A New Chapter in Seismic Data Analysis

Software vendors have expanded their interpretation canvases to accommodate their clients' needs.

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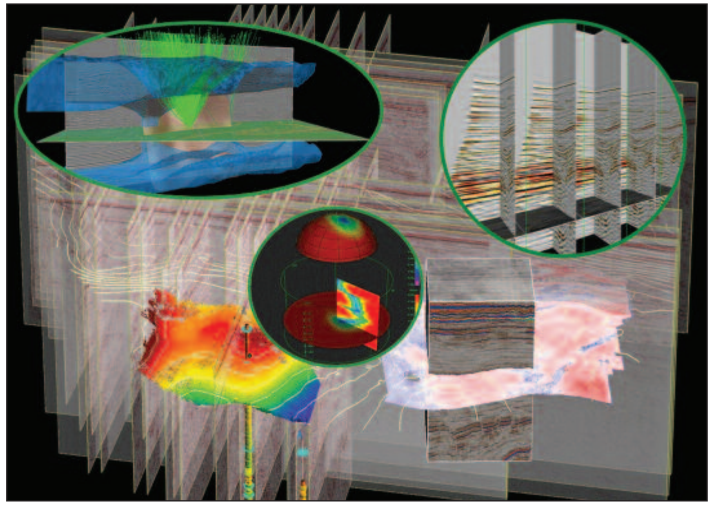
Few would argue that technologies like voxel-interpretation, seismic facies classification, edge detection, and wave shape-based horizon propagation have had an impact on the seismic interpretation process and a significant influence in finding, ranking, and developing hydrocarbon resources. While high-performance computing technologies such as seismic imaging seek to clarify seismic position and quality, these interpretation technologies have enabled additional image processing and image analysis activities to be carried out at the workstation, further clarifying and qualifying seismic signatures that can be correlated to depositional features, structural features, and quality prospects.

In a sense, these technologies have reshaped, if not "re-defined," seismic interpretation, as oil and gas geoscientists have made these once "nice-to-have" technologies core technologies that must be administered as part of exploration and development interpretation projects. Standardization of these processes is something that Paradigm and its customers have come to appreciate through commercialization of products such as VoxelGeo, Stratimagic, Coherence Cube, and the 3-D Propagator, where extending the interpretation process to incorporate these technologies has been made necessarily transparent.

Meanwhile, changes in seismic acquisition, data size, interpretation objects, desktop computational capacity, visualization capacity, and data complexity have ensured that a "static" interpretation portfolio is not feasible. To accommodate these changes, software vendors have had to expand their interpretation canvases. Extensible multisurvey canvases that scale in size, number of users, types of data, and types of interpretation services are required today to support regional to prospect operations for oil companies. Automation, ergonomics, and interoperability are other defining features that differentiate modern interpretation systems.

Is the industry ready to reshape and redefine the interpretation scene again? One of the consequences of a decade of improved collaboration among asset team members has been an increased awareness of the dependencies of the interpretation process on the quality and scope of the contributing data and the processes required to create these data. One type of contributing data is prestack data, which can assist the interpreter in qualifying velocity models, primary reflection energy, and lithology determinations made from amplitude versus azimuth and inversion processes. Historically, analysis and use of these data were reserved to applications and windows foreign to the interpretation canvas. Advances in disk speeds, network bandwidth, and software engineering have mitigated data access barriers so that use of prestack data with poststack images can be carried out in the same canvas, allowing interpreters to make real-time decisions with this new information with the full interpretation set.



Original data are shown in the subsurface illumination image *(Data courtesy of Devon Energy Corp.)*

Collaboration also has broadened interpreters' understanding of the dependency of seismic reflection data on the acquisition and velocity model. While subsurface illumination has been proven to provide a useful bridging technology for these domains, the process traditionally has been carried out in special applications, also foreign to the interpretation canvas. This process should be "absorbed" in the interpretation canvas where illumination scenarios can be evaluated with different velocity models, seismic acquisitions, or ray-tracing methods. By pulling these technologies together, interpreters are able to qualify seismic blind spots and assess reflection "reliability," a new measure that can lead to higher confidence in subsurface interpretation.

Interpreters also traditionally have made use of a variety of "flattening" techniques to better understand depositional settings and to rationalize structural frameworks. Many of these techniques rely on 2-D operators, where the seismic traces simply are translated vertically. These techniques have been shown to be unreliable, particularly in heavily faulted areas where incomplete horizons or fault gaps result. These problems can be eliminated with true 3-D stratigraphic flattening operations that make use of 3-D displacements of each seismic sample rather than vertical stretching. This paleo-flattening can be applied simultaneously to horizons that belong to a conformable sequence, providing interpreters a tool to validate structural frameworks, fault seals, fractures, and spill point probabilities during the interpretation process.

Seismic imaging trends also are having an impact on the interpretation process. New data decomposition and imaging methods can be used to generate full-azimuth angle gathers that sample both acoustic (reflection) and structural (directional) information. In gas shale plays, for example, interpreters are able to directly observe the influence of stress-related anisotropy without resorting to sectoring approximations. Stress orientation and intensity attributes generated with different methods allow interpreters and engineers to construct drilling plans based on this information. It is believed that these new techniques will make seismic data more relevant for the gas shale plays.

Whether interpreting with prestack data, interpreting full-azimuth data, or qualifying prospects with full-azimuth illumination and true 3-D stratigraphic flattening, seismic interpreters are ready once again to extend their reach with new technologies that will redefine their interpretation process and strengthen their exploration and development programs. ■