Fracture and In Situ Stress Patterns in Khuff Structural Traps, Eastern Offshore Saudi Arabia *

Mohammed S. AMEEN  
Western Area Exploration Department, Saudi Aramco, Dhahrnan, Saudi Arabia (mohammed.ameen@aramco.com)

This presentation summarizes the results of a comprehensive characterization of fractures and in-situ stresses for exploration and prospect evaluation in ten offshore periclinal structural traps, in the Eastern Province of Saudi Arabia, where several major gas discoveries were made in the deep Permian-Triassic Khuff Formation. Borehole image logs, oriented cores, seismic, gravity-magnetic data, and dynamic observations were used in the study. Two mesofracture systems were identified: a younger, major system which enhances reservoir permeability and an older, minor, fully mineralized system. The older system consists of subordinate northerly striking extensional mesofractures, including joints and faults, which are fully mineralized. This mineralization occurred during an early diageneitic-phase. This system acted as paleo-fluid conduits facilitating the occlusion of matrix porosity and deteriorating the reservoir quality in the immediate vicinity of the fractures. The younger system is regionally dominant, and includes mesofractures with persistent strike ranging from NE-SW to ESE-WNW irrespective of local structure. These younger fractures are nearly parallel to the present day maximum horizontal in-situ stress and perpendicular to the minimum horizontal in-situ stress. The development of this system commenced during the convergence of the Arabian and Eurasian plates (Late Cretaceous to Cenozoic) and culminated during the continental collision. The fractures are predominantly extension joints and were facilitated by increases in pore pressure due to the oil placement and the subsequent cracking of this oil into gas. Hydrocarbon migration into the Khuff reservoirs was crucial in slowing down diagenesis and preserving both fracture apertures and matrix porosity. Therefore, most of the fractures in this system tend to be partly mineralized, mainly by carbonates, and/or coated with hydrocarbons. These fractures show channel-type apertures that enhance permeability. The channel apertures can endure operational changes in reservoir pressure with little or no reduction of their permeability.

*Description from key presentation in the AAPG GTW Unconventional Resources: New Ideas for Future Challenges in Brazil, 15-17 July 2012 | Rio de Janeiro, Brazil.