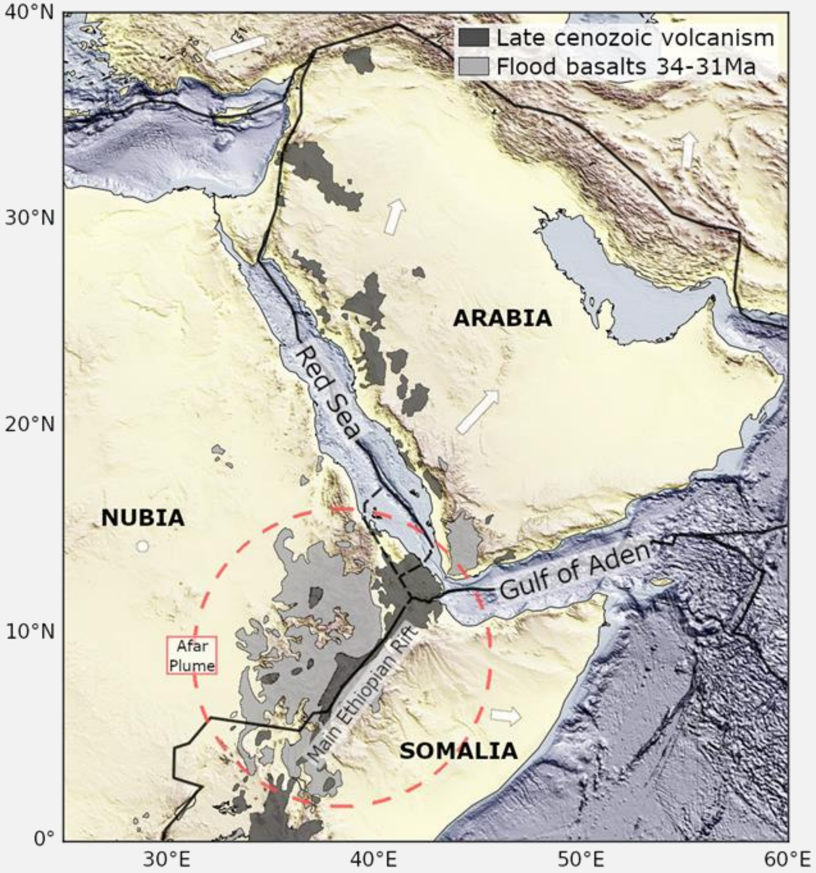
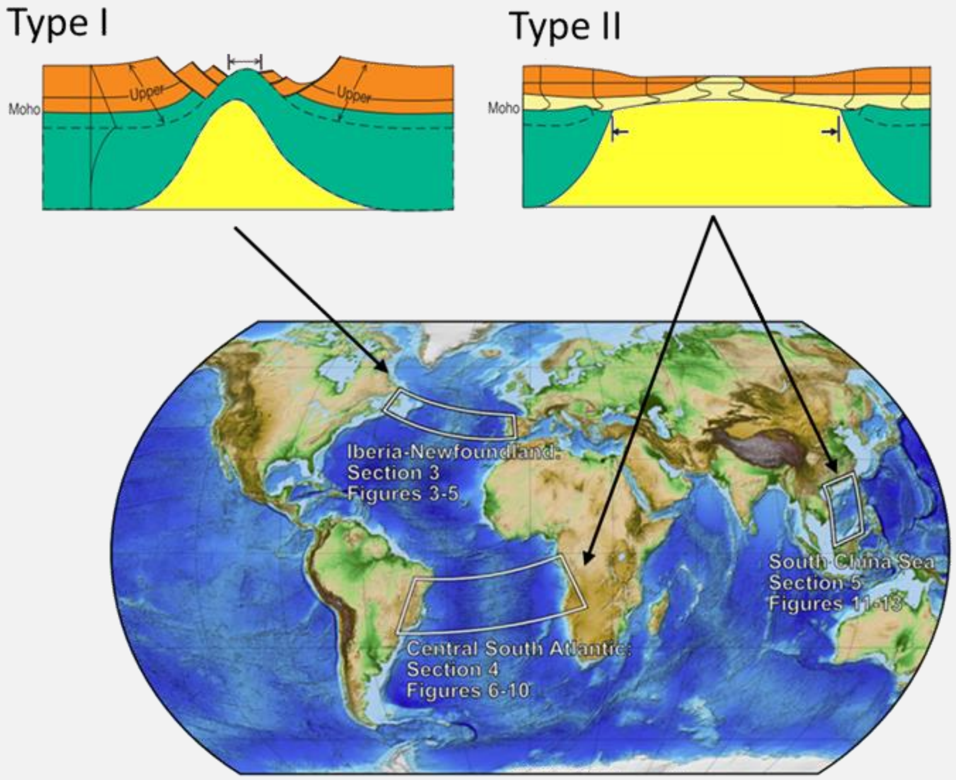
Ran Issachar, Jörg Ebbing, Yixiati Dilixiati, and Ángela María Gómez-García

Research Question - Which End-Member Type of Rifted Margins in the Red Sea?



- Numerical simulations show that the rheology of the crust has a major influence on rifted margins architecture.
- Strong crust can lead to an extreme crustal thinning after only limited extension like in the case of the Iberia-Newfoundland conjugate margins (Type I).
- Weak lower crust can lead to protracted crustal extension and the formation of (ultra)wide margins like in the case of the Brazil-Angola conjugate margins (Type II).
- How the proximity to a mantle plume influences crustal rheology and rifting is not clear.
- The Red Sea offers a unique opportunity due to its young age and its close proximity to the Afar plume.

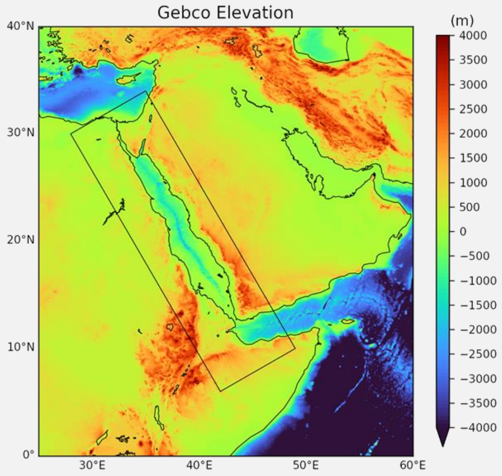


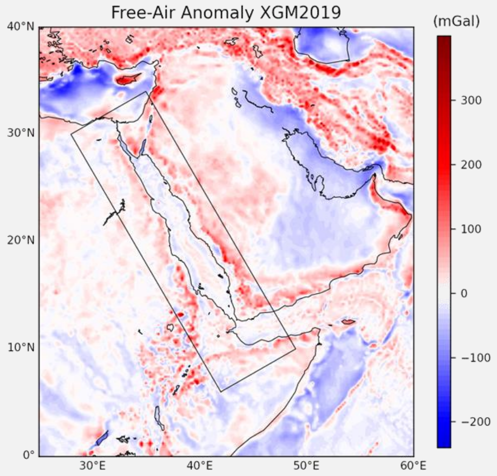
Huismans and Beaumont., 2011; Brune et al., 2017

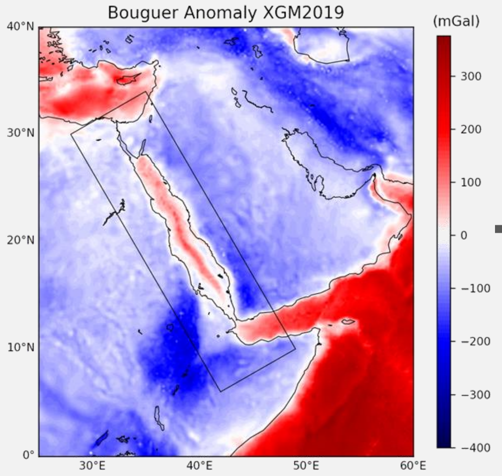
Study Approach – 3D Forward Modeling of Gravity Anomalies (IGMAS+)

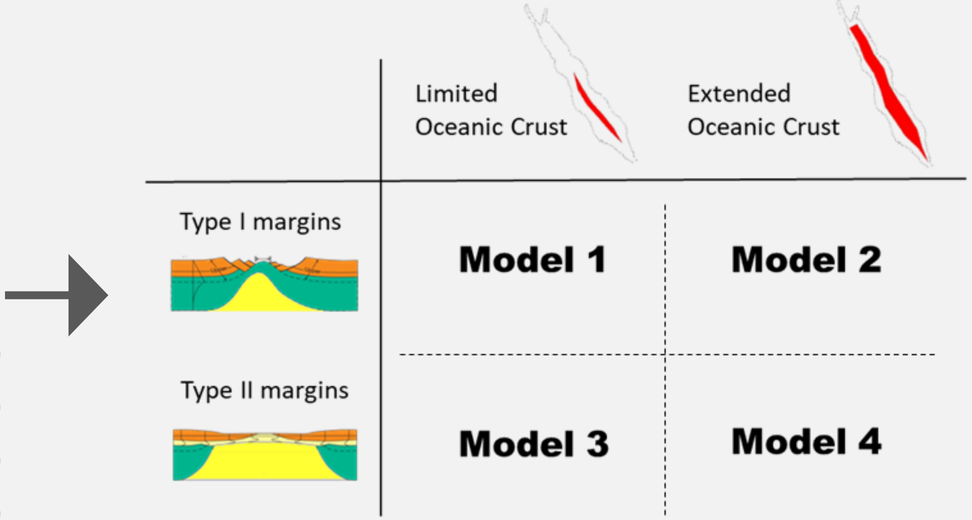
We use free-air gravity anomalies from XGM2019 model (ICGEM) and apply a Bouguer correction using GEBCO bathymetry compilation.
To distinguish between two end member types of rifted margins and two options of oceanic crust distribution we constitute four model:

- **Model 1** – Type I margins and limited oceanic crust distribution
- **Model 2** – Type I margins and extended oceanic crust distribution
- **Model 3** – Type II margins and limited oceanic crust distribution
- **Model 4** – Type II margins and extended oceanic crust distribution









Rifting in the Red Sea – Insights Into the Rift Architecture from Geophysical Data

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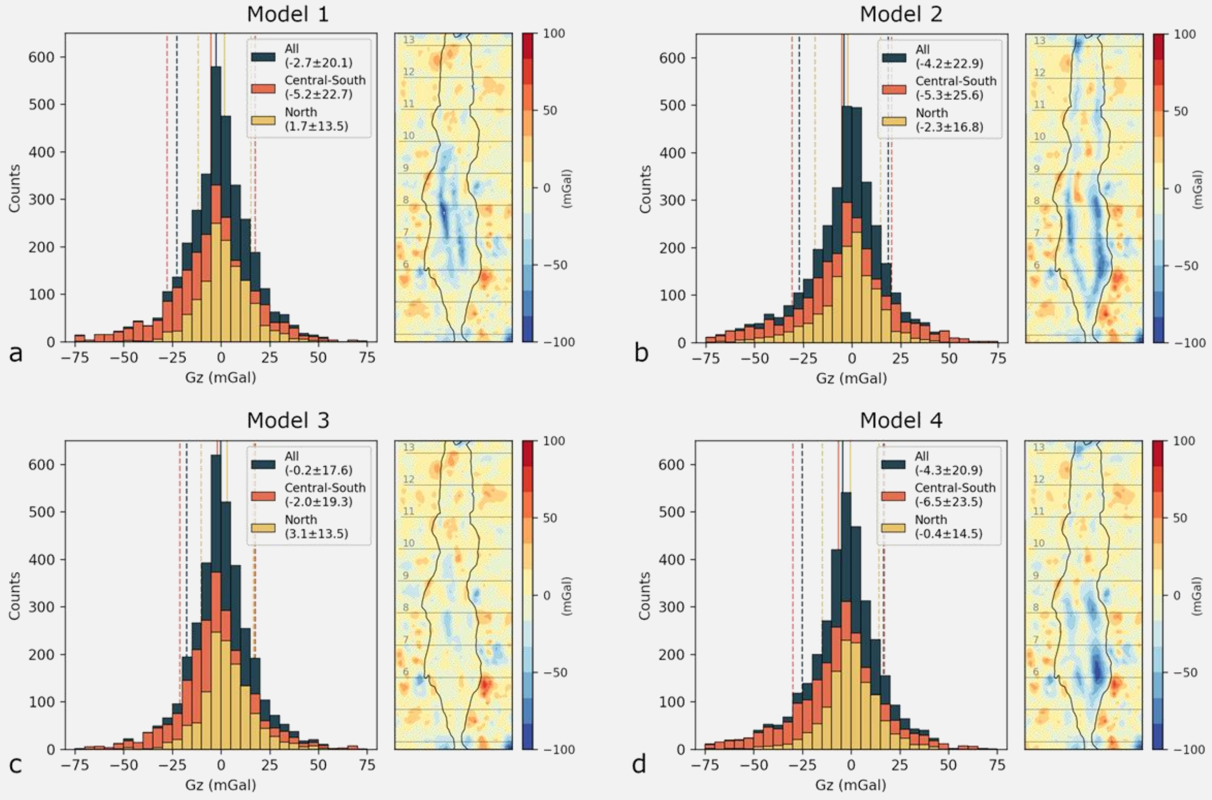
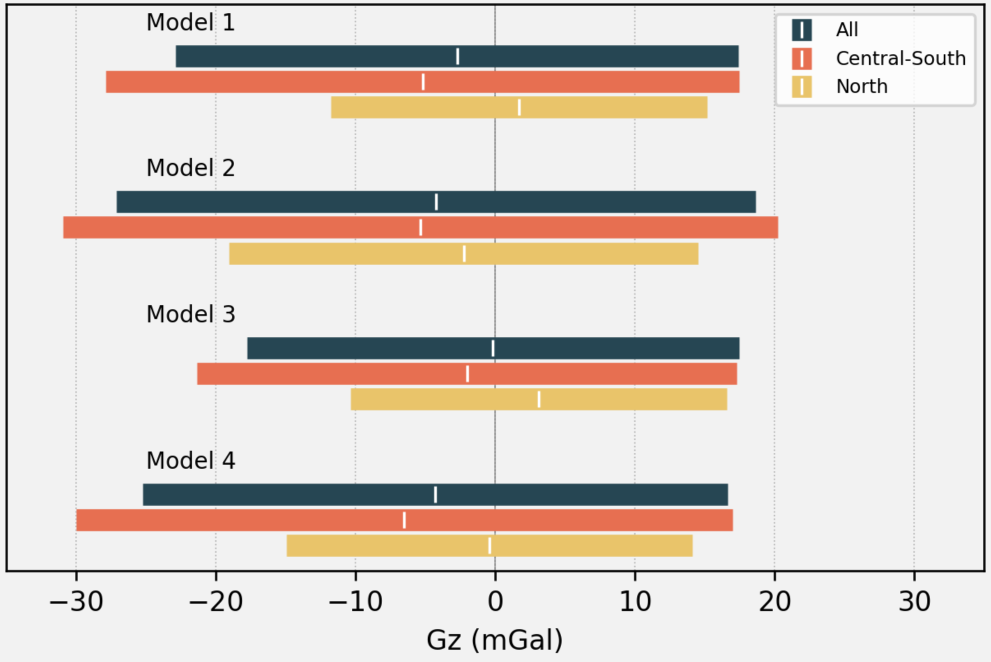
Results – (1) Model 3 in the Central-Southern Regions
(2) All Models in the Northern Region

Model Residuals



Average and Std



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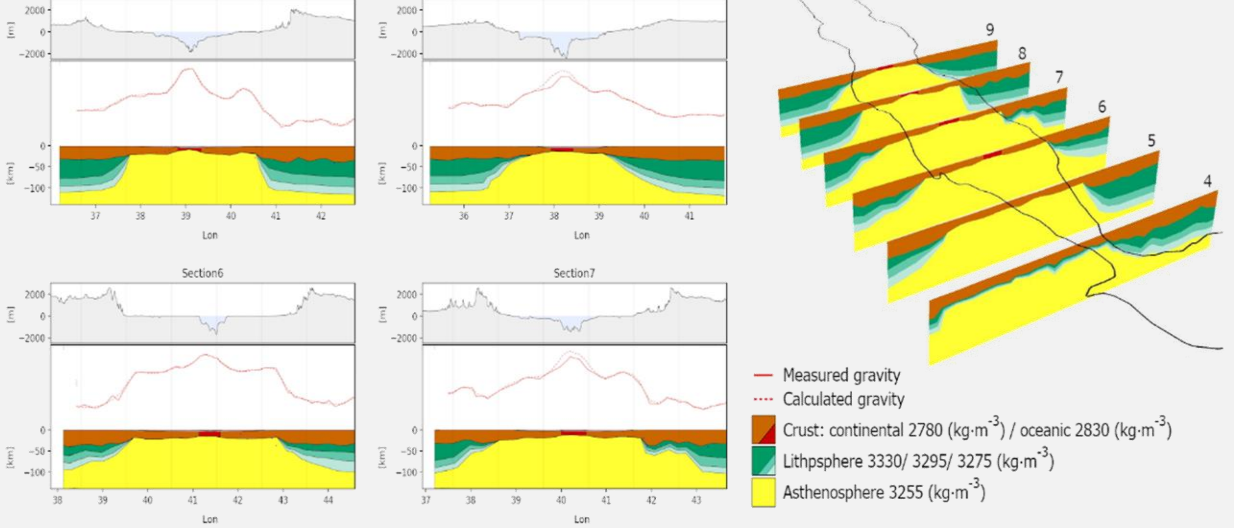
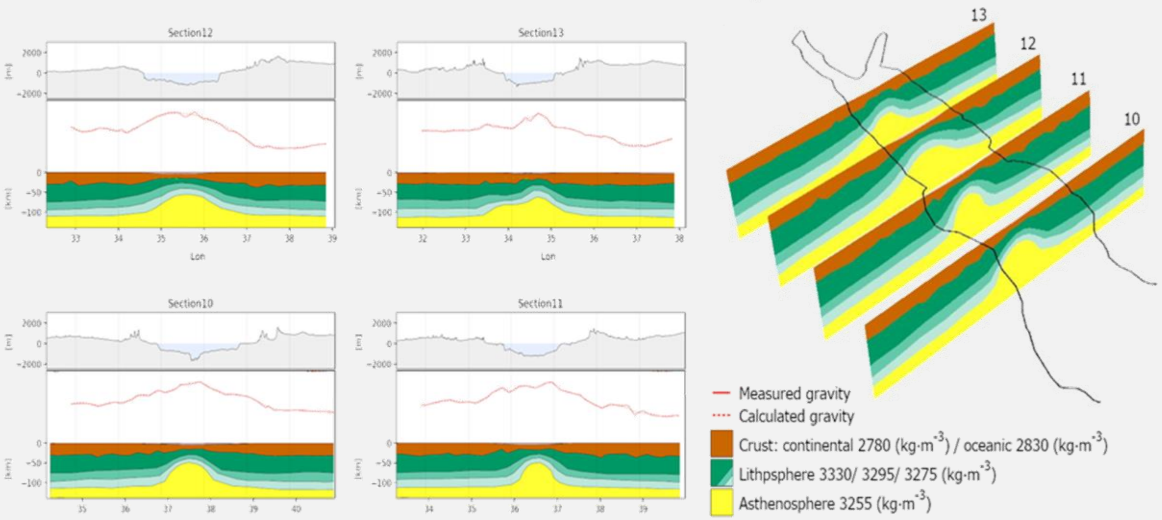
Results – (1) Model 3 in the Central-Southern Regions (2) All Models in the Northern Region

Type I

- In the Central-Southern Red Sea (ultra)wide margins outlined by removal of the mantle lithosphere and broad asthenosphere upwelling (Model 3).

Type II





- In the Northern Red Sea all models fit the gravity data.
- Yet, comparison with tomography suggest narrow asthenosphere upwelling and exhumed continental mantle lithosphere (Model 1).

Discussion – Thermal Softening of the Lower Crust by Plume Activity

- Considering the thermochemical state of the upper mantle in this area (from WINTERC-G model) we find high temperature gradients in the plume area.
- The geological record indicate ~ 10 Myr gap between the arrival of the Afar plume and the initiation of rifting in the Red Sea.
- Together these can explain the development of (ultra)wide margins thermal softening of the lower crust by prolonged plume activity.