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Novel signal enhancement approaches and advanced seismc imaging as applied to a land 3D sesimc survey

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Abstract

Recent advances in understanding the physics of surface waves, coupled with innovative transform methods, can improve land seismic data quality sufficiently to justify the application of more advanced imaging algorithms. This paper presents the results of an effort to improve the imaging of an Oligo-Miocene isolated carbonate platform in a land seismic acquisition setting.

The modeling of Oligo-Miocence carbonate buildups in a land environment

Hydrocarbon exploration and exploitation of Oligo-Miocene isolated carbonate platforms represents an important source of hydrocarbon reserves in Southeast Asia. Interpretation of time-based seismic imaging products has been successful for numerous decades in the exploitation of clastic reservoirs in this region. Likewise, prestack depth imaging is utilized routinely for resolving the complexities of large-scale structures and overburden effects (such as gas clouds). For the Oligo-Miocene carbonate setting, the large velocity contrasts between carbonate and clastic sediments, coupled with the complex small-scale structuring at the top and within the carbonate complexes, requires a detailed depth imaging approach to prevent mapping erroneous structuring and internal features. Workflows required to achieve a successful result are often very different from that used for (marine) clastic depth imaging. Figure 1 is a simplified representation of a carbonate platform, with typical structuring and velocity features incorporated in the model. Figure 2 is an acoustic synthetic time section generated from the model. Note the complex pattern of diffractions and time dips. Figure 3a is a time migration of the synthetic section utilizing the (smoothed) full velocity field. Note the apparent "over" and "under" migration artifacts within and beneath the carbonate section. A common approach to overcome the inherent limitations of time imaging, is is to time migrate with a simplified and/or reduced velocity field. Figure 3b illustrates one such mitigation technique where the synthetic section was migrated with a "clastics only" velocity model. The resulting image does reduce the migration artifacts; however, the overall structure within and beneath the carbonate is still grossly incorrect. In addition, the flat event beneath the left hand carbonate flank has significant time discordance and has the appearance of a fault or structure at this level. Figure 4, a depth migration of the synthetic model,clearly shows a more accurate imaging result.

In the land environment, seismic imaging is often severely compromised by relatively poor sampling and the presence of increased noise levels compared to the marine environment. This can limit the potential benefit to be achieved from "advanced" imaging approaches. Figure 5 is a depth migration of the synthetic seismic section, but with representative levels of noise added to the synthetic prior to migration and desampled to a typical 25m CDP spacing. The degradation in the depth migrated result is obvious.