

3D VSP Modeling of Complex Geological Structures in Gulf of Mexico

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It is critical important to accurately map subsurface structures in salt flank and sub-salt structures in the regions such as the Gulf of Mexico, North Sea, and West Africa, where important petroleum accumulations are often trapped in updip sands around salt domes and beneath salt bodies. However, the sides of a salt dome with irregularly shaped overhangs are hard to image with adequate accuracy by using surface seismic alone. Inadequate data results in interpretation difficulty with the sub-salt structures. Thus, 3D VSP surveys with receivers in wellbore are requested for additional, independent information.

In this paper, we used a 3D VSP modeling package VECON to model subsurface and sub-salt structures in a complex geological region. 3D VSP, walkaway, multioffset, rig source VSP, and salt proximity surveys were designed to best image updip sands between two deviated wells, steep salt-sediment boundary, and sub-salt structures. Information from surface seismic, well logs, and other available geological information were used to construct a 3D velocity model. A wavefront based ray tracing program was applied to generate synthetic seismograms. The synthetics were processed to image targets and help in processing the real data. An optimal VSP pre-survey modeling design was obtained by comparing image results from different VSP surveys. Post-survey modeling was carried out to match real data. This study demonstrates that 3D VSP modeling is a powerful tool for a successful VSP survey design.
