Evolution of Tight-Gas Fracturing Methodology in the Lower Paleozoic Sandstone Formations in Saudi Arabia

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SUMMARY
The lower Paleozoic Sandstone Formations in Saudi Arabia range from as deep as 20,000ft in the South Ghawar and Ruba al-Khali to less than 12,000ft in the North West. The deeper, tight-gas projects in the South Ghawar and Ruba al-Khali have seen the highest activity since 2006. They are the subject of this review in light of four key wells. The targeted lower Paleozoic formations in these wells are Sarah, Qasim, and the Rhuddannian sandstones in the Qusaiba. Sarah and Qasim are sandstones while the Qusaiba is interbedded sandstone and shale. The high pressure, high temperature environment in these reservoirs pose serious technical challenges that need to be overcome when hydraulic fracture stimulation is attempted.

Specific challenges to fracture treatment design in these deep, lower Paleozoic intervals include proppant selection, interaction of fracturing fluid with the formation, interaction of fracturing fluid with drilling mud, fracturing fluid clean-up and load recovery. Four key wells show an evolution in the design methodology to meet these technical challenges. The evolutionary steps take into account geological, geomechanical and petrophysical analyses that are calibrated with field data as project matured. The accompanying lab work has also led to permeability profiles, well calibrated stress regimes and, overall, an enhanced understanding of these complex reservoirs. In turn, better reservoir understanding has improved the completion strategy.

The four key wells provide a detailed account and up to date documentation of the experiences gained in the last four years. Early on, a fluid selection strategy has been developed based on fracture gradient. As field data become available, geomechanics study determined that fracture confinement was the result of a change in the stress regime. Finally, the need for multi-stage fracturing is established to optimize production. The lessons learned from these experiences have been guiding the future exploration activities in the area.