Morrow Fluvial-Sandstone Discoveries in a Densely Drilled Area of Southwest Kansas: Successful Integration of Geology with 3-D Seismic

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Commercial gas production is being developed from basal Pennsylvanian Morrow fluvial sandstones in a relatively densely drilled area of southwestern Kansas with help from 3-D seismic. Although 3-D seismic was essential to the success of the recent drilling program, the 3-D data alone were not definitive. Had drilling been based solely on 3-D seismic maps and displays without integration of geology from cores and wireline logs, the program might have been terminated with one producer and two dry holes. The key to success was integration of 3-D seismic with a geological understanding of fluvial sandstone depositional processes. Additional success came from integration of older 2-D seismic data. This complete integration of data resulted in the drilling of six successful wells proximal to older dry holes which encountered porous, non-productive fluvial sandstones.

The 25-foot-thick fluvial sandstones are too thin to be resolved seismically, but edges of the fluvial valley can be delineated by 3-D seismic isopach mapping. Basal Morrow valleys in southwestern Kansas formed through a combination of subsidence and fluvial incision. 3-D seismic isopach maps clearly define valley segments created largely by localized subsidence with minimal amounts of fluvial incision. Subsidence occurred in earliest Pennsylvanian time and was caused by dissolution of anhydrite in the lower St. Louis formation some 300 feet beneath the basal Pennsylvanian depositional surface. Valley segments connecting downwarped stretches formed primarily by fluvial incision and are less well defined seismically. Our drilling program was confined to a downwarped portion of the valley, and drilling success in penetrating the valley is 90 percent.

A second key element to success was the 3-D structural picture obtained within the valley. However, neither the top nor base of the target sandstones provide seismic reflections, and complications arose from the occurrence of sandstones at various stratigraphic levels, reflecting successive episodes of fluvial incision and deposition within the overall downwarped portion of the valley. Deciphering the sequence of incision and depositional events, including backfilling of the valley with estuarine sediments, was critical to success. This was accomplished by determining the top and bottom of the valley in all valley wells and then mapping the total thickness of the valley fill. Two dry holes, in which the basal Morrow interval was cored, revealed a deep, young, incised channel filled with estuarine sandstone and a thick section of estuarine shale. Recognition that this deep, young channel is a significant component of the trap for gas in older, stratigraphically higher, fluvial sandstones is a major factor in our success. Drilling success in finding commercial gas production using 3-D seismic integrated with geology is 55 percent compared to eight percent without 3-D seismic in the same area 30 years ago.

Biographical Sketch

Charlie Bartberger is a geologist with Amoco Corporation's Mid-Continent Business Unit in Denver, Colorado. He received his B.A. in Geology from Lafayette College and his M.S. and Ph.D. in geology from Syracuse University. Upon graduation in 1976, Charlie joined Shell Oil Company in New Orleans where he worked the Woodbine and Smackover trends in the Gulf Coast until 1980. For the past 16 years, Charlie has been with Amoco in Denver where he has explored for oil and gas in the Williston Basin, Wyoming Overthrust Belt, Alaskan North Slope and Beaufort Sea, and the Hugoton Embayment of southwestern Kansas. ■