Wave Equation Prestack Depth Migration for Deep Gulf Coast Prospecting

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ABSTRACT

The shallow section in the Gulf Coast normally exhibits a simple, depth-variable velocity profile, which implies that prestack time migration (PSTM) methods generally suffice to produce a drillable image. In recent years, however, an exciting frontier has opened in the deep section, with high geopressure preserving reservoir prospectivity. Geopressure is a double-edged sword. In addition to being a drilling hazard, geopressured sediments often exhibit seismic velocities below the compaction trend. Complexity in the velocity field causes focusing effects in the propagated wave fields, and challenges all the assumptions behind PSTM. Even if a PSTM image contains a seismic reflection (not a given), the image time may no longer accurately represent the geology in depth.

For these reasons, prestack depth migration (PSDM) methods have been employed successfully for some time to image the deep section when pressure is an issue. Provided that the velocity complexity can be encoded into a migration velocity model, PSDM can provide a more accurate picture of the geologic structure, in situations like fault shadow.

Typically, Kirchhoff PSDM algorithms have been used in the Gulf Coast. When the velocity complexity is severe, such as under Gulf of Mexico salt, it is generally agreed that Wave Equation PSDM (WEM) algorithms produce superior imaging results. For deep Gulf Coast prospecting, the uplift from WEM over Kirchhoff might be more subtle, but the main difference is likely to be in the amplitudes. WEM algorithms can more naturally handle the amplitude variations due to velocity focusing effects. Because of this, there is a good reason to use WEM for amplitude-versus-angle (AVA) analysis, but until recently, it was not known how to efficiently decompose WEM images into angle "gathers."

We show how a quality shot record WEM algorithm, combined with a recently developed efficient angle decomposition scheme, can produce compelling results on deep Gulf Coast imaging examples.

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