The Structural Style of the NW Arabian Plate: From Mesozoic Extension to the Alpine Orogeny

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ABSTRACT

The NW part of the Arabian plate has been proven to hold world-class petroleum systems. It is located at the boundary of three major tectonic plates and was deformed by several tectonic events throughout its geological history in relation with the interaction of the African, Arabian and Eurasian plates. In this contribution, interpretation of recent 15000 km2 of 3D seismic data in the Levant Basin offshore Lebanon together with extensive fieldwork onshore and structural modelling, shed the light on the evolution of the Levant region, which forms a large part of NW Arabia. The polyphase Permo-Jurassic rifting has marked the region between Syria and the Egyptian Western Desert along the northern Afro-Arabian margin with roughly ENE-WSW to NNE-SSW oriented normal faults documented both offshore and onshore, creating classical horst and graben structures. Regional geodynamic changes during the Maastrichtian/Campanian, have brought Arabia into convergence with Eurasia and caused basin-inversion throughout the northern and NW margins of modern day Arabia, with subduction taking place at the Cyprus Arc. This Late Cretaceous onset of the Alpine orogeny is particularly observed in the Sinai block and the Negev desert, causing inversion of the pre-existing structures and folding of large anticlines. During this time, subtle deformation is documented in Lebanon and Syria and minor folding is suspected in the Palmyrides. In contrast, all field evidence point to an early Miocene main folding and uplift of the Palmyrides and the Lebanese ranges, in accordance with the initiation of collision between Arabia and Anatolia. Therefore, the effect of the Alpine orogeny, uplift and inversion is variable throughout the NW Arabian plate, causing differences between adjacent regions and is felt at different pulses between the late Cretaceous to Neogene times. The propagation of the Levant Fracture System (LFS) during the Late Miocene times has reactivated and amplified existing structures, notably in Lebanon. The pre-existing folds of the Palmyrides, already in place in Lebanon, underwent rapid uplift as a result of the propagating LFS. The effect of this large deeply-rooted fault has resulted in transpression and renewed inversion of pre-existing faults. As a consequence, the inherited structures both offshore and onshore were all subsequently reactivated and inverted resulting in distinct structural styles along the strike of the LFS. The results of this study, based on extensive 3D seismic data, provided an opportunity to investigate in detail the structural traps of the Levant region with a strong correlation with the existing literature. This has led to revise and better constrain the timing of deformation and evolution of structures, such as the LFS, which in turn has de-risked the petroleum systems and lowered uncertainty in exploration.