Opportunities and Challenges of the Deep Kimmeridgian-Tithonian Age Evaporates in the Light of Unconventional Reservoir Appraisal: Kuwait Case Study

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Abstract

Kuwait Oil company is currently engaged in an early phase of appraisal of the deep tight fractured carbonate reservoirs and resource plays of Oxfordian-Callovian age (more than 14,000 ft depth, HPHT) in the northern part of Kuwait, as part of the strategy to meet the long term gas production targets. The operational area in the northern part of Kuwait encompasses approximately 1800 sq km covering eight oil and gas fields. These unconventional reservoirs are immediately overlain by the over pressured (up to 21 ppg mud weight equivalent) Kimmeridgian - Tithonian age Hith-Gotnia evaporite formations (Anhydrite and Salt alternations) which act as the regional top seal.

Hitherto, based on the experience of drilling about 80 vertical and deviated wells in the north Kuwait area, the Hith/Gotnia evaporite section with thickness ranging from 100'-1100' (TVD) is mostly viewed as a significant challenge from the well design and drilling standpoint. Due to the perceived high risk, very sparse data in terms of open hole logs and cores corresponding to this evaporite section could be collected, whereas in most of the wells cased hole log data (Sonic, Neutron and GR) is available.

In particular, the well design and placement of the horizontal appraisal wells is severely constrained by the very highly over pressured evaporite section overlying the target unconventional reservoirs. To mitigate the well placement challenges, an integrated study of all available data pertaining to the evaporite section including kicks and losses information, log data and 3D seismic data was carried out. The study has clearly brought out that overpressures in the Gotnia-Hith section are associated with the fluid bearing (hydrocarbon/water) limestone streaks embedded within the anhydrite layers, giving rise to drilling related challenges. In addition, potential opportunities have been identified in terms of sweet spots for targeting these hydrocarbon bearing limestone units within the anhydrite layers, which is also supported by the recent success reported for the first time based on initial testing in an exploratory well. Also, taking into consideration the hydrocarbon potential of these limestone reservoirs, in two of the recently drilled horizontal wells LWD wash down mode logging has been successfully carried out. To date, eight horizontal appraisal wells have been drilled in the north Kuwait area, successfully negotiating the evaporite section based on the improved understanding from the integrated study.