A Modeling Study for Imaging in Structurally Complex Media: Case History

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Two dimensional finite difference seismic modeling of a complex geologic structure was used to aid in seismic interpretation and the optimization of future acquisition and processing parameters. The depth/velocity model was derived from a balanced geological section in North Eastern British Columbia foothill inferred from a 1998 2D-seismic line, acquired by Husky Energy Corporation, and 5 adjacent wells drilled from 1981 to 2003. The model contains a velocity inversion, rough topography and characteristic structures found in NE BC.

Both acoustic and elastic finite difference modeling techniques were used to simulate waves propagating in the complex medium and the most difficult structural styles to image were investigated. Eight locations in the model (see Figure 1) were studied, using single event Prestack Kirchhoff migration for both first arrival and maximum energy event criteria. The synthetic shot gathers were prestack depth migrated to investigate which migration algorithms would produce the best images in such a complex environments.

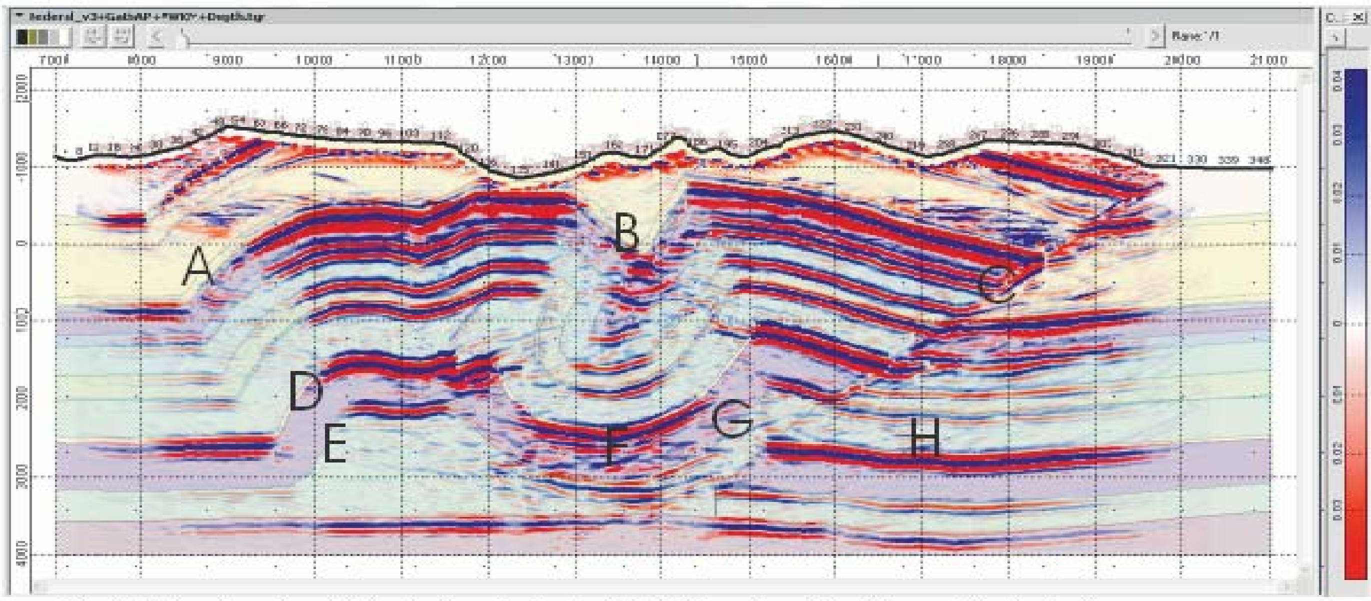

Figure 1. Colored-overlay plot of velocity model on the PreSDM section, model size = 29 x 6 km, letters corresponds to eight locations analyzed in this study.

Long offsets gave a better migrated image when the complexities of the near surface geology were minimal. When the near surface geology becomes more complex, the value of the long offset information in enhancing the image was more limited. Additionally, fine source & geophone spacing gave a some what better image, but reasonable images could still be obtained providing the spatial sampling was adequate and the known velocity/depth model was used for the migration.

The synthetic model contains three noteworthy geological features: a box-fold on the west separated from a fault propagation fold on the east by a central syncline. To test if expanding the aperture could aid in imaging steep dips in the presence of the inverted velocity profile, the model was expanded a few kilometers to the west (See Figure 2). Imaging the more complex geology in the central part of the model, has to date only been successful in imaging geological dips of less than 30º.

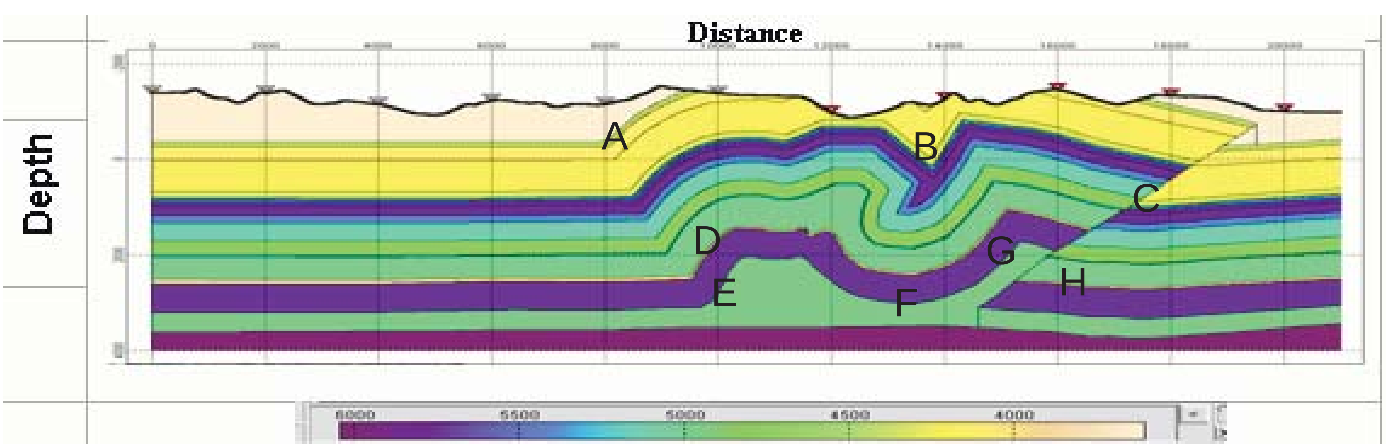

Figure 2. LithoTech Balanced Geologic/velocity Model of northeastern British Columbia created from the seismic line H98-154, using the velocities from five wells on or near the line which is expanded to the east and the structural complexity was removed on the west to help in imaging.

The imaging potential of prestack depth Kirchhoff migration using maximum energy or maximum energy event criteria can be predicted. Inadequate aperture or spatial sampling will distort the point diffractors on a depth section. We will demonstrate the effectiveness of prestack depth Kirchhoff migration using first arrival and maximum energy traveltime in processing the Husky line.

References

Nichols D.E., 1996, Maximum energy traveltimes calculated in the seismic frequency band: Geophysics, **61**, 253-263.