Velocity Model Building in Shale Diapir Provinces: An Example from Tabasco, Southern Mexico

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Shale diapirism of Tertiary age in the “3D Gualas” area of Tabasco, southern Mexico, creates a complex velocity field that compromises seismic image quality above the Mesozoic carbonate reservoir of the Escuintle and Caparroso fields. To optimize the image, we evaluated the geology and incorporated the geometry of the diapirs in building a velocity-depth model, and employed prestack depth migration to produce the final 3D volume. This allowed the seismic interpreter to propose new well locations (Jaguar-1 y Escuintle-1001) and continue the development of this area.

The shallow-lying diapirs of Gualas do not have the density or velocity contrasts with their surrounding sediments necessary to form reflections. Growth faults, utilizing diapir flanks as decollement surfaces, bring faster velocity sediments into contact with the shale diapir, forming strong velocity inversions at the fault to create shadow zones beneath. In deeper areas these diapirs abruptly increase in velocity at their bases.

There is evidence that the diapiric shale has dewatered, consolidating as it compacted, further complicating the velocity field. Where the shale is undercompacted, the seismic facies is typically chaotic, but where compacted, internal reflectors are sub-parallel to the diapirs’ flanks. Hence, rather than build the model by flooding with constant velocity from a picked top diapir surface, we used a velocity scanning technique.

The Kirchhoff ray tracing migration scheme is typically challenged to image deep structure given the extreme ray bending associated with this complex geology. Therefore shot-based full-wave equation migration was employed to produce the final 3D depth volume.