# Impact of New Static Synthesis on Reservoir Heterogeneities and Properties Distribution

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## Abstract

Before starting the construction of a new generation geological model for a giant Cretaceous Middle East carbonate reservoir, with long production history, a comprehensive review of all existing static data / studies has been carried out with the aim to better characterize the main vertical heterogeneities to be modeled, as well as any potential G&G trend to better constrain the reservoir properties (porosity/permeability) interpolation in between wells.

This synthesis includes all relevant data which enable the understanding of reservoir evolution from deposition time: depositional setting, lithofacies type and distribution, High Resolution Sequence Stratigraphy framework; to present day situation: modifications of initial properties during burial linked to complex interactions between diagenesis, structural evolution and hydrocarbon filling history. The applied methodology integrates geological, petrophysical, and seismic data, as well as the feedback from previous History Match.

Early and shallow burial diagenesis has little to moderate impact on reservoir quality. The difference in burial depth between the crest well and the flank wells (of the order of 500 feet), which is due to structuration of the Field during the late Cretaceous and occurred prior to oil charging, is too small to account for the decrease of porosity between crest and flank. Although not well constrained in time and depth, the increase in burial depth during the interval of time required to fill the field from the onset of oil charging onto the structure top down to the flanks, is interpreted as the driving force responsible for the diagenesis differential.

At crest the substitution of water with hydrocarbons has occurred earlier compared with the flank, and halted water-rock interactions as the burial of the field was much shallower than it is at the present-day. The decrease of water saturation down to the irreducible level reduces mass transfer to a negligible rate, and stopped chemical compaction and stylolization to the level achieved at that time. In addition to this, the mechanical compaction of micrites saturated with hydrocarbons is also probably strongly reduced. In the water-bearing reservoirs (flanks), compaction of the micritic facies, stylolitization and cementation with intergranular calcite and baroque dolomite continued. Large reservoir thickness shortening due to stylolites is consistent with this interpretation.

A special focus has been dedicated to the High K streaks (peloidal grainstones, Rudist peloid rudstone, floatstone.) and the so called “intra dense” layers, which correspond to a large variety of features:

Calcite-cemented layers, Stylolitized horizons, Low porosity horizons occurring near weak textural changes, Dolomitized intervals. These two types of heterogeneity are the main Dynamic key heterogeneities, as they have a big impact of the flow behavior and the sweep efficiency.

From a general point of view an asymmetry of properties distribution (North / South versus anticline shape) is observed and is linked to the progressive tilting of the structure toward the NE during Late Eocene and Oligocene. This trend is overlay by the crest / flank variation directly linked to the impact of diagenesis versus hydrocarbon filling of the structure as mentioned earlier. A good correlation between Thickness – Depth – Porosity is observed for the main reservoirs of the field.

The improved understanding of field geological evolution, the better characterization of the main reservoir heterogeneities and the integration of previous history matching feedbacks demonstrate that a better representation of reservoir dynamics was possible. This pre-modeling data analysis and the investigation of rules for heterogeneity modeling will make possible to construct a more heterogeneous model than the previous one. Specific workflows, for the petrophysical modeling stage, will be designed to represent respectively the High K streaks, the intra dense layers and the reservoir “background”.