North Kuwait Carbonate Fields Structural Evolution

Pascal Richard[1], Loic Bazalgette[2], Vijay Kidambi[3], Kamran Laiq[4], Allan Odreman[3], Bashar Al Qadeeri[3], Rao Narhari[3], Chinmaya Pattnaik[3], and Khalid Al Ateeqi[3]

[1]Shell International,
[2]Petroleum Development Oman,
[3]Kuwait Oil Company,
[4]Schlumberger.

ABSTRACT

This paper presents a new structural model for the North Kuwait Carbonate fields as well as its implications in terms of fracture modelling and field development (Richard et al, 2014). It also describes a workflow which can be used as foundation for further fracture modelling study at production and exploration scales alike. This workflow consists of a four step approach: 1) elaboration of a regional structural model, 2) creation of 3D conceptual fracture diagrams, 3) elaboration of constraints capturing the key elements of the conceptual diagrams and 4) creation of fracture model properties for further dynamic simulation. The application of this workflow resulted in the creation of a series of fracture models for the North Kuwait Carbonates fields. During the first step of the study, a new structural model has been elaborated based on key kinematic observations from well and seismic data, as well as experimental and field analogues which have been linked to the known regional phases of deformation. These main phases of deformation are 1) post Triassic rifting, 2) Alpine 1 - late Cretaceous transtension and 3) Alpine 2 - Mid Tertiary compression related to the Zagros formation, which has the greatest impact on the formation of the pre-Gotnia structures and fracture development. The major difference between the new model and previous structural thinking is that the formation of the compressional and transpressional folds in the Carbonate fields (an event that shaped the current outline of the fields) has happened during the Tertiary times instead of Jurassic times. The proposed structural evolution has been used to define characteristic structural domains. These structural domains have defined a foundation to elaborate conceptual fracture diagrams to support fracture modelling study work. The conceptual fracture models have potential implications on fracture development and preferred direction of horizontal and deviated wells. Greater fracture connectivity is expected in compressional and transpressional ridges developed in Tertiary times, while in the area between the compressional ridges, less dense fractures and probably more cemented fractures (likely to have developed before hydrocarbon emplacement) are expected. The new view on the timing of the structural development (i.e., late uplift of compressional ridges regionally) also has possible implications on maturation/charge history as well as reservoir properties development. The newly proposed model for structural evolution is now being used as a foundation for appraisal and fracture modelling activities of the pre-Gotnia carbonate reservoirs.