

Geomorphic response of a continental margin to tectonic and eustatic variations, the Levant margin during the Messinian Salinity Crisis

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During the Messinian Salinity Crisis (MSC, 5.97 ± 0.01 – 5.33 Ma) the Mediterranean Levant margin experienced major eustatic and sedimentary cycles as well as tectonic motion along the nearby Dead Sea fault plate boundary. New structures formed along this margin with morphology responding to these changes. Our study focuses on changes in this morphology across the margin. It is based on interpretation of three 3D seismic reflection volumes from offshore Israel. Multi-attribute analysis aided the extraction of key reflectors. Morphologic analysis of these data quantified interacting eustasy, sedimentation, and tectonics. Late Messinian morphologic domains include: (a) continental shelf; (b) 'Delta' anticline, forming a ridge diagonal to the strike of the margin; (c) southward dipping 'Hadera' valley, separating between (a) and (b); (d) 'Delta Gap' - a water gap crossing perpendicular to the anticline axis, exhibiting a sinuous thalweg; (e) continental slope. Drainage across the margin developed in several stages. Remains of turbidite flows crossing the margin down-slope were spotted across the 'Delta' anticline. These flows accumulated with the MSC evaporate sequence and prior to the anticline folding. Rising of the anticline, above the then bathymetry, either blocked or diverted the turbidites. That rising also defined the Hadera valley. In-situ evaporates, covering the valley floor, are, in turn covered by a fan-delta at the distal end of the valley. The fan-delta complex contains eroded evaporites and Lago-Mare fauna. Its top is truncated by dendritic fluvial channels that drained towards the Delta Gap. The Delta Gap was carved through the Delta ridge in a morphological and structural transition zone.

We propose that during the first stages of the MSC (5.97 ± 0.01 – 5.59 ma) destabilization of the continental slope due to oscillating sea level produced gravity currents that flowed through the pre-existing Delta anticline. Subsequent folding of the Delta anticline diverted several flows towards the Delta Gap during peak MSC desiccation phase (5.59 – 5.5 ma). This resulted in sub-aerial incision of a canyon across the gap that outpaced the tectonic uplift of the anticline. During the Lago-Mare regression (5.5 – 5.33 ma) a fluvio-marine sequence was deposited in the already formed Hadera valley. Another regression before the Zanclean flood (5.33 ma) eroded the top of this sequence and rejuvenated the Delta Gap canyon.