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3-D Integrated Workflow for Understanding the Fracture Interference and Its Impact into the Gas Production of the Woodford Shale

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Abstract

This paper describes the integrated workflow followed for understanding the mechanics of the hydraulic fracture stimulation interference and its impact on the gas production, gas production drivers, well performance, and recovery in horizontal wells in the Woodford Shale of the Anadarko basin. Devon Energy and Schlumberger collaborated on an integrated approach including geology, geophysics, petrophysics, geomechanics, stimulation, completion, production and reservoir engineering disciplines.

A detailed and reliable petrophysical and 3D geological model with geomechanics components at single well level was critical to understanding the fracture interference, its negative impact on the production, defining well performance drivers and operational solutions to mitigate the negative production impact of fracture interference.

Initially single well models are constructed around wells with little or no offset well fracture interference. Once acceptable reservoir parameters and hydraulic fracture geometries were understood, multi-well sector models were constructed in the 3D geologic and reservoir model to evaluate the interaction between wells. An additional benefit of the detailed 3D model is to serve as a foundation for future field development optimizing well spacing and completion designs to improve recovery and economics.

The integrated workflow applied on the project relied on data and interpretations from geology, geophysics, petro-physics, geomechanics, stimulation, completion, production and reservoir engineering domains. While petrophysics were being validated with core data, geomechanical interpretation was started and the 3D Geological Model was being built based on the well and seismic data. The core calibrated petrophysical parameters were then added to the model. The process then shifted to geomechanics and hydraulic fracture simulation. Several iterations was necessary to refine and construct an accurate representative mechanical earth model (MEM) with consistent and repeatable agreement with down-hole pressure interference measurements, diagnostic injection tests, fracture stimulation treatment data and micro seismic data. Based on the results from hydraulic fracture geometry and geomechanical iterations, production history matching using analytical and numerical reservoir simulators was performed. Initial modeling was using petrophysical properties in the 3D model on a single well basis. The process proved repeatable in single wells on opposite sides of a major geologic feature. Once satisfied with single well results, multiple well situations were modeled to explain existing production and well interference conditions and provide a basis for developing operational solutions.