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Decrypting Carbonate Complexity: Key for Effective Exploration of Middle Marrat in Kuwait

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SUMMARY

Marrat Formation of Toarcian age is one of the major reservoirs in Kuwait. Middle unit of the formation, the Middle Marrat, has the greatest reservoir potential and is commercially producing in many areas scattered over the country. Available biodata indicate that the Middle Marrat is probably early Toarcian to possibly middle Toarcian in age, with the likelihood of a moderate duration hiatus at the top, resulting in the absence of late Toarcian and possibly part of the middle Toarcian. The unit is dominantly composed of limestone with sub-ordinate dolomite and anhydrite. The carbonate microfacies consist of mudstone, wackestone, packstone to grainstone with occasional algal boundstone. Reservoir quality ranges from nil in lime mudstone facies to very good in the oolitic grainstones. These grainstones contain moderately well interconnected interparticle porosity. Sourced by the Najmah Shales, grain-prone facies developed in different sequences of the unit in structurally favourable locales provide the avenues for the hydrocarbon accumulations. The reservoirs are capped by thin intraformational anhydrites. Key for successful exploration lies in developing a predictive facies model for pinpointing areas of reservoir development.

In a synergistic approach employing core, log and seismic data, high-resolution sequence stratigraphic studies have been carried out. The Middle Marrat represents a third order sequence comprising a total of eight high resolution transgressive and regressive cycles. Core data has been utilized for understanding of gross depositional patterns of individual sequences. Country-wide isopach maps of the depositional sequences were calibrated with lithofacies data deciphered from the cores to prepare paleogeographic maps. The gross depositional environments cover an entire spectrum of environments of a typical carbonate ramp ranging from sabkha, tidal flats, lagoon, barrier / shoal, outer ramp to basin. Mostly, the transgressive systems tracts are represented by muddier facies. Coarser facies with well-developed interparticle porosity preferentially occur in highstand systems tracts corresponding to the progradation of the clinoforms sloping towards the basin. Successively younger sequences show gradual basinward shift of the facies belts in an overall regressive phase. Basinward shift of potential reservoir facies can be linked to shift in prospective locales and provide a predictive tool for identification of prospective areas for future exploration.