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Structured Multidiscipline Data Acquisition and Integration for Optimum Unconventional Reservoir Drainage and Field Development

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SUMMARY

Unconventional resources have gained prominence after their potential to produce hydrocarbons has been proved. Production from these resources became economically feasible as a result of combining horizontal drilling and multi-stage hydraulic fracturing reservoir stimulation along laterals targeting tight rocks with favorable petrophysical qualities. The extraction of hydrocarbons from these source rocks requires a step by step process starting with basin mapping, drilling coupled with geosteering, adequate cementing of the lateral in the wellbore and hydraulic fracturing completion. Each of these steps has key ingredients that need to be understood for a successful tight reservoir well.

Unconventional resources have gained prominence after their potential to produce hydrocarbons has been proved. Production from these resources became economically feasible, as a result of combining horizontal drilling and reservoir stimulation, using multi-stage hydraulic fracturing along laterals with favorable petrophysical and geomechanical properties. The extraction of hydrocarbons from the source rocks requires a step-by-step process, starting with basin analysis, drilling coupled with geosteering, adequate cementing of the lateral wellbore and hydraulic fracturing completion. Each of these steps has key ingredients that need to be understood for a successful unconventional reservoir well.

It is imperative that initial exploration of unconventional resources start with an adequate portfolio of data acquisition schemes, which are analyzed by multidisciplinary teams focusing on geological, petrophysical, geomechanical, engineering and other aspects of the reservoir. Comprehensive consideration of petrophysics, geomechanics, reservoir fluid characterization, hydraulic fracture modeling and reservoir simulation, are crucial in the early exploration and appraisal stages.

This paper outlines a workflow for establishing structured data acquisition and integration to facilitate reservoir characterization, sweet spot mapping, optimization of hydraulic fracture design, maximization of recovery and field development planning. The paper details initial steps after a specific area or formation is considered worthy to pursue for an unconventional resource exploration program. This will be followed by a detailed acquisition of key petrophysical and geotechnical logs for enhancing the team understanding of reservoir quality, vertical stress profiles and hydraulic fracture propagation. Diagnostic fracture injection tests are beneficial in calibrating vertical stresses and providing reservoir parameters, such as permeability, reservoir pressure and leak off coefficients, which impact fracturing and drainage.

The integration of initial flowback data with hydraulic fracture models, production logs and microseismic can improve calibration of models and further understanding and aiding optimal reservoir hydrocarbon recovery. Understanding hydraulic fracture mapping by using microseismic and pressure interference is critical for well performance analysis. Microseismic event patterns can be used to estimate hydraulic-fracture geometries and provide a foundation for building reservoir simulation models. Though microseismic measurements are acoustic, tying them with pressure mapping can refine observed geometries.

Figure 1 Mechanical Earth and Wellbore Stability Model

Figure 2 3D and Map View of Unfiltered Microseismic data indicating possible downward growth

Figure 3 Frac Model Geometry with '40# Cross-linked Fluid