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De-Trending of Frequency-Broadened Seismic Acoustic Impedance for Fluid Discrimination

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ABSTRACT

Conventional reservoirs have been elemental in the development of techniques to help identify, delineate, and de-risk potential hydrocarbons. A persistent issue is the variability of properties with depth, caused by overburden, compaction, dewatering within formations or even parasequences. These variations pose a challenge when identifying characteristics of hydrocarbon-bearing rock over several stratigraphic sequences. Generally, this can be addressed by calibrating each interval individually and generating several localized analysis. This investigation aims to remove part of the depth variability by de-trending rock properties using frequency-broadened acoustic impedance. The results allow the continuous evaluation of inverted properties along the complete wellbore, their correlation to completed zones, and identification of bypassed or undrilled potential. This study of a Gulf of Mexico field shows that shale, wet sands, and pay sands can be identified using frequency-broadened seismic inversion. Further, the correlation between petrophysically defined lithology and seismic defined lithology is quantified for statistical verification. Ultimately, eliminating the variability of impedance values as a function of depth or pressure allows improved imaging and separation of shales, wet sands, and pay sands in a single display. A shale, wet sand, and pay sand lithology scheme was defined using 10 control wells with full log suites. Logged shale impedance values were averaged within 6 Maximum Flooding Surfaces and used as a baseline. Pre-stack simultaneous inversion was computed using commercial software, including the 10 control wells with petrophysical analysis. The average logged shale impedance values for each maximum flooding surface was used to analyze their corresponding acoustic impedance volume response. The correlation between the lithology at each of the wells and the corresponding seismic impedance intervals were found to have a match of approximately 80%. Further, it was observed that drilled pay sands defined by petrophysics and seismic impedance had been completed and produced. Other undrilled similar signatures were identified. This procedure allowed to discriminate pay sands from wet sands, sand intervals from shale intervals, and confirmed findings statistically with log and production data. When incorporating completion and production history, this methodology improved the delineation of produced and unproduced hydrocarbon across the study area, and served as a robust risk assessment tool.