Geological Interpretation of Mass-Transport Deposits in the Deepwater Gulf of Mexico: Integrating Borehole Geology, Borehole Geophysics, and Reservoir Engineering

Eric Zimmermann[1], Carlos Guzman[1], Mike Vercher[1], Stan Hewitt[1], Anish Kumar[2], Michael Mahnke[2], Vinay K. Mishra[2], Elizabeth Ruiz[2], and Nellyana Charmelo[2]

[1]LLOG Exploration, 1001 Ochsner Blvd., Ste. 200, Covington, Louisiana 70433

[2]Schlumberger Oilfield Services, 1325 S. Dairy Ashford Rd., Houston, Texas 77077

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ABSTRACT

The deepwater Gulf of Mexico is one of the most actively explored deepwater basins in the world, with hundreds of wells drilled to date. However, although much knowledge has been derived from extensive drilling experience, the Gulf's geology offers many surprises. In general, if the horizons of interest are not located subsalt, then seismic-derived attributes can provide a reasonable understanding of the subsurface geology. In practice, the deepwater Gulf of Mexico geology is sufficiently complex that technology such as borehole imaging, borehole seismic data, and pressure and fluid sampling need to be included in the well evaluation to complement the surface seismic interpretation. Incorrect subsurface interpretations impact the drilling and well placement decisions to result in additional well and facilities costs.

In an example from the Gulf of Mexico, the sub-seismic-scale geological interpretations from borehole image data and high-frequency vertical seismic profile (VSP) reflection data were integrated with state-of-the-art lower frequency surface seismic data. The dip and image data obtained from the borehole imager, VSP, and surface seismic appeared to be contradictory when individually considered; however, a careful evaluation of the data reconciled the differences and provided a more complete picture of the subsurface. The example demonstrates how the combination of these different borehole data types was able to identify cycles of high-energy mass-transport deposits followed by relatively lower energy phases of sand deposition.

The impact of geological deformation affects the geological interpretation and the connectivity and types of fluids present in the reservoir. Pressure and fluid analysis from formation testing data confirmed nonlinear relationships at different depths, which were analyzed for implications to the reservoir.

In the challenging geology of the deepwater Gulf of Mexico, geological analysis based on only one kind of data often leads to incomplete understanding of the reservoirs

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and that, in turn, can lead to ineffective field development plans. Integrating surface seismic, borehole seismic, borehole geology, and reservoir pressure and fluid data is essential for better understanding Gulf of Mexico deepwater reservoirs, especially in regions of complex geology.