Amplitude Variation with Offset and Sandstone Reservoir Characterization, Shallow Offshore Niger Delta

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Abstract

This work focuses on the characterization of gas sand reservoirs from seismic data using rock physics and seismic inversion techniques to constrain observations from increasing amplitudes with offset (AVO) in the study area. Brine sand was observed to produce similar AVO characteristics as gas filled sand, therefore, the need to study this reservoirs especially at locations away from well information so as to avoid the drilling of wet sand. Two composite wells, full seismic stack, near, mid and far angle stacks were used for the analyses.

Six sandstone reservoirs (A-F), surrounded mainly by shale bodies were identified such that impedance contrast between the lithologies indicated a geological model of high impedance shale and low impedance sandstone interfaces. Apart from the gas sands with increasing AVO (classes IIp and III for sands E and F respectively) at well location, brine sand C was also observed to have class III response. Two other areas that showed increasing AVO were also observed away from well location. The challenge is to discern brine saturated sands from gas sands.

Results from shear impedance inversion revealed that increase in shear velocity (as described by the shear impedance inversion) from brine to gas sand at well location is an indication of the type of fluid in the reservoir despite the similar AVO intercepts. In this basin, acoustic impedance (AI) inversion alone showed poor discrimination of fluids and lithologies while it combination with elastic impedance (EI) inversion revealed better separations. Moreover, Lambda-Mu-rho inversion analyses where low values of Lambda-Rho coincide with high value of Mu-Rho produced a more direct identification of gas reservoirs from brine sands. Therefore, empirical relations and conceptual illustrations of the log and seismic based Lambda-Mu-Rho showing the changes in gradient and intercept in the plots of Lambda-Rho versus Mu-Rho were generated to aid interpretation at locations where well information are not available. To further confirm the clusters from seismic inversions for brine and gas saturated sands and also, shale and sandstone lithologies, well log based rock property template (RPT) was developed, this however, support the fluid classifications from RPT and isolates AVO effects from non-gas bearing sands. This work has helped to recognize two other prospects as gas reservoirs away from well control.