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Unlocking Hydrocarbon Production Potential: A Study of Reservoir Quality Assessment and Depositional Architecture of Minjur Formation (Late Triassic), Burgan Oil Field, Kuwait

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Abstract

The Minjur Formation, a stratigraphically Late Triassic (Carnian to Rhaetian) unit, is considered a significant potential hydrocarbon-bearing sandstone reservoir in the Burgan Oil Field, Kuwait. This study aims to provide a detailed geological analysis through the integration of sedimentological lithofacies types with petrographic analyses (thin section and scanning electron microscopy) and routine core analysis. This integrated approach serves to define facies type sequences, assess reservoir quality for hydrocarbon production enhancement, and interpret the data with regard to possible paleo-environmental settings.

The reservoir characterisation of the Minjur formation was established based on the sedimentological core description on selected core interval at depth 13625.00-13690.00 ft. The detailed description revealed that the presence of around 33 lithofacies types grouped into six main facies groups (Figures 1 and 2): (1) Mudstone, (2) Siltstone; (3) Interbedded Mudstone-Sandstone Facies Type; (4) Sandstone, (5) Conglomerate and (6) Dolostone. The composition, internal organization of these facies types and assemblages, along with the stacking patterns of fining-upward cycles observed in the cored successions, suggest deposition in shallow marine settings. These settings likely experienced fluctuations between tidal channels/flats (subtidal to intertidal sand/mud/mixed-flats) and restricted lagoonal environments.

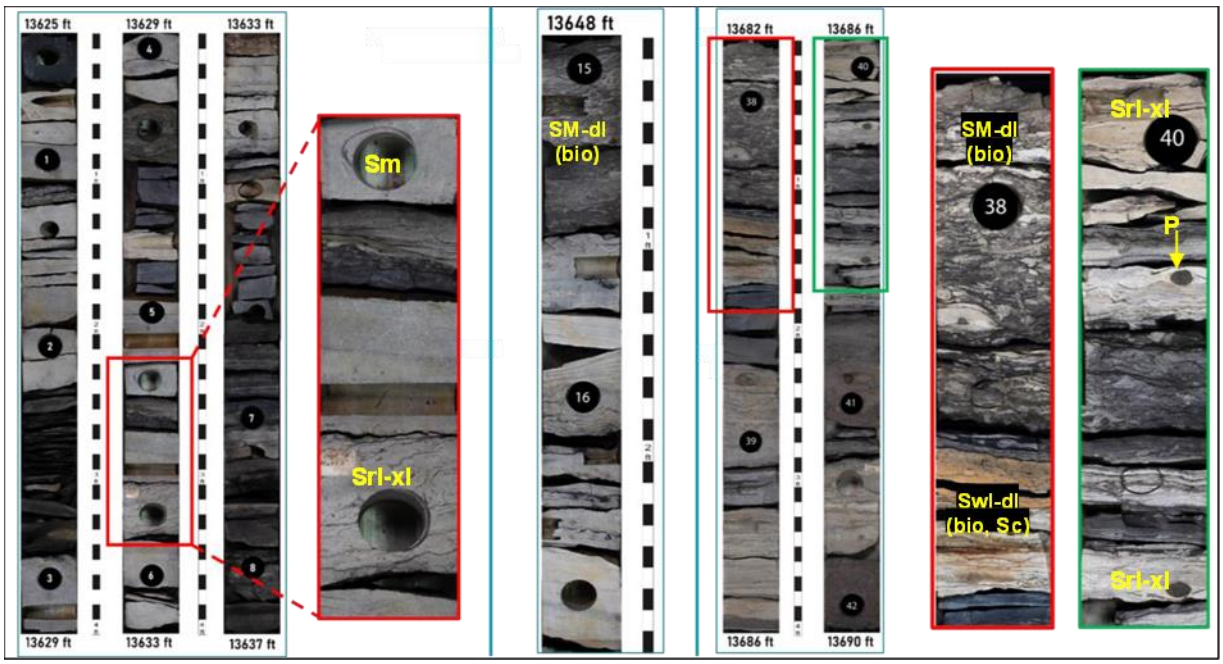

Figure 1: Core photos show some examples of the identified facies types in the studied core intervals

(Abbreviations: Sm: Massive Sandstone; Srl-xl: Ripple and Herringbone Cross-Laminated Sandstone; SM-dl (bio): Deformed Laminated, Bioturbated, Muddy Sandstone; Swl-dl (bio, Sc): Wavy to deformed laminated, Bioturbated Sandstone [with Siderite Cement]; Py: Pyrite Nodules)

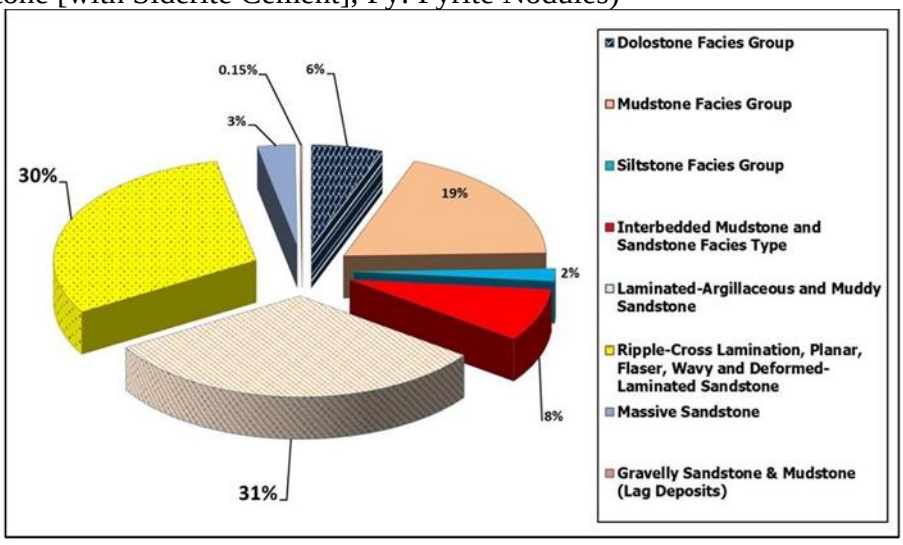

Figure 2: Pie-diagram shows the facies group / types distribution in Minjur Formation

Key sedimentary structures in tidal depositional setting that observed in the studied core; include herringbone cross-stratification (will be only form in areas of overlap between banks of cross-beds of different orientation, or if the currents change position; Figure 3), muddrapes, ripple, flaser and wavy-lamination (Figures 1 and 4). Some organic matters / coal fragments and bioturbation are also observed. On the other side; the biogenic contents include bioturbation index (Skolithos, Palaeophycus, Thalassinoides and Diplocraterion) and also the bioclastic-fauna that detected petrographically in the studied cores; include gastropods, green-algae, ooids, peloids and benthic foraminifera. The tidal depositional setting is fluctuated to lagoonal setting in some parts; this interval shows a mixed carbonatesiliciclastic facies include dolostone and dolomitic sandstone facies types. These sediments confirmed by the petrography analysis and suggested to be probably deposited as early highstand deposits in the inner lagoonal plains.

Figure 3: Cartoon sketch (A) and thin section scanned slide (B; @ depth 13637.50 ft and C; 13669.50 ft) show the herringbone cross-bedding sedimentary structure.

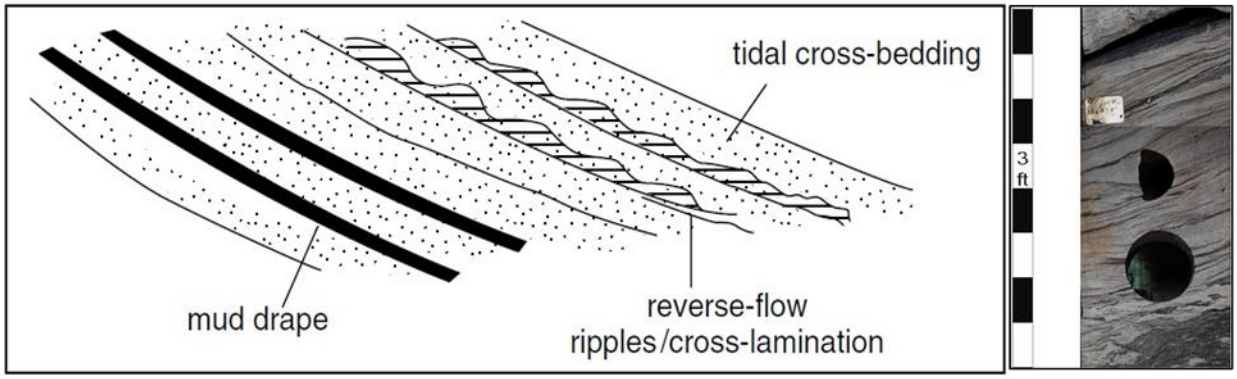

Figure 4: Cartoon sketch and core photo (@ depth interval 13646.60-13647.40 ft) shows the ripple/cross-lamination and mud-drape.

Reservoir quality assessment of the Minjur Formation was conducted on the studied cores. This assessment integrated sedimentological and petrographical observations with routine core analysis data (helium porosity and nitrogen permeability). The results showed porosity values ranging between 0.38% and 9.34%, and permeability values ranging from 0.014 mD to 73.998 mD (Figure 5). The reservoir quality was influenced by various diagenetic controls, which significantly impacted both porosity and permeability. This

enhancement was particularly notable for permeability, driven by: A) Increased dissolution of carbonate cements (ferroan dolomite), which created interparticle pore type; and B) Decreased infiltration of detrital clays (depositionally) and authigenic clays (kaolinite booklets and chlorite plates; with micropores have been observed by scanning electron microscopy).

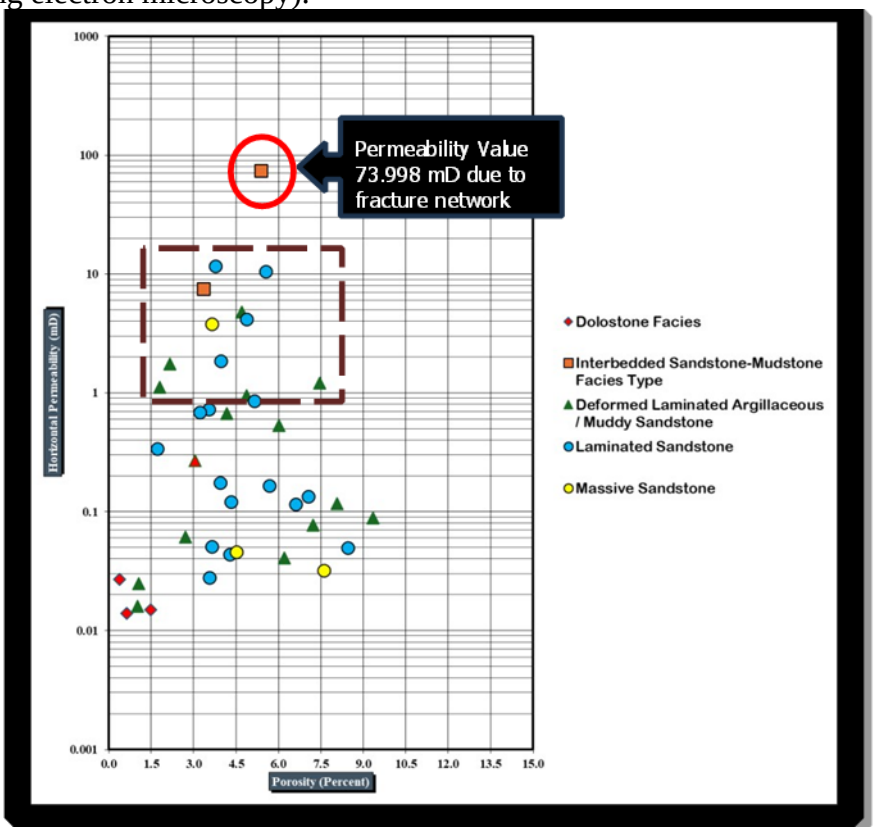

Figure 5: Poro-Perm (@ ambient 400 psi) Cross-Plot Sorted by Facies Types.

Fractures network were moderately noticed during detailed sedimentological description and petrography (thin section analysis) throughout sandstone, mudstone and dolostone facies. Hair-line Fractures (horizontal to sub-vertical and vertical directions) are present at scattered intervals along of the studied cores; and occur as open, partially-open to completely filled / closed by ferroan dolomite cement. Pressure-solution surfaces (micro-stylolites – filled with clays, pyrite and organic matters) are noticed in some of the described intervals and reflect chemical-compaction on the reservoir. Notably, the highest permeability value (73.998 mD; Figure 5) was detected where an open fractures network system is present, highlighting its crucial role in improving the Minjur Formation's reservoir quality.

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