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The Tectonics of the Levant Province: The structural patterns of a fading ocean

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Conventional tectonic models consider the Levant region to be located between an emerging ocean in the Red Sea and a fading ocean in the Mediterranean Sea. The models imply that the tectonic regime that closes the Mediterranean does not affect the tectonic processes that open the Red Sea, and presume that the only tectonic link between these two regions is the Dead Sea Transform. However recent research suggests that all these concepts are poorly founded. Sand-box analog modelers found out that the oblique convergence between Arabia and Eurasia along the Bitlis-Zagros continental collision, which is contemporaneous with the Makran subduction to the south-east, leads to the anticlockwise rotation of Arabia. They showed further that as the collision front expanded gradually and the subduction zone contracts, the position of the extensional zone shifted as well. The models showed that these extension zones developed in geometric patterns that resemble the structural setting of the Gulf of Aden and the Red Sea.

Recent centrifuge models clarified some aspects of the evolution of extensional structures in subduction domains. Modeling of subduction that applied only enhanced gravity and deformed juxtaposed scaled oceanic and continental lithospheric slabs illuminated some aspects of the break-up and rifting of back-arc basins due to subduction roll-back. The experimental slabs comprised upper brittle layers and lower ductile layers, and both slabs floated on a denser and very pliable "asthenosphe". These models showed that extension in the over-riding slab derived from the roll-back of the subduction zone affected the lithospheric components differently. While the "ductile continental lithosphere" stretched and extended as the roll-back deformation persisted, the "brittle lithosphere" broke up and rifted apart after a short phase of minor extension. The main difference between the sand-box models and the centrifuge ones was that

while the centrifuge models developed their rifts in the over-riding slab, resembling the evolution of back-arc basins, the composite subduction-collision of the sand-box models produced the extensional zone in the underthrusting slab. It seems that in order to correlate between the results of the sand-box model and the Red Sea province, the effect of the northwestwards propagation of the Carlsberg Ridge should be considered as well.

It is therefore speculated that two contemporaneous events shaped the tectonics of the Levant and adjacent terrains since the Miocene. As the northwards subduction of the central NeoTethys reached maturity, northern Arabia approached central Eurasia, and the collision along Bitlis Zone started while subduction prevailed along the Zagros Front. Concurrently Carlsberg Ridge reached the southern parts of Arabia. The extensional zone that developed in southern Arabia due to the oblique subduction deflected the propagating SW Indian Ridge westwards to rift open the Gulf of Aden and to propagate into East Africa in the early Miocene. As the Tethyan subduction turned to continental collision along the Zagros Front, the extensional stress field in Arabia rotated, so that the propagating oceanic rift partly abandoned East Africa and broke open the Red Sea and the Suez Rift in the middle Miocene. At the most recent tectonic development of the composite subduction-collision process, the propagating rift gradually abandoned the Suez Rift and broke-up the Dead Sea Rift. Furthermore, oblique subduction also affected the zone west of Arabia in the eastern Mediterranean, and, concurrent with the Bitlis collision, northward subduction took place in the Ionian province. Since no oceanic ridge affected the western branch of the Africa-Eurasia convergence, the extension-associated processes occurred in the over-riding slab, and led to the opening of the Aegean Sea as a back-arc basin since the middle Miocene. The roll-back of the Ionian subduction pulled Anatolia westwards along the North- and East Anatolia Faults, as recent GPS measurements demonstrated.