Transtensional Reactivation of Suture Zones: Insights from 3D Numerical Modelling of Pull-Apart Basins

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1 – Motivation

- Suture reactivation involves extension across a fossil subduction interface.
- Some enigmatic localized post-collisional magmatic events along a suture zone are observed (e.g. Sava Vardar Zone).
- Can transtensional events locally reactivate a suture?

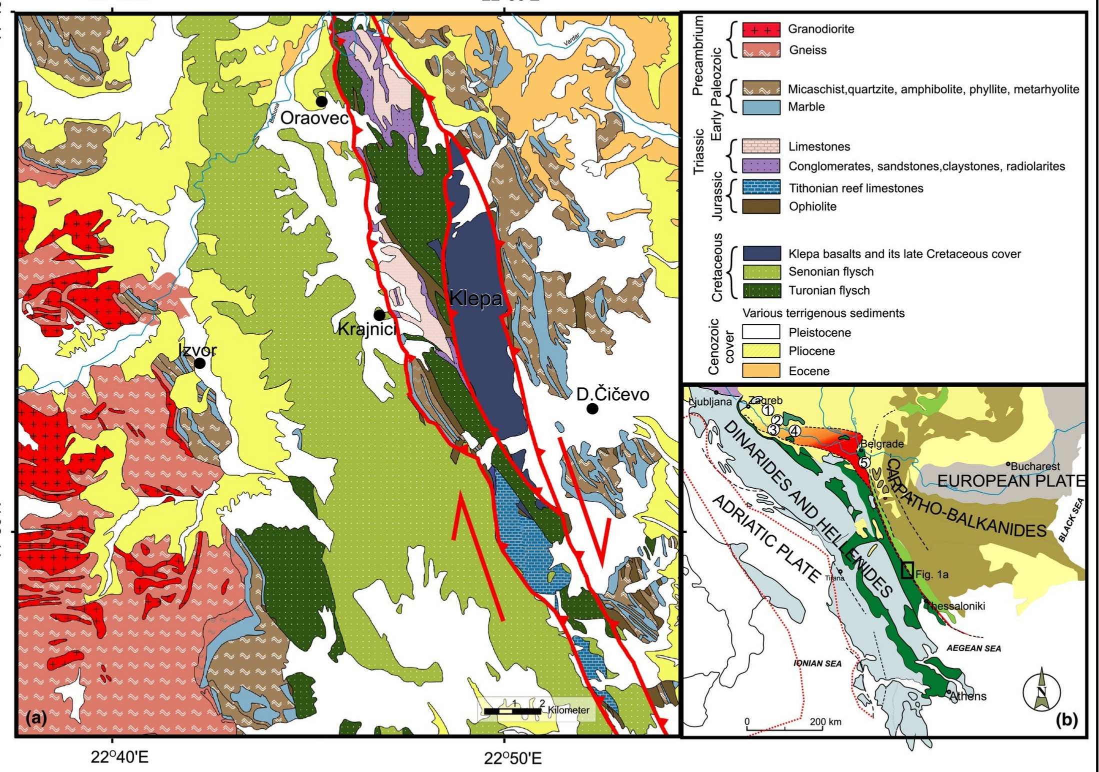

Figure 1. An example of locally reactivated suture zone might be found in the Sava-Vardar Zone (e.g. Ripanj, Klepa, Jelica). In the panel a) the Figure shows the geological map of the Klepa locality (Republic of North Macedonia). Regional map is shown in b), while the legend is given in the top-right. Adopted from Prelević et al. (2017).

2 – Model Setup

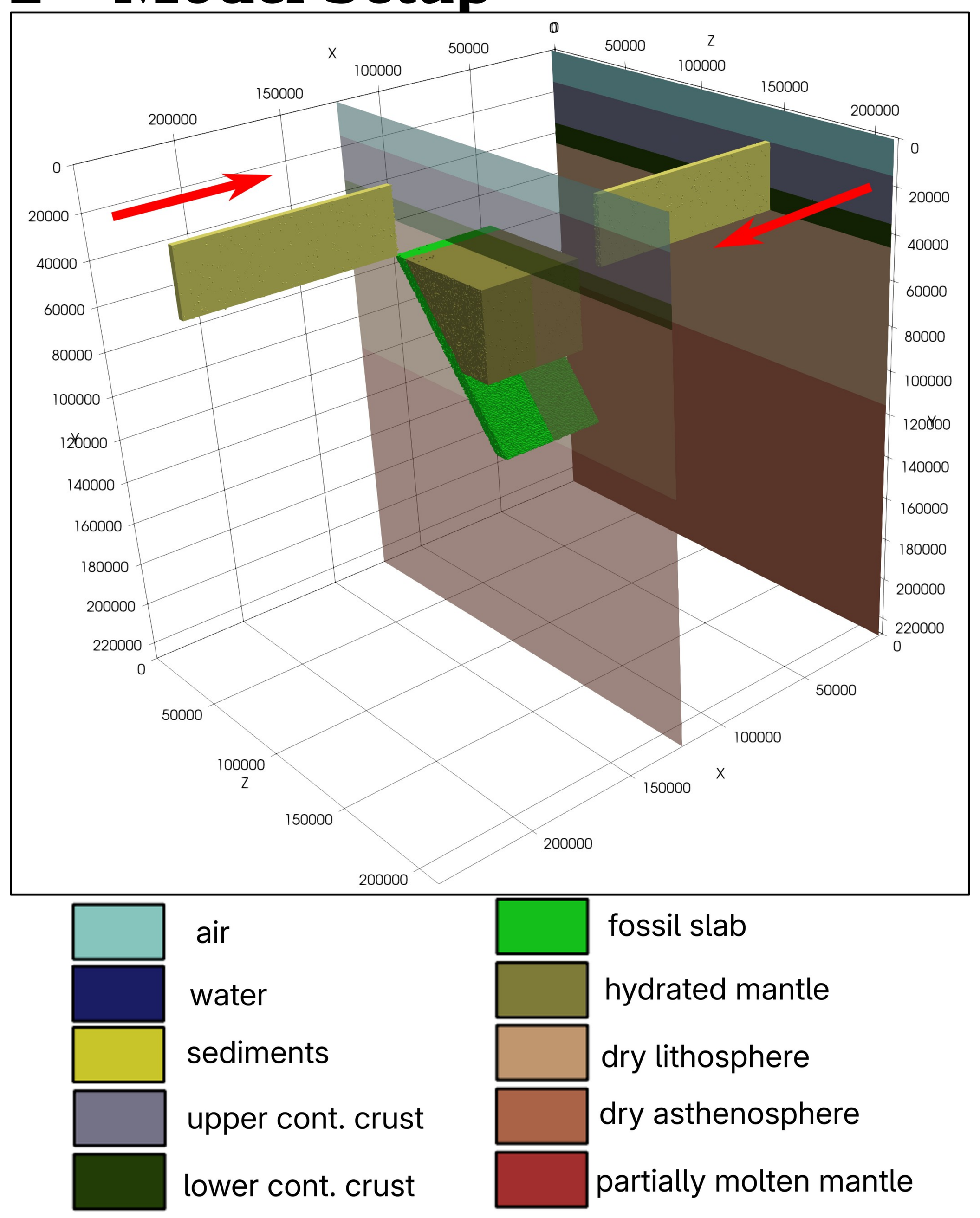

Figure 2. Initial configuration of the composition field. 3D view of the crustal weak zones (yellow) and the suture. Two parallel vertical rock composition profiles are given for reference. Legend for the compositional field is given at the bottom. Red arrows denote the strike-slip motion of the two continental blocks.

3 – Results: formation of pull-apart basin + suture reactivation

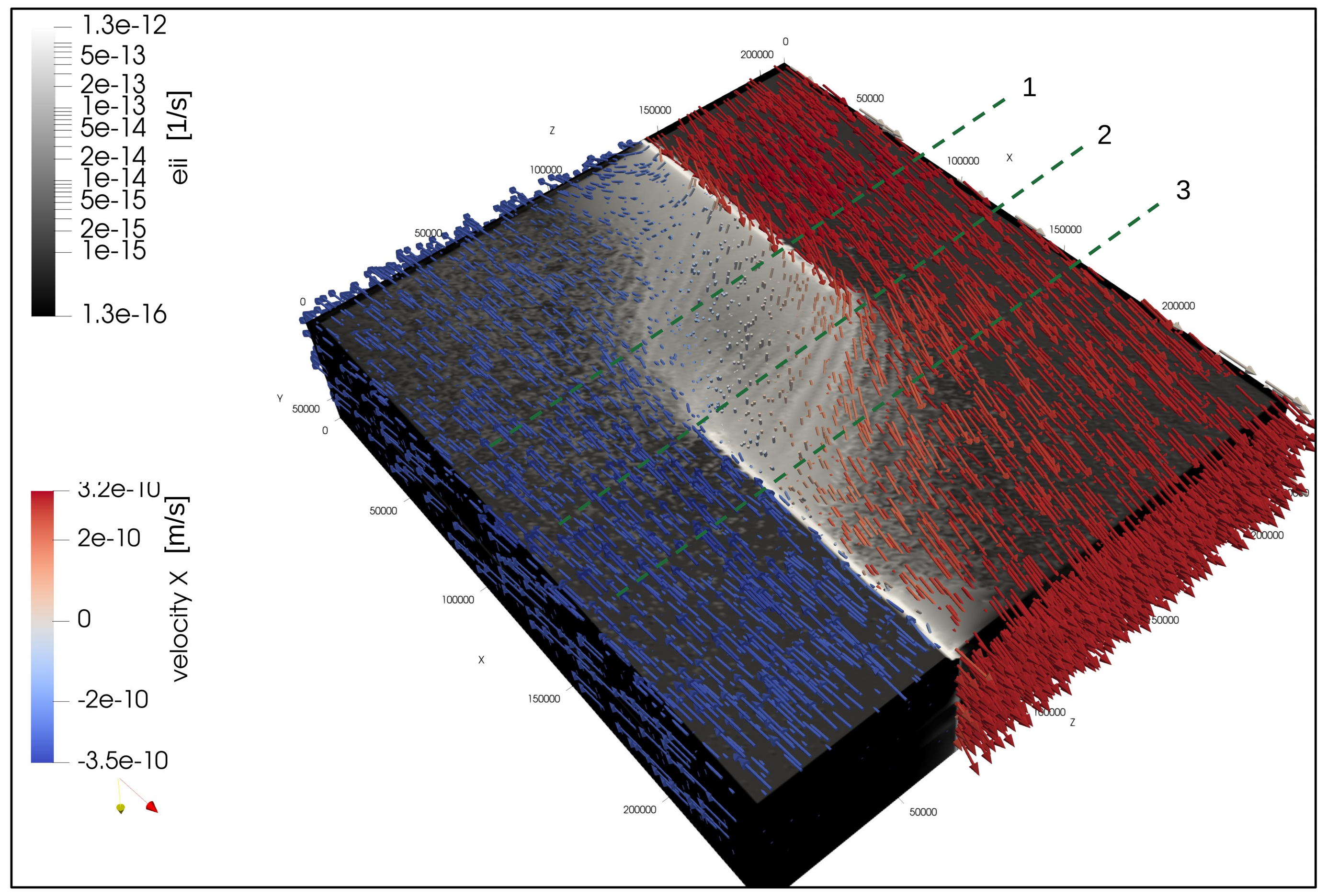

Figure 3. Development of a pull-apart basin. 3D view of the strain rate map. Superimposed is the velocity vector field. Arrow size is proportional to velocity magnitude, whereas the color corresponds to the x component.

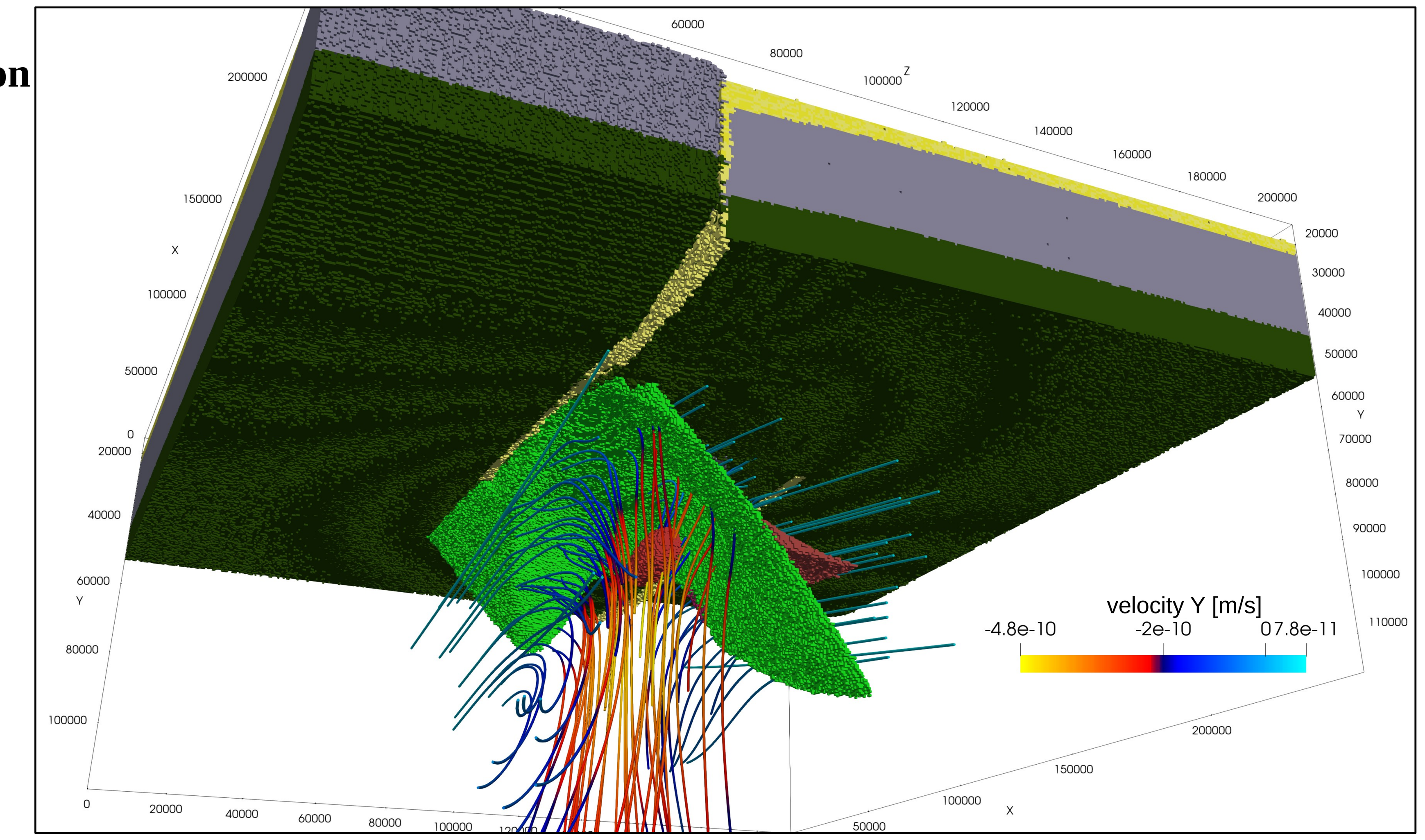

Figure 6. Asthenospheric upwelling underneath the suture. 3D view of the deformation of the suture zone underneath the continental crust. Velocity field is represented by the streamlines. Color of the streamlines corresponds to the vertical velocity component. Upward flow leads to partial melting of the mantle (red volume).

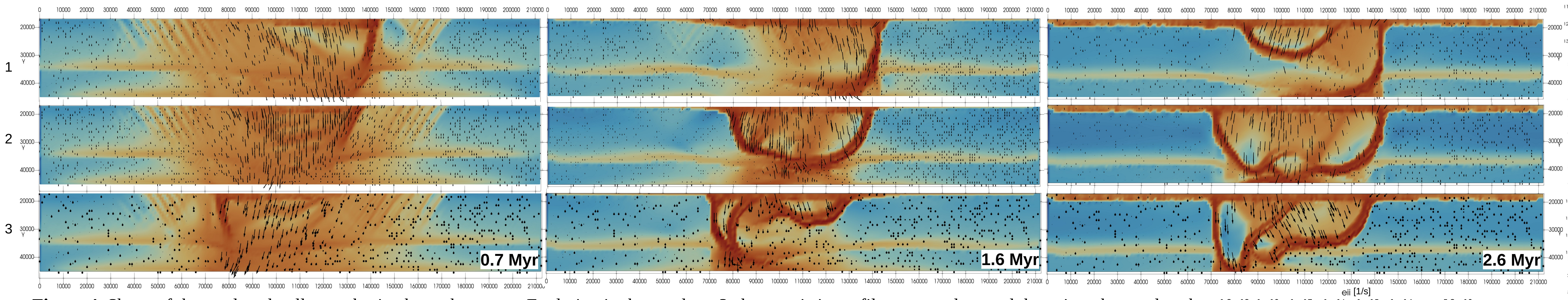

Figure 4. Shape of the produced pull-apart basin above the suture. Evolution is shown along 3 characteristic profiles centered around the axis orthogonal to the motion of continental blocks, at 3 timesteps. Sections represent contour maps of strain rate, whereas black arrows represent velocity field.

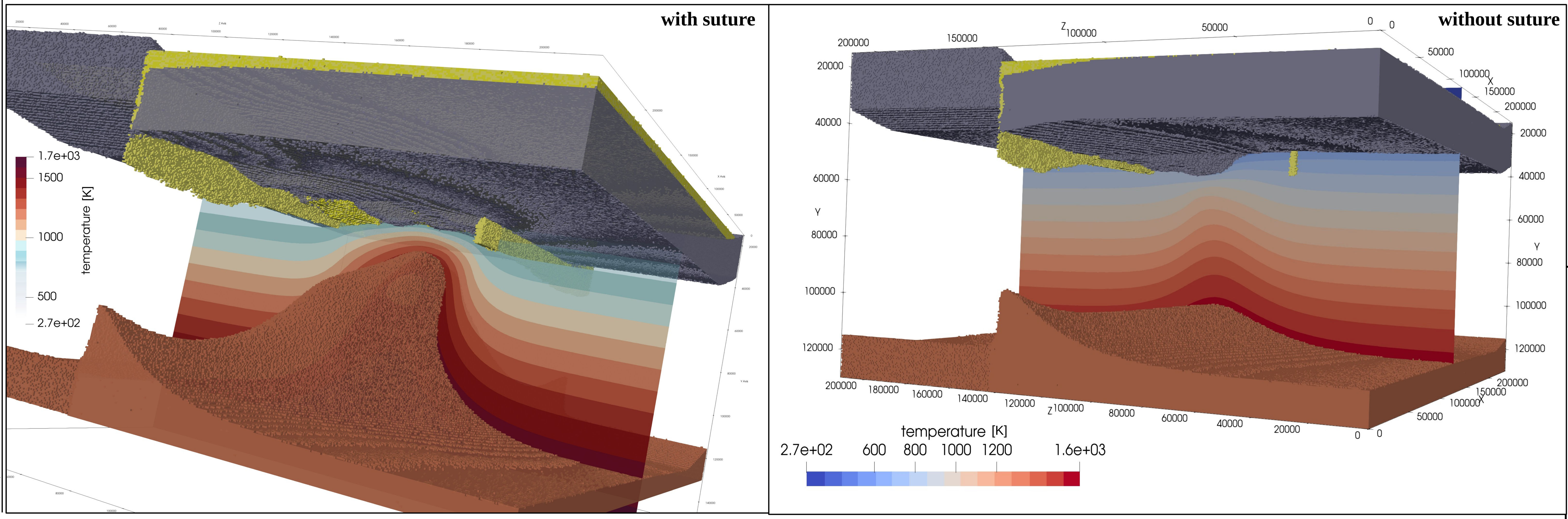

Figure 5. Thinning of the lithosphere. 3D view of the upper crust (blue) and asthenosphere (red). Upflow leads to the rise of temperature at the suture and partial melting. Temperature field is represented by the contour map in the vertical cross-section. Presence of a suture zone allows for more efficient upward mantle flow (left), whereas its absence inhibits it (right).

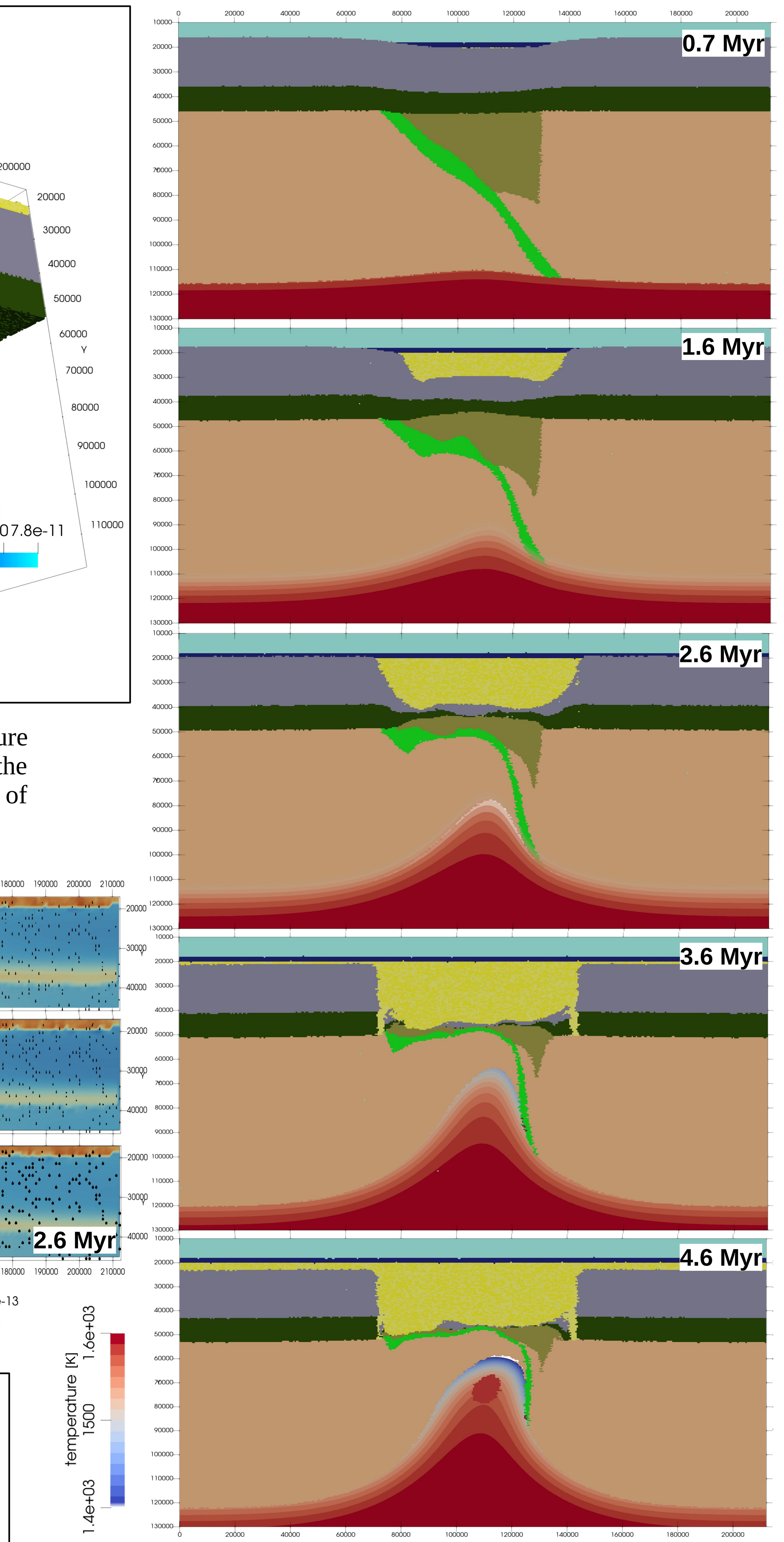

Figure 7. Time evolution of the model represented by the five profiles of the composition field corresponding to five characteristic timesteps. The profiles are oriented parallel to the dip direction of the suture and are intersecting it's center. Asthenosphere is represented by the temperature contours.

4 – Conclusions

- The step-over along the inherited structures and the imposed velocity field lead to sufficient deformation in the transfer zone to form a pull-apart basin.
- The transtensional stress field results in local extension along the inherited structures by reactivating the weak suture zone.
- The presence of a fossil subduction interface and hydrated mantle in the suture governs enhanced thinning of the lithosphere.
- Transtensional suture reactivation involves mantle partial melting.

Refferences:

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