Detecting Depletion in the Middle Bakken using Drillbit Geomechanics

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The technology of Drillbit Geomechanics generates high-resolution measurements of near-wellbore mechanical rock properties to advance drilling and completion practices by quantifying stratigraphic variability, fracture density, fracture initiation, and state-to-stage production variability in wells. These high-resolution rock property measurements also can be used to identify both natural and induced mechanical variability within individual rock units along a horizontal wellbore.

The effect of pressure and hydrocarbon depletion on mechanical rock properties was studied in a recent project in the Williston Basin. In January of 2017, a Middle Bakken formation horizontal well was drilled in close stratigraphic proximity to three horizontal wells that were drilled in 2008. The three 2008-vintage wells were drilled as part of a Consortium aimed at optimizing drilling, completion and production of horizontal Middle Bakken formation wells. The wells were extensively logged, variably completed (two fracture stimulated wells, one monitoring well), and monitored during completion and production using microseismic technology and fluid tracers. The 2017 horizontal well was drilled perpendicular to the existing 2008 wells, and was geosteered directly beneath the wells. The bottom hole assembly on the 2017 well was equipped with downhole vibration data recorders that collected the data from which mechanical properties were calculated. Mass spectrometer data was also collected at the surface to provide a geochemical profile of carbon and inorganic compounds that might contain a depletion signature.

Fracture ID processed the acceleration data collected in the 2017 well to provide Young's Modulus, Poisson's Ratio and fracture indication along the wellbore. Distinct mechanical signatures along the wellbore that may be indicative of pressure and hydrocarbon depletion, in combination with variability in fracture identification and auxiliary data collected at the surface, correlated with data collected in the 2008 Consortium wells. As two of the three wells were completed using hydraulic fracturing methods, indications of depletion and induced mechanical heterogeneity were observed only adjacent to those stimulated wells.

The high-resolution Poisson's Ratio, converted to minimum horizontal stress, was used to inform the staging of the hydraulic fracture stimulation. Positioning hydraulic fracture stages to minimize the difference in minimum horizontal stress within each stage leads to higher perforation breakdown efficiency.