Thermo-mechanical modelling of a pull-apart: approaching 3D

Alexey G. Petrunin[1,2] **and Stephan V. Sobolev**[1,2]

[1] *GeoForschungsZentrum-Potsdam, D-14473 Potsdam, Germany*
[2] *Institute of Physics of the Earth, RAS, 123810, Moscow, Russia*

Pull-apart basins belong to a special type of sedimentary basins associated with continental transform faults. They are depressions that are formed as a result of crustal extension in domains where the sense of fault overstepping or bending coincides with the fault motion sense. The outstanding classic example of a pull-apart basin is the 150 km long Dead Sea basin which is located at the Dead Sea Transform and where more than 8 km of sedimentary cover has accumulated since 15-17 Ma.

To study factors controlling localization and partitioning of the strain during strike-slip lithospheric-scale, we use the internally consistent finite element thermo-mechanical modelling technique in extended 2-D (Sobolev et al., 2005).

As a next step, we develop a simplified 3-D thermomechanical model of a pull-apart basin formed at an overstepping of an active continental transform fault. The modelling shows that, in addition to the magnitude of strike-slip displacement, the major parameter which controls basin length, thickness of sediments and deformation pattern beneath the basin is the thickness of the brittle layer. The unusually large length and sediment thickness of the Dead Sea basin, the classical pull-apart basin associated with the Dead Sea Transform, can be explained by 100 km of the strike-slip motion and a thick (20-22 km, up to 27 km locally) brittle part of the cold lithosphere beneath the basin (Petrunin and Sobolev, 2005). The thinner sedimentary cover in the Gulf of Aqaba basin, located at the southernmost part of the Dead Sea Transform, close to the Red Sea Rift, is probably due to a thinner brittle part (less than 15 km) of the warmer lithosphere. The modelling also suggests no more than 3 km of Moho uplift beneath narrow (10-15 km) pull-apart basins formed in cold lithosphere, like the Dead Sea basin. We also infer that the values of surface heat flow of 40 mW/m^2, reported for the Dead Sea, are probably much too low, because, otherwise, either the depth of the Dead Sea pull-apart basin would be more than 16 km or no pull-apart deformation would occur in such cold lithosphere.

References:

Sobolev S.V., Petrunin A., Garfunkel Z., Babeyko A.Y. and DESERT Group. Thermo-mechanical model of the Dead Sea Transform, Earth Planet. Sci. Lett., doi:10.1016/j.epsl.2005.06.058., 2005.

Petrunin A.G. and S.V. Sobolev. What controls thickness of sediments and lithospheric deformation at a pull-apart basin? Submitted to Geology.