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Genesis and growth of the NW trending normal fault array of the Levant Basin

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The Levant basin, located in the Eastern Mediterranean region, presents a conspicuous normal fault array in the interpreted Oligo-Miocene units. How did the faults grow, evolve and interact with each other is important in order to increase our understanding on the growth of normal fault systems in general and the structural setting of the Levant Basin in particular.

Found offshore Lebanon, and partly offshore SE Cyprus and Israel, these faults are layer bound and comprised only in the Oligo-Miocene units, bounded by the base Messinian horizon and Eocene unconformity horizon at their top and bottom respectively. They correlate well with the thickness of the Oligo-Miocene sediments which might explain their distribution. Quantitative and qualitative fault analysis techniques were applied to a 3D seismic reflection dataset. Deduced thickness variations at the Miocene interval (across the faults) and growth index calculations show that the motion of these faults is syn-sedimentary since the Early Miocene time. As observed in cross-section; most of the faults are throughgoing faults and do not show significant refraction or bifurcation. However, the displacement data show that the fault history is complex and imply that the Cenozoic package is characterized by a significant mechanical layering. The latter has influenced the fault development with preferential and double nucleation sites of fault segments which later linked by vertical tip propagation. An asymmetry in the upward and downward vertical restriction is also deduced and horizontal linkages also occurred.

The various geometric observations and displacement distribution indicate a strong resemblance between the normal faults of the Levant Basin and the widely documented polygonal fault systems. As polygonal faults are characterized by polygonal planform geometry and the faults in the Levant Basin are linear, we attribute the difference in their planform geometry to a regional anisotropic NW-SE stress field dominant since Oligocene times. These faults are thus possibly formed in relation with the vertical contraction of the fine-grained host rock unit with the conjunction of a complex fluid pressure profile in the sedimentary pile. Our interpretation suggested that growth of contractional faults on a basin-scale generally follows the isolated model, at least in their early history, accumulating length proportionally with displacement. When subject to an anisotropic regional stress field, they will grow very similarly to normal tectonic faults, being then influenced by mutual interaction and mechanical layering.