AAPG EXPLORER

Maybe It's In the 'Process'

Teams Need To Be on Same Page

The emerging technique of seismic petrophysics will be included at least twice at the AAPG annual meeting in Houston, slated March 10-13 at the George R. Brown Convention Center.

Roger Young and Gordon Van Swearingen, both with eSeis, will lead a pre-meeting short course, sponsored by the Houston Geological Society, titled "Rock-Based Integration: Geologic Interpretation of the Integration of Seismic and Petrophysical Data," at 8:30 a.m. Saturday, March 9.

Van Swearingen also will present a paper, "Interpreting Complex Traps From Seismic Outcrops," at 4 p.m. Tuesday, March 12.

By LOUISE S. DURHAM
EXPLORER Correspondent

Oil and gas asset teams are very much in vogue these days.

The upside: Interdisciplinary team members contribute their individual expertise, interacting for the common goal of finding and producing hydrocarbons.

The downside: How do you communicate when each discipline has its own unique language?

Drillers talk about penetration rates, pore pressures, compressive strength and such. Geologists talk about matrix, lithology and porosity, while their geophysical counterparts speak in such esoteric terms as impedance and velocity.

"This is a big problem with asset teams," said Roger Young, chief technology officer at Houston-based eSeis Inc., "where they all want to understand the rocks, but they have no common way to communicate.

"If you look at an outcrop, you don't see impedances, you see lithology."

To cut to the chase and get all team members onto the same page, Young preaches the theme of seismic petrophysics, or rock-based integration. Unlike many of today's statistically based inversion programs, seismic petrophysics takes the concepts of well log analysis – where the available data are cross-plotted to yield information about reservoir lithology, porosity and fluids – and applies them to seismic data.

"People take well logs to the rocks using log analysis," he said, "and we're doing this with seismic, which is the most spatial data. The seismic becomes lithology, porosity and fluid, so now we're all talking the same thing."

Young pioneered development of the "LithSeis" processing technique in the early 1990s while at Union Texas Petroleum Holdings (UTP), where he noted the process played a role in the discovery of the Alpine Field on Alaska's North Slope.

The Canadian-based company retained by UTP to write the computer code and develop the software for the technique was purchased by eSeis early last year.

'A Quicker Look'

This approach to hydrocarbon detection can be used with both 2-D and 3-D seismic data. Using amplitude variation with offset (AVO) analysis – looking at the seismic data before the individual traces are averaged, or stacked – shear and compressive impedances are extracted from the seismic data. The shear wave data can be inferred without being acquired via multicomponent acquisition technology.

The information from the compressional and shear waves is cross-plotted and color coded using LithSeis, indicating formation lithology, relative porosities and fluid content, noted eSeis president Dan Morris.

He cautions this is not a standalone tool, noting the end result must undergo geologic scrutiny to determine if it is plausible in the particular geologic setting.

"It is a good device for studying AVO and extracting interpretable information," said University of Cape Town senior lecturer in applied geophysics George Smith. Author of numerous published technical papers on AVO and inversion, Smith said he has kept a close eye on the technique since he was first introduced to it about five years ago. He noted that some promising tools have been added to its basic toolbox, such as the approach to moveout velocity extraction and absorption

Morris emphasized the technique reduces turnaround time dramatically, enabling asset team members to work through an entire 3-D data set in a day and come up with multiple leads.

Ron Neal, president of Houston Energy and Development (HED) and an AAPG member, concurs.

"It does offer a quicker look," he said. "LithSeis begins with AVO, and if you have a line or volume of AVO, then the tool is not only relatively quick but also relatively inexpensive."

If a company has no AVO, the eSeis team reprocesses the available data for AVO analysis and then takes it to LithSeis.

"This makes the assumption the processing gives reliable AVO," Neal cautioned.

Although it will be about 90 days yet before HED drills a well where the technique was used in the evaluation process, Neal said he is very positive on it as a potential indicator.

Ibhubesi Success Story

Still, the ultimate value of any hydrocarbon detection technique is proven only with the drillbit.

Forest Oil International has some impressive results to show for using

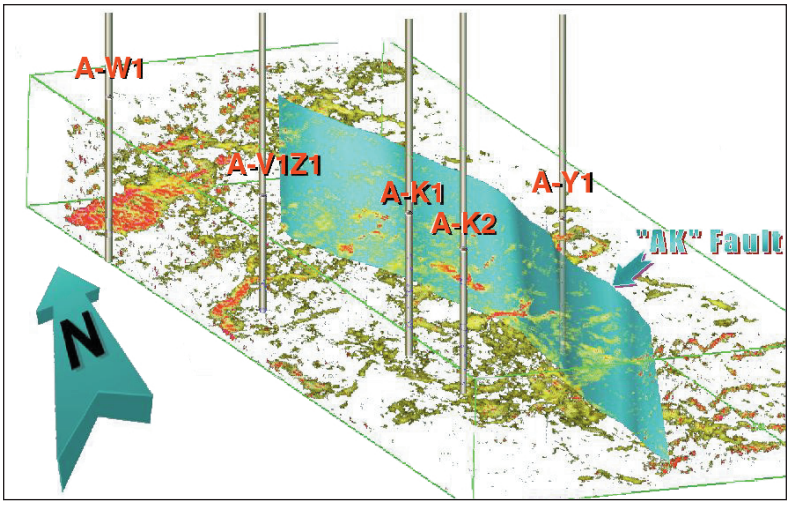

Figure 1 – A 3-D view of AK gas accumulation highlights thick gas-charged sand reservoirs.

LithSeis in its active – and expanding – drilling program in the Ibhubesi Field in South Africa.

The Albian-Lower Cretaceous stratigraphic play was first discovered in the mid-1980s by Soekor, the south African national oil company, which thought it was drilling a small structural test, according to chief geophysicist and AAPG member Tim Berge at Forest. The test well had a DST for gas but was considered uneconomic at the time and was plugged and abandoned.

Forest became a leaseholder on a couple of blocks there via a trade with Anschutz in 1998 and subsequently rediscovered the field.

"There was a lot of 2-D in the block area, and about 18 wells had been drilled," he said, "with three of these having a DST recovery of gas or oil.

"We began mapping on the 2-D and couldn't get the structure to close," Berge said, "and we couldn't account for the gas trapping with a simple structural model. We realized there had to be a stratigraphic component to the field and argued for 3-D to image that.

"The upside is that a structural closure would have to have been limited areally and the field size would be small," he said. "We now think the stratigraphic accumulation is regional in nature and much larger than we originally might have suspected."

Indeed, while Berge refrained from designating an estimated ultimate recovery from the field, he pegged the estimated regional resource at 10-20 Tcf.

Thus far, Forest has drilled four wells at a depth of 3,400 meters, or about 11,000 feet, with one dry hole and three commercial gas discoveries. The A-Y1 well was the largest gas test in south African history, testing 70 MMcfgd and almost 2,000 barrels of condensate, Berge said.

"LithSeis was the primary data volume on which the drilling campaign was based," said AAPG member Jeff Aldrich, chief geologist at Forest. "It let us have a much higher confidence in what we were drilling and the visualization of the reservoir."

He said that quantifying the reserves is quite complicated because of the complex geometry of the reservoirs. There are numerous compartments that in themselves are winding, meandering fluvial channel systems.

"To map the reservoir effectively, we needed some sort of inversion that would intervalize the reservoir," Berge noted. "In a regular seismic volume, you get the reflection off the top and off the bottom. What we needed to do was to look at an event that corresponded to the reservoir itself and not a reflection from top and base, and we needed to invert the data to do that.

"This tool makes P-wave and S-wave inversion and cross-plots the two traces, and it uses gathered data, which isn't used in simple recursive-type inversion," he continued. "It doesn't require – although it benefits from – well calibration, so it can be used in the early phase of exploration where there's not a lot of well control."

Aldrich said they estimate that using the combination of 3-D and LithSeis in the evaluation resulted in an increased chance of success rate of 67 percent in the drilling program.

"We made 10 reservoir predictions in the course of the program," Aldrich said. "All 10 found reservoir, and eight found commercial gas reservoir."

Berge mentioned that other inversion approaches they took required a lot of well control for calibration, but they are using some of these to predict water rather than gas.

"Even though we have an 80 percent success rate for gas content prediction," he said, "we're trying to solve the other 20 percent of the problem."

There will be plenty of opportunities for problem solving. Forest intends to add to its existing 312 kilometers of 3-D data when it kicks off a new 3-D program in December that will encompass 2,000 square kilometers of 3-D acquisition.

"We think we've just hit the edge of the play," Berge said, "and we plan 77 wells for full development."

Because there is no gas infrastructure in South Africa, Forest is building the gas

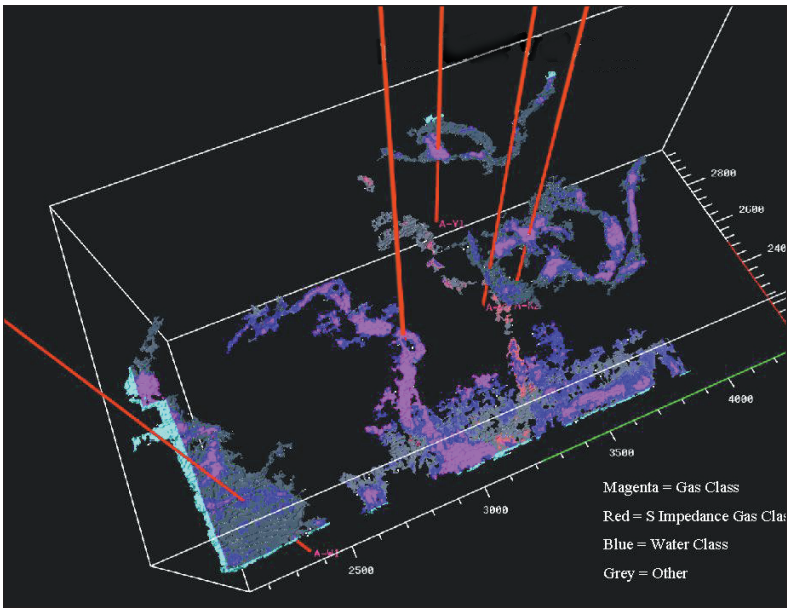

Figure 2 – P-S inversion hybred volume.

Graphics courtesy of eSeis Inc.

pipeline and the infrastructure, while proceeding to develop the components of the field. Production is expected to commence in 2004.

The whole program including the infrastructure could ultimately be a $2 billion investment, anticipated to come from multiple sources, according to Berge. He predicts it will have a huge economic impact on the whole western Cape province.

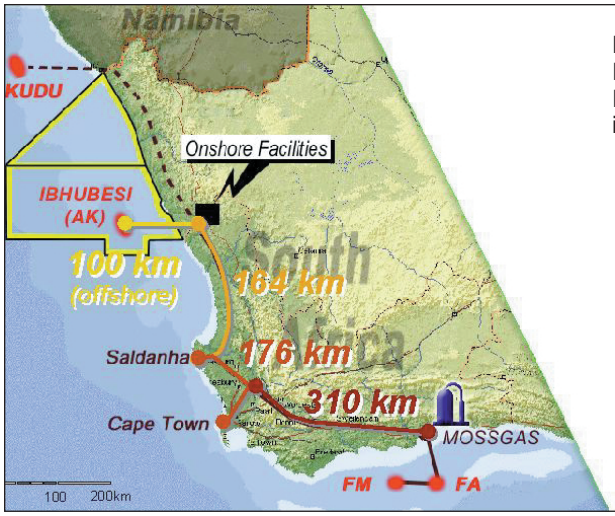

Figure 3 – Forest Oil International's Ibhubesi gas project in South Africa.

Trap Play

The sensitivity of the LithSeis technique to gas – even 10 percent gas in oil or water will show up as gas – isn't deterring Larry Baria, president of Jura-Search, who's using the tool in north Louisiana and south Arkansas, where he's wildcatting for oil potential in the Smackover.

"We're probably pushing the limits of the tool trying to find oil," he said, "but we ran test lines through existing fields and the porous productive wells stood out against the porous wet ones. We're boldly going to drill a LithSeis anomaly shortly.

"We've also used the technique 'after the fact' following our discovery well at Mariner Field in Hancock County," Baria added. "There, we're looking at lower Miocene Amphistegina sands with 34 percent porosity and as much as 95 percent gas saturation, so it really lends itself to hydrocarbon indicator processing."

Baria said he plans to drill three development wells in the field during the next five months based on the technique. He cautioned that it's advisable to have a good seismic product to put into the processing tool upfront. And he noted there appears to be a lower porosity cutoff limit.

"It's mainly effective for high porosity, stratigraphic traps," he said. "While it's not a panacea, it does seem to have a balance of throwing AVO, absorption, inversion and several other things into the pot in the proper ingredients to come out with something that so far seems to work.

"I'm hoping that four months from now we'll be so elated," Baria said, "that we'll be revving up to use this technology in any number of basins." ❑