Age and petrogenesis of young Afar basalts

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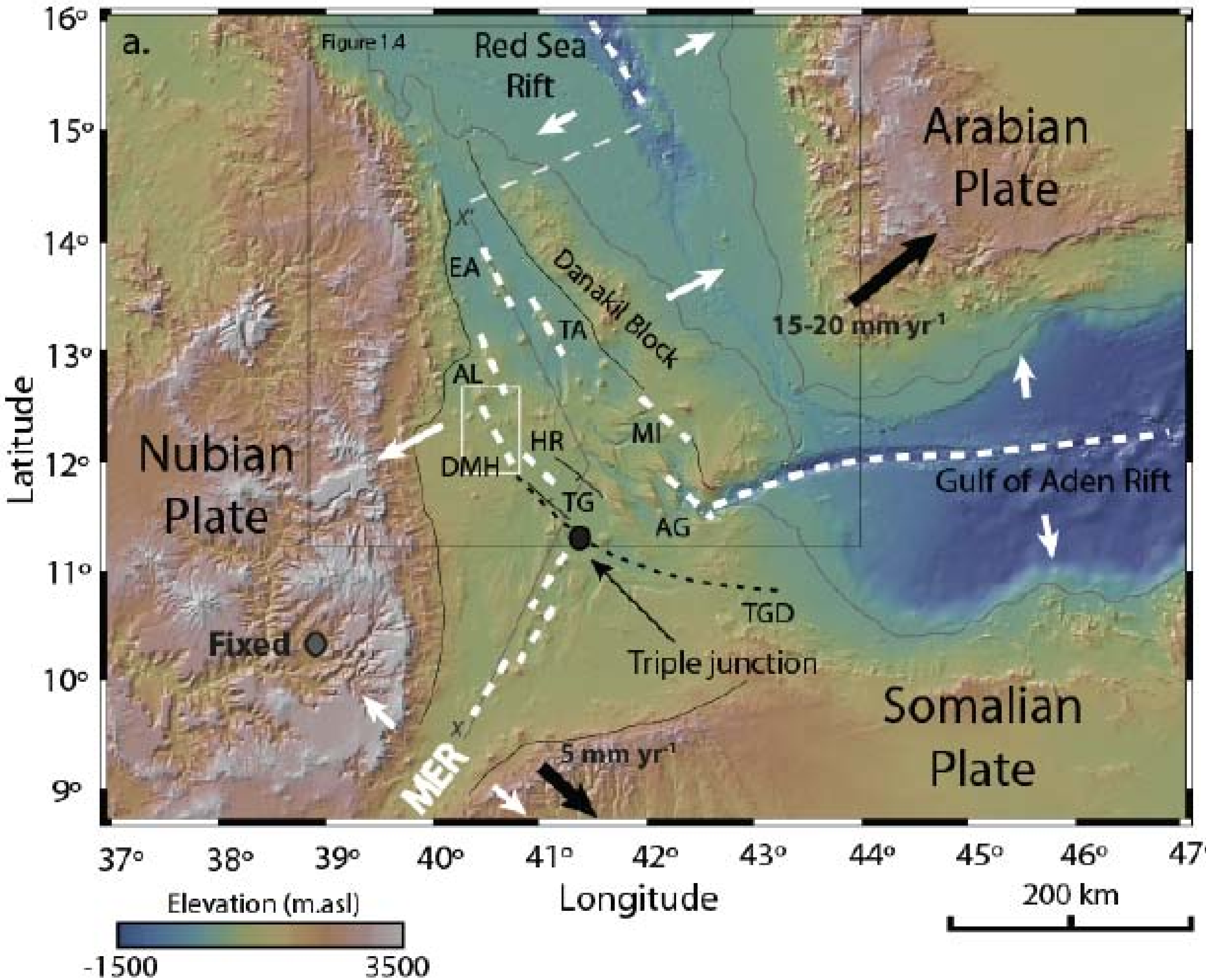
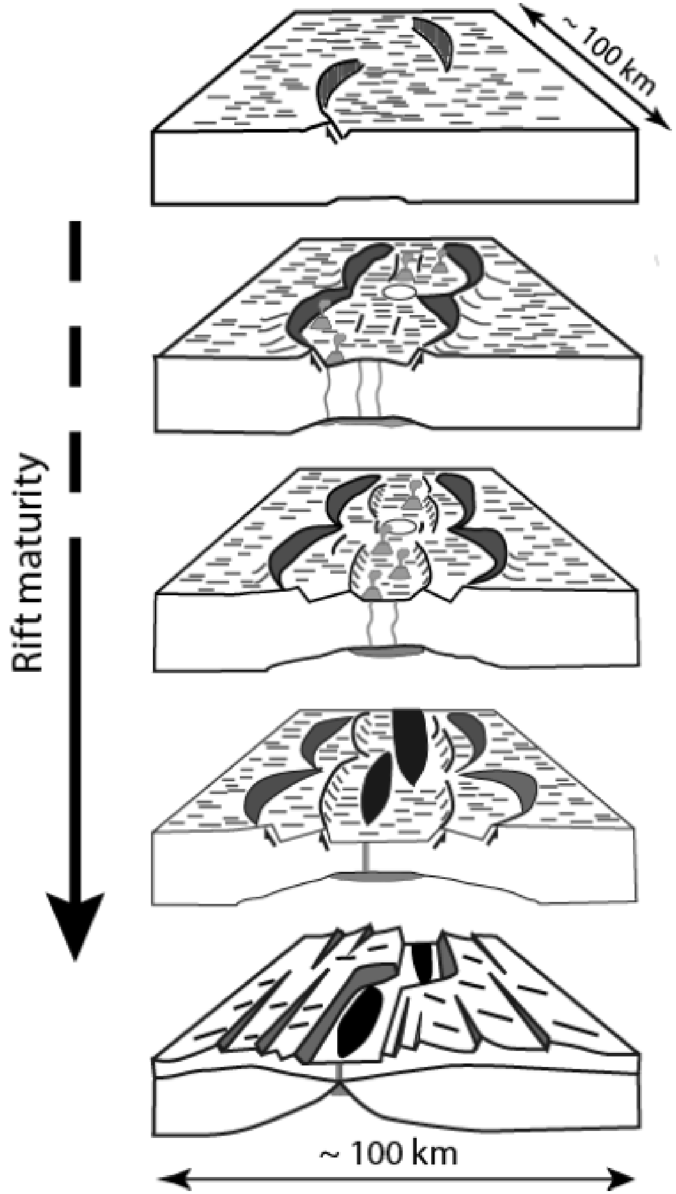
Dabbabu – Manda Hararo rift segment



Evolution of a magmatic rift



1. Intital extension, formation of half grbens

2. Full graben formation, extension accomodated on large border faults

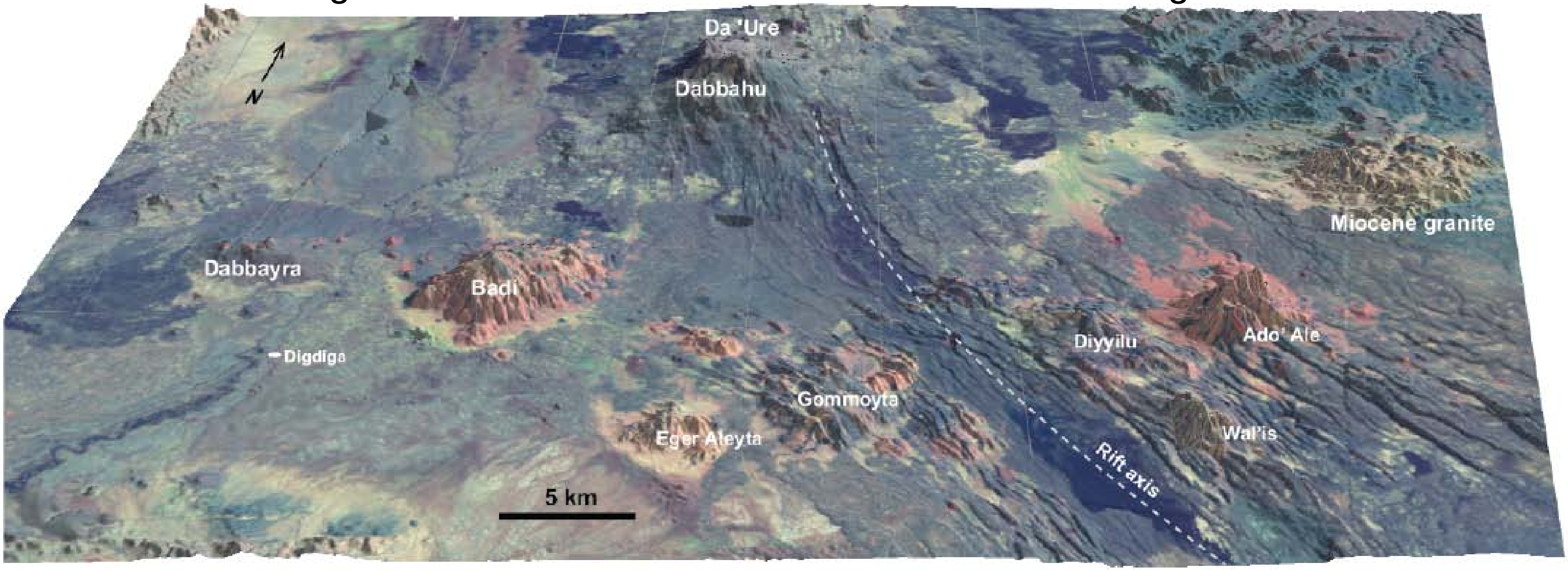
3. Abandonment of large border faults, forrmation of new intra-rift rift graben

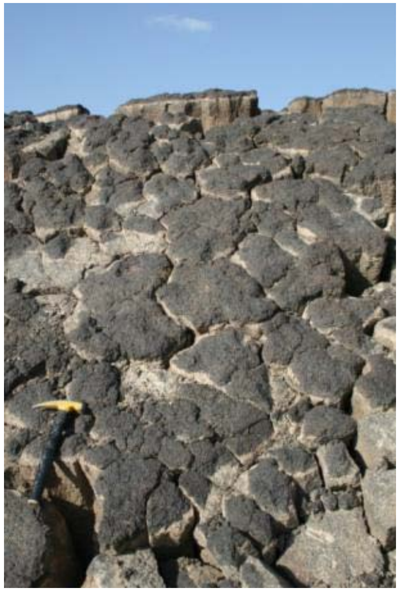
4. Establishment of axially focussed volcanism, formation of magmatic rift segments

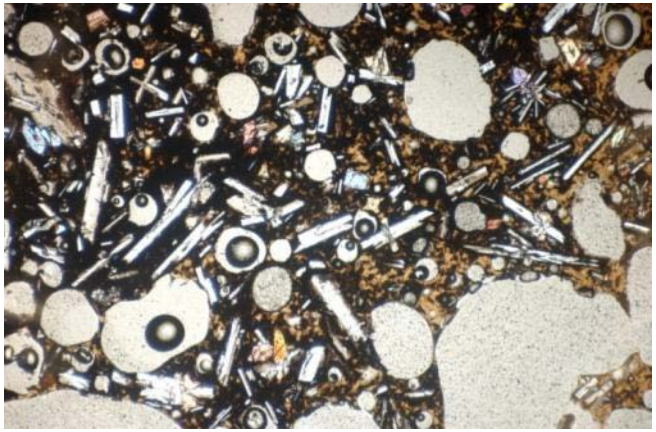
5. Rupture of the lithosphere, onset of oceanic spreading

Hayward and Ebinger, 1996

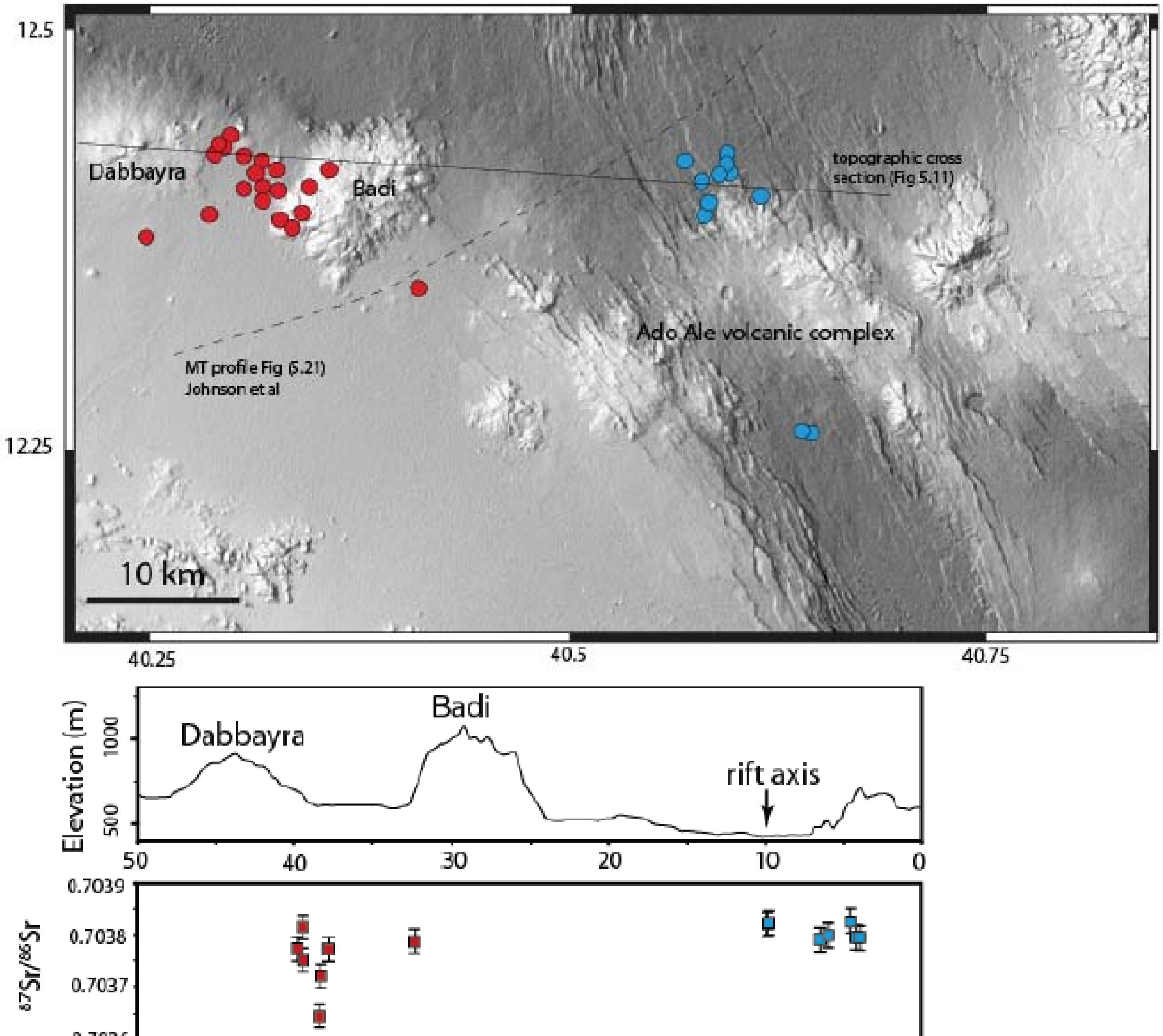
Magmatism of the Dabbabu – Manda Hararo rift segment



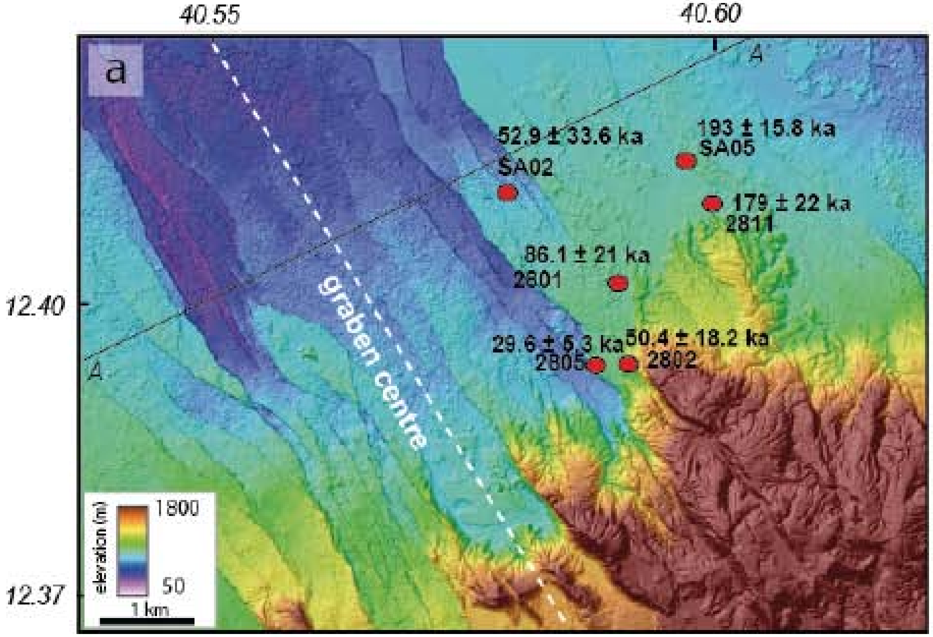


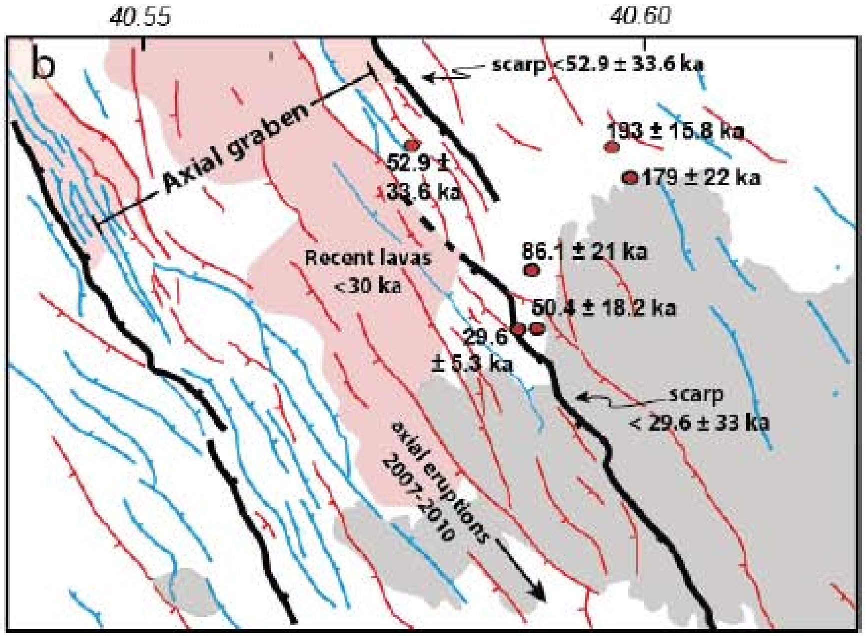


Sample locations: on and off-rift

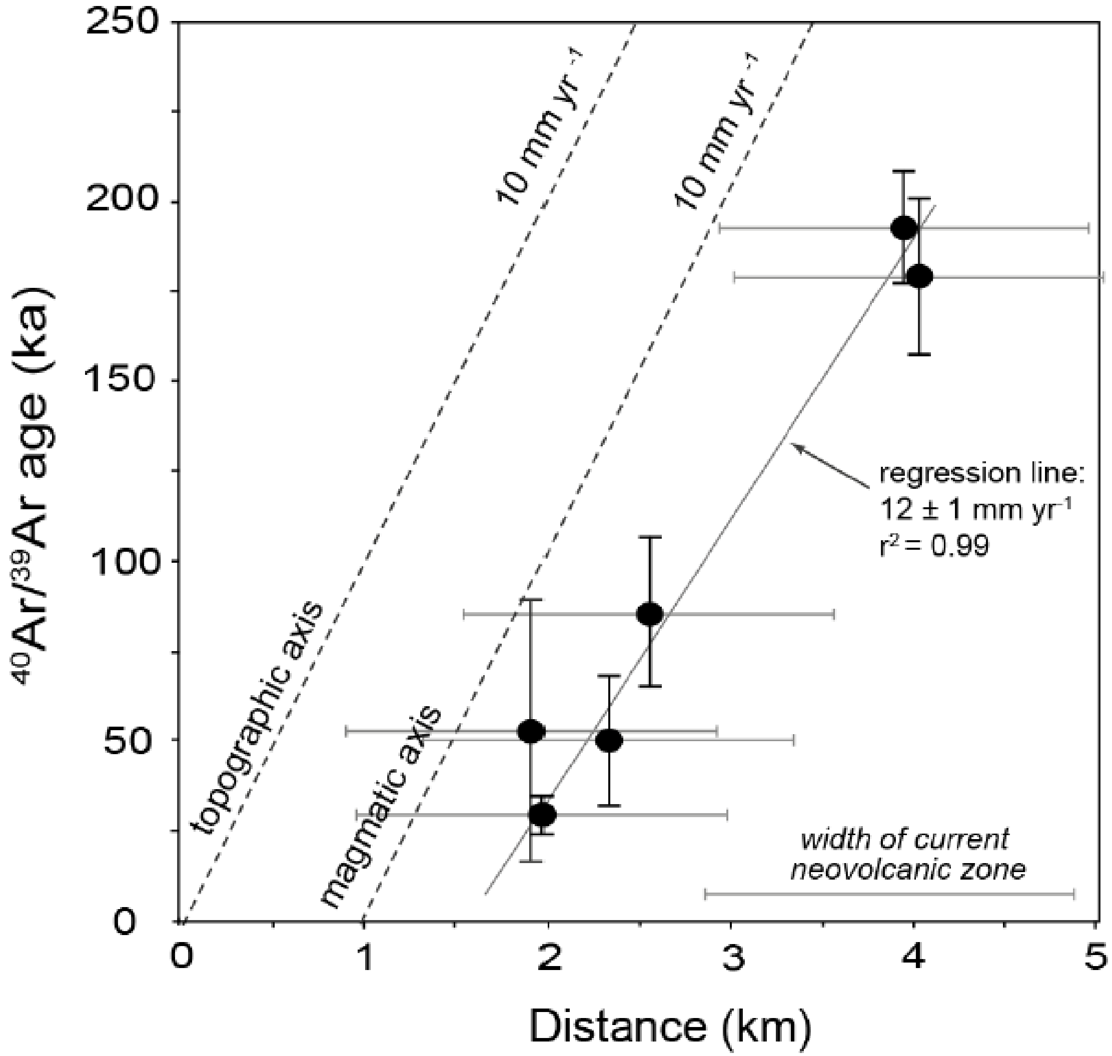


^{40}Ar-^{39}Ar dating of young basalts



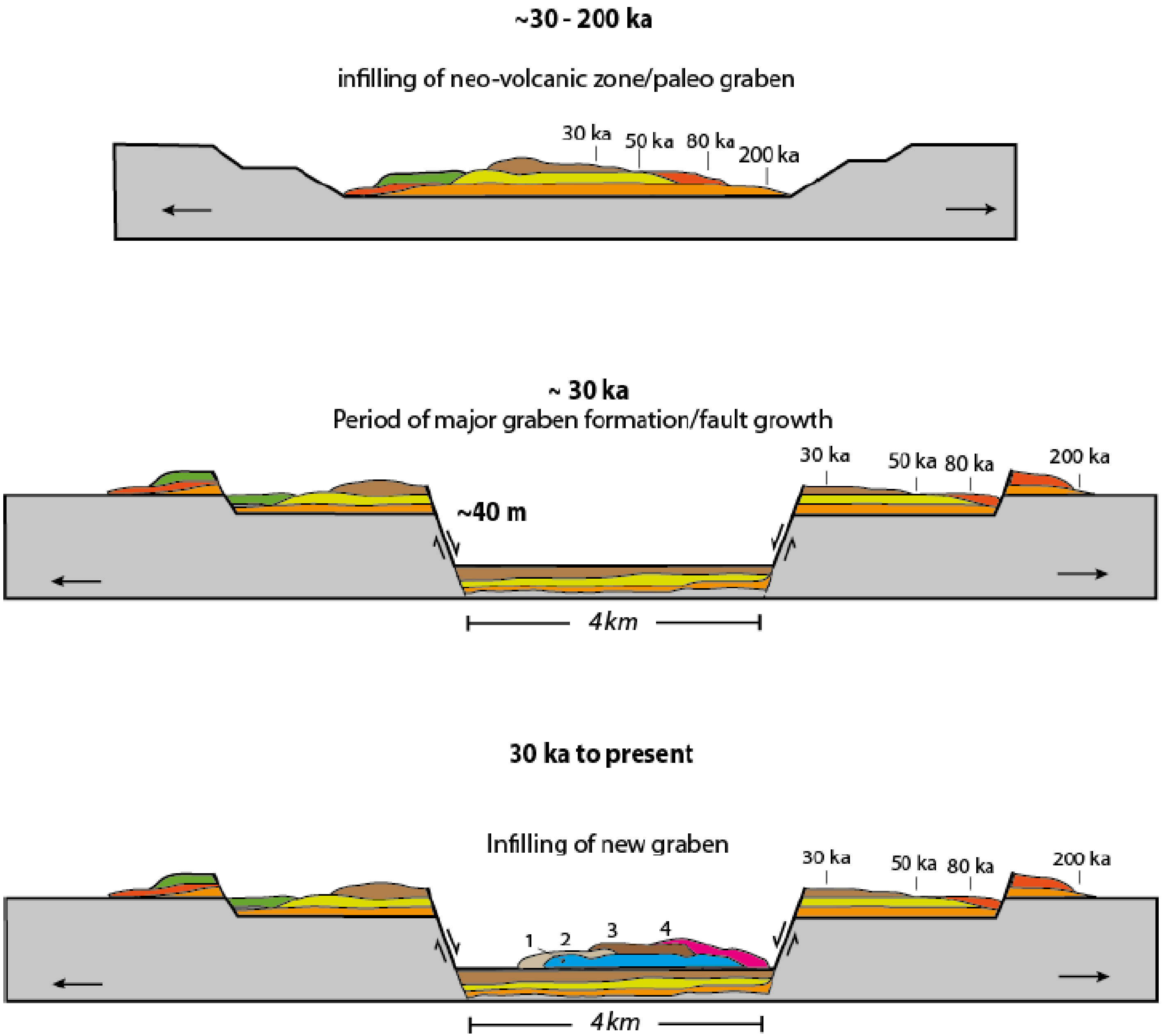


^{40}Ar-^{39}Ar dating of basalts: inferred half spreading rate

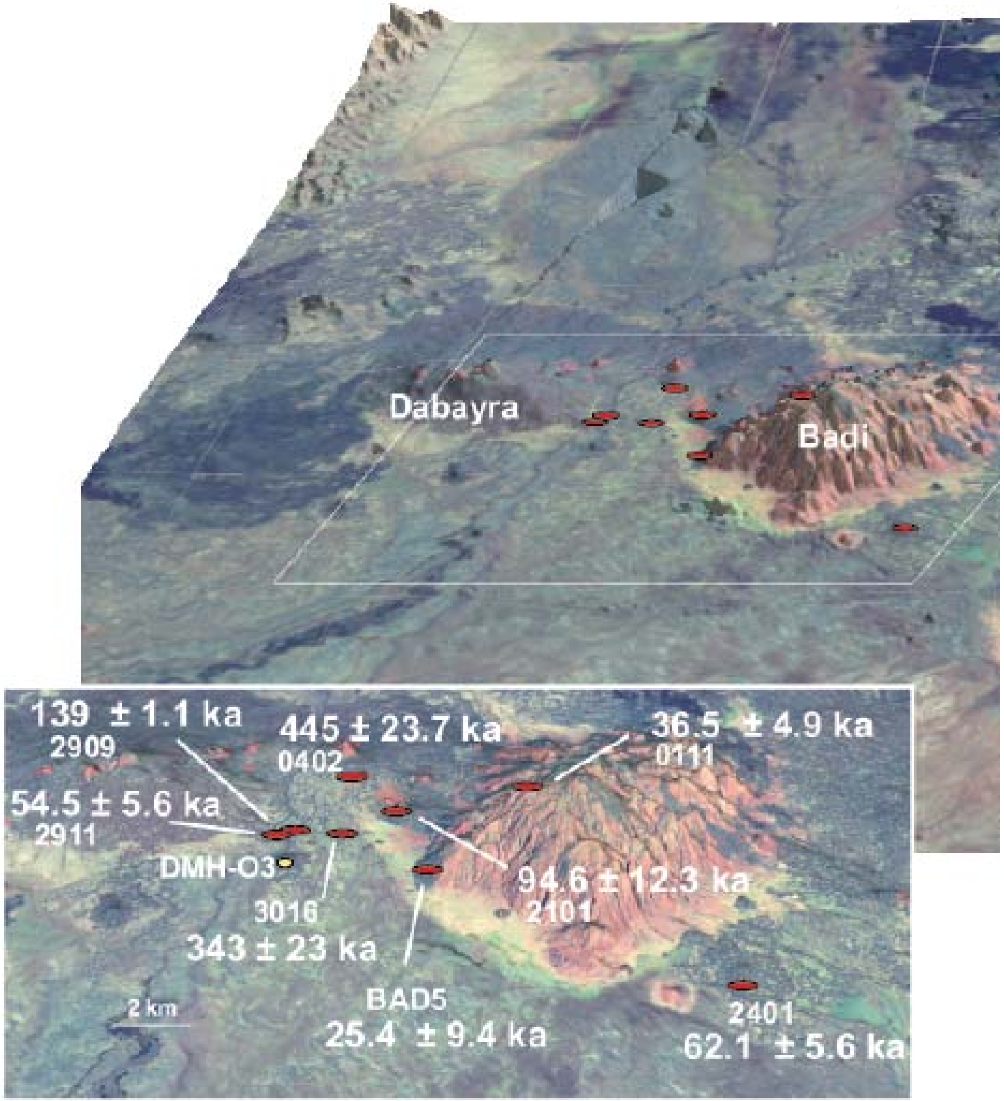


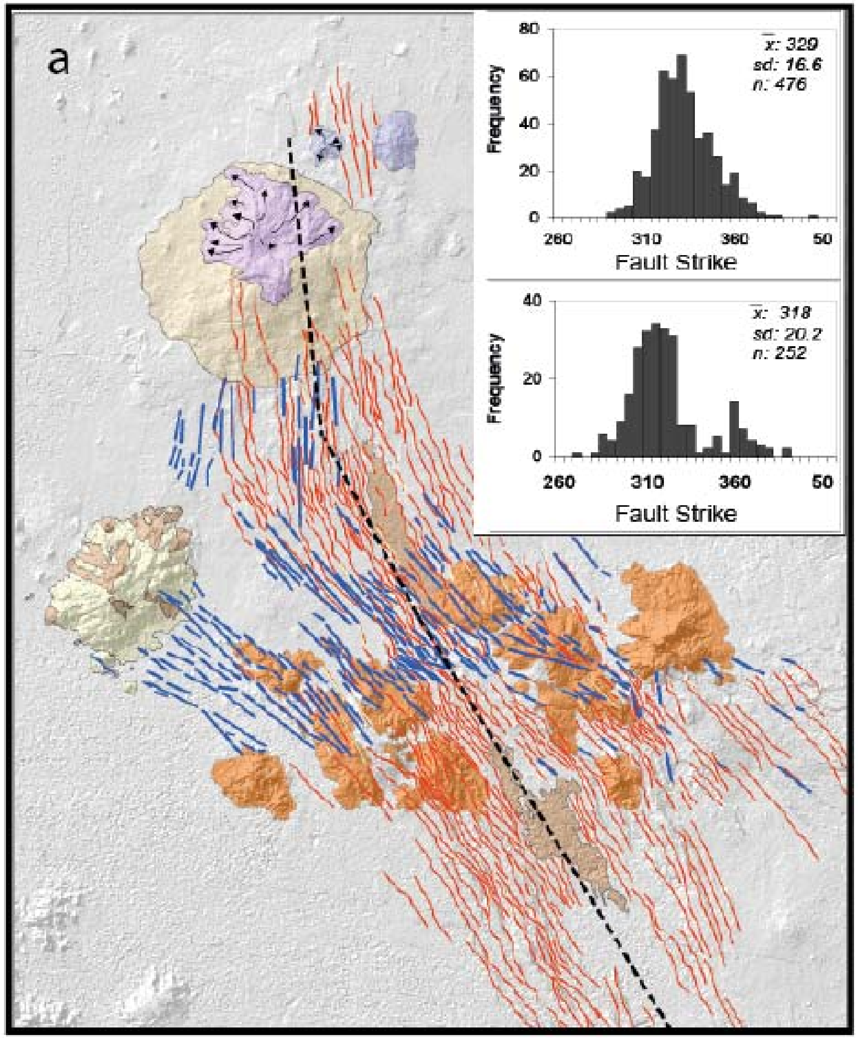
Afro-Arabian extension (~ 8-10 mm/yr) can be accommodated for the past 200 kyr by extension in the Dabbahu – Manda Hararo segment

Development of lava flow age profile across a spreading rift



Off axis volcanism: ages





D-MH Rift Segment Lavas

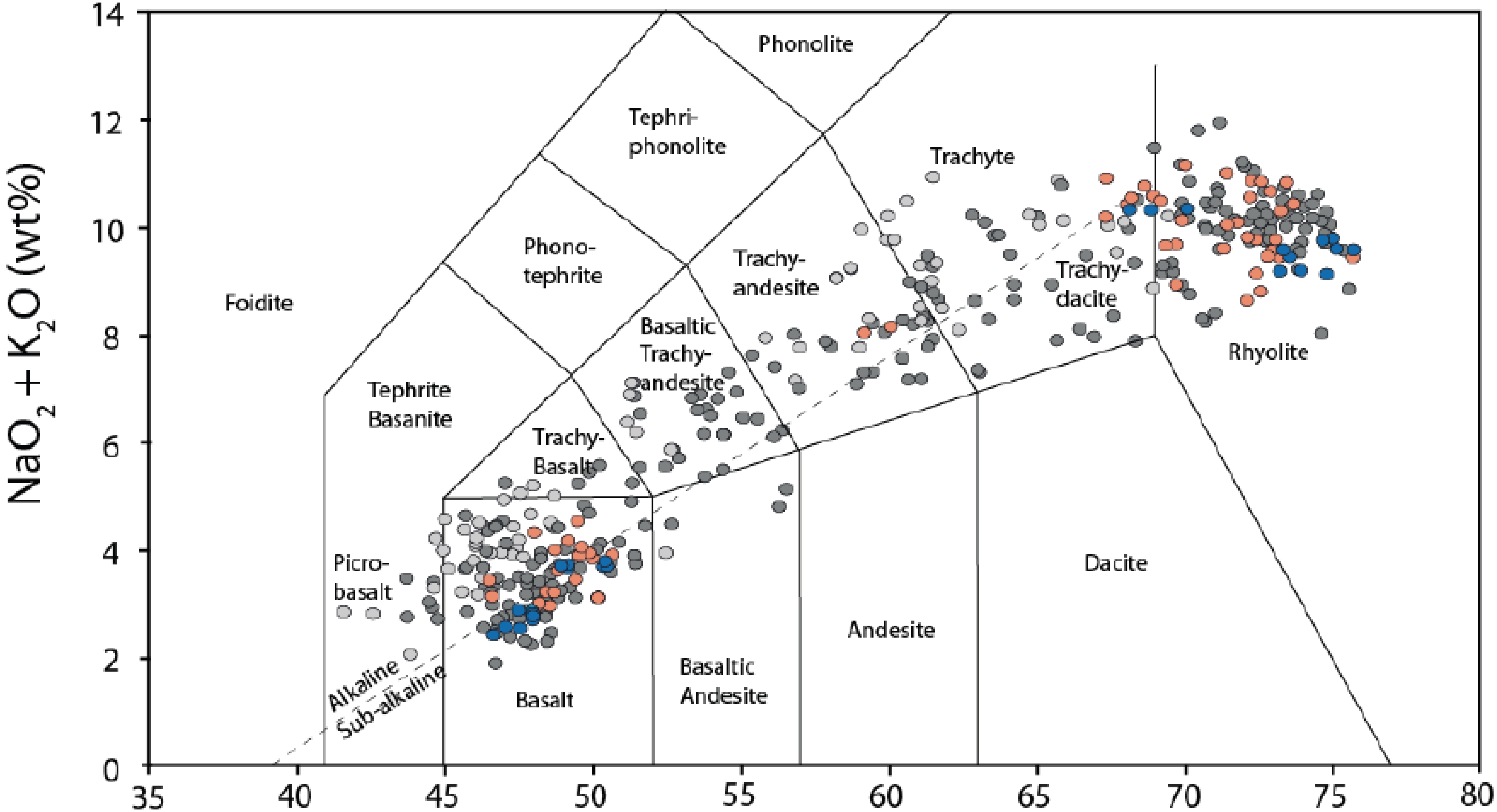
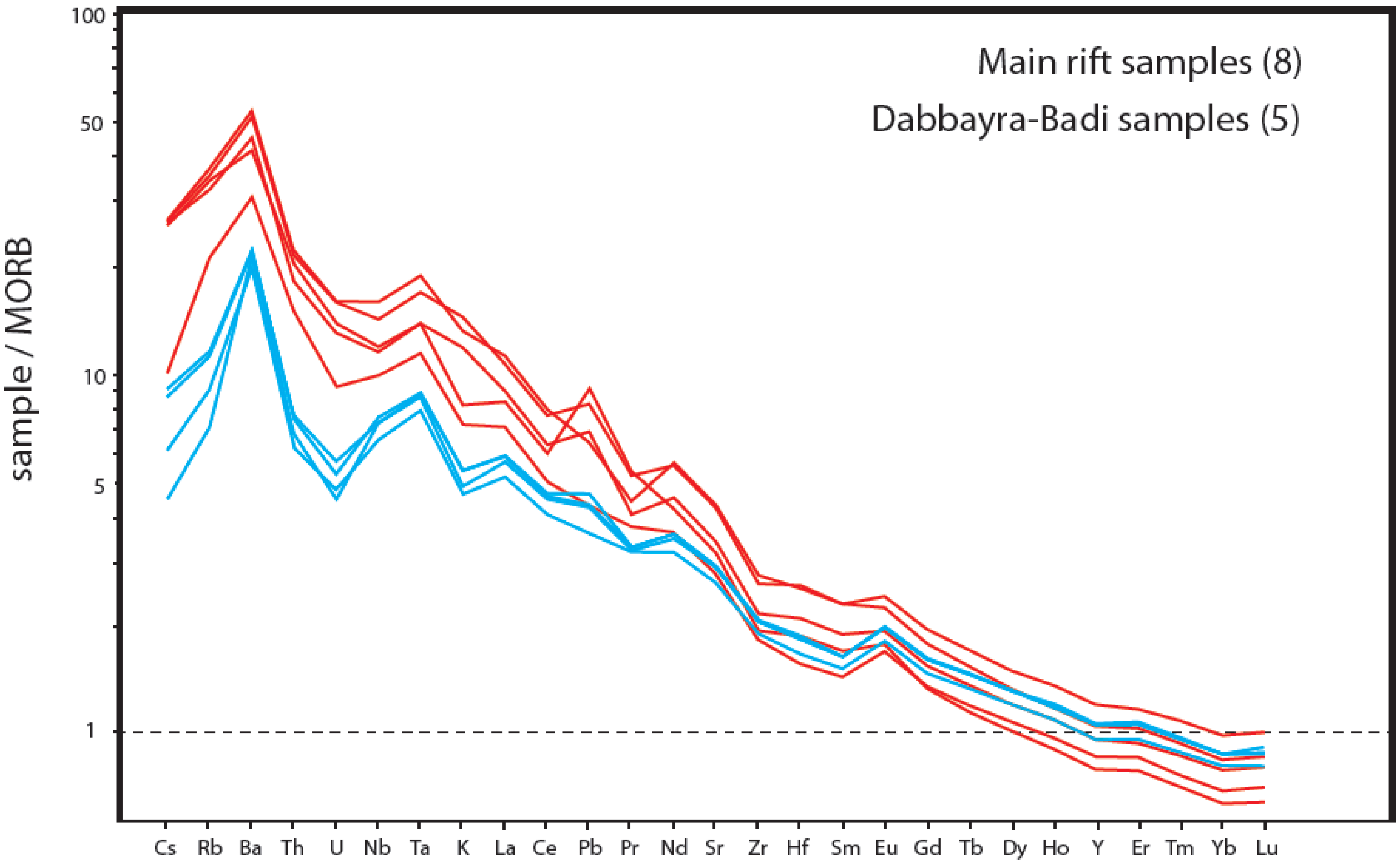


Figure 1.5 Total-Alkali vs. Silica (TAS) plot for lavas erupted across Afar. In general there is a strong bi-modal basalt-rhyolite character to lava compositions, however lava with intermediate compositions are found at several volcanoes located along both axial rift zones (i.e. Dabbahu) and at transverse zones (i.e. Assab). Red and blue symbols indicate lavas analysed in this thesis (red symbols: DMH axial segment, blue symbols: Badi-Dabbayra volcanic region). Dark grey symbols represent lava erupted along axial segment, light grey are for lavas from transverse/marginal volcanic zones. Data sources: Barberi and Varet, 1970; Barberi et al., 1974, 1975; Bizourd et al., 1980; Civetta et al., 1974; De Fino et al., 1978; Deniel et al., 1994; Barrat et al., 1998, 2003; Wiart and Oppenheimer, 2000; Field, 2011; and this study. Alkaline-subalkaline divide after Macdonald, 1968.

Dabbahu Manda Hararo Rift: Basalts



Red: off-axis lavas
Blue: axial lavas

Dabbahu Manda Hararo Rift: Basalt evolution

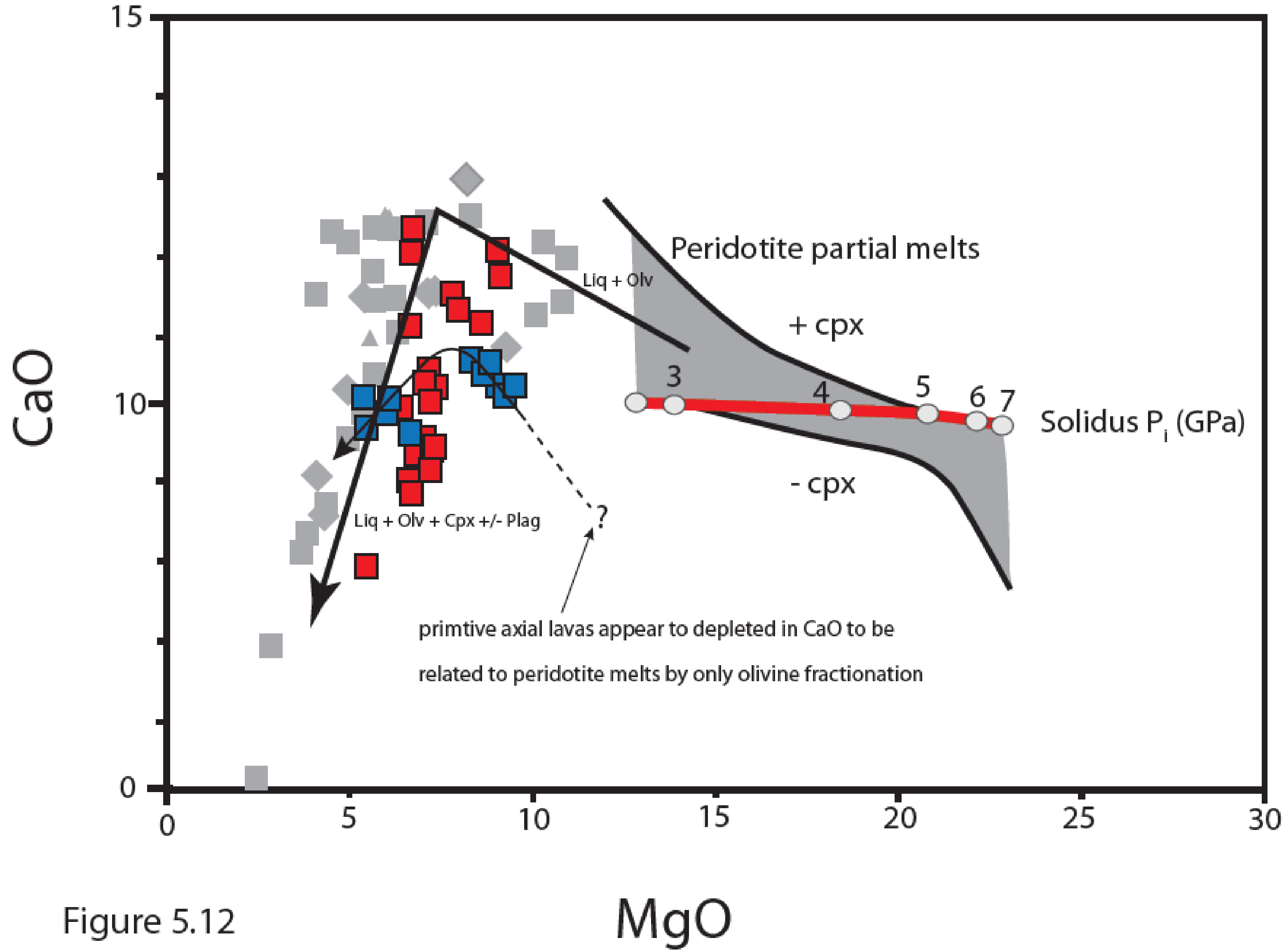
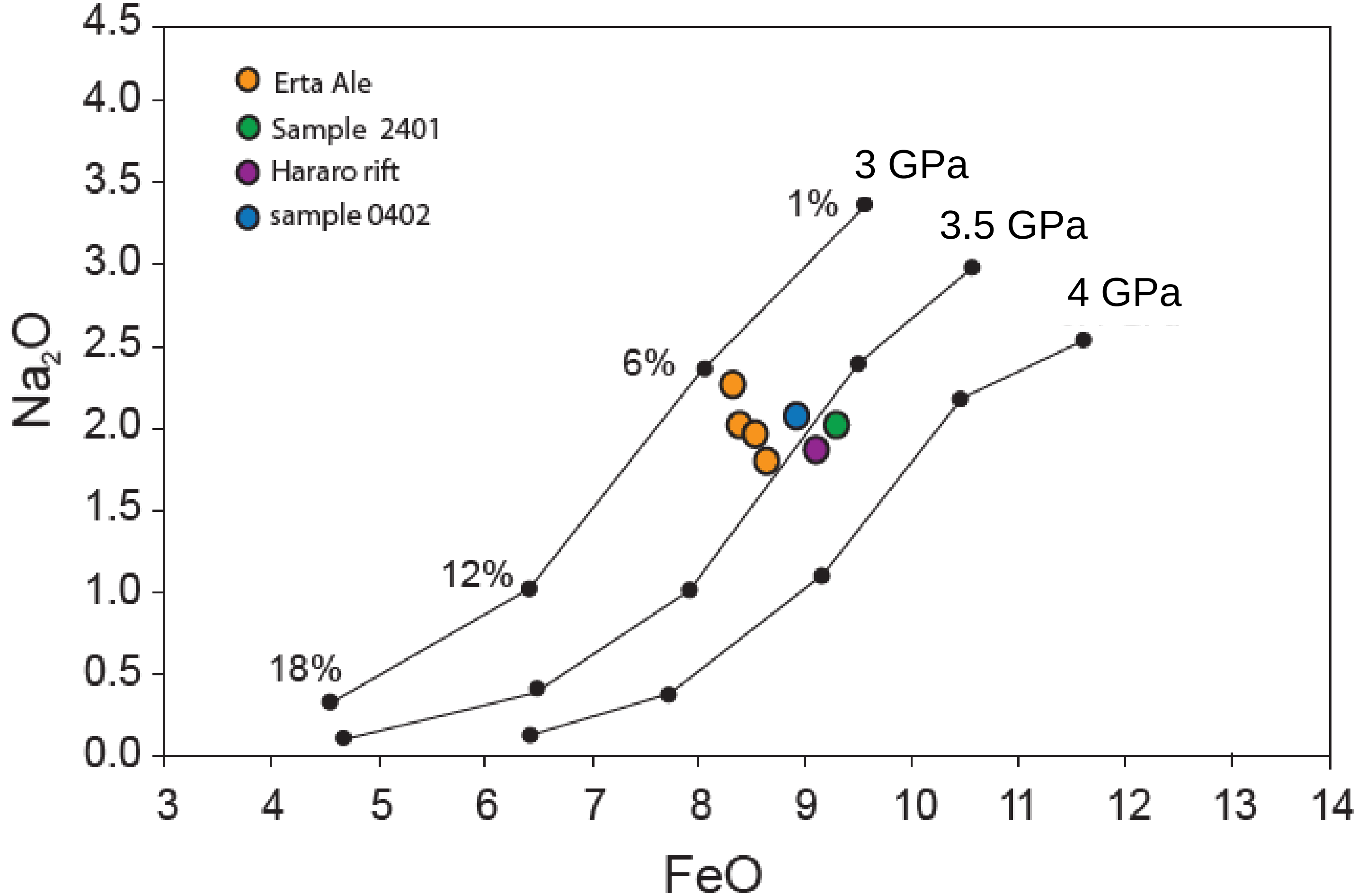


Figure 5.12

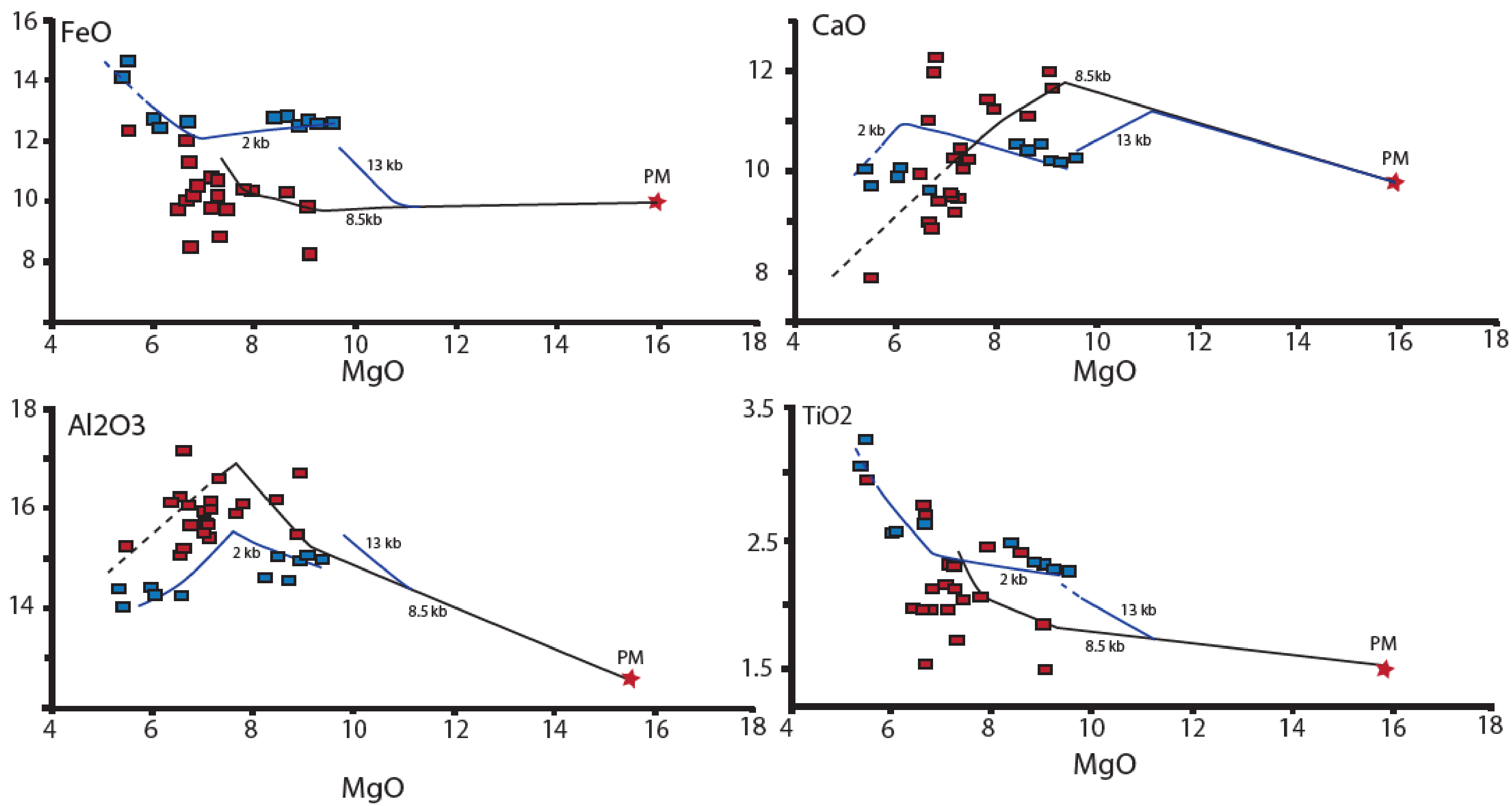
Axial lavas don't follow the same fractionation path from parental melts as off-axis lavas

Melting model



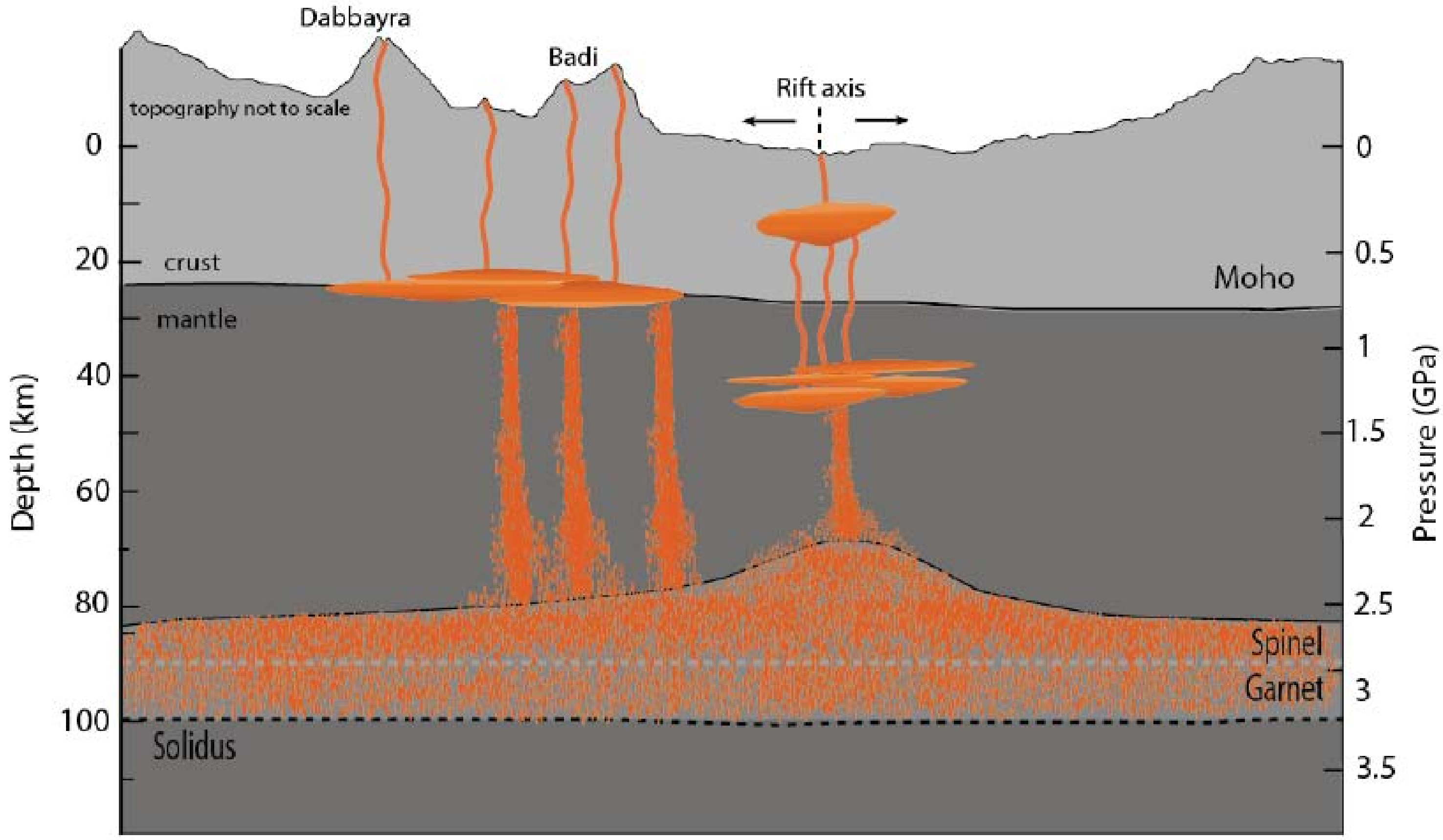
Compositions of calculated primary melts to DMH rift basalts are consistent with polybaric melting beginning at about 3.5 GPa, with a mantle potential temperature of 1470 ^{o}C, and a melting extent approaching 10%.

Dabbahu Manda Hararo Rift: Crystallisation model



Axial lavas don’t follow the same fractionation path from parental melts as off-axis lavas: They appear to require a degree of high – pressure crystallisation.

Synoptic model for basalt genesis



New ^{40}Ar-^{39}Ar age constraints are consistent with axially-focussed magmatism in the Dabbahu – Manda Hararo Rift for >200 kyr

Chemical differences between axial and off-axis basalts are small, and relate to the shallow storage and differentiation histories of the melts.

Dabbahu Manda Hararo Rift: Basalts