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3D Reservoir Characterization and Integrated Completion Optimization for Understanding Horizontal Well Spacing and Frac Staging of the Niobrara Fm., DJ Basin

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ABSTRACT

Detailed subsurface characterization for developing unconventional oil and gas assets is a critical component in understanding where and how to drill horizontal wells, pinpoint subsurface targets, identify reservoir sweet spots, optimize well spacing in a DSU, determine resource-in-place [STOOIP] and engineer completion designs. A new methodology is developed employing statistical rock physics techniques in order to address these complex unconventional challenges. This procedure integrates petrophysics, rock typing, 3D seismic attributes and geostatistics to build the reservoir model, and most importantly, directly incorporates the model results into frac designs. This methodology is employed on the Cretaceous Niobrara fm. in the DJ Basin where horizontal pad drilling has been in practice for a number of years with much experimentation in terms of well spacing, stage spacing and job size. As a result of the industry downturn, operators are now more focused on increasing recovery factors in a DSU while maintaining individual well economics; i.e. ROCE. This new process goes right to those concerns which will allow operators to make more informed decisions going forward. Applied statistical rock physics approach for reservoir characterization integrates fundamental petrophysical concepts of effective porosity, hydrocarbon saturation and geomechanics with statistical and non-statistical pattern recognition, 3D seismic elastic properties and geostatistics. The petrophysics allows for the linkage between reservoir properties with seismic responses and to extend the data for training purposes in a supervised neural network or an unsupervised classification scheme. Geostatistic simulations add spatial correlation and small-scale variability along with uncertainty analysis in the model. This approach, along with the engineered completion designs, is proving to help in high-grading and ranking Niobrara horizontal well pads, managing production expectations and identifying the critical factors for increasing bbls/CFLAT in any given area of the basin. Directly importing our reservoir models into the frac model has allowed for laterally varying properties across the length of the horizontal and more accurate calculations of permeability, stress and frac height. Most importantly, the production predictions obtained from the frac model are in much greater agreement with actual production in the area lending confidence to the quality of the reservoir- driven frac designs.