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Hydrocarbon Prospectivity of the Late Jurassic–Early Cretaceous Makhul Formation in North and Northwestern Kuwait

Raju T. Arasu* (Kuwait Oil Company), S.K. Singh (Kuwait Oil Company), T.F. Al-Adwani (Kuwait Oil Company), B.Z. Khan (Kuwait Oil Company), J. Macadan (Kuwait Oil Company) & A.F.N. Abu-Ghaneej (Kuwait Oil Company)

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Raju T. Arasu (Kuwait Oil Company <rarasu@kockw.com>), Sunil K. Singh (Kuwait Oil Company), Talal F. Al-Adwani (Kuwait Oil Company), Badruzzaman Z. Khan (Kuwait Oil Company), Jose Macadan (Kuwait Oil Company) and Ali F.N. Abu-Ghaneef (Kuwait Oil Company)

The Late Tithonian–Early Berriasian Makhul Formation is the lowermost sedimentary sequence of the Thamama Group in Kuwait. It is underlain by the anhydrite deposits of the Hith Formation, and conformably overlain by the Minagish carbonates. The Makhul carbonates are about 900 feet thick and buried at depths of 11,000 to 14,000 ft in Kuwait.

The depositional environment of the Makhul is interpreted as inner neritic, in a northeast dipping ramp setting. Two highstand system tracts have been identified within the formation. In terms of lithofacies it is divided into upper, middle and lower zones. The upper zone is an argillaceous lime mudstones/wackestone, interbedded with slightly dolomitic limestone. The middle zone is dominated by grey mudstone to wackestone with rare packstone. Occasional thin laminae showing faint fluorescence are present within this interval. The lower Makhul zone consists of kerogen-rich layers with alternating laminae of mudstone and wackestone. It has potential to act as source rock. The porosity of the formation is 3–4%.

In the northern parts of Kuwait the Makhul section is imaged by 2-D and 3-D seismic reflections as a northeastward prograding package, downlapping onto the top of the Hith Formation (Figure 1). The acoustic impedance of the lower Makhul is very low, comparable to the impedance of shale and grading to relatively higher impedance towards the top.

That the tight reservoirs of the Makhul Formation have hydrocarbon potential is proven. A few wells in the south and a recently drilled well in north Kuwait have produced oil in the initial testing. Further, some of the deep wells have recorded very high formation gas while drilling.

Fractures are present in the Makhul rocks as seen in the well data. They may play a vital role for the sustainable production from these unconventional reservoirs. A 3-D seismic-based discontinuity attribute has brought out evenly spaced sub-vertical discontinuities. Interestingly, the wells which have intersected discontinuities gave high gas readings in the mudlog. Anomalous frequency absorption seen at places could be an indicator of hydrocarbon/fractures.

Understanding the trapping mechanism and geomechanical properties of the formation can lead to 'sweet spots' for commercial success in future.

Figure 1: A 2-D seismic line, flattened on the reflection from the top of the Hith Formation, showing progradational features of the overlying Makhul Formation in the northwest Kuwait. The map on the left shows the present day structure of the top Makhul in northwest Kuwait and the location of the line.