Kinematic Interpretation and Structural Evolution of North Oman, Block 6, Since the Late Cretaceous and Implications for Timing of Hydrocarbon Migration into Cretaceous Reservoirs

Jacek B. Filbrandt[1], Salah Al-Dhahab[2], Abdullah Al-Habsy[3], Kester Harris[1], John Keating[4], Salim Al-Mahruqi[5], Sait Ismail Ozkaya[6], Pascal D. Richard[1], and Tony Robertson[1]

[1]Shell International
[2]Daleel Petroleum
[3]Qarat al Milh Petroleum LLC
[4]Shell Exploration and Production Company, US
[5]Petroleum Development Oman
[6]Ozkaya Geoscience

ABSTRACT

This paper describes the structural evolution of North Oman with particular attention given to the Late Cretaceous (Alpine 1) and mid-Tertiary (Alpine 2) phases of deformation. The most important input data are regionally extensive 3D seismic cubes covering north Oman in PDO's Block 6 concession. These have been combined with stratigraphic and structural data from a large number of wells to provide the basis for extending the tectono-stratigraphic interpretation in the Oman mountains into the sub-surface. The interpretation of the seismic and well data sheds light on the late Cretaceous and Tertiary evolution of the foreland south of the foothills. A pervasive and consistent structural grain identified in attribute maps at Natih to Gharif formations oriented approximately NNW-SSE and WNW-ESE forming a distinct structural domain and may seem to be in apparent contradiction to the well-studied collision and southward emplacement of the Semail Ophiolite. Our assessment of kinematic indicators and contemporary stratigraphic growth sequences based on available 3D data suggests that the maximum horizontal stress from Santonian through to Campanian time was oriented NW-SE in this foreland domain and was probably related to the northward passage of the Indian plate past the Arabian plate and emplacement of the Masirah Ophiolite on the eastern seaboard (the Batain coast) of Oman, in combination with the loading from the Semail Ophiolite. Based on strike orientations, dip and stratigraphy intersected, the structures identified in the sub-surface may be related to extensional faults mapped in outcrop on Jebel Shams and Jebel Akhdar. These faults are now tilted from their original dip by later folding during the second Alpine collision. Maximum horizontal stress at that time was likely oriented approximately NE-SW, as it is today, and led to inversion of some of the earlier Cretaceous structures in closer proximity to the Oman mountains as exemplified by the Fahud Fault and related folding visible at surface. The superposition of the structural fabrics from 3D seismic data and integration with well and core observations provides the basis for the understanding of the timing of emplacement of fracture families and their potential impact on fluid flow in the sub-surface.