Fracture and In-Situ Stress Characterization of the Unayzah-B/C, Saudi Arabia

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ABSTRACT

Fractures in the Unayzah (Upper Carboniferous-Permian) interval of the South Haradh area of Eastern Saudi Arabia, were identified utilizing core, borehole images, 3D seismic and dynamic data. The main focus of the study was the lower tighter part of the Unayzah, the B/C interval. This study involved the comprehensive analysis of some 15,000 ft of imaged and cored sections from 14 key wells.

The Unayzah-A is generally a non-brittle, sparsely fractured unit with high matrix porosities and fractures that are not essential for production. The Unayzah-B/C is a brittle unit in which meso- and micro-tectonic fractures are dominant and include stylolite related tensile fractures and non-stylolite fractures (tensile fractures and faults). Most fractures are barren with clay mineral or quartz coating or partial mineralization and dead hydrocarbon. The fracture's apertures are of the order of micron scale and where these fractures form clusters they could effectively increase permeability within the tight host rock. These clusters are steep dipping (angle of dip ≥70°) with dominant NE-SW to E-W strikes, and are a scale-independent system; meso-fractures are connected via microscopic fractures.

The maximum horizontal in-situ stress is oriented NE-SW to ENE-WSW nearly parallel to the dominant open fractures. The parallel orientation of the fracture clusters to the plate tectonic stress regime in the region indicates that they are controlled by such stresses rather than the localized fold and faults system (predicted from seismic data). Open tectonic fractures are essential to productivity in tight formations; their impact is a function of their aperture, size, density, clustering and connectivity.

Early diagenitic structures (faults, dewatering and slump structures) were also identified. These are preferentially oriented parallel to the basement faults and forced folds axes, and often, though not exclusively mineralized.