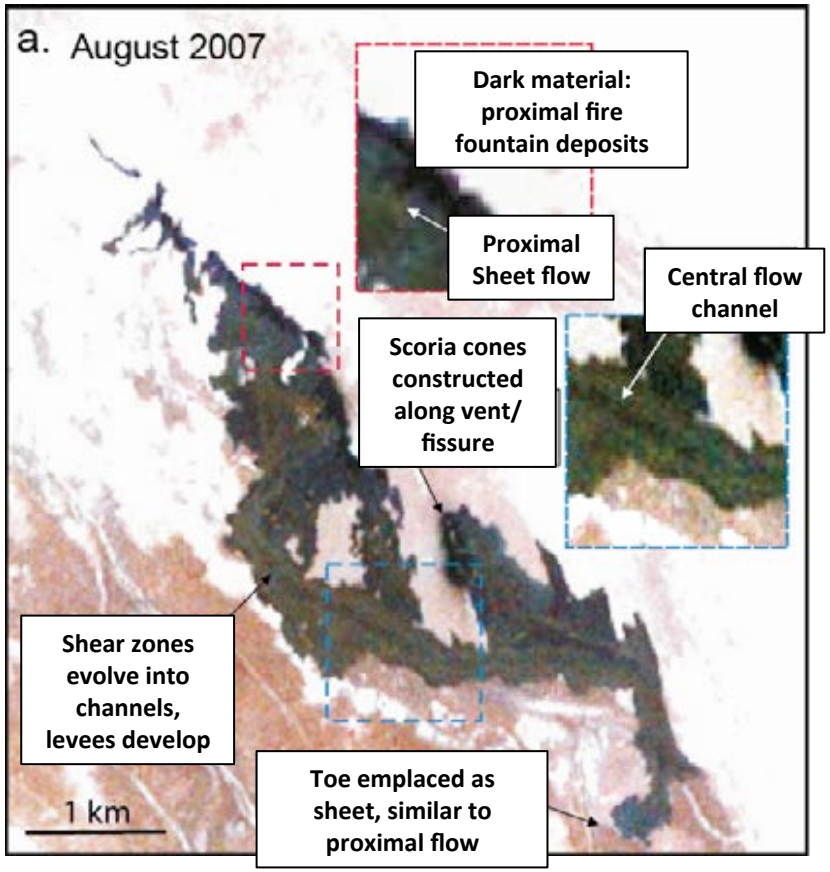




Ferguson et al. 2010

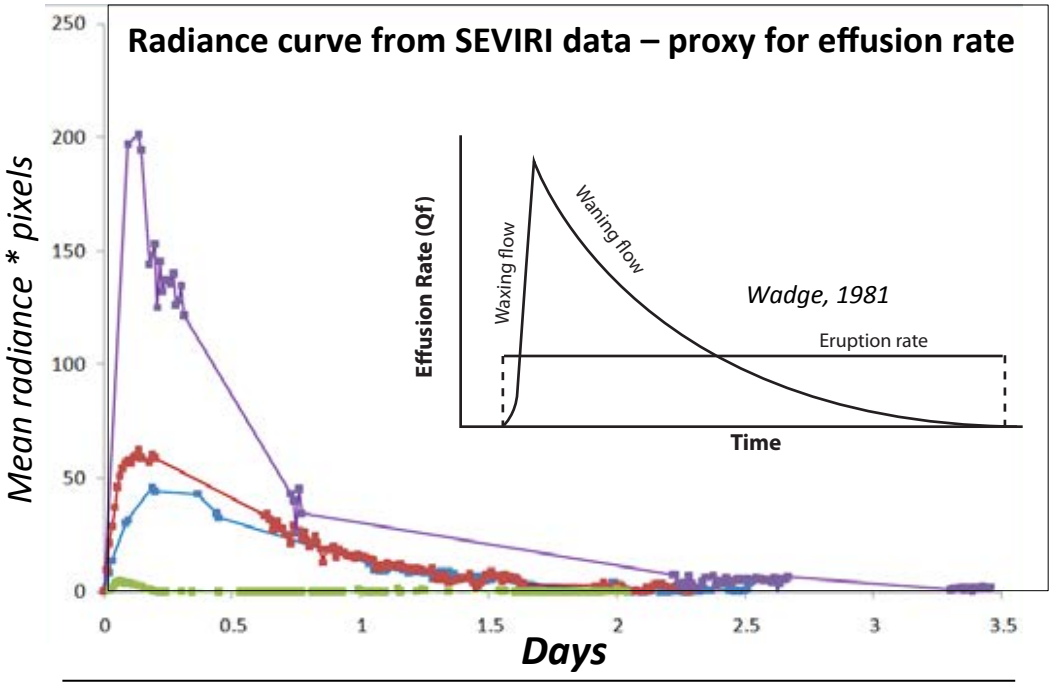


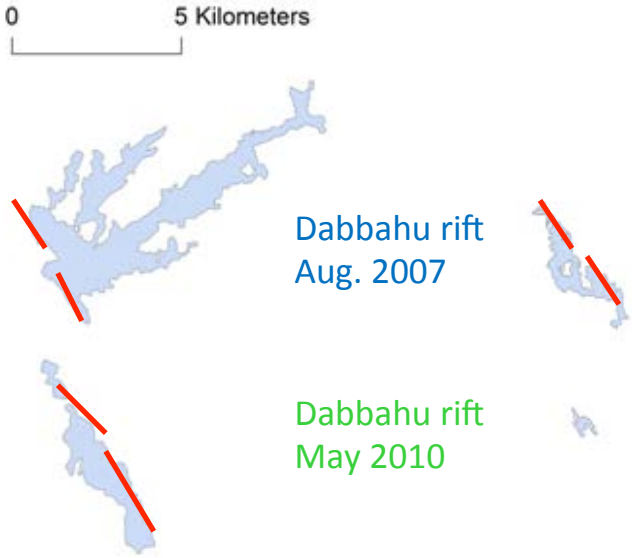




Ferguson et al. 2010

Barnie and Oppenheimer. in prep.

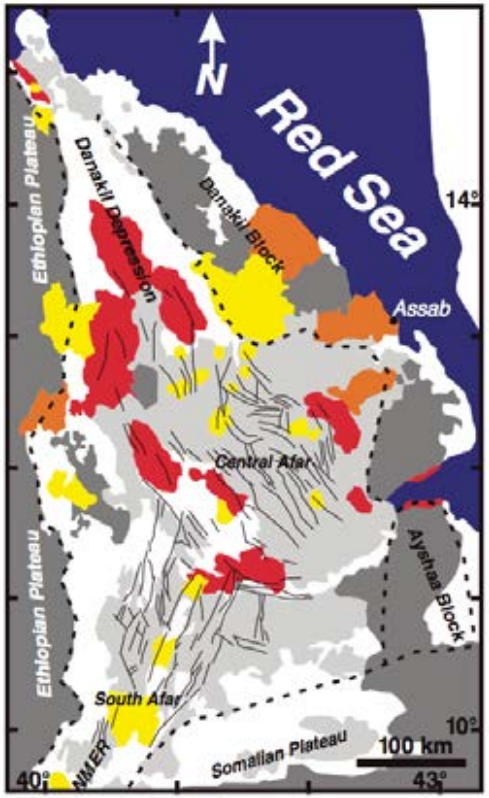




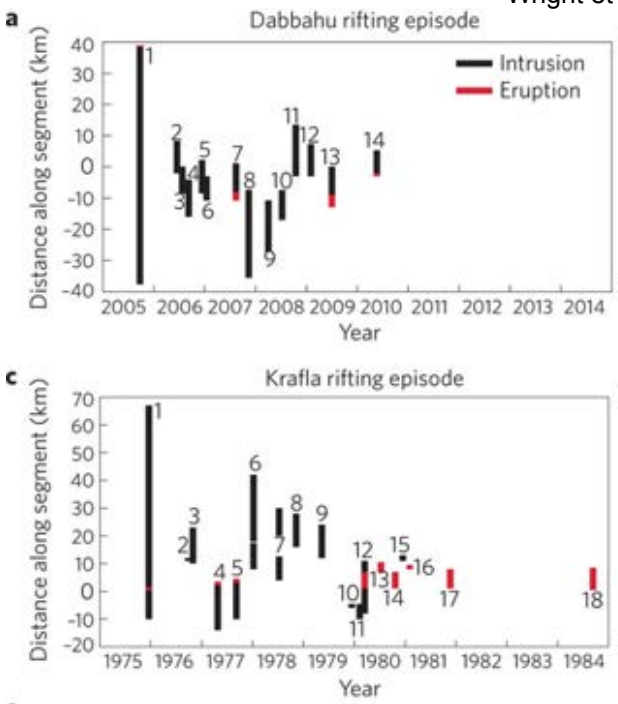
Melt volumes during Dabbahu rifting phase

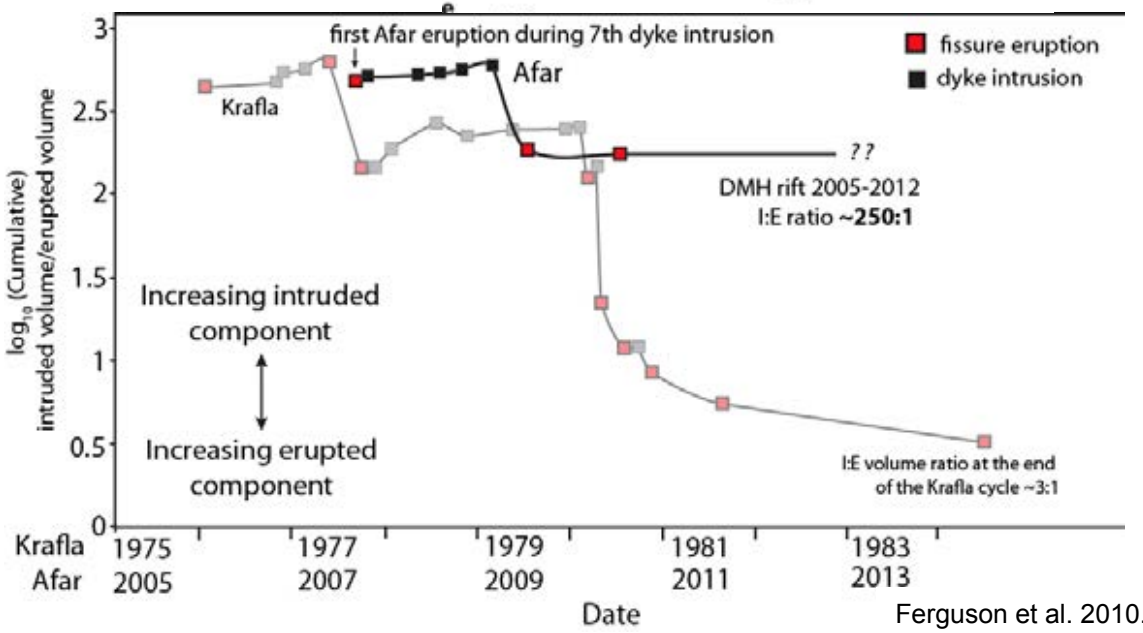
Initial part of rifting cycles are dominated by intrusion, volcanism becomes more likely later in cycle (relaxation of tectonic stress e.g. Buck et al. 2006).

Dabbahu rifting phase has very high intruded to erupted melt ratio – no 'excess' eruptible melt?



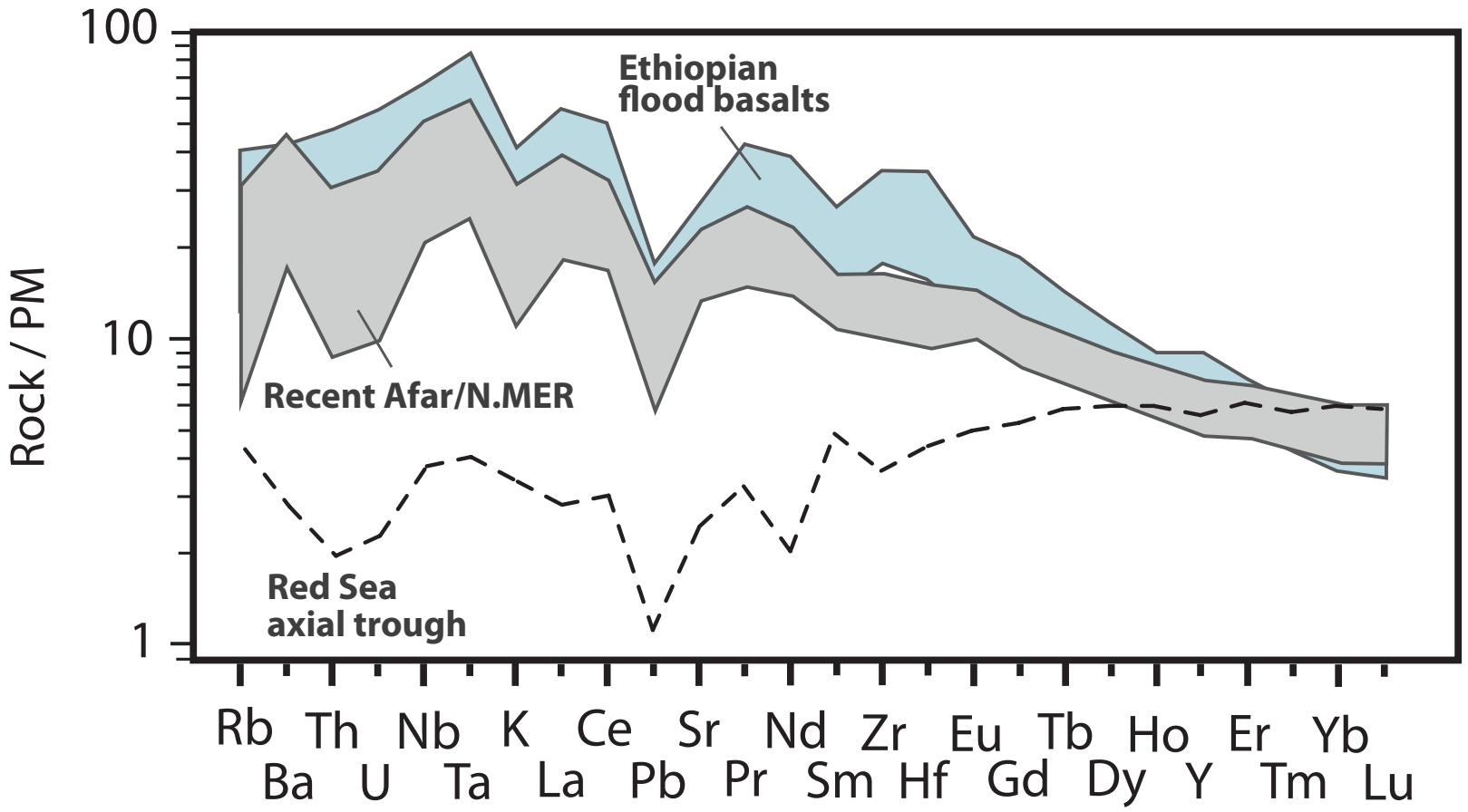
Wright et al. 2012.





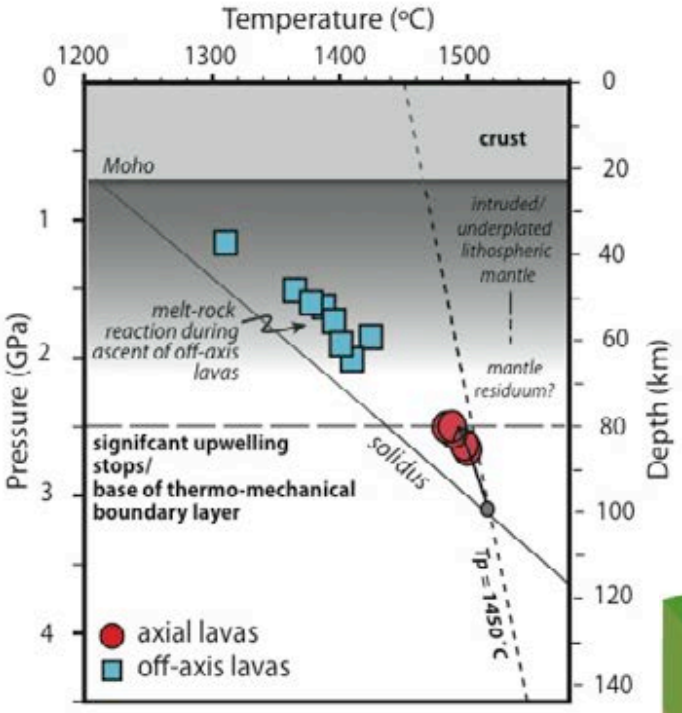
Ferguson et al. 2010.

Melt generation and ascent: Trace element compositions

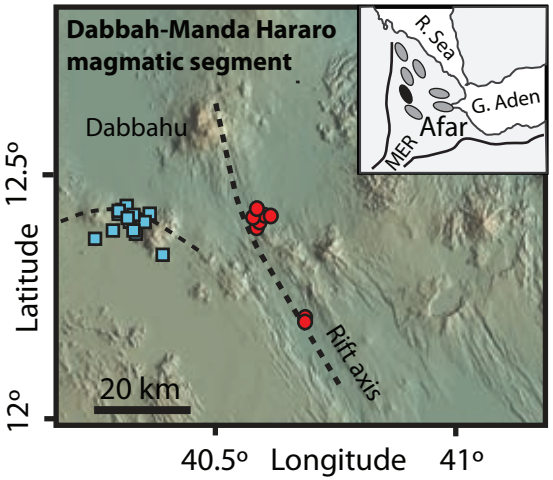


- Afar lavas enriched in incompatible trace element compared to MORB/Red Sea lavas, similar to pre-rift flood lavas - Afar lavas are not MORBs!
- TE ratios such Ba/Nb, Ce/Pb and La/Nb similar to OIB

Melt ascent

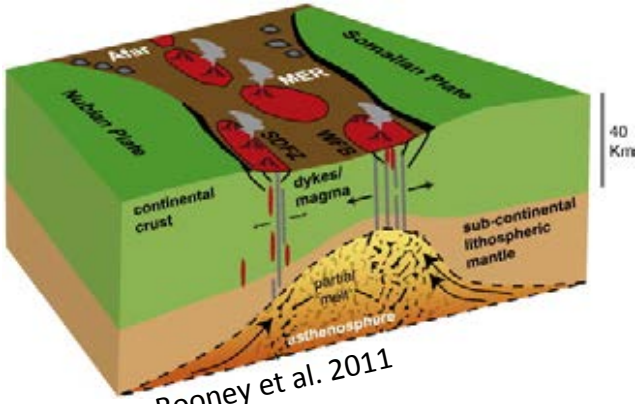


P-T's calculated using Si and Mg thermobarometer: Lee et al. 2009



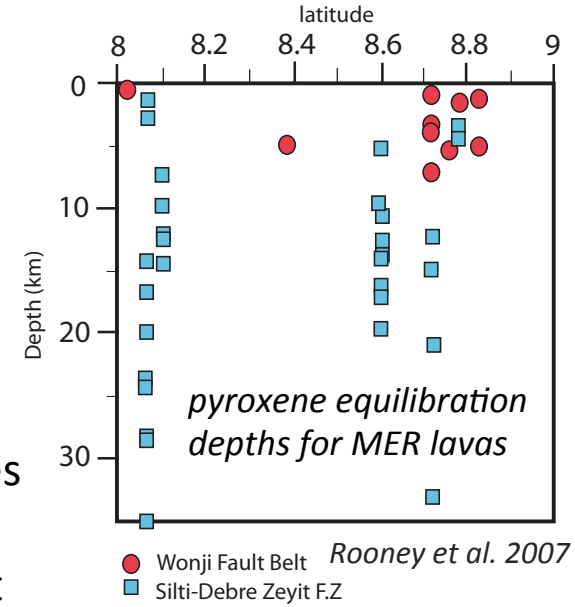
Fractionation corrected compositions for Dabbahu rift lavas shows different mantle-melt equilibrium P-T conditions for melts erupted on- and off- axis.

Variable petrogenetic processes for lavas erupted ~20 km apart.



Rooney et al. 2011

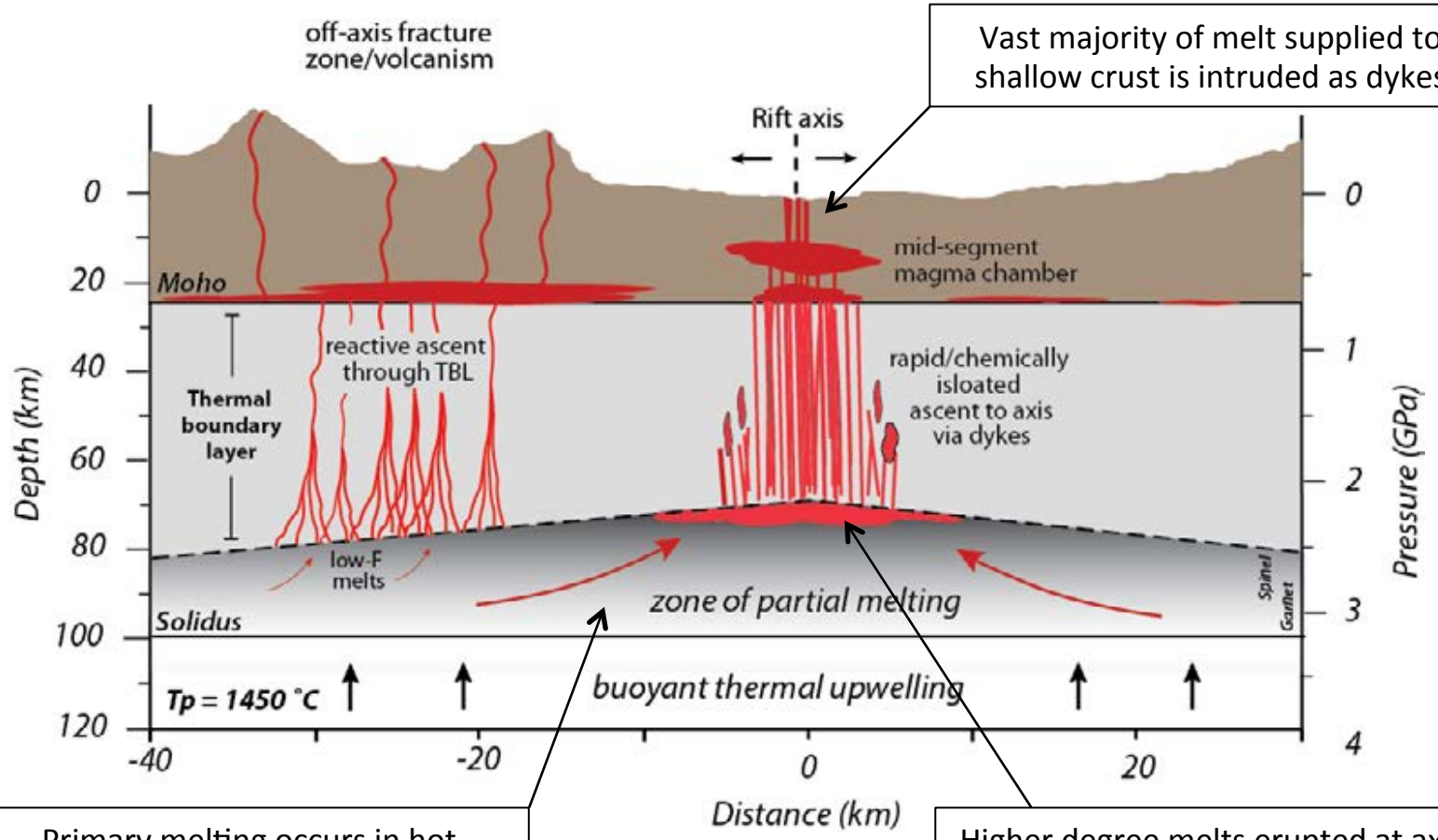
MER lavas show different ranges in crustal fractionation depths depending on distance from rift margin - rift centre lavas ascend more rapidly



Rooney et al. 2007

Melt generation and ascent at an active rift zone in central Afar

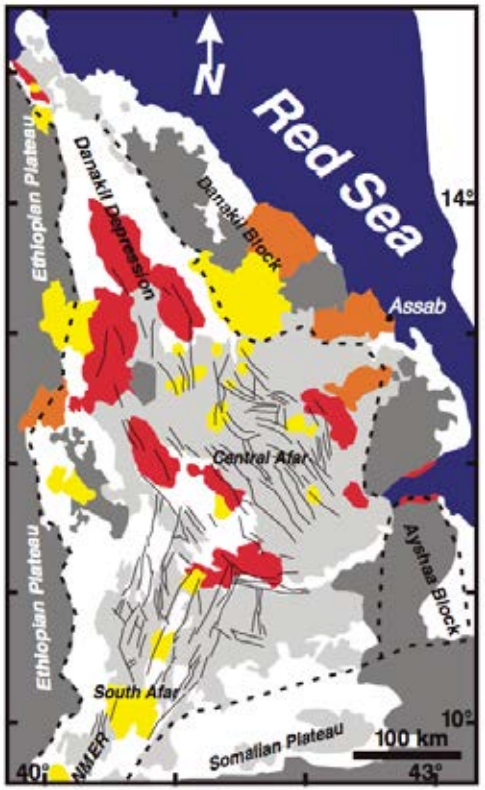
Separate plumbing systems feeding rift axis and off-axis volcanoes



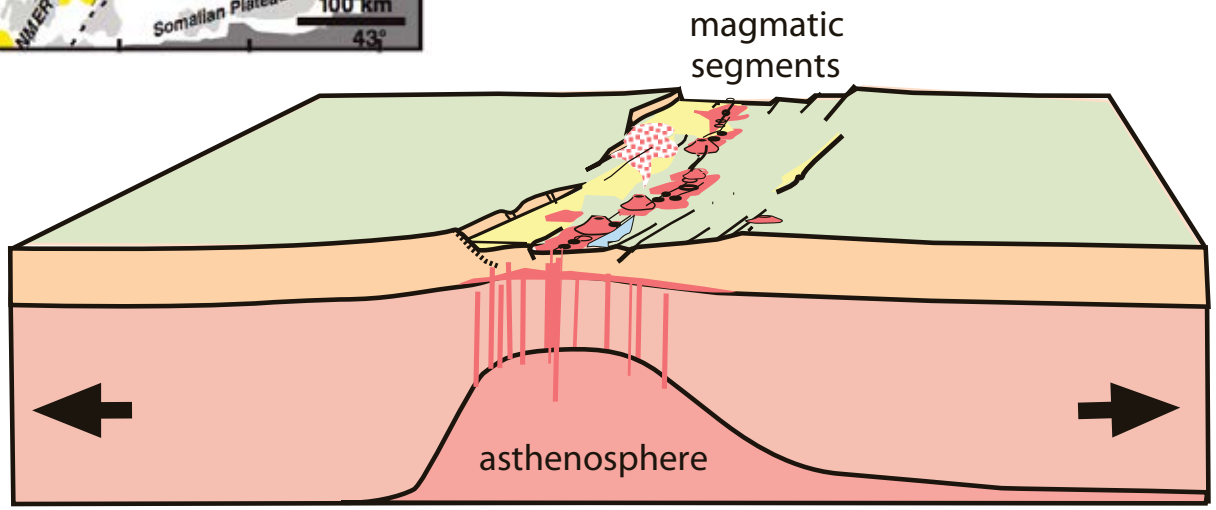
Primary melting occurs in hot mantle, significant upwelling and melting limited to depths > 80 km

Higher degree melts erupted at axis, suggests mantle upwelling is focused beneath axis of recent segment

Future questions….



- How do melting processes vary along strike between the MER and the Red Sea?
- Quantification of melt volumes and volcanic output
- Volcanic architecture and eruptive history/formation of active rift segments
- Structure and composition of the lithospheric plate – xenoliths, melt-rock interactions, thermal models.
- What links mantle processes to recent surface focusing of magmatic-tectonic activity?



Thank you…….