A new geodynamic model of the Azores archipelago: preliminary results

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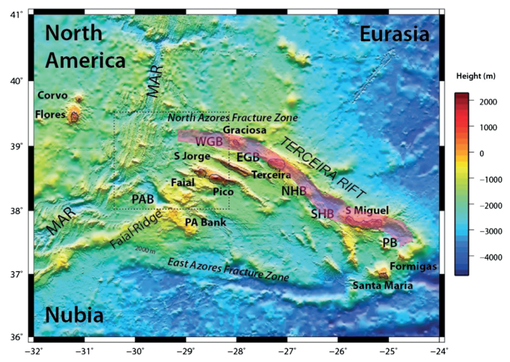
Objectives

- Explore the dynamics of the Azores triple-junction region
- Assess the contraints behind the formation of the Terceira rift, which acts as the connection between the Gloria Fault Zone (GFZ) and the mid Atlantic ridge (MAR)
- Understand the complex vertical motion history of the Azorean archipelago

Methods

- All models were ran using the LaMEM code (Kaus *et al.*, 2016)
- Ridges were implemented as static spreading centers, with varying spread-rates across the ridge
- Shear zones consist of low viscosity regions with their dynamics imposed by the overarching velocity field

The Azores archipelago

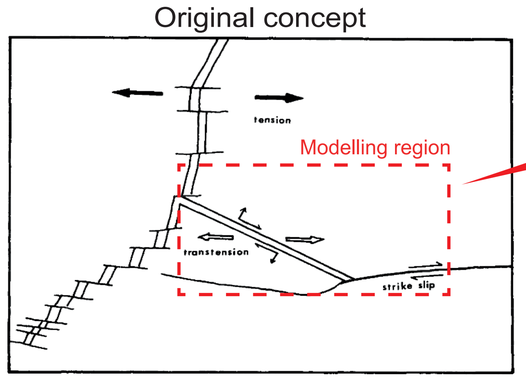


Adapted from Miranda *et al.* (2014)

- Located in the middle of the Atlantic Ocean
- Composed by nine islands, unevenly distributed between the North America, Eurasia and Nubia plates
- Three of the islands are located within the slow-spreading Terceira rift (highlighted in red in the figure to the left)

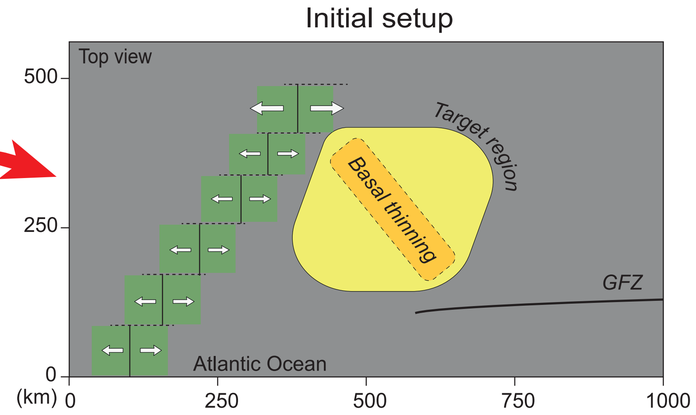
Exploring the formation of the Terceira Ridge

Original concept



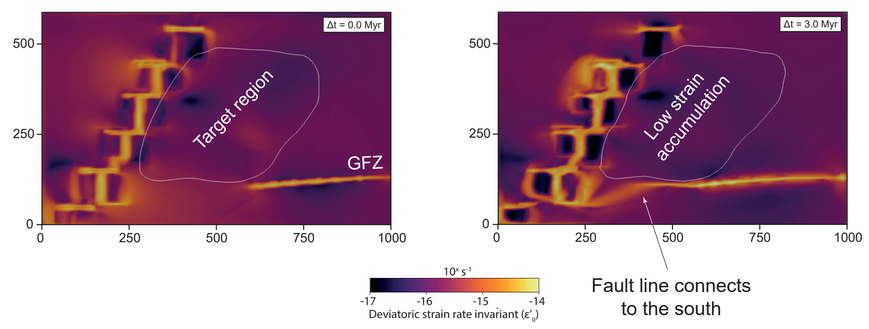
Adapted from Madeira and Ribeiro (1990)

Initial setup



With basal weakening

North trending GFZ

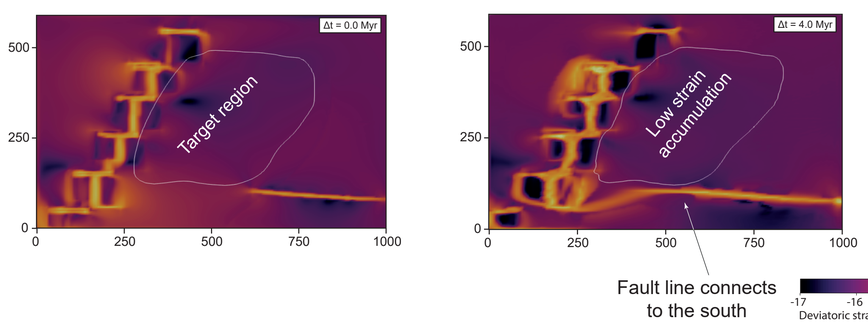


Main observations

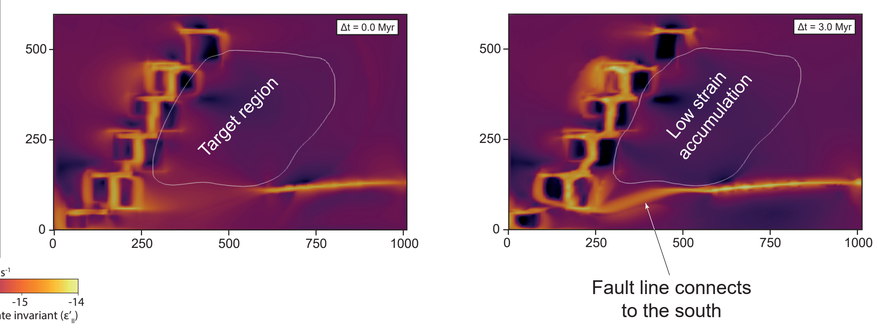
- Despite basal weakening, the GFZ tends to connect to the south segments of the mid-ocean ridge
- The trend of the GFZ seems to not affect the development of the connection
- No strain accumulates within the target region with the current modelling conditions

Without basal weakening

North trending GFZ

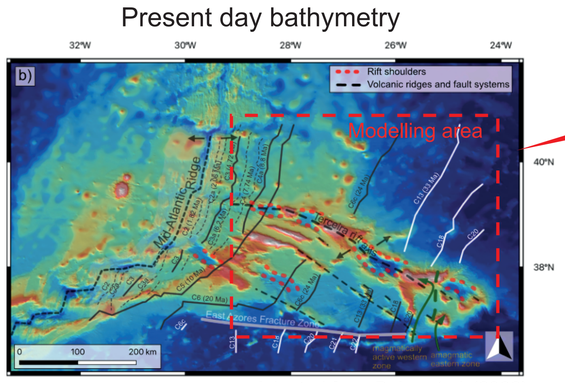


South trending GFZ



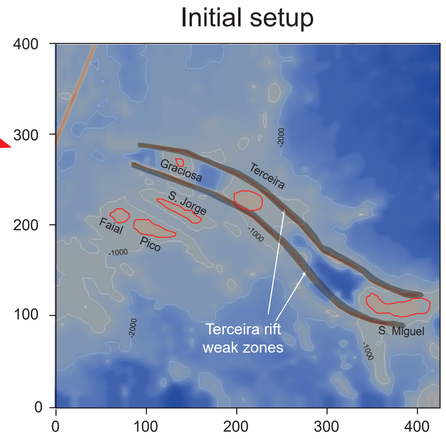
Testing the effects of bathymetry/topography on present-day deformation

Present day bathymetry

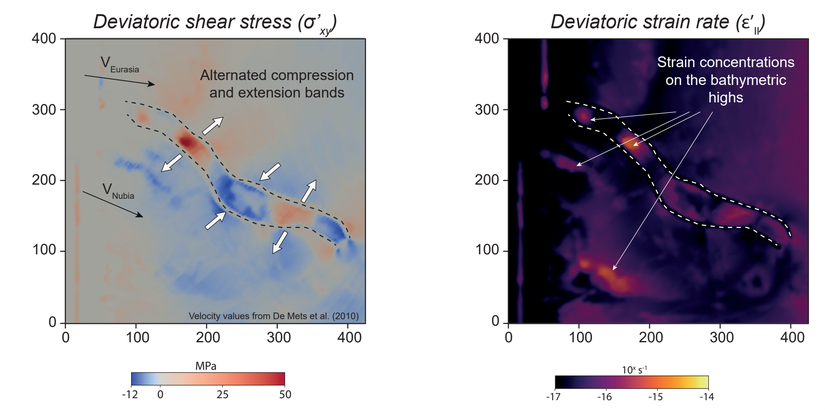


Adapted from Beier *et al.* (2022)

Initial setup



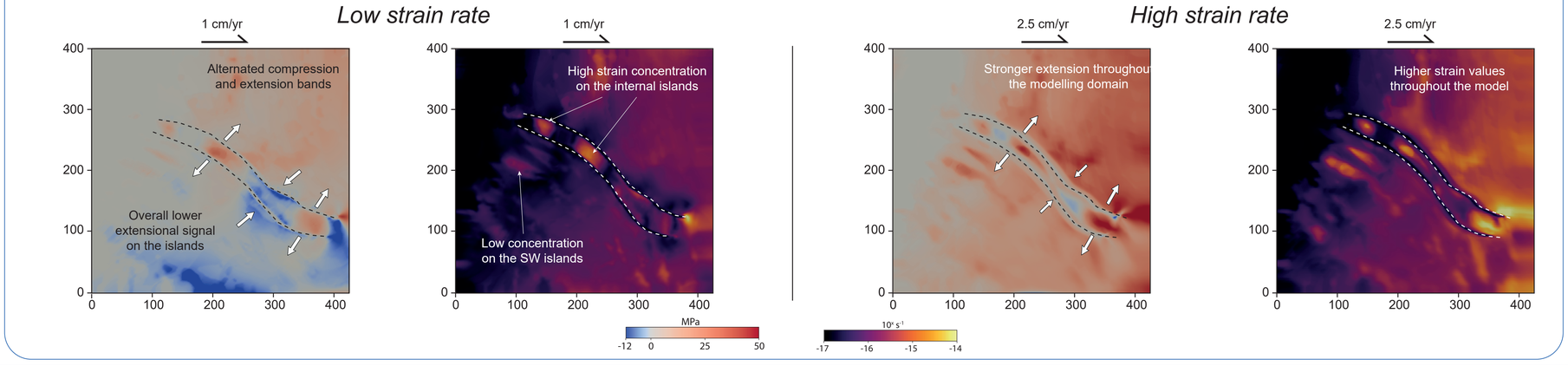
Imposed plate velocities



Main observations

- The region within the Terceira Rift shows alternating bands of compression and extension
- The topographic/bathymetric highs show clear strain localization, showing the relevance of the islands to present-day stress states
- SW islands (Faial, Pico, S. Jorge) stress states differs significantly between the imposed conditions (i.e., compression vs extension)

Imposed shear (xy) strain rate



Future work

- Further testing is required to explain the formation of the Terceira Rift, such as:
  - Longer eastward propagating transform faults
  - A previously established GFZ-MAR connection
  - A shifting far-field stress state, such as the onset of the collision between Eurasia and Nubia
  - Lower the amount of ridge segments to promote localization
- Further testing to assess the effects of topography/bathymetry on the present day stress state of the archipelago:
  - Increased resolution to obtain a finer contrast between the compression/extension bands
  - Model validation with present-day GNSS observations
  - Island-scale modelling with pre-imposed strain rates obtained from large-scale models

Preliminary conclusions

- Additional constraints are required to explain the formation of the Terceira Rift, as the current modelling conditions do not trigger extension within the target region
- Present-day plate motions coupled with the geometry of the Terceira Rift seem to produce complex compression/extension patterns, which will contribute towards the explanation of the historic vertical motions registered
- The stress state of the individual islands is strongly controlled by the imposed strain conditions, which requires further exploration and validation

References

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