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"How seismic expression of eolian sandstone "build-and-fill" deposition stimulates the search for new reserves in the Minnelusa oil play, Powder River Basin, Wyoming"

Abstract

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Introduction

The Minnelusa eolian sandstone oil play in the Powder River Basin, Wyoming is a mature play which has produced over 500 MMBO. The depositional sequence of alternating porous eolian sandstones and intervening evaporites, dolomites, and carbonates provides a strong acoustic impedance contrast that allows porous sandstones to be readily mappable. Minnelusa hydrocarbon traps are primarily stratigraphic.

Early seismic exploration for Minnelusa fields relied on identification of high amplitude negative impedance integrated with existing well control. In this early stage of exploration many high amplitude anomalies were drilled based upon 2D seismic data often without the benefit of a clear understanding of the regional and sub-regional sandstone depositional trends. The small footprint (1-3 mi2) of many early 3D seismic surveys focused on imaging the distribution of the productive or prospective sand body. However, the small 3D survey size did not allow an adequate aperture to place the targeted sand in context with adjacent Minnelusa eolian sandstones or the erosional trapping facies.

3D seismic surveys targeting Minnelusa oil accumulations have grown larger in size, and these larger surveys facilitate a more robust mapping of the potential eolian reservoirs and trapping configuration. Yet, for a 3D survey that is located in an area of sparse well control, a keen understanding of the Minnelusa depositional seismic response greatly improves the chance of economic success.

Build-and-Fill Depositional Model

Fryberger & Hern (2014) proposed the terminology "build-and-fill" to describe a geometric approach to the analysis of global eolian hydrocarbon reservoirs. Minnelusa eolian sandstone deposition may be characterized by this build-and-fill model whereby younger dune complexes are often deposited on the flanks of the underlying sandstones. Seismic data may image these offset dune complexes depending upon formation thickness and seismic frequency spectrum bandwidth.

Seismic Field Acquisition and Processing

In order to seismically detect lateral changes that reflect stacked eolian sandstones of differing ages, seismic acquisition and processing must be optimized to provide a broad bandwidth seismic dataset. Detecting lateral formation changes with broadband data is a key to properly identifying productive and potentially productive sandstones.

Conclusion

Integrating a build-and-fill geologic model into the seismic interpretation not only (1) reduces the risk of drilling an unproductive dune complex, but (2) provides opportunities for new discoveries in adjacent eolian sandstones, whether they be older or younger.

References

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<u>Our Presenter</u>

John Frederick

Active exploration and development of Permian Minnelusa eolian sandstone reservoirs since the late 1970's initiated the quest to seek out how best to optimize seismic acquisition

techniques, seismic data processing parameters, and integrated geological and geophysical interpretive and visualization techniques to increase successful efforts in locating and developing reserves.

After receiving a Bachelors Degree in Physics from Colorado College, John joined Western Geophysical conducting seismic field acquisition operations and seismic data processing. He later joined McAdams, Roux and Associates in Denver as an exploration geophysicist focused primarily in the Paradox and Powder River Basins. After exploration management roles at Ampolex USA, Inc. and Westech Energy Corp John founded Red Leaf Energy in 2005 to provide geophysical consulting services to the oil and gas industry.

In addition to exploration and development projects in Wyoming's Powder River Basin, John's journey as a geophysicist has included most Rocky Mountain Basins, Kansas, onshore Gulf Coast Texas, South America, Australia, and New Zealand.