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# Unconventional Reservoirs, Integrated Petrophysical Approach for Sweet Spot Identification and Fracking Stage Selection

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## ABSTRACT

Carbonate source rocks are one of the most promising shale gas reservoirs in Saudi Arabia. The targeted aged Jurassic source rocks are calcareous and are interpreted to have been deposited in a restricted marine environment within an intra-shelf basin. During the Late Jurassic, the carbonate shelf environment became dominated by broad shelves and local intra-shelf basins, which contained interbedded, kerogen-rich marine lime mudstones and marls. The basinal facies consisted of cycles of laminated, organic-rich, lime mud wackestones that essentially comprise the Tuwaiq Mountain Formation. It was in this setting that the late Callovian-Oxfordian and early Kimmeridgian Tuwaiq/Hanifa Formation was deposited.

Magnetic resonance and elemental spectroscopy tools, combined with conventional density neutron, acoustic and resistivity logs, are used for a better optimization of the petrophysical model, including accurate estimation of organic matter volume, porosity, formation water saturation and electro-facies. Total organic carbon, XRD/XRF, GRI data and core facies data are used to calibrate the petrophysical model, the electro-facies and to tie the cores to log responses. A comprehensive workflow has been established to achieve a consistent formation evaluation model.

The rock mechanical properties, stress magnitude, anisotropy and orientation, coupled with petrophysical results, in terms of source rock richness and porosity, have helped determine the landing interval for horizontal well placement and the frac interval selection. The combination of geomechanics and petrophysics allows for a better understanding of carbonate shale gas reservoirs, and a good optimization of the frac design and hence successful wells.