We study potential causes for initiation of subduction in the Western Mediterranean area in the Late Oligocene - Early Miocene. Two scenarios have been proposed for the initiation of subduction in the region: 1) subduction inception at a pre-existing fault along former Iberian passive margin, and 2) polarity reversal of former Alpine subduction zone. We aim to investigate these scenarios using 2-D finite element models. Here we present the results of our numerical experiments for the first scenario.

### 1) Introduction

The Western Mediterranean is located in the convergent plate margin between Africa and Eurasia. The region formed as a result of oceanic subduction and formation of extensional basins on both sides which was started at ~ 30 Ma (Fig. 1). Two scenarios have been proposed for the initiation of subduction in the region: 1) subduction inception at a pre-existing fault along the Iberian passive margin and 2) polarity reversal of former Alpine subduction zone. We study potential causes for initiation of subduction in the Western Mediterranean area in the Late Oligocene - Early Miocene. Two scenarios have been proposed for the initiation of subduction in the region: 1) subduction inception at a pre-existing fault along former Iberian passive margin, and 2) polarity reversal of former Alpine subduction zone.

### 2) Subduction initiation at a pre-existing fault

One of the scenarios which we examine is that subduction has initiated at a pre-existing fault in the Iberian zone. Previous studies show the existence of a STEP (Subduction-Transform Edge Propagator) fault along the Adriatic plate in the Oligocene (Stampfli 2002). According to the proposed scenario a new subduction was initiated at this STEP fault in the North-East part of the Western Mediterranean and propagated towards South-West along the former Iberian passive margin.

### 3) 2-D finite element model

(3a) Model setup for the subduction initiation at a STEP at boundary conditions for the mechanical solution. a) Temperature distribution. b) Material properties and boundary conditions for temperature calculations are shown in figure 5c.

To investigate the scenario described in section 2, we select a cross section to make a 2-D elastic visco-plastic model. The green line in Fig. 2a shows the approximate location of the cross-section, which we select for the model. Constraints on our model come from published geological data and paleogeographic reconstructions for the Late Oligocene - Early Miocene. The model domain covers an area of 1200×600 km. The oceanic plate is moving towards the continental plate with a convergence rate of 2 cm/yr. In Fig. 3a, we select our reference model to have a channel width of 6 km and a dip angle of 20° and we examine the sensitivity of the model results to changes in dip angle.

The initial geometry for thesea plate is defined using the plate model, considering a plate with an age of 120 My and thickness of 110 km. The thickness of the continental plate is calculated based on steady-state deformation equation. An adiabatic gradient of 10 K/km is selected for the mantle below the lithosphere (Fig. 2c).

### 4) Model results

(4a) Model results for a dip- displacement field, k, and k My, respectively, as well as observed fault traces and site point on the subduction zone. The location of selected points on the subduction plate and one point on the subduction zone is shown in Figure 4a. Green arrow shows the direction of a STEP propagation. Red lines indicate the location of the subduction zone before and after STEP fault. White and black sawteeth indicate the location of the shear zones.

Figure 4-a shows the displacement field at different times. Results show that after a short time of resistance, oceanic plate starts to subduct towards the continental plate. To identify the time when subduction started, we compared the velocity of one point on the slab and one point on the subduction zone. Velocity of one point on the slab and one point on the subduction zone are shown in Fig. 4d. At about 5.5 Myr the velocity of the slab exceeds the plate velocity. At the same time the subduction velocity is increasing, indicating that subduction has changed to the self-sustaining state (Fig. 4c). This event happens after ~120 k of convergence which agrees well with the results of Hall et al. 2003.

### 5) Sensitivity Analysis of the model results

(5a) Sensitivity of the channel width. a) Channel width b) Channel width of 6 km c) Channel width of 8 km. d) Channel width of 10 km. e) Channel width of 12 km. f) Channel width of 14 km.

We perform a sensitivity analysis of some initial parameters, which we chose in our reference model, and compare them with the evolution of deformation in our reference model (Fig. 5). Sensitivity of parameters to the results of our model is shown in Figure 5. Sensitivity of the channel width shows that increases in width of the channel speed up the initiation process. When the width of the channel increases, the subduction zone becomes steeper and the subduction process becomes more efficient.

### Conclusions

Results of our numerical model show that subduction becomes self-sustaining after ~120 km of convergence. A dip angle of 40-45 degrees facilitates subduction initiation. A slower channel speed leads to an increase in the amount of coupling between two plate models. This coupling leads to slowing down the subduction process. A STEP fault converts into a subduction zone more easily when in addition to the ridge push, integrated forces from adjacent subduction zones drive plates towards each other.

### References