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Imaging Technologies Reduce Risks

By Patrick Ng
and Ian Anstey

HOUSTON–The Texas and Louisiana Outer Continental Shelf of the Gulf of Mexico has re-emerged as an active area for increased exploration as well as continued exploitation of existing producing assets. Old fields are being reworked and deeper gas wells are being planned. With deep gas exploration comes a set of new challenges, however. Seismic surveying is one of the key tools used today to help operators manage different kinds of risks and increase their probability of success.

Over the past few years, depth imaging has brought a new dimension of clarity and quality to subsalt exploration, giving operators increased confidence in drilling for hydrocarbon reservoirs that lie beneath or in close proximity to salt. Not only does depth imaging help minimize structural uncertainty and better define the container shape, but when applied over a large area, also helps improve the understanding of the petroleum system on a regional scale. Lacking a thorough understanding of the deep source rock potential, operators would continue to face high geologic risk.

Beyond the challenges of structural uncertainty, the methodology and the process of three-dimensional prestack imaging also requires interpreters to pay close attention to velocity, algorithm, aperture and salt geometry. That learning process is itself interpretive and iterative.

Evolution Of Best Practices

In fact, over the years the seismic industry has seen many changes in conventional wisdom. Is this a bad thing? No. As seismic professionals learn more about emerging technologies, the industry's thinking continues to evolve, and we come up with new ways to improve technological and business approaches. The reality is that best practices evolve over time.

On the exploitation front, thanks to advances in computing, operators have become increasingly interested in applying amplitude-versus-offset analysis on a regional basis. When balancing a port-

FIGURE 1

Business Solution Products

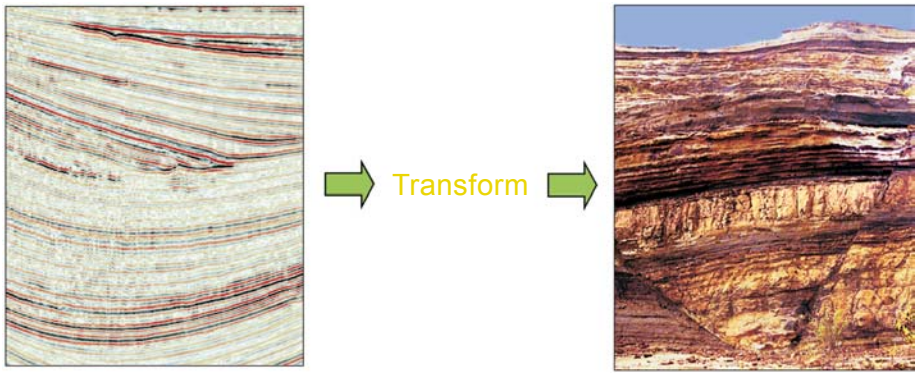
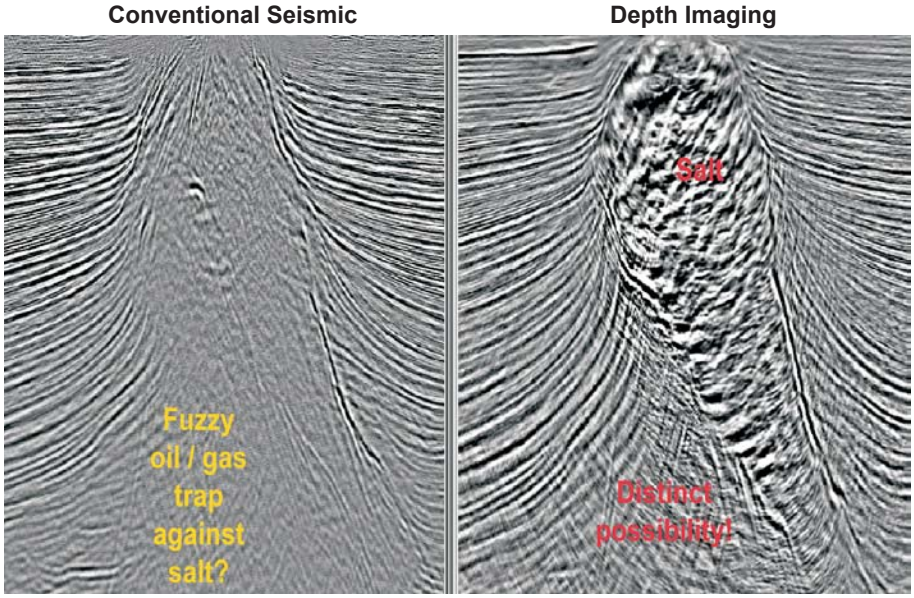


FIGURE 2

3-D Depth Imaging versus Conventional 3-D



folio, an attractive option is to use cash flow from existing shallow production to fund exploration programs going after deep targets.

Newfield Exploration Co.'s recent discovery in West Cameron Block 294 confirms the presence of the deep target and validates such a strategy. In a late November press release, Newfield announced that well logs had indicated that the West Cameron 294 No. 5 wildcat discovery had encountered more than 100 feet of pay to date. Casing was being run on the interval and drilling operations were to resume to test deeper objectives in the well bore. The well is Newfield's first successful field development in the emerging deep Shelf trend. Newfield is the operator, with an 85 percent working interest. The company says it may drill another deep prospect near the No. 5 discovery later this year.

What has the industry learned so far in imaging the subsurface? Improved quality seismic surveying can take us beyond mapping structure, and prestack imaged data is the foundation for more detailed analysis. Figure 1 illustrates how the "right" seismic products can be created, not just for structural imaging, but also for lithology, fluid and pressure identification. McKinsey & Company, a management consulting firm, reckons the net benefits to the oil industry from 3-D seismic imaging amounts to $11 billion a year.

FIGURE 3

Example of 3-D Depth Imaging Quality
(Using Large-Radius Aperture and High-Fidelity Prestack Algorithm)

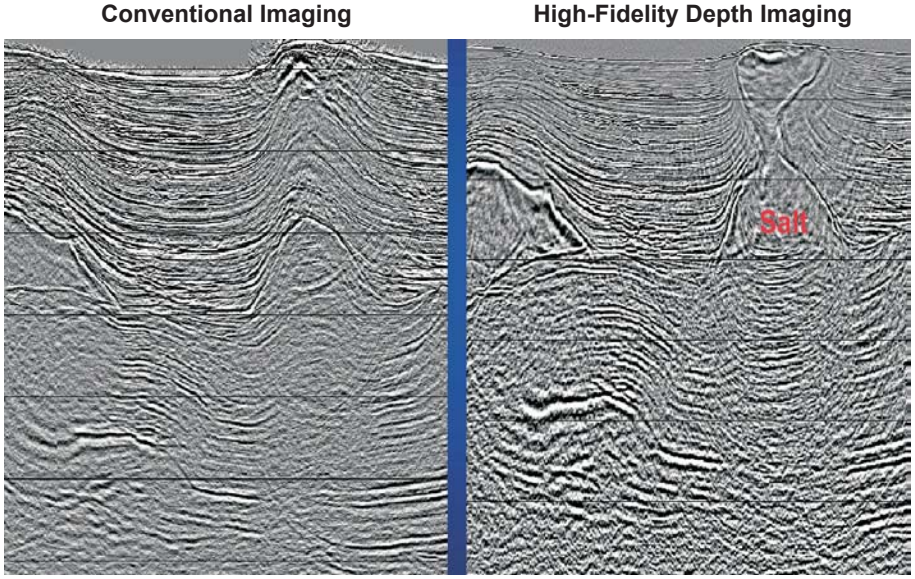
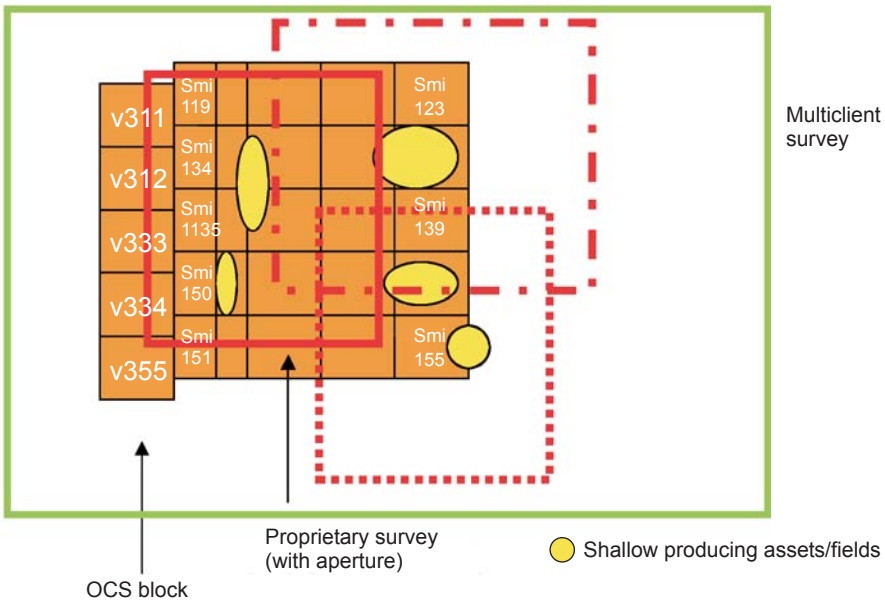


FIGURE 4

The Multiclient Seismic Model (Map View)



Reducing Technical Risks

Imaging technology reduces technical risks. In fact, when properly imaged, seismic data can have material impact on the entire exploration program (Figure 2). Arriving at the optimum image, however, requires judicious parameter selection based on sound physics. Some specific considerations include:

- High-quality sediment velocities. Instead of the normal stacking velocity analysis, prestack imaging should be performed to position energy as close to the right place as possible before velocities are analyzed and picked.
- Fit-for-purpose algorithms. Classic salt bodies along the Gulf Coast have overhangs and steep flanks, while salt bodies in deeper waters exhibit complexity beyond conventional wisdom. Imaging these features requires an algorithm that can handle turning-wave energy, before the salt boundaries can be pinpointed.
- Aperture. Without sufficient aperture that is tied to the size and listening time of an individual 3-D survey, getting the best velocities and algorithm will not do much good. Figure 3 shows an example of the quality that can be attained using a large-radius aperture of 40,000 feet and a high-fidelity prestack depth imaging algorithm. The difference of having and not having a quality image is between drilling into tens of thousands of feet of salt (hourglass structure) versus moving to a more favorable drilling location, resulting in two totally different outcomes.
- Salt interpretation. If the interpreter does not know what is there, he cannot possibly interpret a salt overhang correctly. The conventional approach of picking salt approximately every kilometer is too imprecise, and taking great care to pick velocity, algorithm and aperture will not enable the interpreter to define salt geometry with confidence. Three-dimensional visualization is a key component in the pursuit of excellence in salt interpretation, helping to spot clo-

sure of salt bodies and deeply-rooted stems. The best approach is to fully integrate interpretation into the data processing workflow from the onset, and apply 3-D visualization to increase confidence and reduce risks.

Reducing Economic Risks

Imaging technology's ability to reduce economic risk is related to the Gulf of Mexico's geologic and business settings, the need for reduced lead times (time-value proposition) and improved drilling success rates, as well as innovative business models emerging for the future.

Shallow salt basins with arcuate discontinuous growth fault systems characterize the Texas-Louisiana Outer Continental Shelf. The faults normally detach at a mobile salt substrate or salt diapir. For 20 years, operators have concentrated on developing and producing hydrocarbons from the Pleistocene and Pliocene sands near or around salt. For such purposes, operators only need to acquire seismic data centered on the field or prospect, hence the term "postage stamp 3-D."

Successes in deepwater exploration have taught the industry that a regional approach is fundamental to evaluating the prospectivity of the deep Miocene play because of the complexity introduced by the salt above. Noting the impact of large aperture in Figure 3, it is no wonder that oil and gas companies need to think beyond the postage stamp. Here, we define 3-D contiguous regional coverage to be not 10-20 blocks, but 500-2,000 OCS blocks.

One business model that has worked well in the Gulf of Mexico is the multiclient seismic program (Figure 4). Proprietary surveys place the seismic company under contract to acquire and process seismic data for only one client. In a multiclient program, the seismic company risks its own capital acquiring and processing seismic data, and makes the results available for licensing to a number of clients. An example of a multiclient program on the Shelf is a recently launched program that covers more than 29,000 square kilometers, or 1,430 OCS blocks, to create a corridor of contiguous fully-merged, prestack-imaged 3-D volumes.

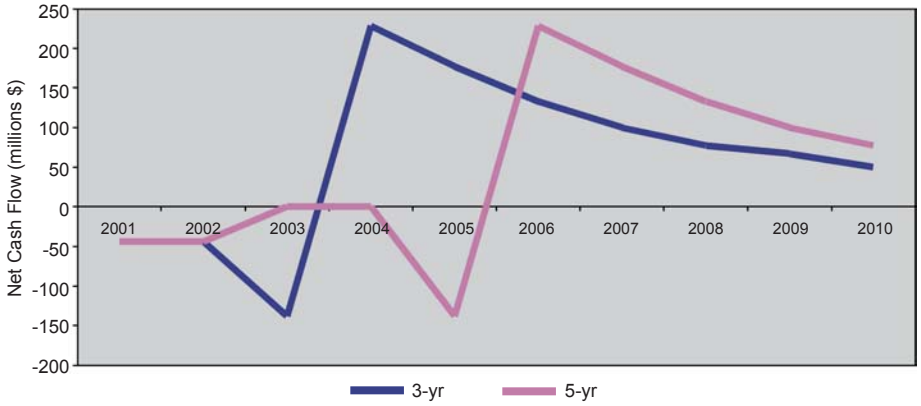
While improving reserve replacement through deep exploration is important in the long term, cash is more pressing in the short term. Exploration and production companies must not underestimate the need to increase production and lower finding, development and subsequent lifting costs. By taking advantage of seismic imaging technologies, combined with detailed reservoir characterization and drilling plans, operators can enhance the economic value of existing fields.

Getting the right data, the first time, has significant impact on the net present value of a project. This is demonstrated in Figure 5 by comparing the discounted cash flow between three- and five-year lead times to first oil. The difference in the implied internal rate of return is 17 percent, which can have a material impact on any investment decision.

Renewed activity and interest in older fields will invigorate a new business cycle. With more than 100 operators actively working the Shelf, coupled with a bullish investment climate of asset swaps and mergers and acquisitions, we see sus-

FIGURE 5

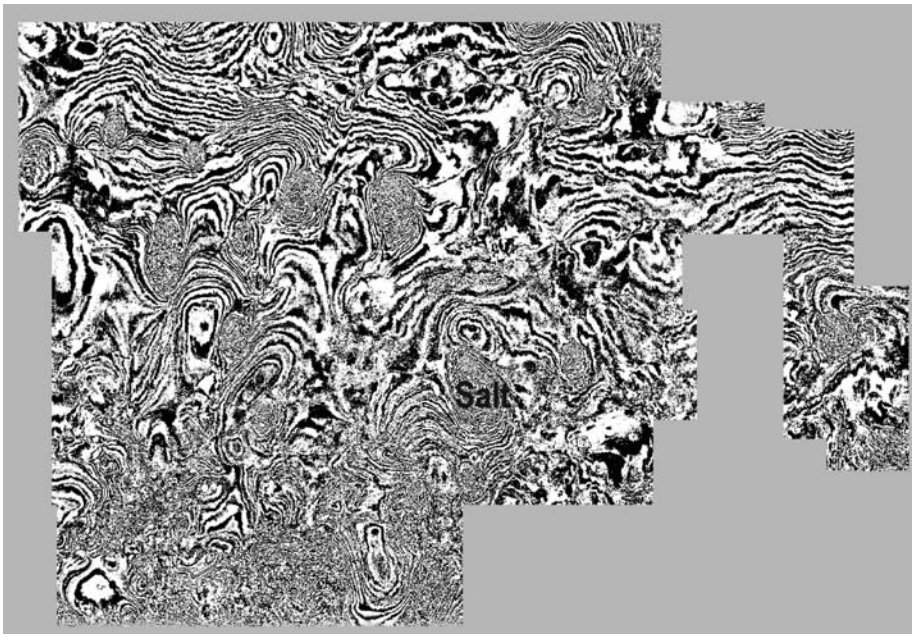
Capturing Value by Reducing Lead Time



Comparison of Economic Impact		
Lead Time	Three Years	Five Years
NPV	$256.7 million	$189.6 million
IRR at discount rate 12%	51%	34%

FIGURE 6

Map View of Regional Slice Through 3-D Seismic Data Ocean-Bottom Cable over 9,600 km^2 (470 OCS Blocks)



tainable demand for new and improved seismic technologies in spite of a declining rig count.

Getting the right data on the appropriate regional scale (Figure 6) helps operators quickly evaluate multiple opportunities for further exploiting their current property bases, and assess both undrilled potential in asset swaps and drilling upside in new property acquisitions. Rewards await those with unique insights and skills, and who are willing to take a fresh look and think outside the box.

Complementary Partnership

In the future, seismic companies will assume a regional perspective and invest in enhancement products that will enable operators to concentrate on prospect and field-specific detailed analysis to do what they do best: find, develop and produce oil and gas. Such a complementary partnership will lead to sustainable and profitable growth in an otherwise talent-constrained industry.

Having the right relationship with vendors and services providers will not be a luxury, but a necessity. The demographic distribution of those employed in the oil and gas industry is highly asymmetric, heavily skewed toward maturity past age 45 with only dripping infusion of young talents, according to published membership profiles from professional associations such as the American Association of Petroleum Geologists and the Society of Exploration Geophysicists. One speculation is that the industry is poised to work the relation dimension. Companies that exploit this early and successfully will develop a sustainable edge over their competitors.

The bottom line is that today's advanced geophysical tools reduce both technical and economic risk. Seismic imaging technologies reduce structural uncertainties, prestack attribute analysis helps discern hydrocarbon potential and optimize drilling programs, while 3-D depth imaging enhances the understanding of the petroleum system for the deep gas play and minimizes the uncertainty in unraveling the geologic puzzle. Prestack products also enable efficient exploitation of existing producing assets and undrilled potential, as well as timely assessment of multiple opportunities. These are the building blocks of any comprehensive approach to manage increasingly rapid and short business cycles because of the volatility of commodity prices. Getting the right data the first time assures time-value capture.

In addition, building the right relationships creates sustainable win-win outcomes for both the oil and gas company and the seismic contractor, creating a new relation value proposition. Regional multiclient prestack imaging programs offer cost-effective options to help operators reduce risks when exploring for deep gas opportunities on the Gulf of Mexico OCS. Working in partnership with seismic companies, operators can pursue what they do best more efficiently and more effectively, and get to first oil more quickly.

Seismic technology has been the single most important contributor to operator success in the last decade. The enormous recent successes in the Gulf of Mexico are, in large part, the result of the integration of new technology and the new business model. Continuous success in the next decade will undoubtedly go to those who can apply and integrate emerging technology and innovative business practice most effectively. ❐

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IAN ANSTEY

Ian Anstey is project manager, new ventures, for WesternGeco in Houston. He joined WesternGeco in the U.K. data processing group in 1983. Anstey has served as data processing center manager in Jakarta, Indonesia, and was instrumental in creating the first nonexclusive 3-D seismic survey in Indonesia. He is responsible for the regional EMerge™ *prestack imaging programs on the Gulf of Mexico Outer Continental Shelf and developing new investment opportunities in North and South America.*

PATRICK NG

Patrick Ng is general manager of multiclient programs for WesternGeco in Houston, responsible for the multiclient investment portfolio, marketing and sales in North and South America. Ng began his career with WesternGeco in 1982. His experience spans research and development, operations, software development, marketing, and technology management. His areas of interest are commercialization of emerging technologies and business innovation, including e-commerce.