AP03

A New Reference Section for the Lower to Middle Jurassic Southwest of Riyadh: Detailed Stratigraphic Architecture and Regional Correlation with the Subsurface of Saudi Arabia and Kuwait

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SUMMARY

The Marrat and Lower Dhurma formations were deposited during a period of transition between tectonic inversion and differential subsidence in the Late Triassic, followed by rifting of Gondwana in the early Middle Jurassic. This is reflected by a switch from predominantly fluvio-deltaic clastics of the Minjur Formation, to mixed carbonates and clastics of the Dhurma Formation, and the establishment of platform carbonates of the Tuwaiq Mountain Formation. Note that the Marrat and Dhurma formations were originally defined from field work in Saudi Arabia in the 1950s. These definitions differ from those currently used in the subsurface of Kuwait, where the Lower Dhurma of Saudi Arabia is called the “Upper Marrat.” This is a source of considerable confusion. Within an outcrop belt to the southwest of Riyadh, and within the subsurface of the Rub’ al-Khali Basin, the Marrat and Lower Dhurma formations consist of north-easterly prograding fluvio-deltaic sandstones, alternating with finer grained paralic to shallow marine sandstones, mottled red to purple pedogenic siltstones, dark lagoonal mudstones and sandy dolomitic limestones. Within the Eastern Province of Saudi Arabia, these formations consist of clean shelfal limestone, alternating with thin interbedded argillaceous lagoonal limestones.

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During 2008 and 2009, Saudi Aramco drilled, cored and logged three shallow outcrop boreholes located on a series of closely-spaced, off-stepping escarpments to the southwest of Riyadh. These areas are located within a transition zone between the siliciclastic facies to the southeast and carbonates to the northwest. A comprehensive suite of wireline log data was recorded from each well. This was followed by a systematic program of sedimentological, biostratigraphic and geochemical analysis, with the aim of extracting as much information as possible from the Marrat and Dhurma formations. Techniques included graphical core-description, palynology, nannopaleontology and thin-section micropaleontology and stable isotope ($\delta^{13}\text{C}$, $\delta^{13}\text{C}$ and $87\text{Sr}/86\text{Sr}$) analysis. Significant vertical overlap exists between each successive borehole. Wireline log signatures, in conjunction with isotope trends, were used to precisely splice datasets together to produce a composite section. This work produced a single composite reference section, extending from the top of the Minjur Formation, upward to near the top Dhurma Formation, spanning the Marrat, Faridah, Sharar and Lower Fadhili reservoir equivalents. Detailed analysis of the observed stratigraphic architecture has led to an improved understanding of regional depositional systems, transgressive-regressive cycles, temporal variations between hot dry and wet climates and basin evolution.

Stable isotope analysis and paleontological analysis suggest the presence of a condensed Aalenian (Lower D1), section at the base of the Lower Dhurma Formation (D1-D2). This section is directly above the top Marat Anhydrite and directly below an influx of *C. turbatus*, which in turn is overlain by early Bathonian dinoflagellates. The Aalenian records a period of highstand progradation, which can be correlated throughout the subsurface of eastern Saudi Arabia and Kuwait where it terminates in a series of thin anhydrites. Upper Marrat carbonates are characterized by superabundant specimens of the spore *C. torosa*, which confirms a Toarcian age. The distinctive spore *Kekryphalospora distincta*, along with *Gleicheniidites spp.*, and the dinocysts *Nannoceratopsis gracilis* and *Nannoceratopsis spp.*, have been recorded from fine grained siliciclastics, immediately below the base of the Marrat carbonates. These suggest an earliest Toarcian-late Pliensbachian age for the upper Minjur Formation and a transgressive, rather than erosive, basal contact for the Marrat Formation.