MECHANICAL PROPERTIES DISTRIBUTION WITHIN A MIXED CARBONATE-SILICICLASTIC DEEP-WATER FAN OF THE WOLFCAMP A FORMATION, PERMIAN, DELAWARE BASIN

Taufik Al Amin

ABSTRACT

Variability of facies, mineralogy, texture, grain size, and diagenesis in a mixed carbonate-siliciclastic fan of the Wolfcamp A formation in Delaware Basin results in different elastic and mechanical behaviors in different parts of the fans. We aim to investigate and semi-quantitatively analyze spatial variation in facies and their mechanical properties using core, acoustic logs, rock physics models, and 3-D seismic. We also apply an inversion-based technique to estimate mineral composition and use an inclusion-based rock physics model of Self-Consistent Approximation (SCA) and Differential Effective Medium (DEM), optimizations on the aspect ratio for rock mineral frame and pore, and apply fluid substitution to build the rock physics model. Data visualizations within theoretical bounds were used to observe and predict the facies variability influence on elastic and petrophysical properties in deep-water mixed carbonate-siliciclastic fans. Subsequently, we build a 3-D geocellular model of facies and logs-derived mechanical properties to examine vertical and lateral changes of facies and mechanical properties. Cores, rock physics models, and 3-D geocellular facies and mechanical properties models quantifiably predict the carbonate-dominated inner part of the fans (axis and off-axis) to have relatively stiffer modulus and faster velocities because of stronger mineralogical constituents. In contrast, the frontal and distal fringes are dominated by argillaceous facies with varying volumes of clay content and organic matter and, therefore, have a much weaker rock with a more compliant modulus and slower velocities. These findings suggest that there are locations within the medial part of the fans that have interbedded higher strength carbonate-dominated facies and lower strength silicious-mudstone beds that are suggested to be the best area for stimulation with a stacked of good reservoir quality as well as fracture barrier. Well-calibrated inclusions-based rock physics and 3-D geocellular logs-derived mechanical properties model can be a predictive technique for observing the variability of elastic and petrophysical properties across different parts of deep-water mixed carbonate-siliciclastic fans. The assessment and quantification of mechanical variability in deep-water sediment has tremendous implications for planning horizontal drilling and fracking in unconventional reservoirs in the Permian Basin and elsewhere.

Xavier Janson