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4D Seismic Monitoring of Water Influx at Bay Marchand: The Practical Use of 4D in an Imperfect World

Multiple seismic surveys over time not intentionally designed for 4D evaluation can be used for imaging fluid and pressure changes, and locating bypassed reserves. Bay Marchand is a mature Gulf of Mexico field with a series of stacked reservoirs separated by shale. The first 3D seismic survey was acquired after first production and the second seismic survey was a non-exclusive survey having very different acquisition parameters. These circumstances make interpreting 4D results difficult, but not impossible. We were able to make a reasonable interpretation of the 'A' fault block on the original data before cross-equalization although cross-equalization improved the cubes. We were able to identify areas of water influx and areas not yet invaded by water, even though we were prevented from following the typical steps in 4D. Reliability estimates were derived for estimates of saturation change as a function of signal-to-noise ratio and scatter in the rock physics relationships. This paper discusses these steps in contrasting the ideal case with Bay Marchand and show where a 4D project can still be successful even with compromises forced by lack of early data or current budget. Successful wells have been drilled in the Upper Miocene 7100' and 7600' Sand reservoirs using the 4D results. In the 7100' Sand, the aerial extent of the strong amplitude on the second seismic survey was targeted. This area along the crestal portion of the reservoir was drilled as a secondary target, logged oil, and was subsequently completed with a horizontal well. In the 7600' Sand, the 4D was used as direct evidence of oil saturation. Changes in amplitude were consistent with production from that sand during the time period between the acquisition of the two surveys (1987-1998) but the distribution of oil was not a gravity stable front.