Core, Log and Seismic Data Integration to Develop a Heterogeneous Earth Model for Unconventional Reservoir Characterization, and Example of the Vaca Muerta Formation in Neuquén Basin, Argentina

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Abstract

Thorough characterization of shale reservoirs is a necessity to assess reserves and potential producibility, particularly during the stage of hydrocarbon exploration. In this paper, a new shale reservoir characterization workflow is presented in which different methodologies enable the analysis of multiple data sets at various scales, leading to a better understanding of property variations within the reservoir and reducing the overall uncertainty in the reservoir characterization.

The workflow integrates seismic interpretation, classification and the numerical modeling of geologic processes, and is being exemplified on the Vaca Muerta Formation in Argentina. Seismic horizons are extracted with the Extrema technology through the automated detection of all seismic events in the 3D seismic volume, and seismic discontinuities are identified and extracted following an automated approach using different seismic attributes for edge detection and enhancement. Seismic classification of log- and seismic responses for unconventional reservoir characterization—referred to as seismic heterogeneous rock analysis (sHRA)—incorporates core, well log and seismic data for the population of measured properties from core scale through log scale to seismic scale, producing a 3D landscape for the Vaca Muerta Formation. The results of both analyses as well as supplementary information such as sediment source and volume are fed into the geologic process model (GPM) that simulates at basin scale the processes that created the stratigraphic configuration and rock properties observed today. While all three methods produce independent results, their integration can significantly improve their consistency and build advanced knowledge crucial for successful shale reservoir characterization.