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Survey Data RE-IMAGI

LEGACY DATA CONTINUES TO ADD VALUE TO OIL, GAS AND CCS PROJECTS.

By Wendy Laursen

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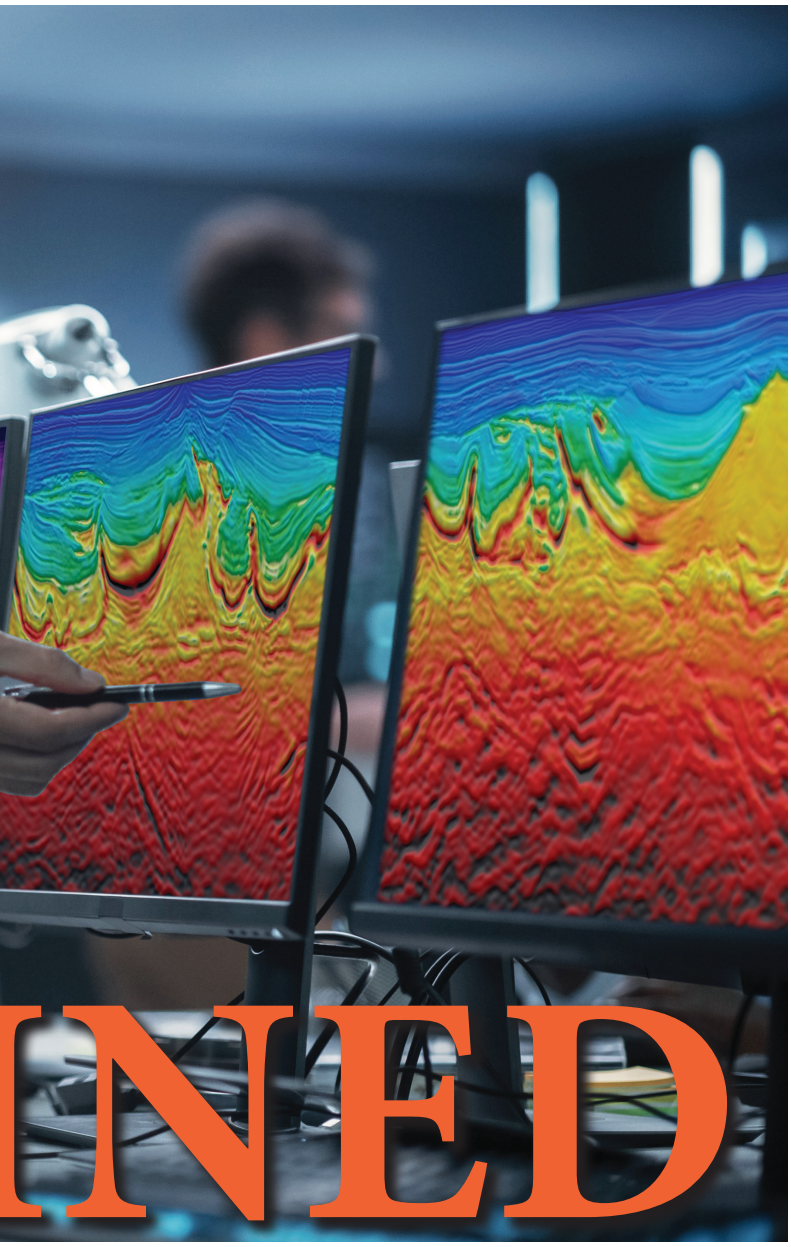

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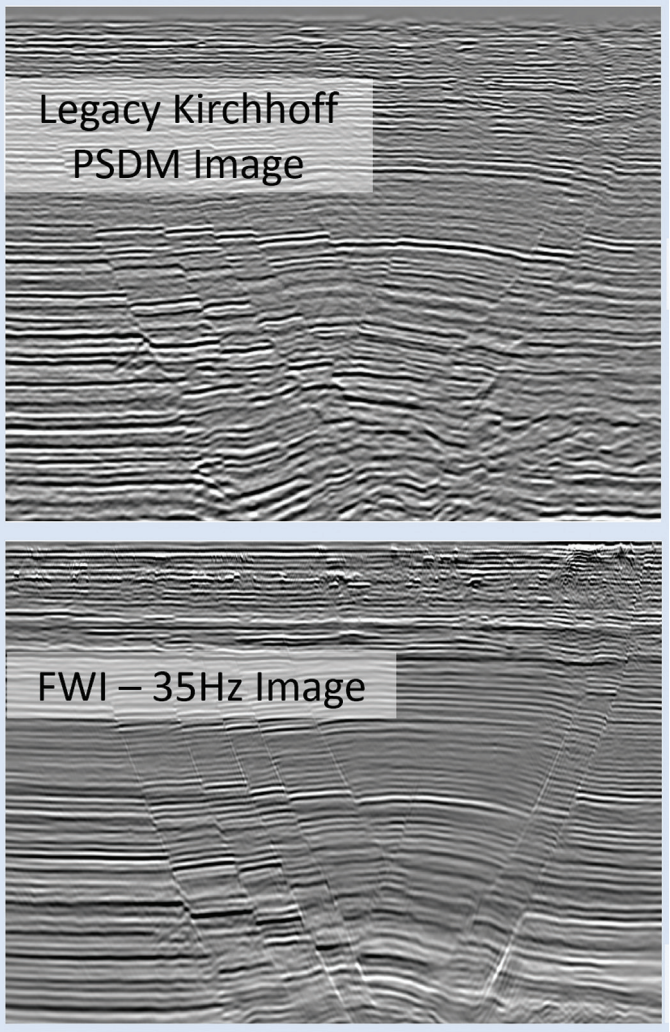
With the latest seismic processing technologies, legacy seismic data can provide good resolution images of the target formation and its overburden.



* All images courtesy Viridien

More than 10 million wells have been drilled globally to date, costing hundreds of billions of dollars. Yet, data from old wells can quickly be devalued: it didn't lead to financial gains before, so it's easily forgotten.

"Even successful historical wells can fall into the folklore category," says Ceri Davies, digital geology manager, Earth Data at Viridien, who looks after the company's well library database which contains searchable, detailed information from millions of well reports and documents worldwide. "Every one of these wells provides a direct window into the subsurface at their location. By reprocessing, collating and curating this legacy data, we provide explorationists with the opportunity to revisit the excitement that drove the initial investment in the well." And in the future, says Davies, AI will also be used to identify trends and missed opportunities.

Well library data has already been combined with other legacy data to screen for carbon storage sites in the GoM. To do this, Viridien employed many different types of well data as part of a Storge Play Quality Index assessment including well log suites, check shot surveys, well test data, core data, biostratigraphy, water chemistry and formation pressure data.

Following an initial screening of sites, the data was used to create a structural framework for imaging legacy seismic data to enable storage potential to be characterized in 3D. "With

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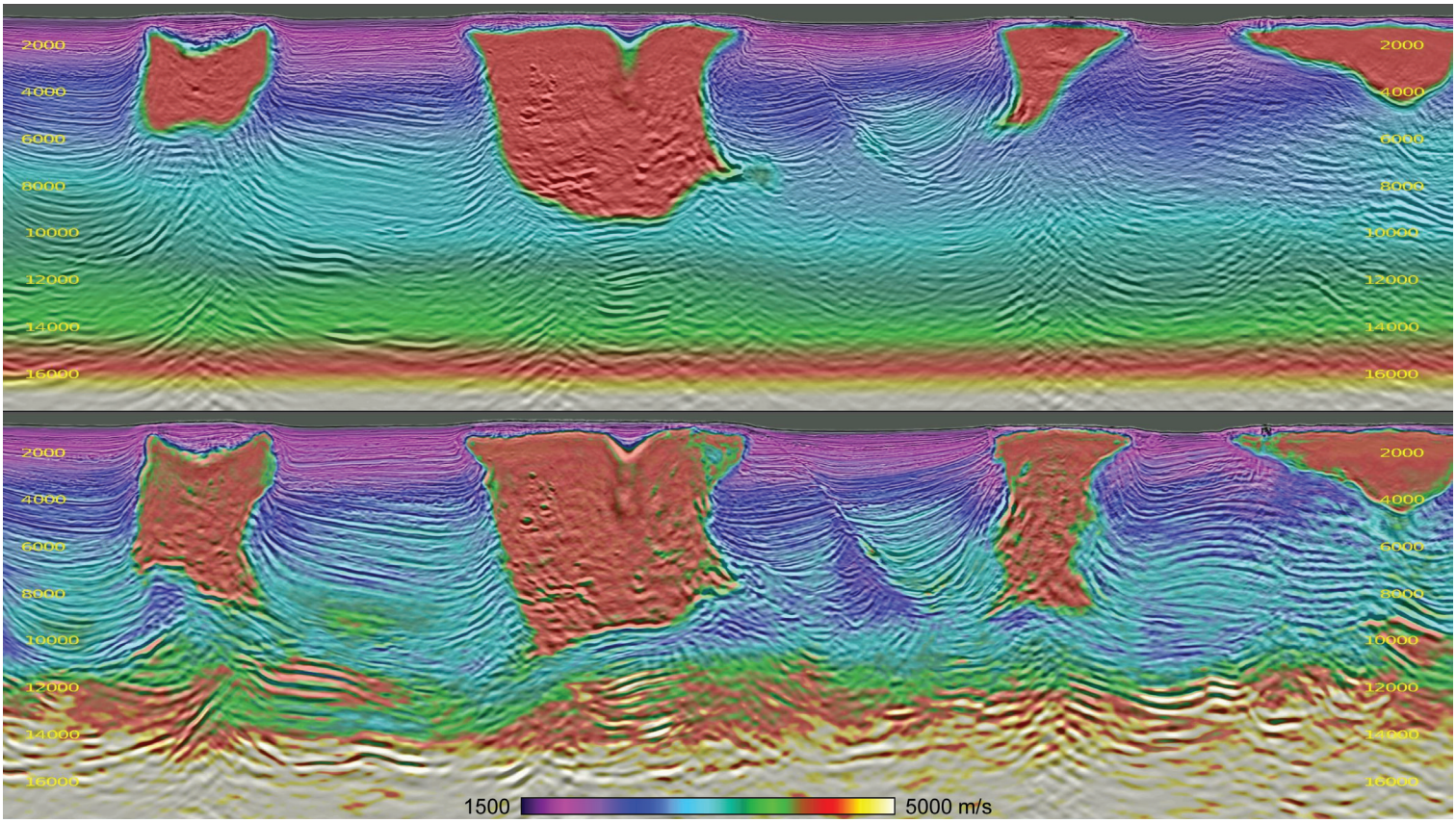

Reprocessing of legacy wide-azimuth towed streamer data acquired in 2010 using TLFWI resulted in significant improvements in subsalt imaging. Top - 2010 legacy velocity model overlaid with RTM; Bottom - 2024 8Hz TLFWI velocity and its RTM.

the latest seismic processing technologies, legacy seismic data can provide good resolution images of the target formation and its overburden," says Gregor Duval, carbon storage manager, Earth Data at Viridien. "The most recently awarded storage licenses include a commitment from developers to reprocess legacy seismic data."

New oil and gas discoveries are also sparking interest in legacy data. The play-opening giant discoveries of Baleine and Murene-1 (Calao) offshore Tano Basin, Côte d'Ivoire, have reinvigorated exploration in the equatorial margin of Africa, and in 2024, Viridien merged and re-imaged a seamless and contiguous volume of 6,434 km2 of 3D multi-client seismic data in the basin.

The data included four separate surveys acquired over multiple blocks between 2000 and 2014 from the shelf to the outer slope domain. These four surveys with differing cable depths and streamer profiles, along with significant variations in legacy processing workflows, were merged to create a contiguous seismic volume. The new re-imaging was undertaken from field tapes using proprietary technologies such as time-lag full-waveform inversion velocity model building.

In the North Sea, Viridien recently reprocessed multi-client seismic streamer data to create value for clients evaluating the Central North Sea and the Southern North Sea. "We were able to enhance the legacy streamer data with significant uplift to the final images," said Hari Krishna, Director Europe, North Africa & Middle East, Earth Data, Viridien.

Clients found the new depth models to be accurate within 1% of the target depth for exploration wells, enabling them to place their wells optimally. "All of our reprocessing projects in the past 5-6 years have been very well funded. In our estimates, more than 70% of active blocks in the Central North Sea use Viridien data as their primary database.

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"In the Southern North Sea, our reprocessing of streamer data from 2014 fundamentally changed the reservoir model. As a result, the client changed the infill well locations and improved their production and reserve estimates."

Krishna expects new streamer acquisition to decrease in volume and go more hybrid (Ocean Bottom Node (OBN) + streamer data) or fully OBN to provide enhanced reservoir imaging.

OBN data is generally considered better than streamer data because it provides a much richer subsurface image due to its ability to capture a wider range of seismic wave arrivals, including longer offsets, full azimuthal coverage and better low-frequency information.

Seismic imaging is constantly advancing. Viridien uses full-waveform inversion (FWI) algorithms that produce highly detailed, data-driven models of subsurface velocity, absorption (Q) and reflectivity by minimizing the difference between observed and modeled seismic waveforms. FWI is now the industry standard for velocity model building and has been applied to legacy and new seismic survey configurations.

Time-lag FWI (TLFWI) is a proprietary Viridien technology that addresses issues which plagued earlier FWI algorithms, such as cycle-skipping issues related to an inaccurate initial model, amplitude mismatches between observed and modeled seismic and a poor low-frequency signal-to-noise ratio of field data. TLFWI has been highly successful in velocity model building for complex geological settings around the world, including sub-salt, carbonates, thrust belts and shallow gas. It is often used in conjunction with OBN data sets and as a way of improving the image on legacy seismic data.

FWI Imaging takes the process a step further by outputting an image of subsurface reflectivity directly, often providing a superior result in complex areas where migration algorithms struggle.

"TLFWI and FWI Imaging, whether in their acoustic or elastic versions, have brought tremendous value to the reprocessing of legacy seismic data," says Rongxin Huang, VP, US Imaging, Subsurface Imaging, Viridien. "Although TLFWI and FWI imaging were initially developed for the most advanced data, i.e. OBN data with good low frequencies, long offsets, and excellent spatial and azimuthal sampling, applying these technologies to legacy seismic data, which are sometimes more than 25 years old and often have poor low frequencies, short offsets, and limited spatial sampling, still generates step-change improvements in the seismic images.

"The application of TLFWI and FWI Imaging has greatly unlocked the value of legacy data, allowing operators to reduce costs and shorten turnaround times (compared to acquiring new seismic surveys) when better seismic images are needed to make important decisions for their prospects and reservoirs."

Seismic imaging is moving towards even more advanced algorithms, such as high-frequency multi-parameter elastic FWI, with the aim of deriving accurate seismic reservoir attributes (compressional wave velocity (Vp), shear wave velocity (Vs), and density) directly. Legacy data on its own is increasingly insufficient to meet these advanced demands, says Huang.

"New acquisitions providing better data, such as OBN, are expected to become mainstream in operators' exploration and development programs in the next 5–10 years. This will be facilitated by decreasing acquisition costs as new acquisition technologies and more streamlined operations continue to improve acquisition efficiency."

This means that, while there is still considerable value in legacy data, in challenging geological areas it needs to be complemented by new acquisition for seismic imaging.

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