Tuesday, February 15, 2005

The Sofitel Hotel • 425 Sam Houston Pkwy. North
Social 11:30 a.m., Lunch 11:45 a.m.

Cost: $30 Preregistered members; $35 Nonmembers & Walk-ups

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by ***Kevin B. Hill***
Hill Geophysical Consulting
Shreveport, LA

Grayson Field Jurassic Smackover Reservoir: A Case Study Using Leading-Edge Reservoir Characterization Seismic Processing of 3D Seismic Data

The discovery well at Grayson Field was drilled on a four-way dip closure defined by three 2D seismic lines. Investors were hoping to find a maximum of 20 feet of pay. After the discovery of 158 feet of pay at 8000 feet measured depth in the Jurassic Smackover limestone in January 1993, the participants decided that a 3D seismic program was needed. The objective of the 3D seismic program was to define the structural and stratigraphic limits of the new field.

The Grayson Field Smackover reservoir is a low-velocity zone encased wtihin high-velocity rocks. This is a classic Type III AVO case.

Specific processing and interpretive tools will be illustrated in this presentation with many different seismic displays. Evidence will be presented that 1) relative amplitude of the Smackover reflector does not define the reservoir's stratigraphic parameters, 2) attributes of the acoustic impedance data (inversion) show good statistical correlation to key reservoir parameters, 3) A.V.O. shows a hydrocarbon indicator over the reservoir and 4) reservoir characterization data (petrophysical volumes generated with Hampson-Russell Emerge software) generated with the 3D seismic data delineate the production.

In July 1995 gas injection was begun in the field. In February 1998 a water flood program replaced the gas injection. In-fill drilling and 3D seismic data was needed to optimize the production. The resolution of the reservoir was not really clear enough on the original processing. Seismic data was reprocessed with "state-of-the-art" parameters such as detailed editing of each shot record, pre-stack time migration, and post-stack inversion (acoustic impedance), and A.V.O. and petrophysical volumes.

Tuning thickness of the wavelet at the Smackover level is 9 milliseconds (approximately 54 feet). Identification of the upper and lower pay intervals is very difficult because the upper zone is thinner than tuning. The two pay zones appear to merge into one thick, high-amplitude seismic event.

Sonic and density logs from the wells were used to calibrate and generate an acoustic impedance data volume. This multi-linear regression technique yields a data volume that better defines the two layers within the reservoir. The acoustic impedance (velocity) of the upper 100 feet of the Smackover was evaluated with different attributes to see if there was a correlation to the overall reservoir. Cross-plots of certain seismic attributes exhibit a good statistical fit with the reservoir's porosity and pore-volume maps generated from well information.

The Grayson Field Smackover reservoir is a low-velocity zone encased within high velocity rocks. This is a classic Type III AVO case. A positive AVO P*G (primary times gradient) response is seen at the producing wells, while no AVO P*G response is observed in the non-producing areas.

The difficulty of identifying the thin upper pay interval was overcome by making deep induction, and gas effect "seismic" volumes that could be used in conjunction with the relative amplitude, AVO, and acoustic impedance volumes.

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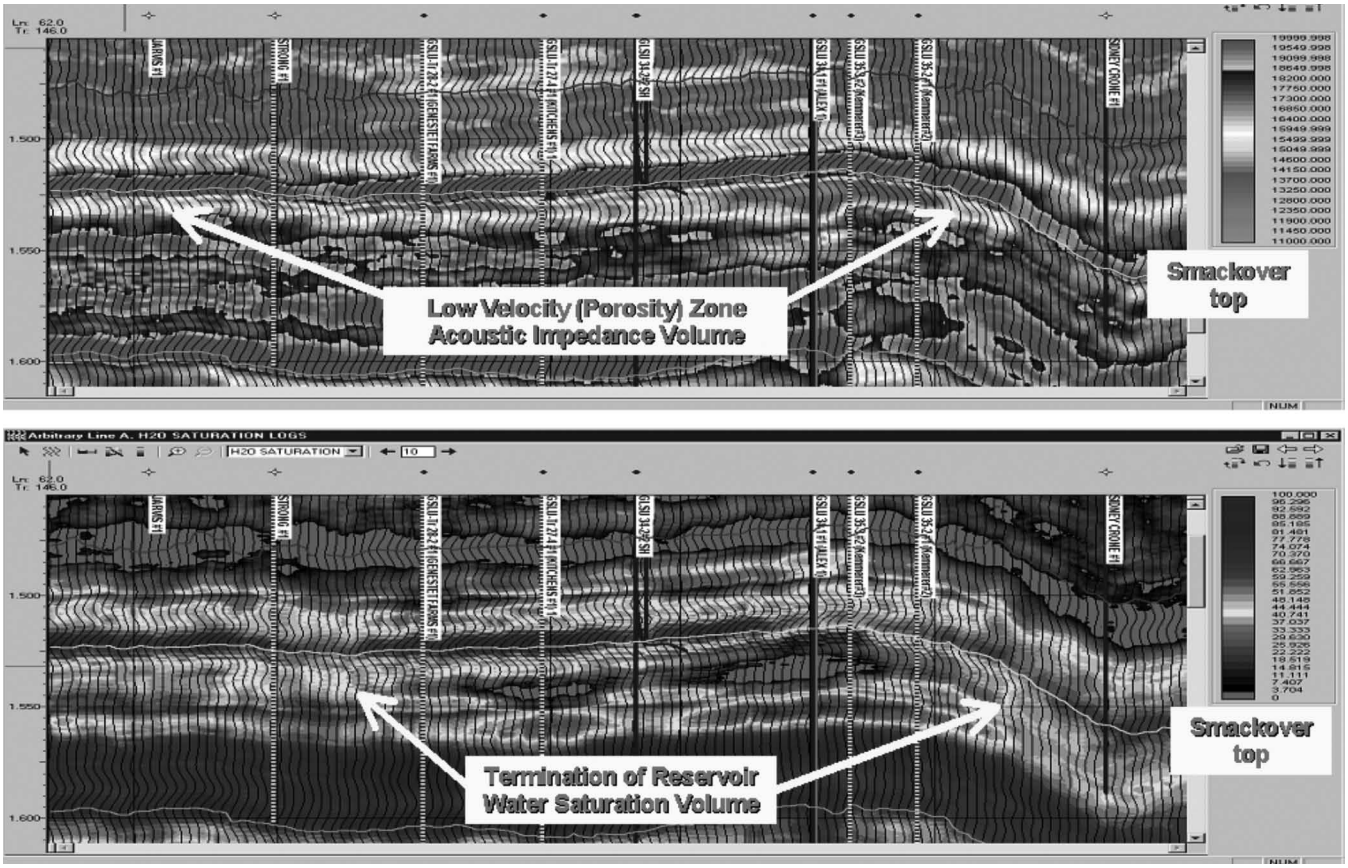

Grayson Field seismic lines showing response to petrophysical rock properties.

Conclusion

3D seismic data was a significant asset in the development of Grayson field. The 3D seismic data allowed Petro-Chem Operating Company to drill the best structural locations within the field. Reprocessing the 3D seismic data brought out the stratigraphic nuances of the field. The relative amplitude strength of the top Smackover reflector does not define any reservoir parameters. The acoustic impedance data volume shows a good statistical correlation to the gross reservoir parameters of the upper 100 feet of the Smackover. Multi-attribute inversion using an artificial neural network algorithm (Emerge) successfully computed the deep induction, density porosity and neutron porosity volumes. "Seismic" volumes of gas effect, water saturation, and hydrocarbon saturation clearly delineate the reservoir. New wells drilled using these 3D seismic volumes greatly increased the production rate and ultimate recoverable reserves in the field. Recent drilling proves that the 3D seismic effort and expense was well worth the money. ■

Biographical Sketch

Kevin B. Hill is a geophysical consultant with more than 26 years of broad Gulf Coast and international experience in exploration and production geophysics and geology. He is president of Hill Geophysical Consulting in Shreveport, Louisiana.

Hill received a BS-Professional Degree in geology in 1977 from Louisiana State University, Baton Rouge, LA, where he was president of Sigma Gamma Epsilon, and received the H.V. Howe award for outstanding geology graduate. Prior to becoming a consultant in 1987, he worked as Senior Exploration Geophysicist for Sonat Exploration in Shreveport, LA; Regional Exploration Geophysicist for Forest Oil Corporation in Lafayette, LA, and Jackson MS; and Senior Geophysicist for Cities Service, Company in Tulsa, OK, and Jackson, MS.

Mr. Hill is a member of the Society of Exploration Geophysicists, American Association of Petroleum Geologists, and Shreveport Geological Society and is a Grand Sénéchal in the Confrerie des Chevaliers du Tastevin, France.