Wednesday, January 28, 2009

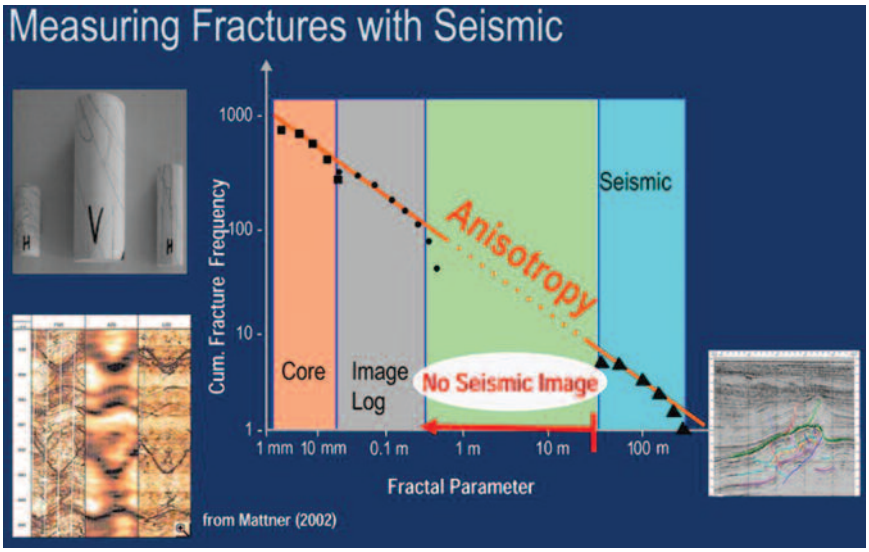
Petroleum Club • 800 Bell (downtown)
Social 11:15 AM, Luncheon 11:30 AM

Cost: $30 pre-registered members; $35 for non-members & walk-ups; Emeritus/Life/Honorary: $15; Students: FREE

To guarantee a seat, you must pre-register on the HGS website (www.hgs.org) and pre-pay with a credit card.
Pre-registration without payment will not be accepted.
You may still walk up and pay at the door, if extra seats are available.

David Paddock*, Christian Stolte, Lei Zhang, Javaid Durrani
Schlumberger Data & Consulting Services, Houston
John Young
WesternGeco, Denver
Thomas Hay
Schlumberger Data & Consulting Services, Denver

Seismic Reservoir Characterization of a Gas Shale Utilizing Azimuthal Data Processing, Pre-Stack Seismic Inversion and Ant Tracking



Prospective hydrocarbon-bearing zones in gas shales are characterized by primary gas storage entrapped in the sediment matrix with some additional gas in the open fractures. This gas is economically recovered by horizontal drilling and fracturing. Mineralization of faults is a reservoir risk. Faults also represent significant completion risk, as fracture completion jobs often are "captured" by nearby faults.

A wide azimuth 3D survey was acquired of the studied shale to highlight areas exhibiting seismic velocity anisotropy for detection of open fractures. Simultaneous prestack inversion of the seismic data to Poisson's ratio targets matrix-stored gas. Seismic processing for the detection of horizontal anisotropy targets the gas stored in fractures. Reservoir risk related to fault mineralization is addressed through a detailed imaging of the fault planes and the detection of anomalously low anisotropy along and adjacent to faults.

Integration of anisotropic data processing with pre-stack seismic inversion and Ant Tracking provides a superior tool to explore for gas in gas shale.

Prospective zones for gas production are identified by areas of anomalously low Poisson's ratio away from faults, with (in this particular shale) high velocity anisotropy. This study documents the results of an integrated workflow of data processing, pre-stack seismic inversion and Ant Tracking to successfully characterize faults and fractures and to identify sweet spots in the gas shale.

During data processing, azimuthal anisotropy analysis was conducted to determine the dominant direction of Vfast and Vslow. In general, there is good agreement between the azimuthal seismic data processing velocity analysis and Ant Tracking results.

Simultaneous amplitude versus offset (AVO) inversion was done on prestack data to invert for acoustic impedance (AI) and Poisson's ratio. Areas of low Poisson's ratio away from faults are thought to be promising hydrocarbon leads or prospects.

Delineation of Matrix Storage of Gas

Simultaneous prestack inversion of the seismic data for Poisson's ratio proved to be effective in delineating areas of low Poisson's ratio that are thought to indicate the primary, more siliceous, relatively more porous, gas-charged sweet spots.

Because the studied gas shale is thought to produce primarily from the sediment matrix **HGS General Luncheon** *continued on page 37*

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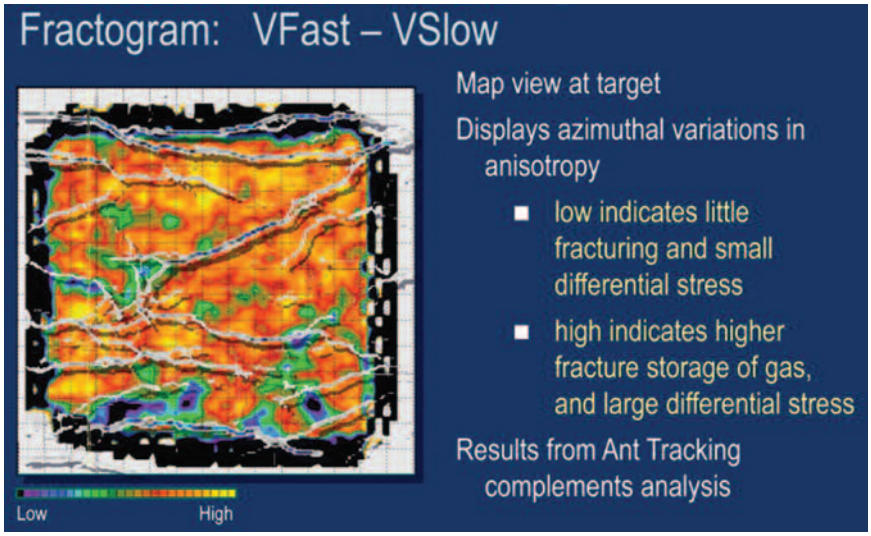
rather than open fractures, the inversion was run on a full-azimuth basis. In a shale where open fractures are more important, we would recommend running the inversion twice, once on the fast-direction data (as determined by the azimuthal anisotropic data processing) and separately on the slow-direction data. The fastdirection would give a good measure of the matrix-only effects of lithology, porosity, and charge. The slow direction would provide, by comparison, a measure of the effects of gas-charged open fractures.



Delineation of Gas-Charged Open Fractures

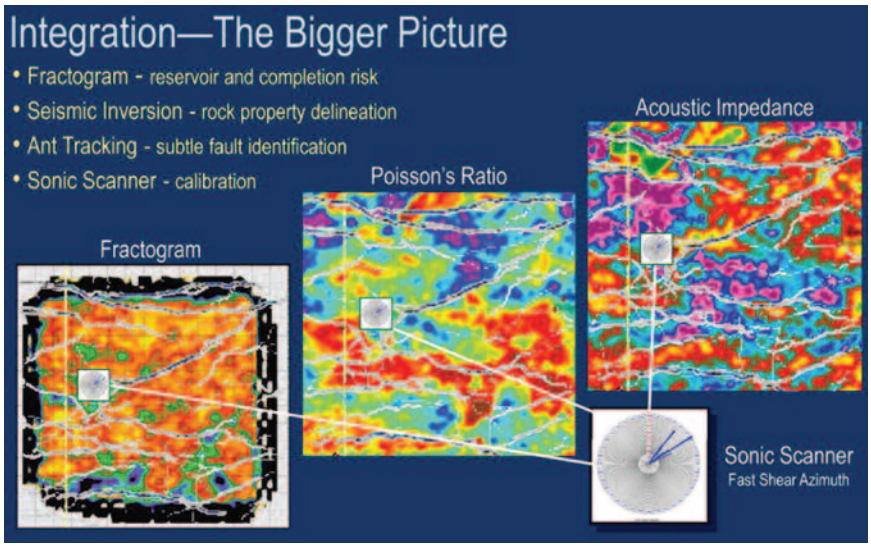
Azimuthal velocity analysis for anisotropy was used to delineate areas of open fracturing and stored stress. Comparisons of well productivity with rock physics seismic attributes have revealed that wells drilled into areas of high anisotropy in this particular shale have anomalously long-lived production, presumably from more effective fracture completions.

Detailed Imaging of Faulting

Ant Tracking reduces the risk of drilling near faults (a reservoir risk due to expected mineralization) by providing a high resolution image of fractures and faults beyond what can be interpreted from conventional seismic data. Faults were expected to be mineralized, with some mineralization extending out into the surrounding shales. **HGS General Luncheon** *continued on page 39*

HGS General Luncheon continued from page 37

Integration with the anisotropic analysis confirmed this for most faults. Some faults, however, lacked the diagnostic low anisotropy expected with mineralization.



Conclusions

Integration of anisotropic data processing with pre-stack seismic inversion and Ant Tracking provides a superior tool to explore for gas in gas shale. The integration of Poisson's ratio, fractogram, azimuthal anisotropic analysis, and Ant Tracking from surface seismic data provides actionable information for leasing and well placement, including the delineation of areas with enhanced porosity and charge, areas with open fractures, and areas with faulting, revealing likely sweet spots as well as areas to be avoided in drilling. ■

Biographical Sketch

David Paddock is Reservoir Characterization Team Leader and Principal Geophysicist for Schlumberger DCS Reservoir Seismic Services for the United States. Since September 2000, Mr. Paddock has been with Schlumberger Data & Consulting Services leading a wide range projects, but with a special emphasis on the onshore United States. Prior to Schlumberger, he was a geophysicist at ARCO and Vastar for 18 years, working in the greater Gulf of Mexico and Permian basins.