

## The Potential of Stratigraphic Traps for the Arabian Plate

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### ABSTRACT

The subsurface of the Middle East hosts a major proportion of the Earth's proven hydrocarbon resources and includes both the world's largest conventional carbonate and clastic accumulations, the Ghawar Field of Saudi Arabia and the Burgan Field of Kuwait, respectively. Many of the largest fields were discovered several decades ago. As with many other petroleum provinces, the majority of the Arabian Plate's discovered reservoirs reside within simple structural traps.

Traditionally, exploration has focussed on these "easy-to-find" structures; however, with the probable exception of the Zagros fold and thrust belt, most of these have been drilled. Thus, there is a need for explorationists to focus on subtle trapping styles associated with stratigraphic variations, such as lateral facies changes, onlap pinch-outs, depositional reliefs, subcrops, erosional truncations and diagenetic variations. Globally, significant volumes of hydrocarbons have been discovered in many mature basins within stratigraphic traps; however, across the Middle East, this approach remains relatively limited and there are many untested, underexplored and often overlooked stratigraphic play concepts that offer potential attractive conventional targets. For example, significant success has been achieved in pinch-out and subcrop traps in the "Hercynian" and Late Permian break-up unconformities of Saudi Arabia and Oman, yet other regional unconformities on the Arabian Plate with additional subcrop potential remain largely unexplored.

Prograding carbonate lowstands have been recognised in the region since the 1950s, particularly in Kurdistan, where the younger Oligocene carbonate platforms significantly overstep the older Eocene platform. Similar examples are extensively documented for the Shu'aiba Formation of the UAE and strongly influence reservoir distribution and production characteristics. Large-scale progradation is identified in other parts of the Cretaceous stratigraphy of the Gulf region, notably in the Natih, Mishrif, Habshan, Minagish and Yamama Formations.

While carbonate lowstands are undoubtedly present, they can be difficult to seal from their preceding highstands. However, they are important in forming productive brittle units in Arabian Plate resource plays. A more prospective conventional exploration option comprises traps formed by drowned isolated platforms sealed by an overlying deeper water facies. This play relates to periods of increased subsidence, particularly in the Late Cretaceous foredeep.

Lowstands are also commonly associated with significant incision at the top of the exposed highstand platforms, known in the UAE, Oman, Iran and Saudi Arabia in the Shu'aiba, Mishrif, Sarvak and Natih Formations. These incised channels, depending on available provenance, either became back-filled with coarse clastics and topped with their distal equivalent fine-grained material (e.g., Raven et al., 2010), infilled by

fine-grained siliciclastics alone, or contain iron-rich and carbonate facies associations (e.g., Grelaud et al., 2010). Thus, regional understanding is paramount.

Siliciclastic lowstand systems also offer significant exploration potential across the region. Notable examples are the proven Cretaceous Tuwayil Formation of Abu Dhabi and identified potential within the Early Cretaceous Zubair and Burgan Formations of Kuwait and Southern Iraq. While at times these siliciclastic systems remained stranded on wide shelves, at major lowstands corresponding to periods of combined eustatic fall and tectonism, it can be predicted that these systems were capable of generating shelf-edge deltas, with corresponding deep marine fan deposits.

Other levels of major siliciclastic reservoir potential also deserve further analysis for stratigraphic trap potential. Recent discoveries in the Late Triassic and Early Jurassic Minjur and Dhurma Formations of the Rub al Khali Basin demonstrate the importance of rejuvenation of old structures, leading to sand reworking and generation of new plays.

Deeper Paleozoic siliciclastic plays also offer significant potential within the Late Ordovician shallow marine Sarah Formation of Saudi Arabia, the early Silurian interbedded deep marine sandstones of the Qusaiba Formation and the Late Carboniferous to Permian glaciogenic continental Unayzah Formation.