SIPES Luncheon Meeting

Developing an Exploration Tool in a Mature Trend: a 3-D AVO Case Study in South Texas

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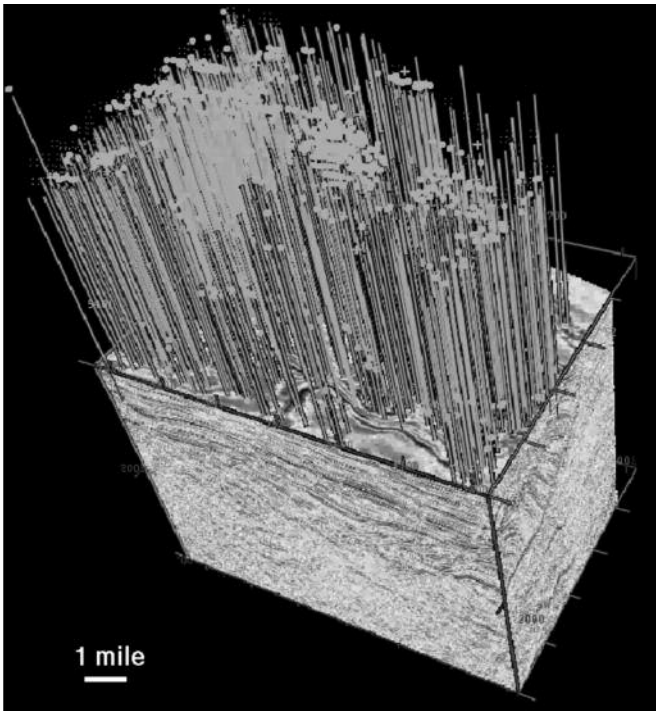

Figure 1. A 100-mile2 portion of the Vicksburg Trend, drilled with a density of up to 20 wells per square mile.

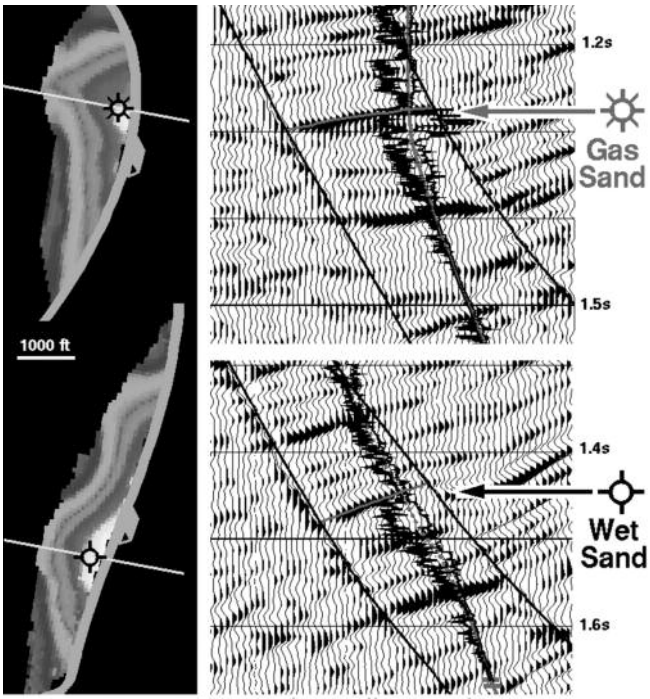

Figure 2. Two geologically similar prospects resulted in a gas discovery and a dry hole. Structure maps and conventional migrated sections are shown.

If at first you don't succeed, try something unconventional. Successful exploration for new reservoirs in mature trends often requires trying techniques unproven in the area. The mature Oligocene Vicksburg play in south Texas has been heavily explored since the 1920s (Figure 1) using subsurface geology and structural mapping based on conventional seismic data. There is a scarcity of direct hydrocarbon indicators such as bright spots that have been key to much of the success in other Tertiary formations in the region. Our initial exploration campaign with conventional 3D seismic was disappointing. However, attention to rock properties coupled with application of a novel processing technique allowed us to develop a solution to our dilemma.

In the 1990s a large nonexclusive 3-D seismic survey which was acquired in the area led to increased exploratory activity. The prime motive for the 3-D was to image the complex faulting and resulting compartmentalization of the Vicksburg. Given the mature nature of the area, typical exploration targets are moderate-potential fault blocks in productive intervals and higher-potential targets in deeper, untested section.

Edge Petroleum and Carrizo Oil and Gas licensed a 450-mile^2 portion of the 3-D survey. Early work led to the identification an drilling of several Vicksburg structural traps, resulting in one commercial gas discovery, one noncommercial discovery, and three dry holes. Given the moderate potential of the prospects, a 20% success ratio meant the economics of our exploration program were marginal. Hence, we were prompted to search for an exploration tool that would help us to improve our success rate.

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Two prospects drilled a few miles apart in our initial exploration campaign targeted Vicksburg sandstones at 5500-7500 ft. Our technical evaluation showed them to have analogous stratigraphy, structure, timing of trap formation, and proximity to source. Neither exhibited anomalous seismic amplitude. Drilling found the predicted reservoir facies in both. However, one was a commercial gas discovery and the other a dry hole (Figure 2). Perplexed and challenged by these results, we selected these two prospects as our laboratory for developing a better risk-assessment technique.

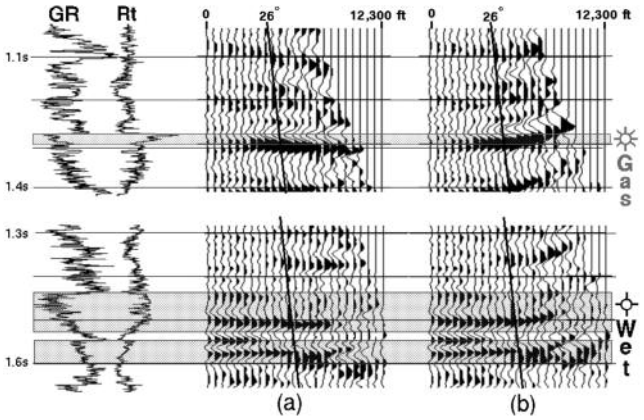

Figure 3. Reprocessed CDP gathers at the two test wells with (a) nonhyperbolic moveout and (b) conventional normal moveout reveal a Class 2 AVO anomaly at the gas reservoir. The best-developed part of the anomaly would be muted on a stack processed with conventional normal moveout.

Seismic models were generated using dipole sonic data gathered in the discovery well. The models suggested that Class 2 AVO anomalies would be associated with Vicksburg gas reservoirs. A pilot reprocessing study demonstrated that known gas reservoirs generate Class 2 AVO anomalies and that seismic incident angles greater than about 26 degrees are required to observe them. It was observed that the application of conventional normal moveout resulted in improper imaging of the far offsets needed to discern the Class 2 anomaly. However, reprocessing the data utilizing nonhyperbolic moveout produced usable data at incident angles of up to 40 degrees, resulting in proper stacking of the needed far offsets (Figure 3).

Resulting angle stacks were visualized on a workstation. Several untested AVO anomalies were identified, including stratigraphic traps. Wildcat drilling based on this effort resulted in six commercial discoveries and two dry holes, a success rate significantly higher than was achieved through conventional subsurface geology and structural mapping in this mature play. ■

Biographical Sketch

Mark Gregg is President and CEO of KiwiEnergy, Ltd., an independent E&P company based in Houston. He began his career in 1981 with The Superior Oil Company, followed by Mobil Oil and Edge Petroleum, primarily in exploration roles, including several years in both Indonesia and Nigeria, before founding KiwiEnergy in 2000. Mr. Gregg has over 28 years of exploration experience and is responsible for numerous discoveries along the Gulf Coast and in Nigeria. He received his B.Sc., Geophysical Engineering (1980) from the Colorado School of Mines and MBA (1988) from the Bauer College of Business, University of Houston. He is a Director of the Society of Exploration Geophysicists Foundation, an officer of the Houston Chapter of the Society of Independent Professional Earth Scientists, and a member of SEG, AAPG, Houston Producers Forum, and IPAA.