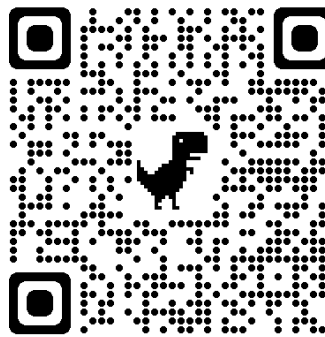


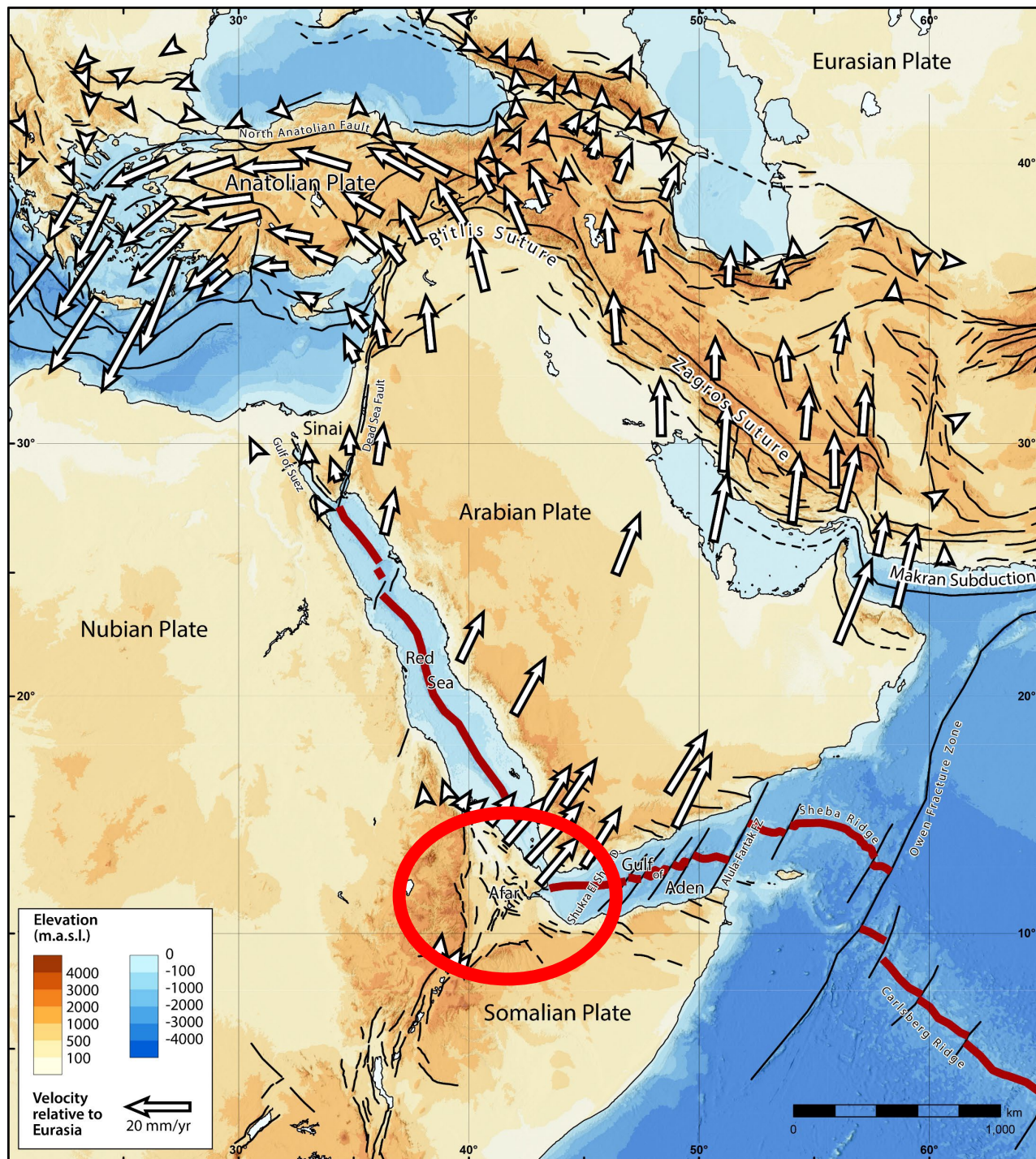
# New mapping of the Afar Depression: towards the better understanding of rift dynamics in a hotspot-influenced continental rift zone

Valentin Rime<sup>1</sup>, Anneleen Foubert<sup>1</sup>, Balemwal Atnafu<sup>2</sup>, Tesfaye Kidane<sup>3</sup>.

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- 2) Addis Ababa University, School of Earth Sciences, Ethiopia.
- 3) University of KwaZulu-Natal Durban, School of Agricultural, Earth and Environmental Sciences, South Africa.







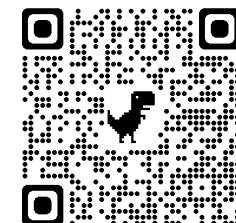
## The Afar

- Part of the Afro-Arabian rift system

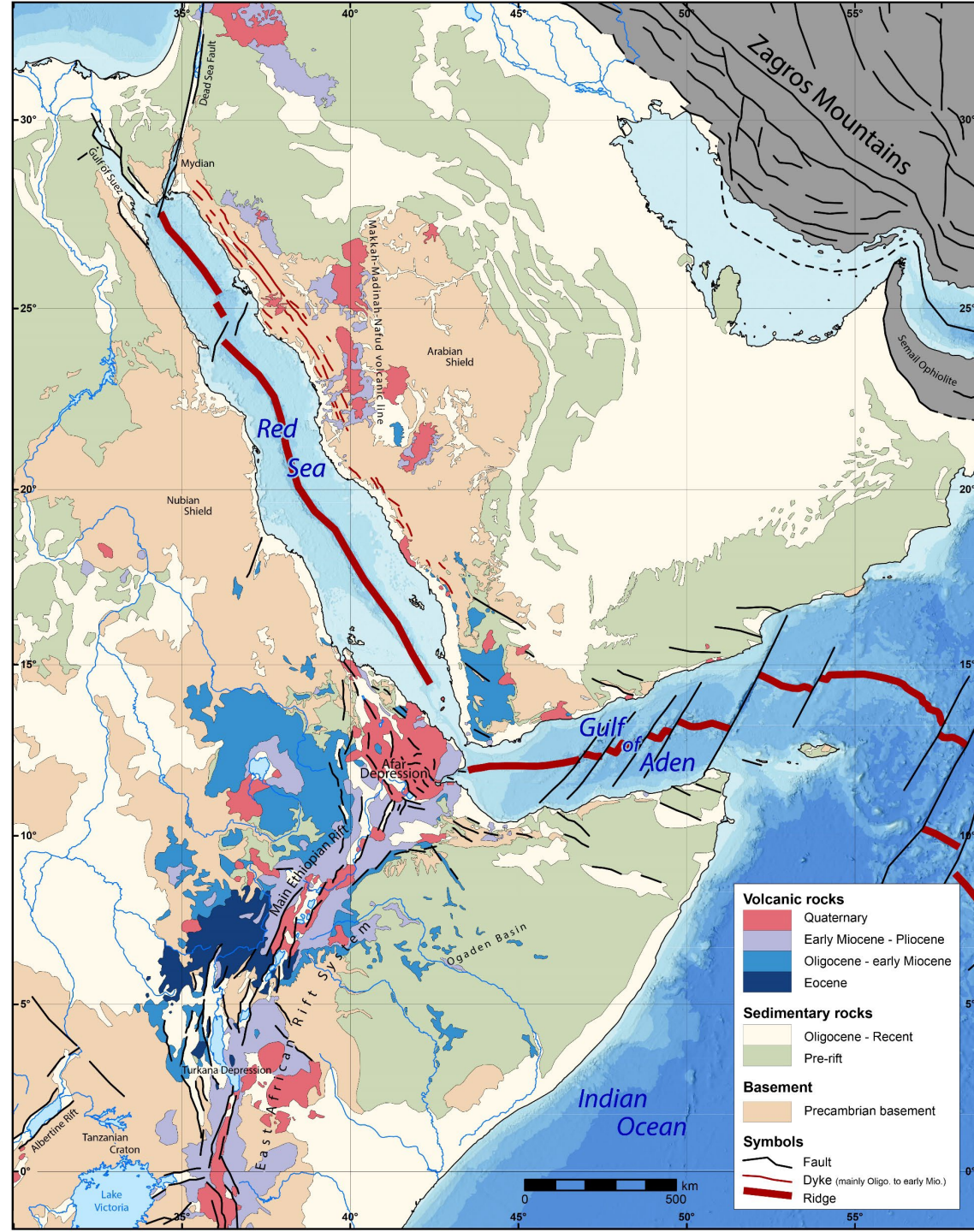
### Velocity vectors relative to Eurasia:

Black lines indicate faults, red lines indicate oceanic ridge.

Data from Reilinger et al. (2006),  
Reilinger & McClusky (2011)

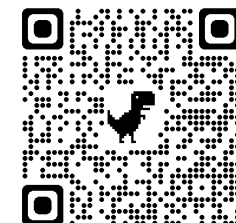


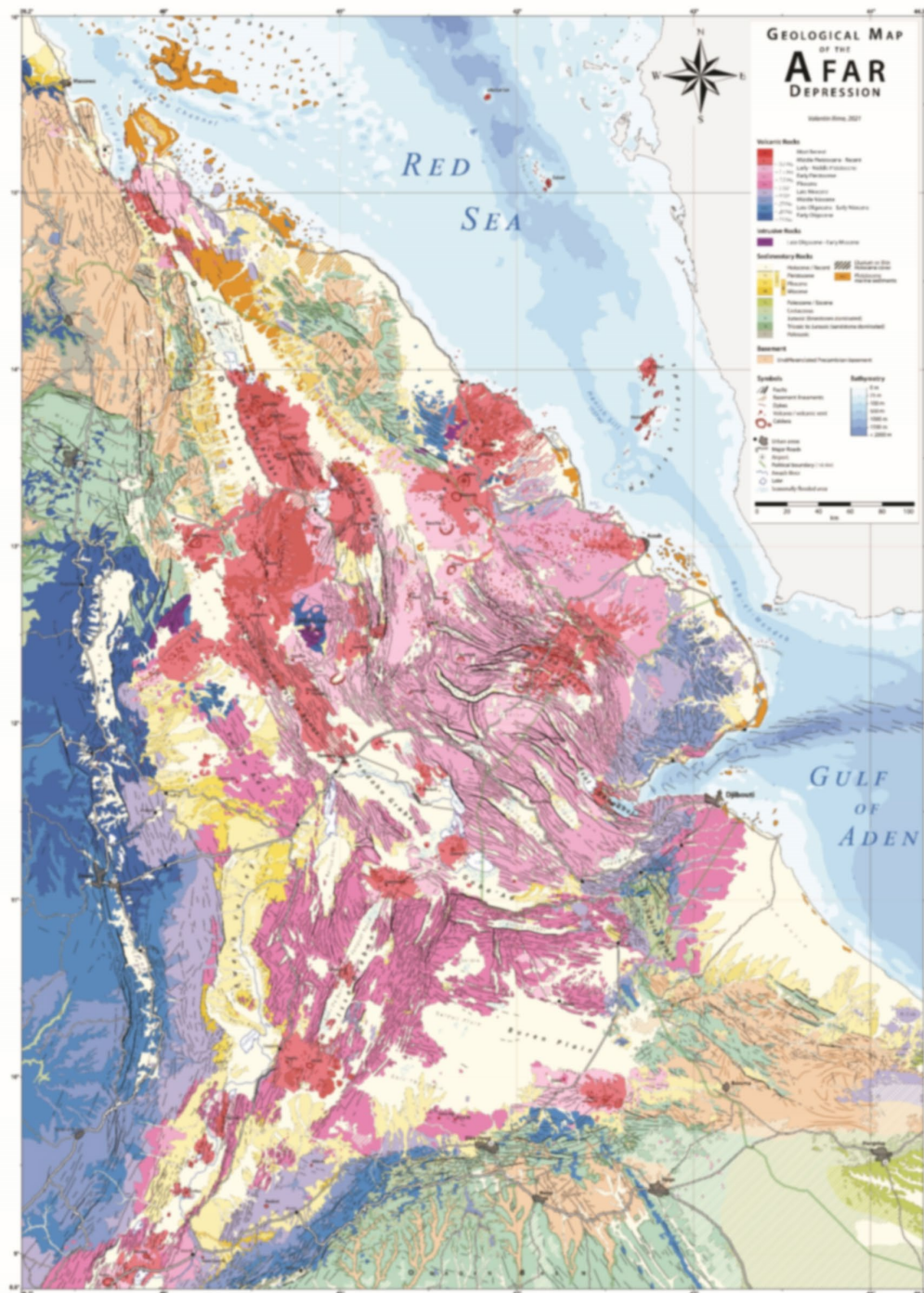




## The Afar

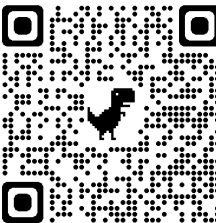
- Part of the Afro-Arabian rift system
- Initiated in the Oligocene after the eruption of flood basalts





## Geological map of the Afar

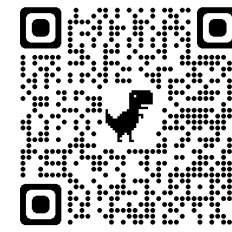
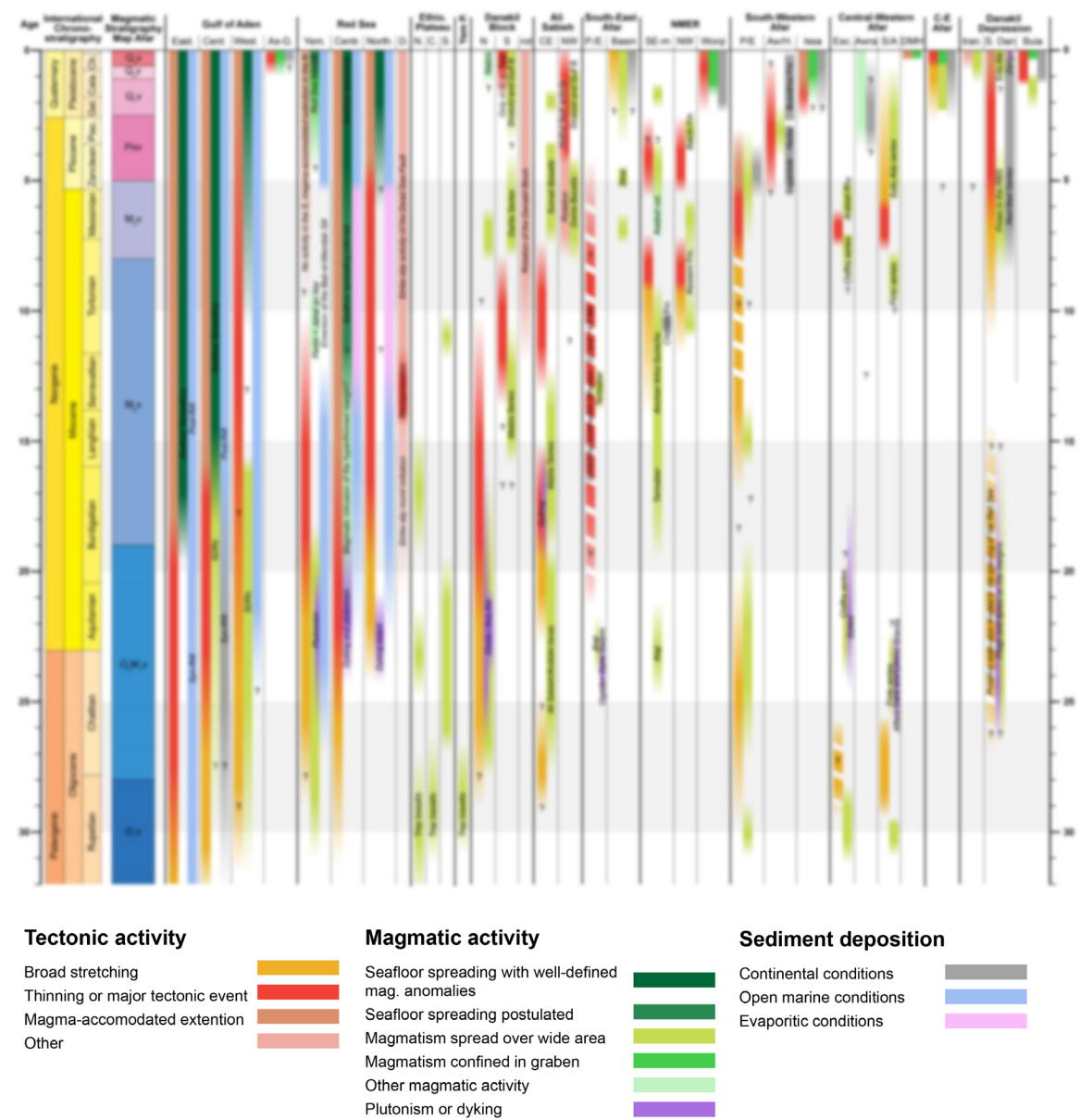
- Based on data from the literature (>200 references), remote sensing and field mapping
- Homogenization of lithostratigraphy





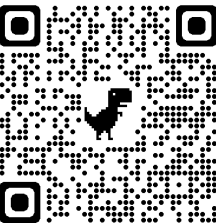
# Review chronological events

- Review of **tectonic**, **magmatic** and **sedimentary** events for different parts of the Afar and surrounding regions

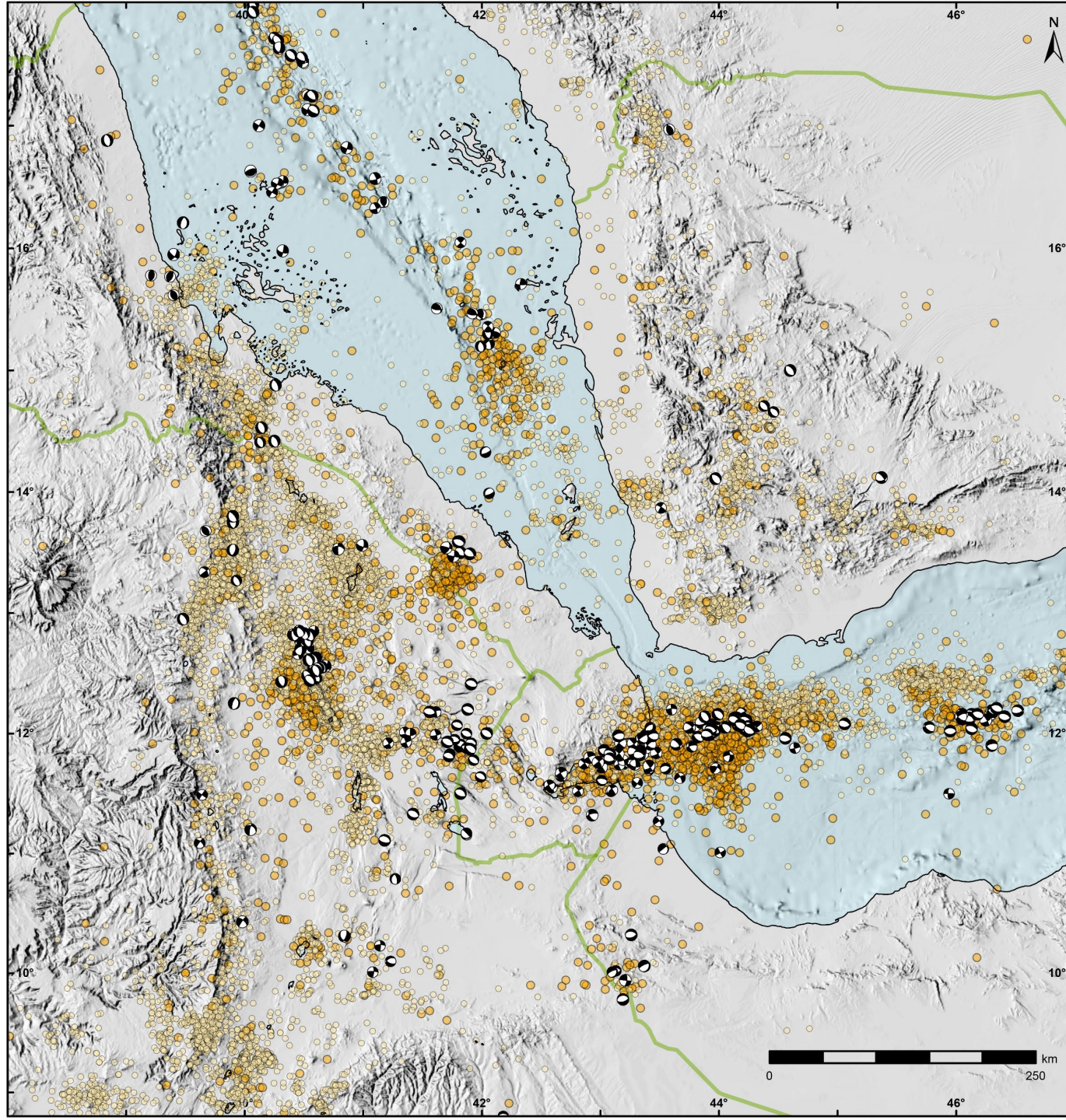


## Discussion:

- Rift arms interaction and rift propagation in Afar



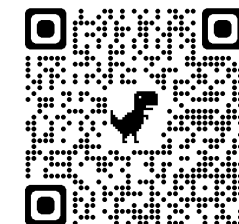




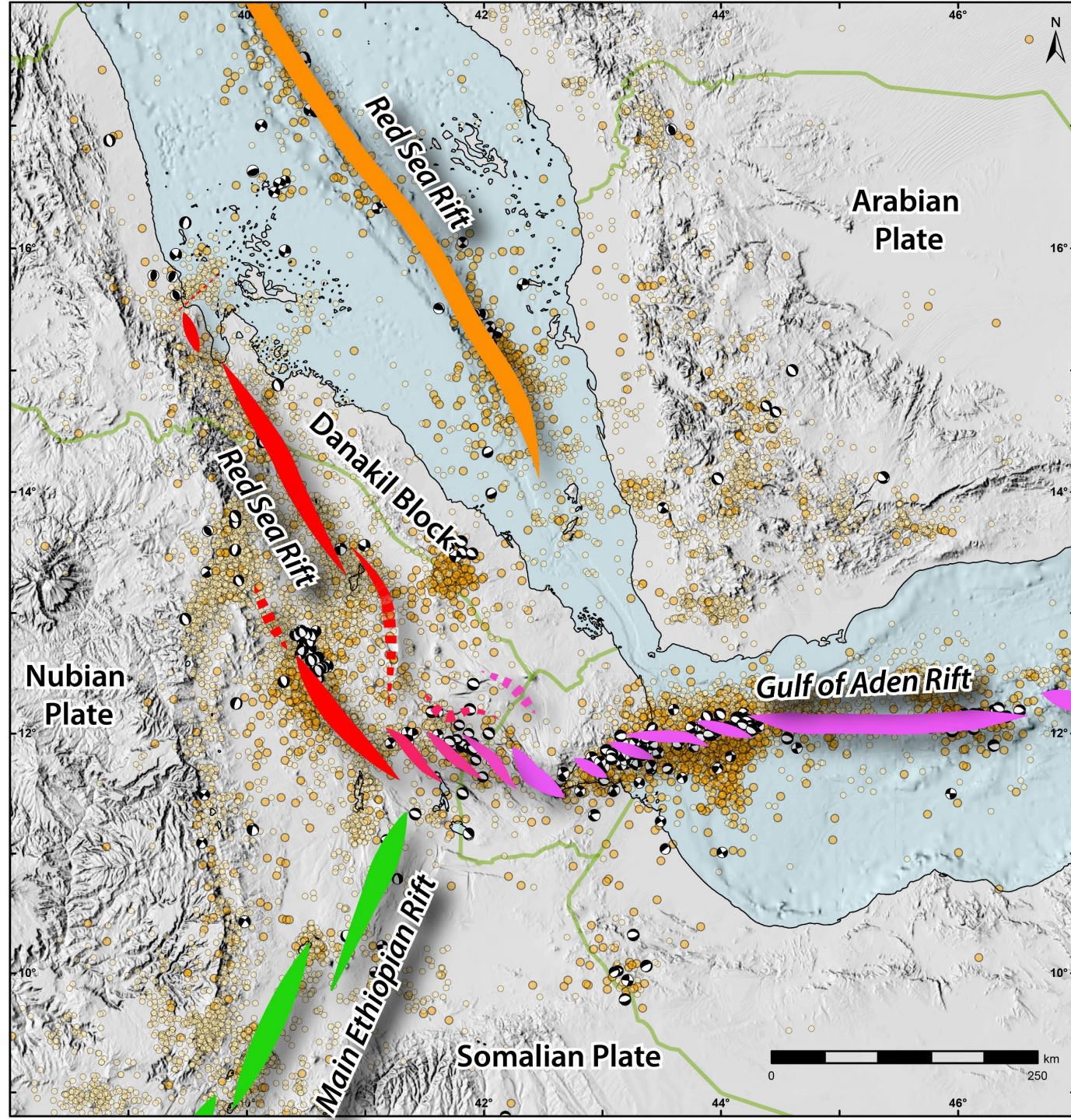
## The triple junction

- Gulf of Aden rift
- Main Ethiopian Rift (East African Rift System)
- Red Sea Rift

**Earthquake map of the Afar Region.** Bright orange dots indicate magnitude  $> 3.5$ . Light smaller dots indicate magnitude  $\leq 3.5$  or unknown Earthquakes position from Ruch et al. (2021), Zwaan et al. (2020) and ISC Bulletin. Focal mechanisms are from Hofstetter and Beyth, (2003) and Global CMT Catalogue.



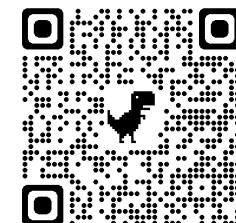




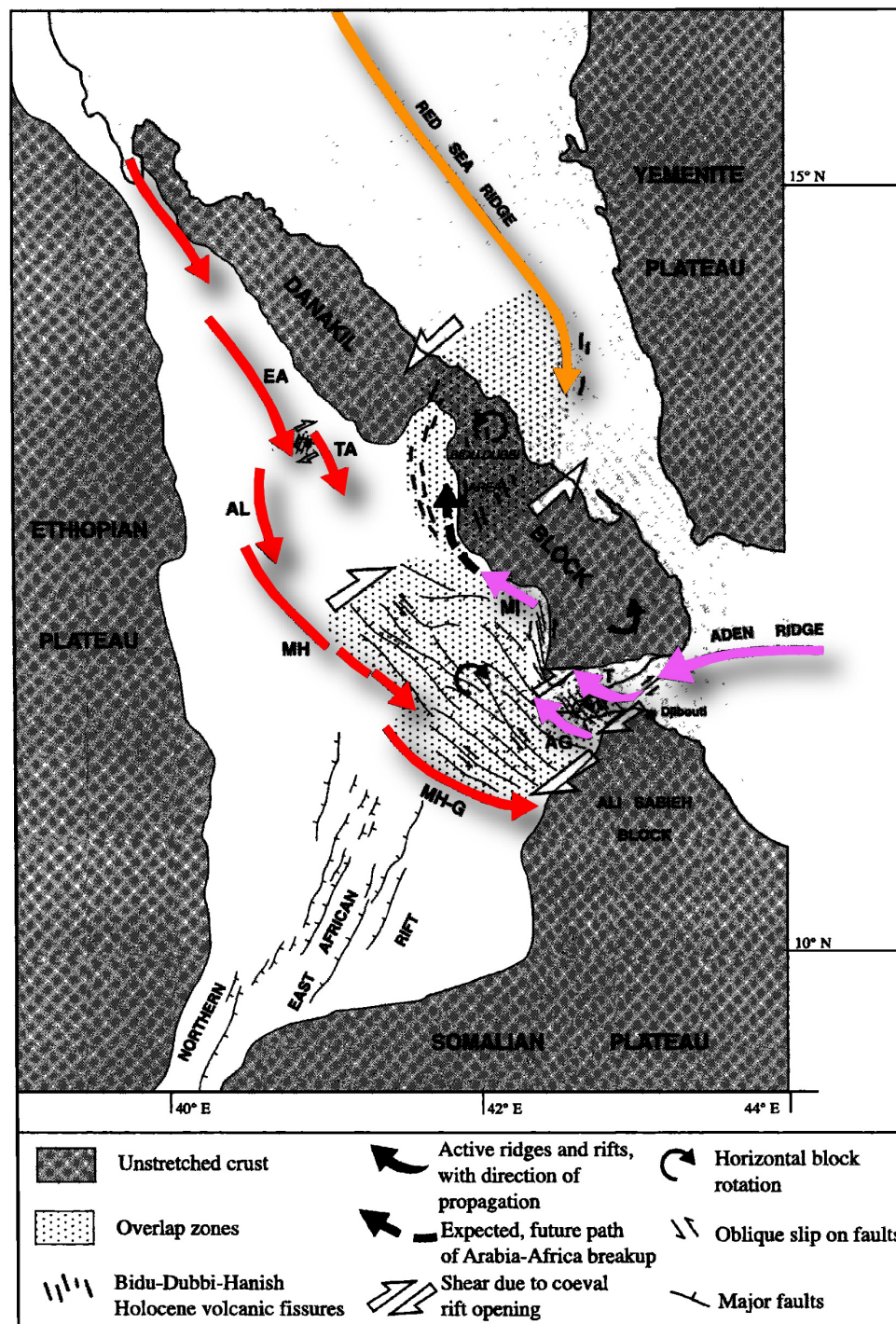
## The triple junction

- Gulf of Aden rift
- Main Ethiopian Rift (East African Rift System)
- Red Sea Rift (2 branches separated by the Danakil block)

**Earthquake map of the Afar Region.** Bright orange dots indicate magnitude  $> 3.5$ . Light smaller dots indicate magnitude  $\leq 3.5$  or unknown Earthquakes position from Ruch et al. (2021), Zwaan et al. (2020) and ISC Bulletin. Focal mechanisms are from Hofstetter and Beyth, (2003) and Global CMT Catalogue. Rift segments after Corti (2009), Doubre et al. (2017), Pagli et al. (2014), Ruch et al. (2021) and Sangha et al. (2022).





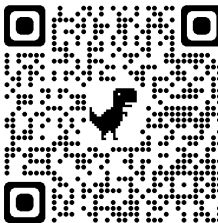


## Rift Propagation

Model of Manighetti et al. (1998, 2001):

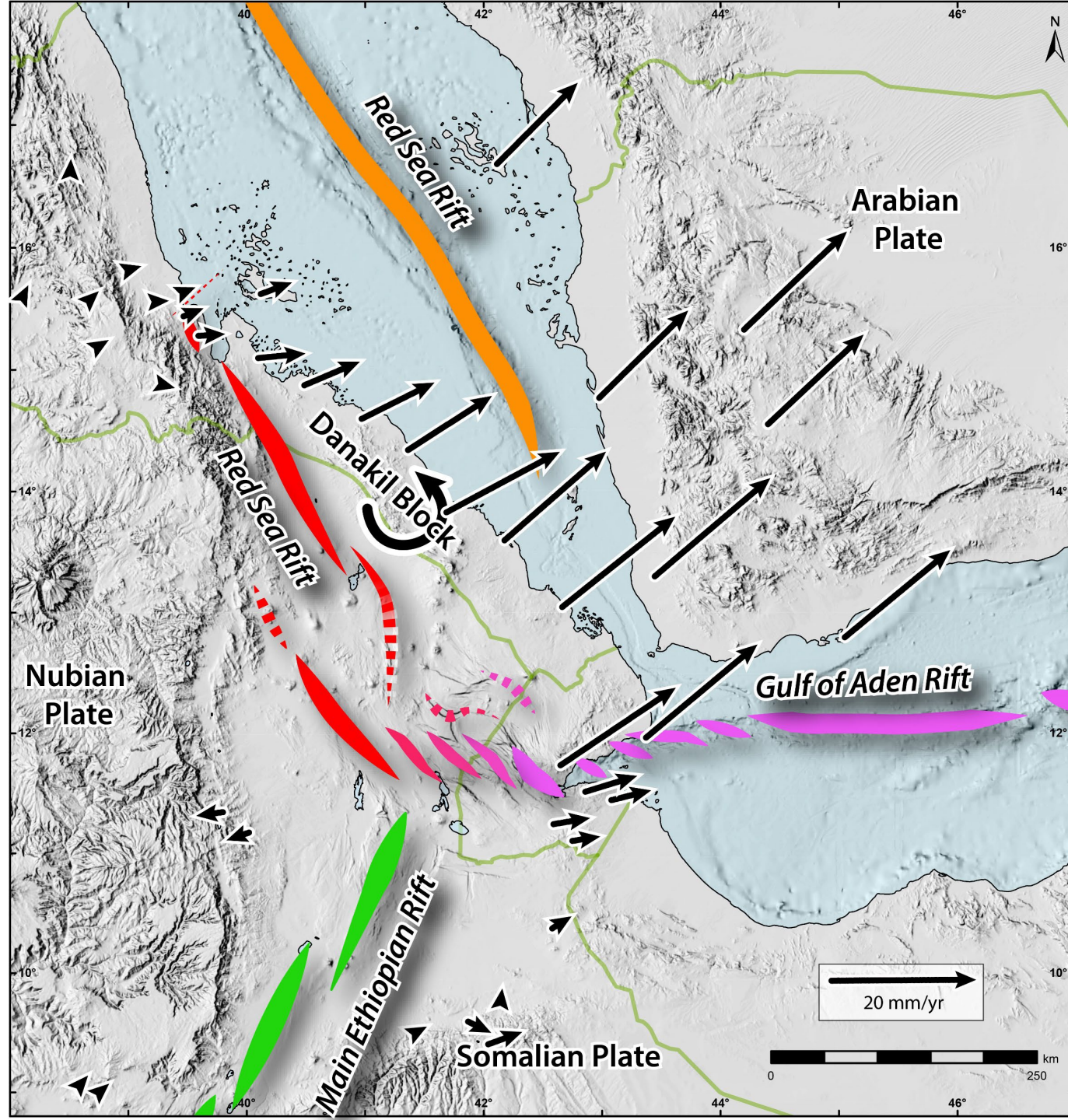
- Gulf of Aden Rift: westwards propagation
- Red Sea Rift: southward propagation

?



Rift propagation: Figure from Manighetti et al., 2001

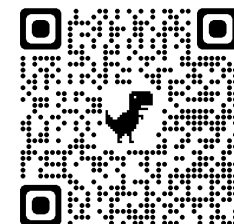




## Rift propagation in Afar

- Counter-clockwise rotation of the Danakil block

**Velocities relative to Nubia:** Data from Doubre et al. (2017); McClusky et al. (2010); Viltres et al. (2020)



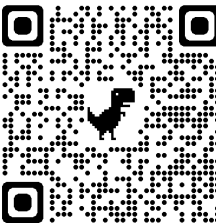




## Rift propagation in Afar

- Counter-clockwise rotation of the Danakil block implies a propagation towards N

Click to play video!

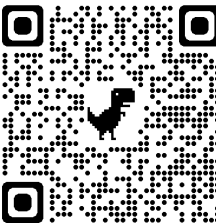




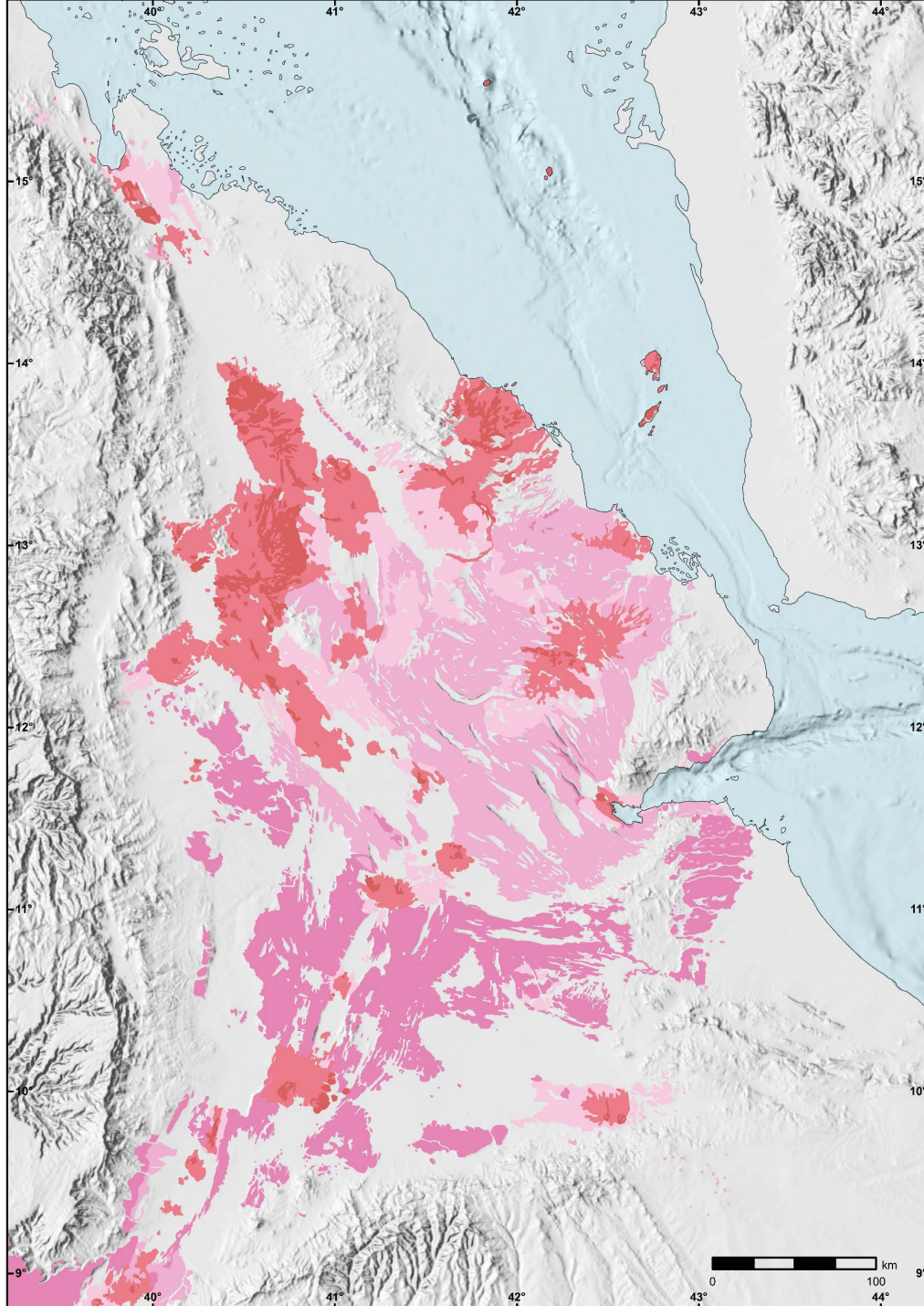
## Rift propagation in Afar

- Counter-clockwise rotation of the Danakil block implies a propagation towards N

Click to play video!



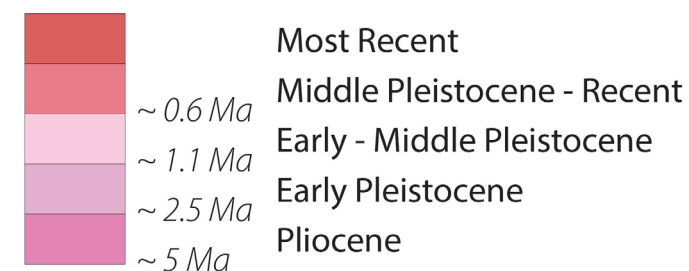




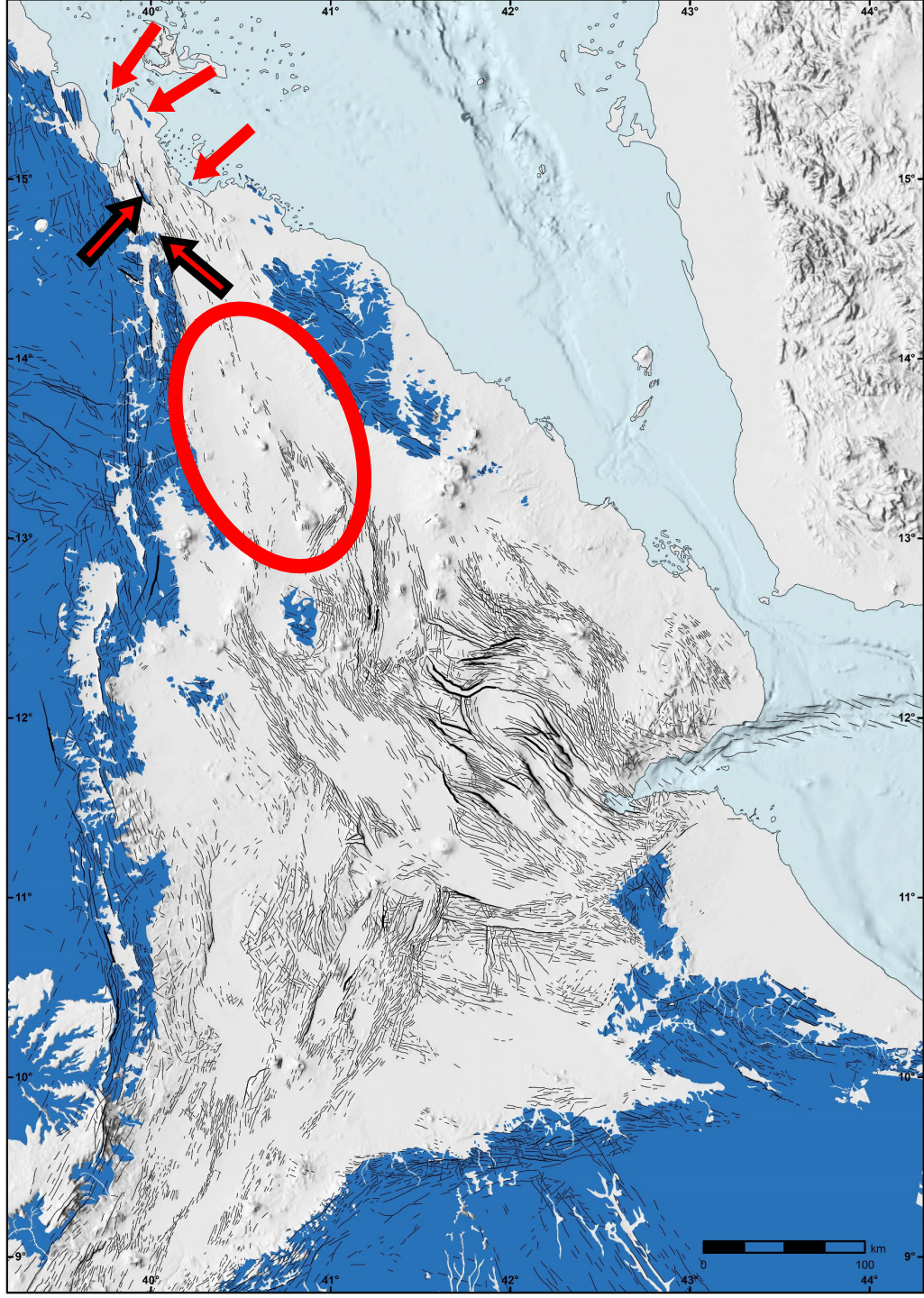
## Rift propagation in Afar

- Counter-clockwise rotation of the Danakil block implies a propagation towards N
- Younger magmatic material in the N

### Volcanic Rocks



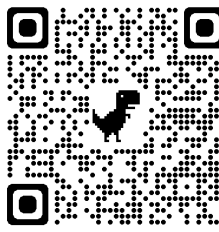




## Rift propagation in Afar

- Counter-clockwise rotation of the Danakil block implies a propagation towards N
- Younger magmatic material in the N
- Basement outcrops in the N (lower crustal separation)

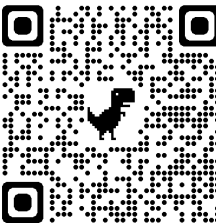
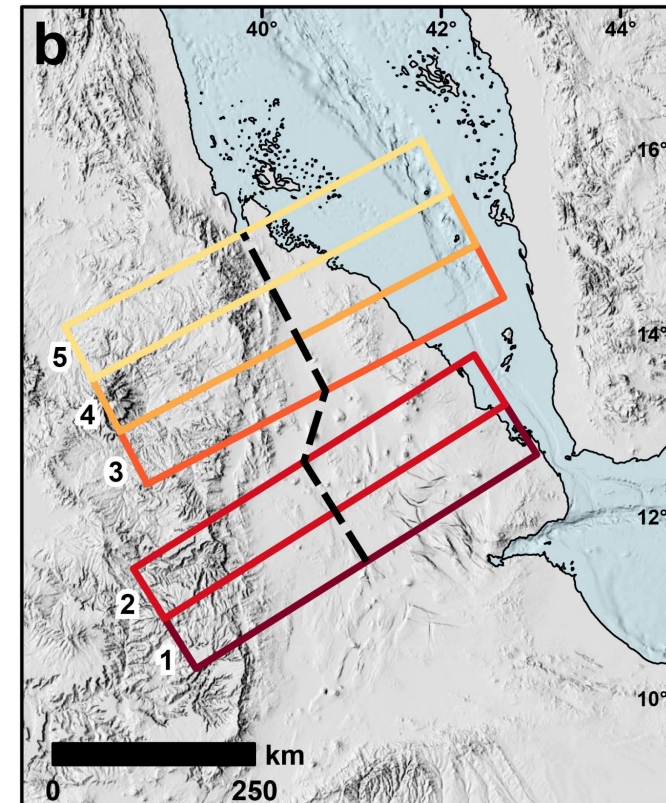
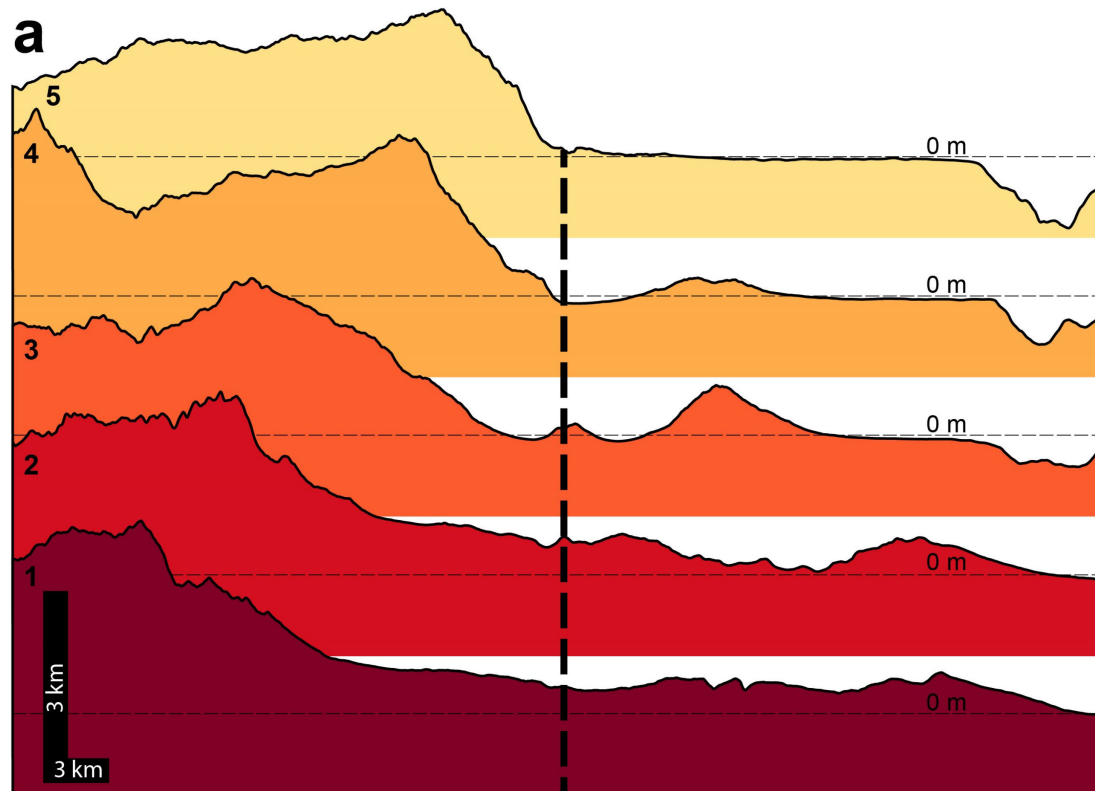
Pre-rift rocks

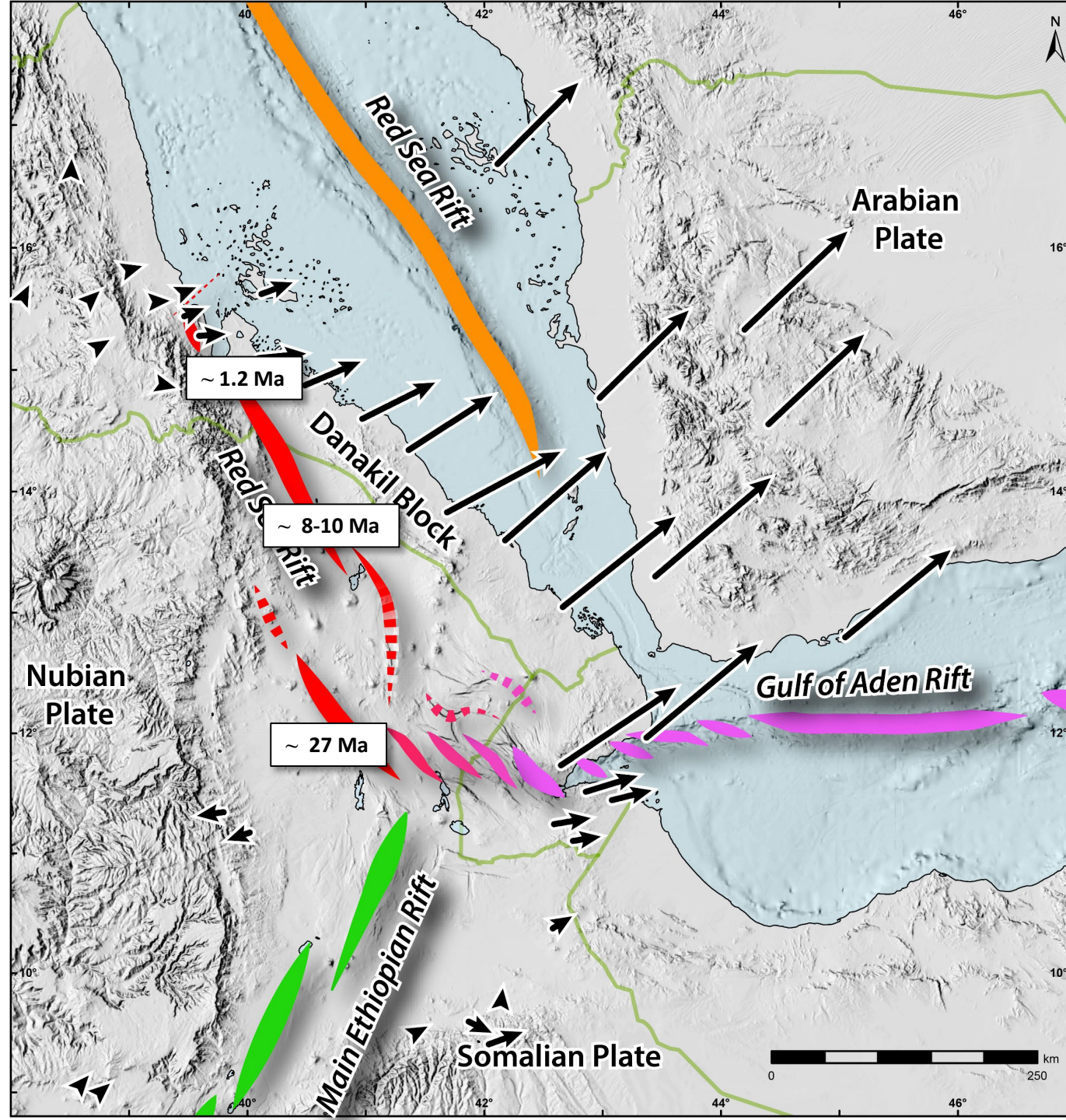




## Rift propagation in Afar

- Counter-clockwise rotation of the Danakil block implies a propagation towards N
- Younger magmatic material in the N
- Basement outcrops in the N
- More immature topography in the N



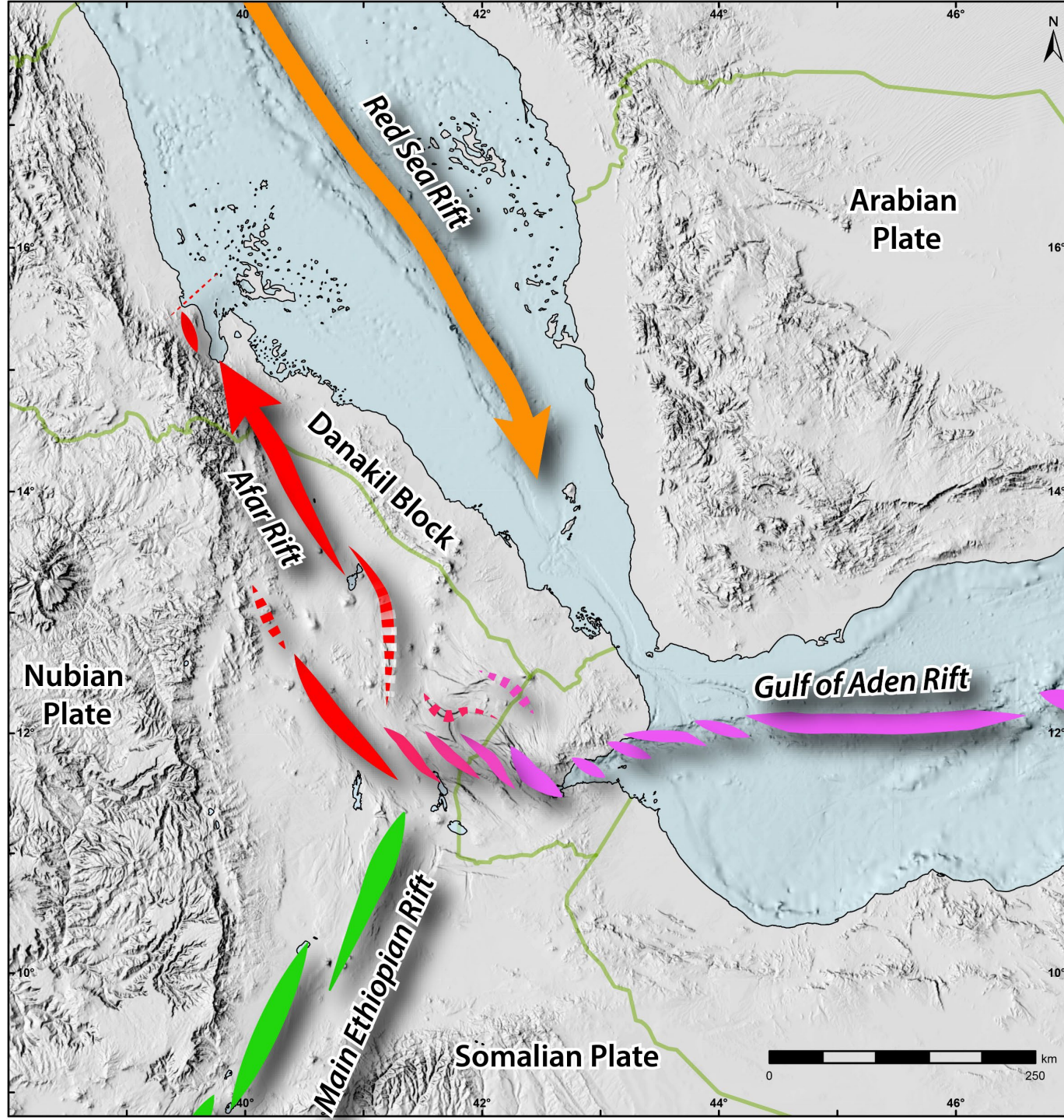


## Rift propagation in Afar

- Counter-clockwise rotation of the Danakil block implies a propagation towards N
- Younger magmatic material in the N
- Basement outcrops in the N
- More immature topography in the N
- Younger rift in the N

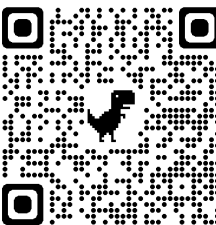




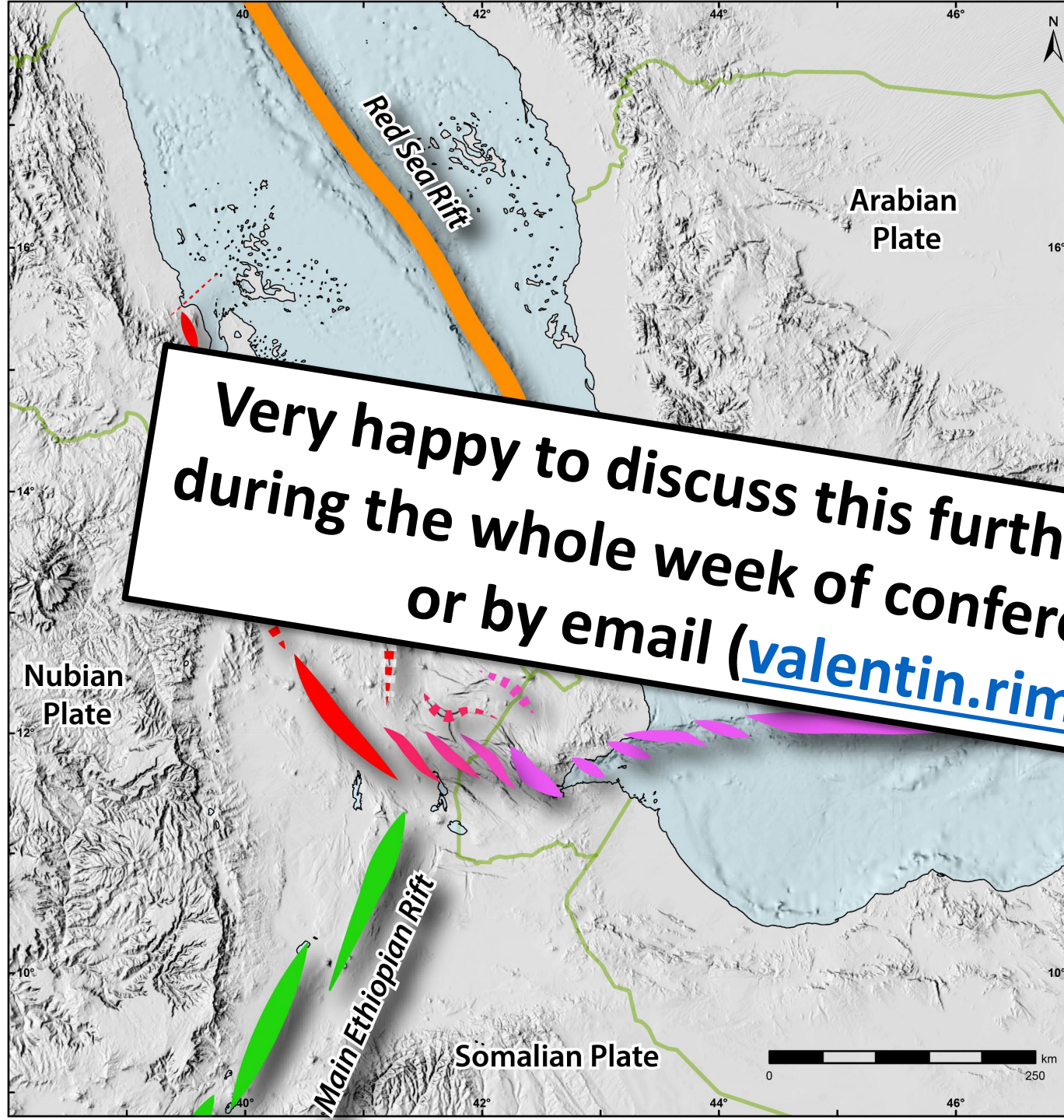


## Rifting in Afar is propagating towards the north.

- Rifting in Afar is not a propagation of the Red Sea Rift s.s.
- It forms a relay structure with the Red Sea Rift s.s.
- It forms a nearly continuous structure with the Gulf of Aden Rift.
- For clarity among scientists we propose not to call it Red Sea Rift anymore but the **Afar Rift**.
- This distinction is useful at regional scale, but at larger scale, the conventional model remains appropriate.







## Rifting in Afar is propagating towards the north.

- Rifting in Afar is not a propagation of the Red Sea Rift s.s.
- It forms a relay structure with the Red Sea Rift s.s.
- It forms a nearly continuous structure with the Gulf of Aden Rift.

Very happy to discuss this further with you, in person during the whole week of conference, in the comments or by email ([valentin.rime@unifr.ch](mailto:valentin.rime@unifr.ch))!

clarity among scientists we propose  
rift anymore but  
nal  
com  
appropriate.

