Converted Energy in Towed-Cable and OBC Data

Dimitri Bevc, 3DGeo Development Inc., Victor Pereyra, Weidlinger Associates, Alexander M. Popovici, and Sean Crawley , 3DGeo Development Inc.*

Converted-wave energy is significant in both standard towed-cable and ocean-bottom cable (OBC) acquisition geometries. We present a 2-D modeling study designed to investigate the use of converted-wave energy to image geological structure below high-velocity salt layers. Rock physics properties typical of Gulf of Mexico oil bearing environments were used to numerically generate synthetic data sets. The synthetic data sets were generated by elastic ray tracing, acoustic modeling, and elastic modeling. These modeling results were analyzed to determine the conditions under which significant amounts of energy are converted from P-wave propagation to S-wave propagation, and to gain an understanding of the nature of these conversions so that they can be used for optimal reservoir imaging and characterization. We investigated converted waves for both towed-cable and OBC acquisition. Substantial energy and information can be obtained from OBC data for reservoir characterization in difficult to image areas where the reservoir rocks may not have a good P-wave impedance contrast with surrounding host rock or when imaging is obscured by phenomena such as gas clouds.

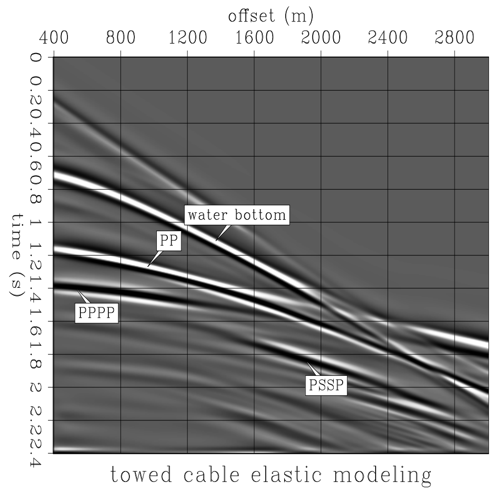

Figure 1: Elastic modeling results for marine towed-cable acquisition. To facilitate comparison, the P-wave leg in the water column has been eliminated from the conversion notation in the labels. The PSSP bottom-salt reflection is energetic and represents an important imaging target.

Figure 1. is an elastic modeling result obtained for a simple flat layered earth model. The headwave event seen splitting off from the PP reflection denotes the point at which the P-wave critical angle is reached for the top-salt reflector. At this point the PP reflection energy splits into a post-critical reflection and a headwave. The PPPP arrival energy begins to decrease significantly at the P-wave critical angle, while the PSSP arrival energy begins to increase. This verifies the rock physics prediction that the maximum P to S conversion begins at the P-wave critical angle.

The modeling study allowed us to corroborate the rock physics predictions based on the Zoeppritz equations, while migration of symmetric-mode converted-wave data illustrated the feasibility of converted-wave imaging. Modeling and migration results of increasing complexity will be discussed in the presentation.