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Lower to Middle Jurassic Marrat Formation in Kuwait: Biostratigraphy and Paleoenvironments

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SUMMARY

The lower Marrat (Sinemurian to early Toarcian) is characterized by its common sabkha-tidal flat anhydritic and dolomitic composition changing at top to argillaceous limestones. In these upper limestones agglutinated foraminifera *Haurania deserta* and *Almijiella amiji* are generally present and the abundance of acritarchs, dinocysts and uncommon nannofossils indicate slightly deeper shallow neritic setting.

The middle Marrat (early-middle Toarcian) at the lower section shows the consistent presence of *Siphovalvulina*, *Everticyclammina*, and *Mesoendothyra* species, suggesting shallower conditions. This assemblage is followed by a biofacies dominated by acritarchs, *Pseudocyclammina*, and *Mesoendothyra* species together with miliolids interpreted as a platform complex with shoals/barrier and lagoon. A deeper biofacies deposited basinward to the east is characterized by *Glommospira* species and common sponge remains and spicules. This biofacies is followed, in the upper section of middle Marrat by agglutinated and calcareous benthic foraminifers, and few sporomorphs indicating low terrestrial influence and the final biofacies dominated by miliolids interpreted as lagoonal setting.

Upper Marrat (Aalenian to early Bajocian) displays low microfossil and palynomorphs diversity, echinoid debris, and bivalve debris. A gradual shallowing is suggested by the succession changes of common miliolids and high numbers of ostracods. These assemblages suggest shallow lagoon to tidal flat environments.

This study focuses on benthic foraminiferal stratigraphic and paleobathymetric ranges of the Lower and Middle Jurassic Marrat carbonates of Kuwait. Foraminiferal assemblages and other microfossils have been studied mostly in thin sections from recent cores, in conjunction with palynological data.

The Marrat Formation has been subdivided in Kuwait in upper, middle and lower units. The lower Marrat (Sinemurian to early Toarcian) is characterized by its common sabkha-tidal flat anhydritic and dolomitic composition changing at top to argillaceous limestones. In these upper limestones agglutinated foraminifera *Haurania deserta* and *Almijiella amiji* are generally present and the abundance of acritarchs, dinocysts and uncommon nannofossils indicate slightly deeper shallow neritic setting.

The middle Marrat (early-middle Toarcian) at the lower section shows the consistent presence of *Siphovulvulina* species, *Everticyclammina praevirguliana*, and *Mesoendothyra* spp., suggesting shallower conditions. This assemblage is followed by a biofacies dominated by acritarchs, *Pseudocyclammina liassica*, and *Mesoendothyra* species together with miliolids interpreted as a platform complex with shoals/barrier and lagoon. A deeper biofacies deposited basinward to the east is characterized by *Glommospira* species and common sponge remains and spicules. This biofacies is followed, in the upper section of middle Marrat by *Mesoendothyra croatica*, *Siphovulvulina* species, calcareous benthic foraminifers, and few sporomorphs indicating low terrestrial influence and the final biofacies dominated by miliolids interpreted as lagoonal setting.

Upper Marrat (Aalenian to early Bajocian) argillaceous and anhydritic section displays low microfossil and palynomorphs diversity, echinoid debris, and bivalve debris. *Pseudocyclammina maynci*, *Redmondoides lugeoni*, *Timidonella sarda*, and few miliolids are present. A gradual shallowing is suggested by the succession changes of common miliolids and high numbers of ostracods. These assemblages suggest shallow lagoon to tidal flat depositional environments.

Paleoenvironments of Marrat interpreted on selected species change from sabkha-tidal flat to moderately shallow marine for the lower Marrat interval. The middle Marrat associations suggest a relatively shallow marine to moderately deep biofacies below wave base, and sabkha- lagoonal setting continued in the upper Marrat.

The characterization of the reservoirs in a sequence stratigraphic framework has been facilitated by the integration of the revised biofacies distribution with logs and sedimentology studies.