Modelling overriding plate deformation and slab rollback in the Mediterranean

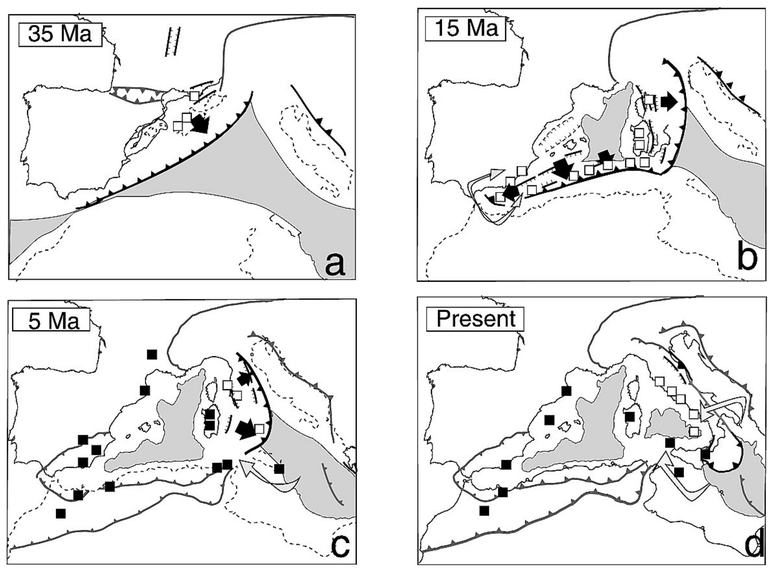
L.F.J. Schuurmans[1], W. Spakman[1], M.R. Fraters[1] & D.J.J. van Hinsbergen[1]

[1]Department of Earth Sciences, Utrecht University, Utrecht

Problem formulation

Stagnation and reactivation of back-arc extension occurs in several (former) subduction systems. Examples include the Western Mediterranean and the Lau Basin. However, the cause of this stagnation and reactivation, and whether they are caused by the same process, is still unknown. The aim of this project is to study the effect of overriding plate rheology and slab tip location on the evolution of back-arc basins and rollback timing.

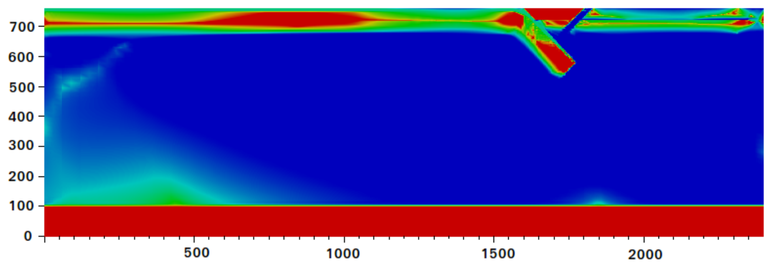
Geological setting



[*Faccenna et al., 2004*]

Since 30 Ma, back-arc extension caused by slab rollback has taken place in the Western Mediterranean. Rollback of the Calabrian slab has been a two-stage process. During the first stage, from 30 Ma until 16 Ma, the Liguro-Provencal Basin opened, and after a stagnation of around 6 My, the Tyrrhenian Basin opened from 10 Ma until present. The continental block containing Corsica and Sardinia moved along with the Calabrian slab during the first opening stage, but was left behind at its current location before the beginning of the second stage.

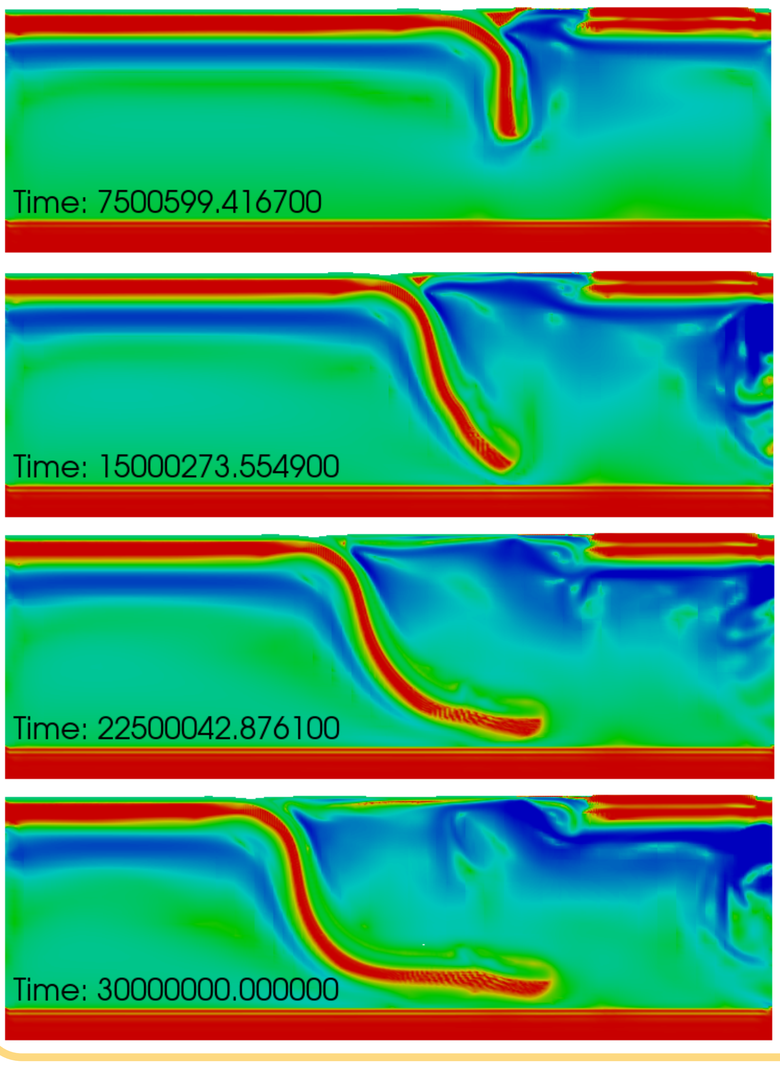
Model setup

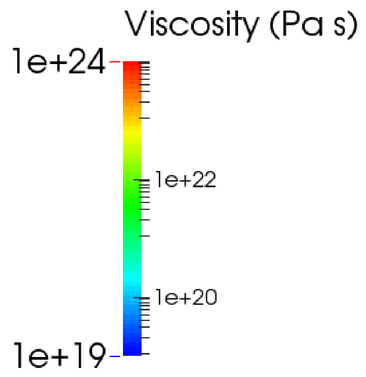


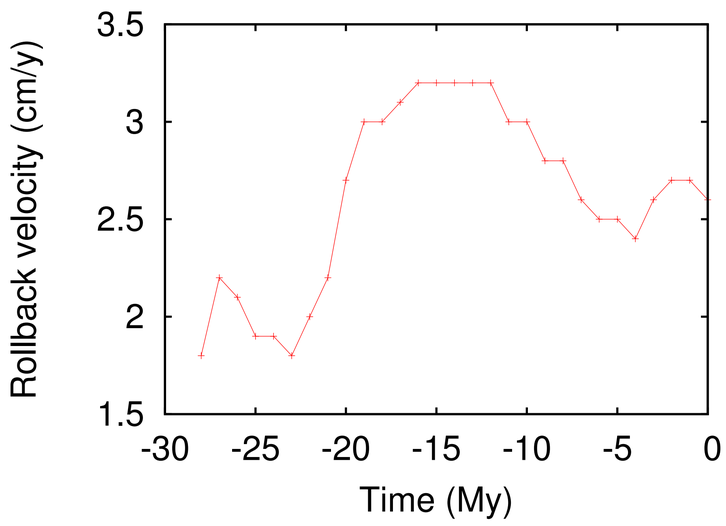
- 2D cross-section through Central Mediterranean with ASPECT
- Evolution of the last 30 My
- Subducting plate velocity: 0.5 cm/y, overriding plate: fixed
- Weak zone in overriding plate to simulate former faults and sutures
- Open vertical boundaries, free surface at the top

Trench rollback velocities

To test whether rollback stagnation and reactivation of back-arc extension occurs, the trench retreat velocity through time is evaluated. To do this, the difference in location of the trench relative to the previous timestep is measured every million year. Trench retreat velocity is increasing from the onset of extension until approximately 16 Ma. After remaining stable for a few million years, the retreat velocity decreases.



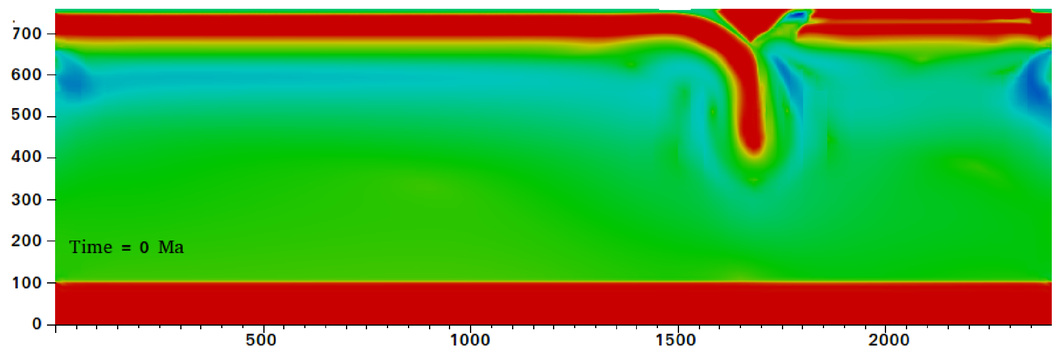




Viscosity averaging schemes

The choice of the viscosity averaging scheme has proven to have an important effect on the model run. The choice of a harmonic averaging scheme, which is physically feasible, results in rollback and back-arc extension. However, the implemented high viscosity continental block does vanish through time due to numerical diffusion. The block is required to remain in existence, since it represents the observable block of Corsica and Sardinia in the Western Mediterranean.

If a geometric averaging scheme is used, the continental block does not vanish, but little rollback and back-arc extension does take place. As a result, the slab does never reach the 660. Seismic tomography reveals that the Calabrian slab does reach the 660, and therefore the current use of the geometric average is not accurate.



Outlook

- Proper viscosity averaging scheme set up has to be found
- Larger weakzone with geometric average may kickstart rollback
- Improve implementation of open boundaries to avoid extra flow near model boundary

References

[1] Faccenna, Claudio and Piromallo, Claudia and Crespo-Blanc, Ana and Jolivet, Laurent and Rossetti, Federico. *Lateral slab deformation and the origin of the western Mediterranean arcs* In *Tectonics '04*