

GEOPHYSICALcorner

Going Super-Deep With P-P, P-SV Data

(The Geophysical Corner is a regular column in the EXPLORER, edited by Bob A. Hardage, senior research scientist at the Bureau of Economic Geology, the University of Texas at Austin. This month's column deals with imaging super-deep targets with P-P and P-SV seismic data.)

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The April 2006 Geophysical Corner described the value of 4-component ocean-bottom-cable (4-C OBC) seismic technology for acquiring long-offset seismic data across congested production areas.

Since that story was told, however, there has been increasing interest in acquiring long-offset data along the northern shelf of the Gulf of Mexico (GOM), because operators want to locate super-deep gas prospects beneath the numerous production facilities that are already in place across this offshore trend.

We use the term "super deep" here to describe drilling targets that are at depths of nine to 10 kilometers (30,000-33,000 feet). To create optimal images of geology at these depths, seismic data need to be acquired with source-to-receiver offsets that extend to nine to 10 kilometers.

Such long-offset data are difficult (impossible?) to record with towed-cable technology, where there are closely spaced production facilities that limit the movement and use of long cables.

In contrast, long-offset data are relatively easy to record across congested areas when receivers are stationary on the seafloor, as they are in a 4-C OBC deployment.

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We now extend the story that was started in April 2006 to show the maximum depths to which P-P and P-SV modes can image when 4-C OBC data are acquired with 10-kilometer offsets.

In this investigation, interpreters examined 5,900 kilometers (about 3,700 miles) of long-offset OBC profiles across the West Cameron South, East Cameron South and Vermilion South areas of the Gulf of Mexico (figure 1). These interpreters looked at each profile as a team, and after some debate, agreed where to position a horizon on the P-P image and a companion horizon on the P-SV image that defined the deepest interpretable data on each seismic line.

These interpreted horizons should not be confused with structural horizons because each horizon crosses

(Editor's note: If you thought figure 3 in the December Geophysical Corner ("Curvature Can Be a Map to Clarity") was confusing, you are correct. Blame it on the PowerPoint program, which inexplicably rotated and flopped the time slices in figures a and b and flopped the seismic data in figure c – but not the line B-B' or the arrows! The correct figure 3 is at the right. The figure on the AAPG Web site archive also has been amended to render the images properly.)

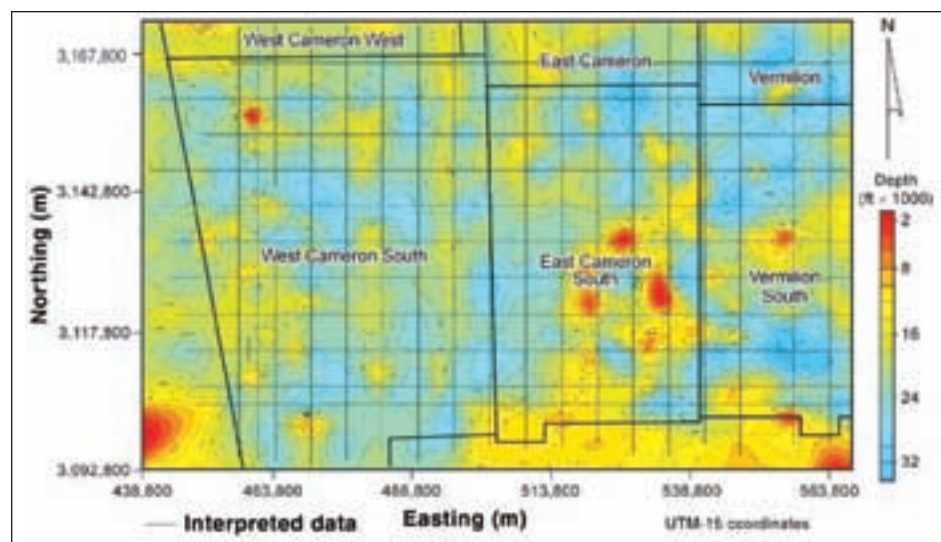
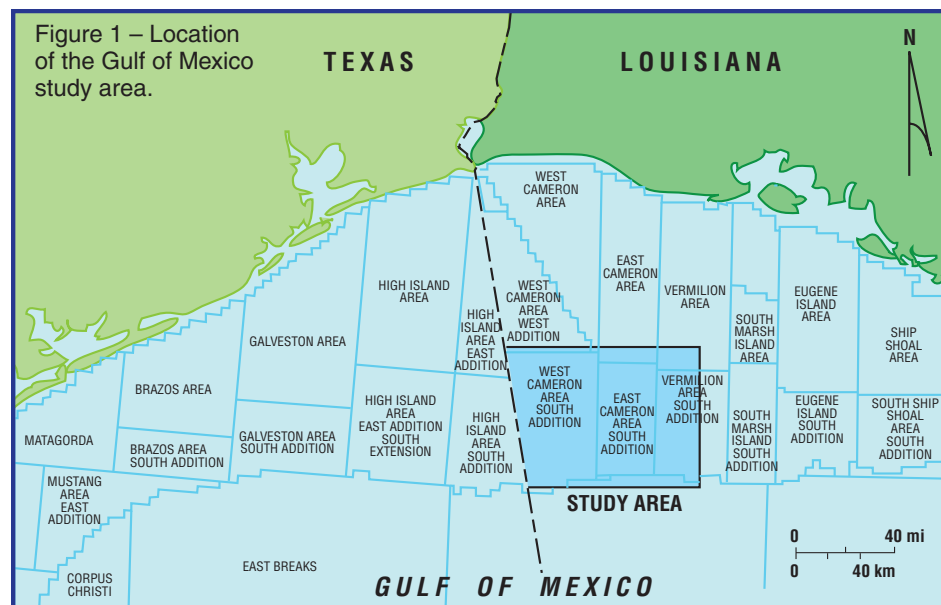


Figure 2 – Base of continuous P-P reflections across the study area. This depth-based map is not a structure map. The mapped surface crosses numerous geologic time boundaries. The map indicates only maximum depths to which continuous, good-quality P-P reflections exist when 4-C OBC data are acquired with 10-kilometer offsets.

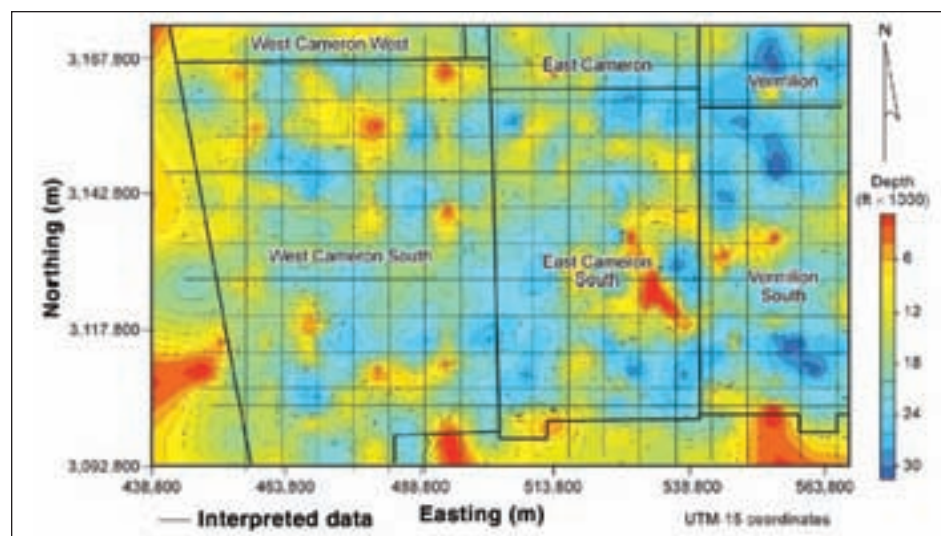


Figure 3 – Base of continuous P-SV reflections across the study area. This depth-based map is not a structure map. The mapped surface crosses numerous geologic time boundaries. The map indicates only maximum depths to which continuous, good-quality P-SV reflections exist when 4-C OBC data are acquired with 10-kilometer offsets.

geologic time lines. The only objective was to define a horizon that marked the depth at which there was a loss of usable reflection signal for the P-P and P-SV modes, without any regard as to where that horizon was positioned in the stratigraphic column.

The P-SV data that were interpreted were first time-warped to convert P-SV image time to P-P image time. The interpretation team concluded that across most of the study area, this time warping was reasonably accurate and caused geology shown by the P-SV data to be positioned within ± 100 ms of where the same depth window was positioned in P-P image space – a rather good first-order depth registration of P-P and P-SV data.

Once a horizon of deepest usable reflection signal was interpreted along each profile, time-based P-P and P-SV maps of these horizons were made and these maps were then converted to depth maps using seismic-derived P-P velocities.

The resulting depth maps are shown as figures 2 and 3, and the grid of OBC profiles that were interpreted is superimposed on each map.

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Comparing the maps of figures 2 and 3 confirms that, in a general sense, P-P and P-SV data image GOM geology to equivalent depths, at least across this particular area.

This statement is only a big-picture view of the maps. Locally there are places where there are differences in the depths to which each mode produces continuous reflection events.

The basic message provided by these depth maps is critical information for explorationists operating in the GOM – namely, long-offset 4-C OBC data can provide good-quality P-P and P-SV reflection images of geology to depths of nine kilometers (30,000 feet).

The fact that good-quality P-P reflections extend down to nine kilometers when 10-kilometer offset data are acquired is not surprising; the fact that equivalent-quality P-SV reflections are obtained for these same target depths is new and important information that should be factored into super-deep prospect plays. □

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(Editor's note: Bob Hardage, Michael DeAngelo and Randy Remington are with the Bureau of Economic Geology, Austin, Texas.)

