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Modeling Dual Porosity Carbonate Reservoirs: Integration of Core, Well Log, 3D Seismic and Well Bore Image Data for Stochastic Modeling of Fault and Fracture Systems, Al Rayyan Field, Qatar

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Al Rayyan Field, offshore Qatar, produces oil from the Upper Jurassic Arab A and C Formations. Reservoir intervals are composed of shallow subtidal to peritidal carbonates and are interbedded with anhydrites that form the top seals.

An integrated reservoir characterization project was initiated which used core, logs, including image logs from horizontal wells, and 3D seismic. Although some faults are identified in the seismic data, it is apparent in the horizontal well logs, and verified in image logs, that sub-seismic faults and fractures are abundant and comprise zones up to 200 ft in width. Integrating image logs with petrography from drill cuttings, fault zones have been subdivided into three types: (1) Very high porosity zones (average 34%) display extensive dissolution in cuttings and a distinctive homogeneous image-log character which indicates no relict depositional features remain. (2) High porosity zones (average 26 %) contain a series of faults/fractures visible in image logs that display an increased amount of dissolution porosity compared with adjacent, non-faulted, reservoir. (3) Cemented zones have decreased porosity relative to the matrix (average 7%), which is verified in image logs and cuttings.

A three-dimensional reservoir model was created, which distributed matrix porosity and permeability deterministically and fault zones stochastically. The matrix and fault zone data were then merged. The section was subdivided into 92 layers (15 million cells) and was later upscaled for simulation to 42 layers. Estimates of mean fault length were derived from seismically observable faults; however, fault orientation was derived from image logs alone due to perceived seismic acquisition bias on the observed fault orientation.