ABSTRACT

In this paper, we present a 3D VSP forward modeling study using finite difference acoustic modeling to obtain high resolution images of thin channel Paleocene reservoirs underneath massively distorting thick karstified carbonate. Finite difference 3D VSP leverages the advanced techniques of surface seismic modeling to optimize subsurface images from the challenging complex geological structure. The 3D VSP image quality varies depending on receivers geometries (receiver spacing, array length and receiver depth along borehole).

A previous finite difference seismic model, which was based on the subsurface complexities over Wiriagar Deep field, was used to generate multiple 3D VSP synthetic seismic volumes. 3DVSPs were simulated from two pseudo wells based on deviated trajectories similar to current development wells being drilled in a nearby field. Well paths were designed along two different azimuths spaced to provide enough data coverage in the overlapping area such that the two VSPs could be merged onto one volume. A dense shot grid was centered over the well surface location. Synthetic shot gathers were extracted from FD model for multiple acquisition geometries (receiver length, depth location and array movements). The output data were 3D Pre Stack Depth Migrated volumes.

Data analysis indicated most of the significant geologic boundaries of Paleocene are easily visible on the 3D VSP volumes. The data quality also indicates some individual channel bodies within the Paleocene may also be resolved. Overall, the image quality of 3D VSP data provides better clarity of all geologic intervals and faults below the massive carbonates. Many of the same subsurface features are not imaged, or poorly imaged, in the previous surface seismic finite difference modeling. The most significant contribution to image quality came from receiver arrays located below thick karstified carbonate. Key learning with regards to receiver depth, array lengths, and receiver spacing will directly impact the cost and time optimization of possible future programs.

BACKGROUND

The seismic imaging challenges due to the complex subsurface in Wiriagar Deep field in Bintuni bay, Papua (Figure 1) made poor seismic data quality in reservoirs underneath massively thick and karstified carbonates. Seismic acquisition type ranges from shallow marine, transition zone, to land data, making seismic acquisition difficult and costly. Historically, conventional 3D seismic data weren’t designed for those complex subsurface structures and the high velocity contrasts of karsted and massive thick carbonate that cause significant wave distortion.

Previous Finite difference modeling of 3D surface seismic data (Supriyatna, et al., 2007) gave us more imaging information due to impact of key subsurface features. The synthetic depth model was extracted and used to simulate different acquisition geometries (narrow and wide azimuth). The image beneath the karsting features was significantly degraded on all surface seismic simulations. The theoretical limit of WAZ150 (Schurter, et al., 2007) demonstrated significant improvement in the seismic image compared to sparse and narrow azimuth acquisition geometries. However the best...