AAPG EXPLORER

All-Azimuth Illuminating

Node Patch Takes Bottom Readings

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Operators continue to grapple with how best to image the vast number of complex reservoirs lying beneath the Gulf of Mexico's salt bodies.

Those ubiquitous salt masses distort seismic signals, resulting in an inferior image.

The latest hoped-for solution appears to be all-azimuth illumination, using ocean bottom seismic technology that can acquire full, or true wide azimuth seismic data by recording in all directions.

This is in contrast to conventional streamers, which routinely record narrow azimuth data with a single illumination direction or else re-shoot in several directions to acquire additional azimuth data – a pricey undertaking.

Some industry experts envision the future for deepwater subsalt imaging lies in ocean bottom seismic systems using autonomous nodes.

In fact, nodal seabed technology will be featured in a special session at this year's Offshore Technology Conference in Houston, May 1-4, on "The Development of Deepwater Ocean Bottom Seismic – Definition to Execution."

The commercial viability of nodal seismic technology is slated to be documented in the results of the ongoing project between Fairfield Industries – its new Z system is designed to work in water depths down to 3,000 meters – and deepwater GOM veteran BP at BP-operated Atlantis field, one of the largest finds in the Gulf.

The program kicked off last October and is anticipated to conclude in early March, to be followed by several months of processing in-house at BP.

"We were ready to go nodal in shallow water, and then BP came along," said Steve Mitchell, vice president, division manager at Fairfield, "and it was not a problem to change the focus to deep.

"We were both already at the point of realizing nodes are the thing of the future even though we got there from different directions," Mitchell said. "The light bulb had already gone off at both companies separately."

Two Objectives

BP had wrestled with the illumination issue at a number of its fields and quickly recognized the problem would be there as long as they continued to play the subsalt.

"We've had a long-lived R&D effort to look at imaging problems in the subsalt area of our development," said Jerry Beaudoin, project manager for deepwater OBS technology at BP. "Once we came to the conclusion that it's an illumination problem, we concluded the way to solve it was through collecting a new class of data that we could process internally with our own algorithms."

Given the tendency these days for E&P companies to depend on the service side of the business to develop and fund – and prove – new technologies, the Atlantis venture is particularly noteworthy.

"The oil companies have been slashing R&D and counting on the contractors more and more to pick it up,

Above, the back deck area with the Z3000 nodes awaiting placement by the ROV, seen here attached to its Tether Management System (TMS).

Left, A Z3000 node being positioned on the sea floor by the suction arm of the ROV.

Photos courtesy of Fairfield Industries

and we have," Mitchell said. "But BP was willing to help pick it up."

Indeed, the E&P giant and its Atlantis field partner, BHPB, stepped up to the plate with big bucks, picking up a goodly portion of the tab for the 900 nodes Fairfield built to deploy at Atlantis.

The program, which encompasses 240 square kilometers in water depths between 1,400 and 2,200 meters, is defined as an "at-scale" field trial of the technology.

"We're doing it at a scale that makes sense," Beaudoin said. "This means we have to have it across the entire field, not just do a little patch and say 'oh, it works.' We're gathering a data set that will be useful in the commercial development of Atlantis.

"The north flank is the primary objective where we think this will make the biggest difference, because we can't see it," Beaudoin said. "But even the crest is partially obscured because it's right under the lip of the salt, so we think we can improve the imaging there as well."

A secondary objective is to understand how this class of data stacks up against regular streamer data outboard from salt. Coverage of the south flank will allow the opportunity to compare the wide azimuth nodal data with the earlier streamer data acquired there.

The initial phase of the two-phase nodal acquisition program at Atlantis is complete, and early peeks at the data reveal the quality looks quite good. The imaging process will get under way once all the data are in from the initial phase.

"We broke the survey into two pieces because it's bigger than we could cover in just one bite," said Allan Ross, seismic operations manager at BP. "It would have been just too costly to build enough nodes to cover the whole field at one time.

"In the first patch, all 900 nodes were used," Ross said. "We deployed them and shot, retrieved, recharged, recalibrated, refreshed them and are putting them down on the second patch now.

"Generally, this is far more cost-effective than OBC (ocean bottom cables), where you cover a limited area at one time," Ross said. "We're covering a much larger area in one fell swoop –130 square kilometers in the first patch and 110 in the second. That's a significant ocean bottom survey, and the fact it can be done in just two patches is a significant development commercially."

Each autonomous node is a self-contained sensor with batteries and a highly accurate clock. The cable-free pods are deployed on the seabed and later retrieved by an ROV to download the data acquired and recharge the batteries.

Challenging Environments

Their reliability gets high marks, according to BP consultant Graham Openshaw.

"It's tricky going from six prototypes to 900 operational units, and the biggest win here is the incredible reliability," Openshaw said. "There were only two failures out of 900 deployed, which is unprecedented in the difficult business of deploying new deepwater technology.

"Once they're on the seabed, they're eating batteries so you have only so many days to get shots into them," Openshaw said, "which is really challenging this time of year."

For example, think days with 20-foot seas and 70 mph wind gusts.

The accuracy of positioning the nodes in the deep water and the navigation system, both under the aegis of Geo Century, grab another thumbs-up.

"We solved the problems of putting receivers all over the Sigsbee escarpment, which is a really complex area to work" Openshaw said. "There's 2,000 feet of scarp slope with gradients up to 30 degrees-plus, which makes it difficult to find locations on the slope of less than 10 degrees to put receivers down and position them accurately with the ROVs," he said. "But it's been very successful."

Project participants took a calculated risk the advanced Ultra Short Base Line navigation system would be adequate – and reportedly it is, providing previously unachievable accuracies in deep water.

One of the achievements in putting down 900 nodes in the first patch was locating all of them on the return to pick them up. There was no long base line array in place.

Diversity Helps

Another crucial supporting technology at Atlantis is the innovative deck handling system.

"One of the requirements in designing the project was that the 200-pound nodes be handled without overhead swinging cranes, and they be handled with as much automation as possible," Ross noted.

"Fairfield found a Michelangelo of metal and hydraulics in Louisiana who sketched out the deck handling system and built it," he said. "It's a beautiful piece of work; the quality and craftsmanship is superb."

Another noteworthy aspect of the project is the time frame.

Given the urgency of the illumination problem, BP set out to deliberately accelerate the pace of innovation. The time from the proposal of the wide azimuth project to the completion of the 3-D node survey spans less than six years, according to Beaudoin. Earlier application of a successful wide azimuth survey greatly increases the value of the seismic data for field development.

"We deliberately picked a challenging place," said Beaudoin, who noted the overlying salt mass at Atlantis is very complex. "It's a real life example where the technology will make a difference commercially."

The synergy between the two principals played a key role in ensuring the program progressed swiftly and smoothly.

"When you consider the vastly different size of Fairfield and BP," Mitchell said, "it was fascinating watching the two of us being able to communicate and deal with each other within the separate corporate structures.

"We had to learn each other's ways and style, which neither could have done alone," Mitchell noted. "It was a good match, absolutely.

"The diversity of the organization in the long run was a benefit because we were each able to recognize the other's strengths and pull on that.

"And if the results are as hoped and anticipated," Mitchell said, "an entire new business model will be under way for us."

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