Geophysical Research Abstracts, Vol. 7, 09814, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09814

Evolution of the Dead Sea Transform and Dead Sea Basin: Observations Integrated by the Model

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To address one of the central questions of plate tectonics - How do large transform systems work and what are their typical features? - geophysical investigations across the Dead Sea Transform (DST), the boundary between the African and Arabian plates in the Middle East, were conducted for the first time and combined with 2.5 and 3D thermo-mechanical modelling. One major component of these investigations are seismic and seismological surveys across the Dead Sea Transform. Main results of this study indicate that the DST cuts through the entire crust, that strong lower crustal reflectors are imaged only on one side of the DST, that the seismic velocity sections show a steady increase in the depth of the crust Moho from 26 km at the Mediterranean to 39 km under the Jordan highlands, with only a small but visible, asymmetric topography of the Moho under the DST. The SKS splitting study demonstrate that a distinct narrow (30 km wide) vertical zone in the mantle exists under the DST with the seismic anisotropy consistent with the shear deformation between decoupled, Arabian and the African plates.

These observations are replicated and integrated by the extended 2D (2.5D) thermo-mechanical numerical model focused on lithospheric-scale deformation at the DST. This model demonstrates that all these observations can be linked to the left-lateral movement of 105 km of the two plates in the last 17 Ma, accompanied by strong deformation within a 20-30 km wide zone cutting through the entire crust and mantle lithosphere. The modelling results also clearly indicate that the DST in the Arava Valley is almost pure strike-slip boundary with less than 4 km of transform-perpendicular extension (rifting deformation component). The preliminary results of the 3D thermo-mechanical model, which incorporates the Dead Sea basin, shows that even this small rifting component may be unnecessary to explain observed crustal structure.