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Deeper Insight into Hydrocarbon Prospects

Interpretation system enables rapid identification of stratigraphic architectural elements.

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Three-D seismic data provide rich and varied information about the subsurface environment. This robust remote sensing method has enabled the oil and gas industry to comprehensively map geological structures, predict lateral changes in depositional facies, and estimate lithological and pore fluid variations.

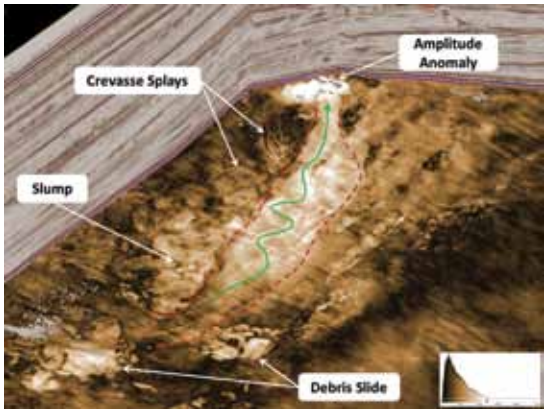
The primary investigator of these data, the seismic interpreter, is tasked with extracting geologically meaningful information from seismic data volumes covering hundreds to thousands of square kilometers. In the case of stratigraphic interpretation – a key approach to understanding depositional environments, reservoir facies distribution, and fluid migration pathways – modern 3-D seismic data can provide images of a quality approaching that of aerial photography.

The challenge comes with trying to identify prospective locations in a 3-D seismic volume. Consider that a moderately sized 3-D survey contains upwards of 150 billion data samples. How does an interpreter locate the few thousand samples that contain information pertaining to a hydrocarbon reservoir? Hunting for less than 0.0001% of the samples in a seismic volume can amount to searching for a needle in a very big haystack.

To tackle these stratigraphic investigations, interpreters require in-depth knowledge of facies models, depositional environments, and a wealth of modern analogues. They also require an interpretation system that will allow rapid isolation of stratigraphic intervals, stratigraphic slicing and visualization of seismic amplitudes, and volumetric rendering of seismic attributes within prospective intervals. The ability to interactively manipulate colors, calculate and test many seismic attributes, and co-render several seismic volumes greatly improves the chance of locating a stratigraphic prospect.

Typically the "interesting" geology lies hidden in weak, discontinuous seismic reflections. When viewed in a vertical cross section, the subtle meaning of amplitudes can easily be overlooked. When viewed along a stratigraphic slice, however, the lateral variation in amplitude patterns can be enlightening. Lateral facies variations, erosional processes, and sediment remobilization features all can be readily extracted from these easily overlooked seismic events.

With the release of Paradigm 2011.3, the stratigraphic interpretation capabilities of the SeisEarth interpretation system have been extended to support rapid stratigraphic prospecting in the same visualization canvas used for multisurvey regional interpretation. New workflows enable geoscientists to perform single-horizon and multihorizon volume flattening (i.e. vertical shifting) and horizon-parallel and multihorizon proportional slicing through seismic data volumes. In conjunction with the 3-D Propagator horizon tracker, interpreters can interactively slice seismic data volumes along interpolated stratigraphic layers with subsample precision while maintaining a regional perspective of the complete depositional system.



A stratigraphic slice through a deepwater depositional interval reveals slump features, debris slides, and an interpreted fluid migration fairway leading updip (green arrow) to a high-amplitude anomaly associated with a structural high (potential direct hydrocarbon indicator). (Data courtesy of AWE Ltd.)

Complementary to surface-based stratigraphic analysis, the voxel rendering technology developed in VoxelGeo has been embedded into the 3-D canvas. Through the use of GPUs, where hundreds of cores are deployed to carry out seismic volume rendering, this visualization process removes artifacts to reveal details of the geology and accelerate refresh speed. By deploying this technology in the same application used for multisurvey interpretation, interpreters can carry out detailed volume rendering of stratigraphic features without the need to move from one application to another.

To coax subtle stratigraphic details from the interval under investigation, interpreters may generate many seismic attribute volumes. These volumes can easily exceed the available workstation memory and limit the ability to perform multiattribute interpretation. To address this limitation, Paradigm 2011.3 can roam through seismic volumes directly from disk. By automatically adjusting display resolution, reading data using multiple processing threads, and leveraging a new sparse brick seismic file format, geoscientists can simultaneously co-render, blend, slice, and interpret many seismic attribute volumes even on workstations with limited system memory.