A new 'node' of acquisition

Nodal seismic technology is becoming the tool of choice for shallowwater surveys.

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The current intense level of activity in the oil and gas industry shows no signs of abating any time soon. Indeed, all segments of the business are running full tilt, including the only recently beleaguered seismic industry.

The vigor that permeates the industry today provides the ideal climate to foster creative new developments in technology, which is fortuitous given that the so-called easy finds appear to be a thing of the past.

Some of these technologies have yet to materialize on the drawing board. Others, however, have already proven their viability during field trials and are being readied to meet the needs of the operators when the right time and appropriate situation are aligned.

One particularly noteworthy example garnering considerable attention today is autonomous ocean bottom nodes for seismic data acquisition.

Nodes, or independent seafloor seismographs, have long been used by the academic community for various applications, and ocean bottom sensors have been used successfully to acquire data in the shallow water, sending the data via buoys or cables to the surface.

The reliability of contemporary electronics has served to catapult nodal technology to the forefront of exciting new seismic applications. The technology has been determined to be strikingly superior to massive and bulky wire-filled cables commonly used for data collection.

Battery-powered nodal seabed seismic systems currently being developed — and on the brink of commercial application — consist of independent self-contained nodal units, which are placed on the seafloor either by remotely operated vehicles (ROVs) for deepwater application or via rope in the shallow water. The use of ROVs and ropes enables unparalleled flexibility in system deployment. Additionally, the relative simplicity of deployment means a system can be quickly put in place immediately where needed, e.g., following an exploration discovery so the operator can determine what really is there (Figure 1).

Advances in clock crystal technology enable the units to be synchronized in the time domain. The independent pods are left in place on the seafloor for a specified period of time where they constantly record sound waves emanating from the source vessel at the surface before being retrieved to download and quality-control the data, recharging the batteries prior to redeployment.

The ascent of nodal seismic technology is timely given the current trend in the exploration and production industry toward all-azimuth data acquisition in order to accommodate the operators' demand for the most sophisticated subsurface image. All-azimuth illumination is essential to accurately image reservoirs that are partially obscured by salt bodies or other velocity complications.

A nodal seabed seismic system can cost-effectively record a true all-azimuth survey, making it a far more valuable tool to image complex reservoirs than conventional streamer systems or ocean bottom cable (OBC), which ordinarily record narrower azimuth data. The individual nodal units are azimuthly symmetrical; i.e., the response is the same in all directions, so the system can shoot any type survey design. Streamer surveys, on the other hand, must be shot at various times in different orientations to approximate the all-azimuth benefits of the nodal survey — a highly expensive undertaking. And only the largest streamer vessels are capable of recording 3-D data with offsets as much as 29,529 ft (9,000 m).

Nodal technology can provide other valuable information not available from streamer surveys, such as:

- Converted wave data for use in

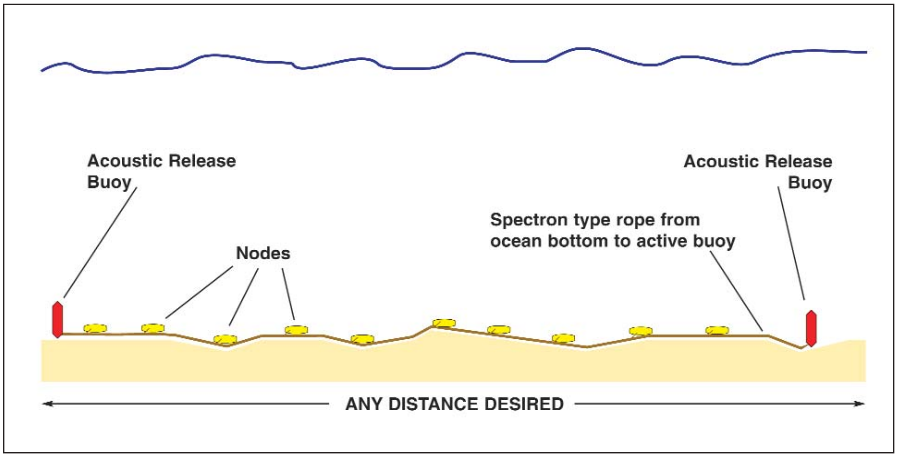

Figure 1. Nodes can be deployed using a remotely operated vehicle or ropes. (All images courtesy of Fairfield Industries)

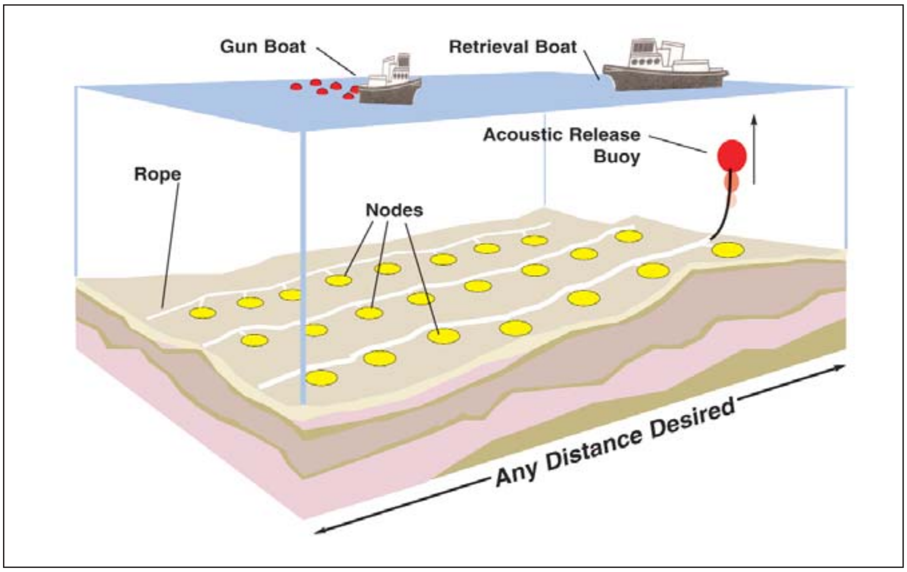

Figure 2. Dynamically positioned vessels are not needed for nodal deployment, offering cost savings over ocean bottom cable operations.

determining reservoir fluid characteristics; and

- P-Z summation as a tool for eliminating surface-related multiples.

Fairfield's intense focus on nodal systems development led to the recent introduction of its Z systems technology — a node-based seismic system for land, shallowwater and deepwater applications — which acquires true, all-azimuth seismic surveys. The technology can be used to complement or, where appropriate, replace traditional acquisition techniques. The deepwater system, Z 3000, is on schedule to begin commercial acquisition at BP's Atlantis field in the Gulf of Mexico.

The Z 700 system designed for shallowwater application is already prototyped and has undergone numerous field trials, where it performed successfully. A full-scale system is scheduled to be completed and in operation mid- to late 2006.

This shallowwater nodal application is suitable for any type play, including the highly active shallowwater deep gas play in the Gulf of Mexico.

The key enabling feature of the widespread applicability of this shallowwater system is flexibility. The nodes most often are deployed by a simple, high tensile-strength rope, which negates the need for bulky, expensive cable with its oft-failing connectors. In fact, more than 99% of the problems encountered in the water environment occur from the connectors outward. The absence of cable becomes particularly advantageous in areas of crowded infrastructure, such as the shallowwater Gulf. Something as simple as tighter turns contributes significantly to greater efficiency.

Deployment via rope provides yet another advantage of this type system in that the operator can hook as many units as needed onto the rope, and the distances between the individual nodes can be adjusted as required; i.e., any group interval is available. This flexibility enables further customization of the survey to better meet the objectives.

As activity industry-wide revved up over the past year or so, demand for conventional streamer data surged accordingly. Demand for conventional OBC, however, has lagged somewhat, despite the promise of better (wide azimuth) data.

The key reason for this disparity is the cost per square mile of an OBC survey versus streamer. The root cause of the added cost of OBC is straightforward: A conventional OBC crew consists of a dual-source vessel and two cable vessels, either or both of which must be a dynamically positioned vessel, which is highly expensive.

In contrast, a full-azimuth nodal survey entails about one-half the crew members of a conventional OBC shoot and only two vessels: the node management vessel and a dual-source shooting boat (Figure 2). Because the sole node handling vessel has no physical connection to the receiver spread on the sea floor, it does not need to be an expensive dynamically positioned vessel. The greater than 40% vessel cost reduction with the nodal crew versus a conventional OBC crew provides a powerful incentive to deploy this system.

Because there is no cable to contend with as well as fewer vessels, nodes also provide a far less expensive approach to parallel profiling. This type survey is a common implementation in many areas, particularly the shallowwater Gulf, where offset distribution can be more important than azimuths in certain geological settings.

The heavily drilled, long-productive shallow subsurface reservoirs (less than 15,000 ft or 4,575 m) in the shallowwater Gulf shelf are ideal targets for 4-D, or time-lapse, seismic to better evaluate reservoir performance in an effort to wring additional hydrocarbons from these zones. Shallowwater nodal systems technology likely is destined to become the method of choice for 4-D in this usually cluttered environment.

The precise, repeatable positioning required for 4-D is achievable without disturbing the production infrastructure. The reliable repeatability combined with the advantage of flexible, cable-free deployment brings exceptional value to the 4-D application.

Where a 4-D program is expected to entail less than 10-15 surveys, repeat shoots using a nodal system could be considerably more economical than a permanent installation. Additionally, the nodal application circumvents the risk of a permanent system degrading over time. E&P