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Effect of inherited structures on strike-slip plate boundaries: insight from analogue modelling of the central Levant Fracture System, Lebanon

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Analogue sandbox modeling is a tool to simulate deformation style and structural evolution of sedimentary basins. The initial goal is to test what is the effect of inherited and crustal structures on the propagation, evolution, and final geometry of major strike-slip faults at the boundary between two tectonic plates. For this purpose, we have undertaken a series of analogue models to validate and reproduce the structures of the Levant Fracture System, a major NNE-SSW sinistral strike-slip fault forming the boundary between the Arabian and African plates. Onshore observations and recent high quality 3D seismic data in the Levant Basin offshore Lebanon demonstrated that Mesozoic ENE striking normal faults were reactivated into dextral strike-slip faults during the Late Miocene till present day activity of the plate boundary which shows a major restraining bend in Lebanon with a $\sim 30^{\circ}$clockwise rotation in its trend.

Experimental parameters consisted of a silicone layer at the base simulating the ductile crust, overlain by intercalated quartz sand and glass sand layers. Pre-existing structures were simulated by creating a graben in the silicone below the sand at an oblique (>60°) angle to the main throughgoing strike-slip fault. The latter contains a small stepover at depth to create transpression during sinistral strike-slip movement and consequently result in mountain building similarly to modern day Lebanon. Strike-slip movement and compression were regulated by steady-speed computer-controlled engines and the model was scanned using a CT-scanner continuously while deforming to have a final 4D model of the system.

Results showed that existing normal faults were reactivated into dextral strike-slip faults as the sinistral movement between the two plates accumulated. Notably, the resulting restraining bend is asymmetric and segmented into two different compartments with differing geometries. One compartment shows a box fold anticline, while the second shows an asymmetric anticline. Thus, analogue modeling has validated observation in seismic data and onshore geology whereby Mount Lebanon and adjacent folds exhibit similar compartmentalization and geometric dissimilarities along the Levant Fracture System. We suggest that the presence of inherited structures will affect to a certain extent the geometry of restraining bends and control the evolution of large strike-slip faults passing through.