Geophysical Research Abstracts
Vol. 12, EGU2010-13013, 2010
EGU General Assembly 2010

Using 1-to-3D modeling approach to constrain thermomechanical evolution of the Dead Sea Transform region

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Dead Sea Transform (DST) fault system is a part of the Syrian-African rift system dividing African and Arabian plates, that accommodated more than 100 km of left-lateral transform displacement. Despite the area of the DST is tectonically active during at least last 17 Myr (Krienitz et al., G3, 2009), heat flow lower than 50mW/m2 is reported for the area. The value of 50mW/m2 is consistent with the thickness of the lithosphere of more than 120 km while observed thickness of the lithosphere at the DST area is 70-80 km, according to seismic data (Mohsen et al., G.J.Int.2005). This discrepancy means that lithosphere around DST was thinned in the past and related high heat flow had not enough time to reach the surface. However, it remains unclear which thickness had the lithosphere before the thinning and when the thinning has occurred. To find the appropriate values for the parameters, we use a gradual complication approach. At the initial stage we solve a number of 1D thermal transient problem. Resulting transient geotherms in combination with additional constraints allow us to constrain magnitude and time of lithospheric reduction to 50-70 km and 15-22 Ma, respectively. At the second stage we use 2.5D thermomechanical modeling technique by Sobolev S.V. et all.(EPSL 2005) to model thermal evolution and deformation at the 1000 km transsection of the lithosphere from Mediterranean to Arabian platform, crossing the DST near the Dead Sea. As an initial setup we use simplified geometry of the lithosphere-asthenosphere boundary and lithospheric structure according to available geophysical data. The lithospheric thickness is reduced within the 300 km -wide domain beneath the DST. The ranges for the time of and magnitude of the lithosphere thinning are given by the 1D model. The 2.5D model allows to use additional constraints for the model such as evolution of a surface topography and rheological patterns beneath the DST fault. In addition we use the brittle brick stretching (BBS) approach (Petrunin and Sobolev, Geology 2006, PEPI 2008) and estimate the present-day thickness of the brittle layer near the DST as 20-22 km. As a result of the 2.5 D modeling, we significantly narrow down the ranges of model parameters. At the final stage we check the obtained parameters using the 3D model of the Dead Sea basin similar to (Petrunin and Sobolev, Geology 2006) that gives good correlation with the sedimentary subsidence rate and present-day geometry of the basin.