Sedimentology and Diagenesis of the Upper Jurassic Arab Formation, Southern Margin of the Arabian Plate

Fatimah Alsinan[1], Matthieu Deville de Periere[2], Cathy Hollis[3]

[1]Saudi Aramco
[2]Saudi Aramco
[3]University of Manchester

Abstract

The Upper Jurassic Arab Formation (Kimmeridgian) was deposited on the southern margin of the Tethys Ocean, recording a widespread shallow marine carbonate platform in response to the large-scale Jurassic transgression. In Saudi Arabia, the Arab Formation shows an overall broad shallowing succession from the Arab D Member at the base to the uppermost Arab A Member at the top. The formation displays considerable variations in both thickness and carbonate facies between the stacked members, with the Arab C Member dominated by cross bedded oolitic grainstones.

In this study, sedimentological and petrographic analyses were completed on one well. A detailed 120 ft. core description was utilized, in conjunction with 50 thin sections, cathodoluminescence on 23 samples and geochemical analyses to provide a better understanding of the depositional and diagenetic history and how both have influenced porosity and other formation properties.

Two types of dolomite were defined, comprising (1) replacive dolomite and (2) dolomite cement. Replacive dolomite, affecting peritidal deposits, was an early diagenetic phase as positive carbon values suggest marine conditions. The coarsely-crystalline, pore filling, saddle dolomite cement was probably precipitated by hot fluids during late burial. Three phases of calcite cement have been observed in the petrography analyses. An isopachous locally dog-tooth to fibrous calcite with a dull orange luminescence (C1) is the first observed cementation phase. C1 is followed by a syntaxial overgrowth on echinoderm debris (C2) with two phases, consisting of poorly luminescent calcite (C2a) and bright orange luminescent calcite (C2b), both of which are concentrically zoned. The most recent phase of calcite cement (C3) is an equant/blocky calcite with a dull orange luminescence and rarely zoned. The quantity of macropores has been reduced owing to the cementation, though a significant amount of secondary macropores are present as a result of dissolution.

Isotopic analyses show the development of replacive dolomite, fine-crystalline planar-e to planar-s associated with negative values of d18O and positive d13C indicating the origin from evaporated marine fluids. The most porous lithologies is associated with oolitic grainstones with partial calcite cementation of the interparticle macropores. In contrast, the least porous lithologies rock type in the studied section is located within pervasively dolomitised mudstones within only scattered micropores.

Additional control data including sedimentology, petrography and geochemistry analyses can be used for further analysis to conduct regional study and evaluate the diagenetic controls on porosity and permeability accurately. It is also crucial to understand the stratigraphic framework and how depositional and diagenetic events can affect the regional area.