Predictions of Gas Hydrates Using Pre-Stack Seismic Data, Deepwater GOM

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A seismic study was employed to predict and characterize gas hydrate accumulations at proposed sites that would be drilled in 2009 by the Chevron-led Joint Industry Project (JIP) in the deepwater Gulf of Mexico. In this phase of research, the JIP focused on finding favorable conditions for hydrate formation - primarily, high-quality sand reservoirs; and secondarily, the availability of methane source and migration pathways. Wells targeting various geologic models in both high and low predicted saturations of gas hydrates (Sgh) were selected, and thus, allowing the test of the seismic prediction techniques.

The methodology for predicting Sgh, using industry standard, 3D seismic data, involves an integrated workflow of seismic interpretation, rock model building, data conditioning, seismic data inversion, and conversion to Sgh. Seismic stratigraphic interpretation was used to identify sequences likely to contain sand reservoirs. Additional site studies also provide other aspects crucial to the identifying hydrates, such as the base gas hydrate stability zone, migration pathways, and availability of gas for source. Rock models of elastic seismic responses of the clastic sediments were constructed using regional knowledge and principles of rock physics and compaction. Preconditioning the offset data is applied to increase the resolution and fidelity of the seismic offset data for subsequent AVO analysis. Inversion of the pre-stack data converts the seismic data to pseudo rock properties (P-impedance and S-impedance), which are compared to the initial rock model. The deviations of impedances from the model are then input for Sgh predictions.

Results of the drilled JIP wells are compared with the Sgh predictions. Initial findings indicate that the methodology works well for predicting relative saturations occurring in thick sand units. High gas hydrate concentrations were found consistently in the wells where high Sgh values were predicted. Accurately predicting low saturations is somewhat more challenging without nearby well control for calibration. In a well where relatively low concentrations were predicted, thin hydrate layers (below seismic resolution) are evident on the well logs . Intervals of hydrate filled fractures were not readily apparent in the Sgh volume, probably due to the formation's overall low concentrations of gas hydrates. In general, the comparison of the drilled results with the predictions are very positive and show that this methodology can be used to estimate moderate to large accumulations of gas hydrates using pre-stack seismic data