

 | Brochure

A Full 360 Degrees of Insight into the Subsurface

# Aspen EarthStudy 360™

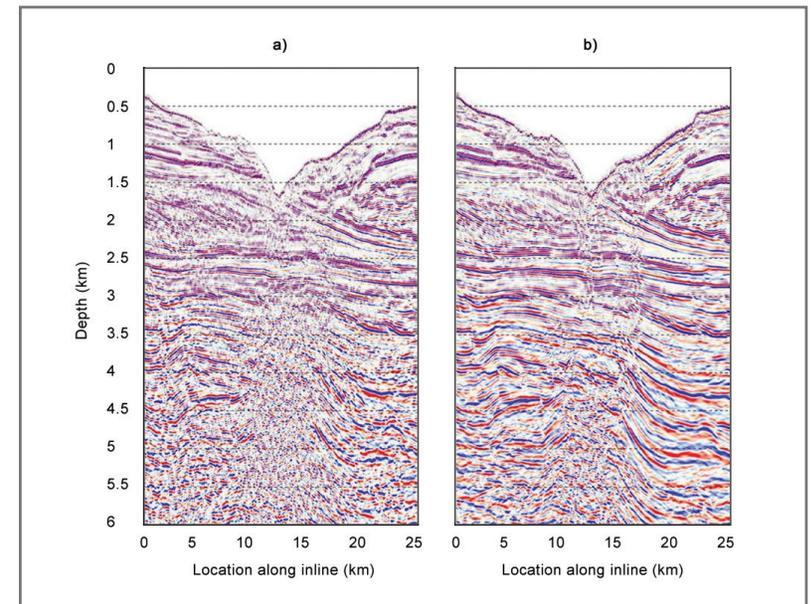
“With EarthStudy 360 we are able to deliver a much better product compared to standard 3D imaging. Reliable attributes estimated using EarthStudy 360 can help define sweet spots for unconventional prospects, as well as provide effective support to decisions about horizontal drilling and hydraulic fracturing. Together, these significantly reduce prospect uncertainty.”

Jerzy Trela, COO, Geofizyka Torun, Poland

## Expanding the Frontiers of Subsurface Exploration

Aspen EarthStudy 360™ is an innovative system designed to deliver to both depth imaging experts and interpretation specialists a complete set of data that enables them to obtain accurate subsurface velocity models, structural and stratigraphic attributes, medium properties and reservoir characteristics. The system extracts unprecedented value from all modern and legacy seismic data acquisitions, especially those with wide and rich azimuth and long offset, in both marine and land environments.

Aspen EarthStudy 360 is most effective for imaging and analysis in unconventional gas plays within shale formations and in fracture carbonate reservoirs. The system delivers highly accurate images from below complex structures, such as shallow low-velocity anomalies like gas pockets, subsalt, sub-basalt and high-velocity carbonate rocks. These result in accurate and reliable solutions for anisotropic tomography and for fracture detection and reservoir characterization.



Hidden structure revealed by EarthStudy 360.

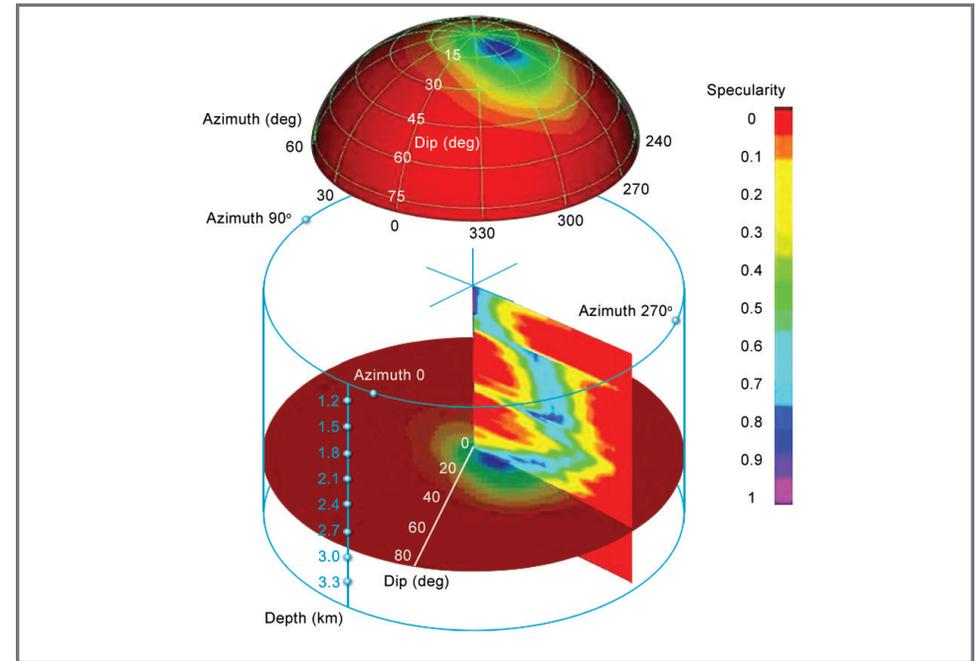
# Added Value for Geoscientists

Aspen EarthStudy 360 creates a wealth of seismic image data, decomposed into full-azimuth, angle-dependent reflection and directional (dip and azimuth) data components. These can be selectively sampled, creatively combined, dynamically visualized, and further processed to secure images of the subsurface. The images can reveal the information needed for velocity model determination, as well as provide details regarding the presence of micro-fractures, the orientation of faults and fractures, the influence of anisotropy, the directions of contributing illumination, the elastic properties of target reservoirs and the boundaries of those reservoirs.

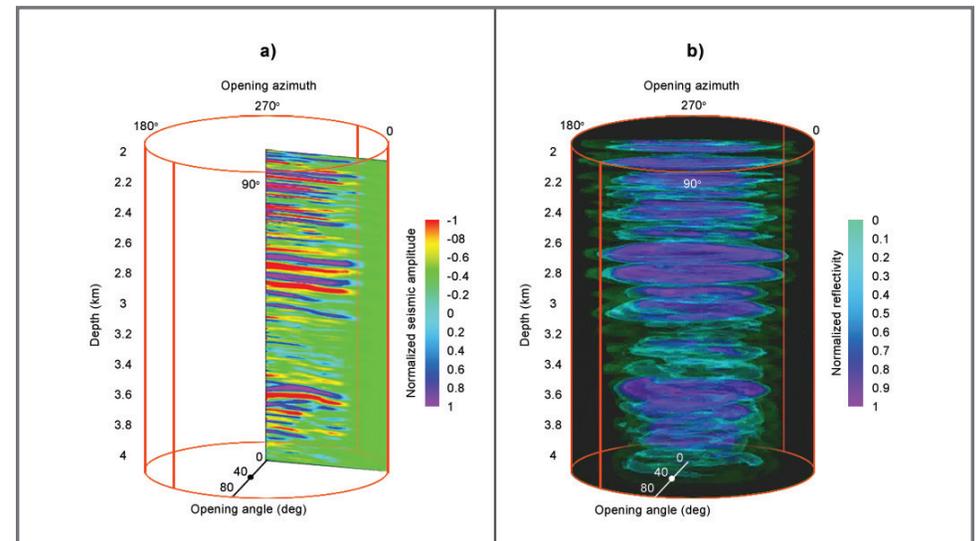
## Directional and Reflection Angle Gather Systems

Aspen EarthStudy 360 enables geophysicists to use all recorded seismic data in a continuous fashion directly in the subsurface local angle domain. This results in two complementary, full-azimuth, 3D angle gather systems: **Directional** and **reflection**.

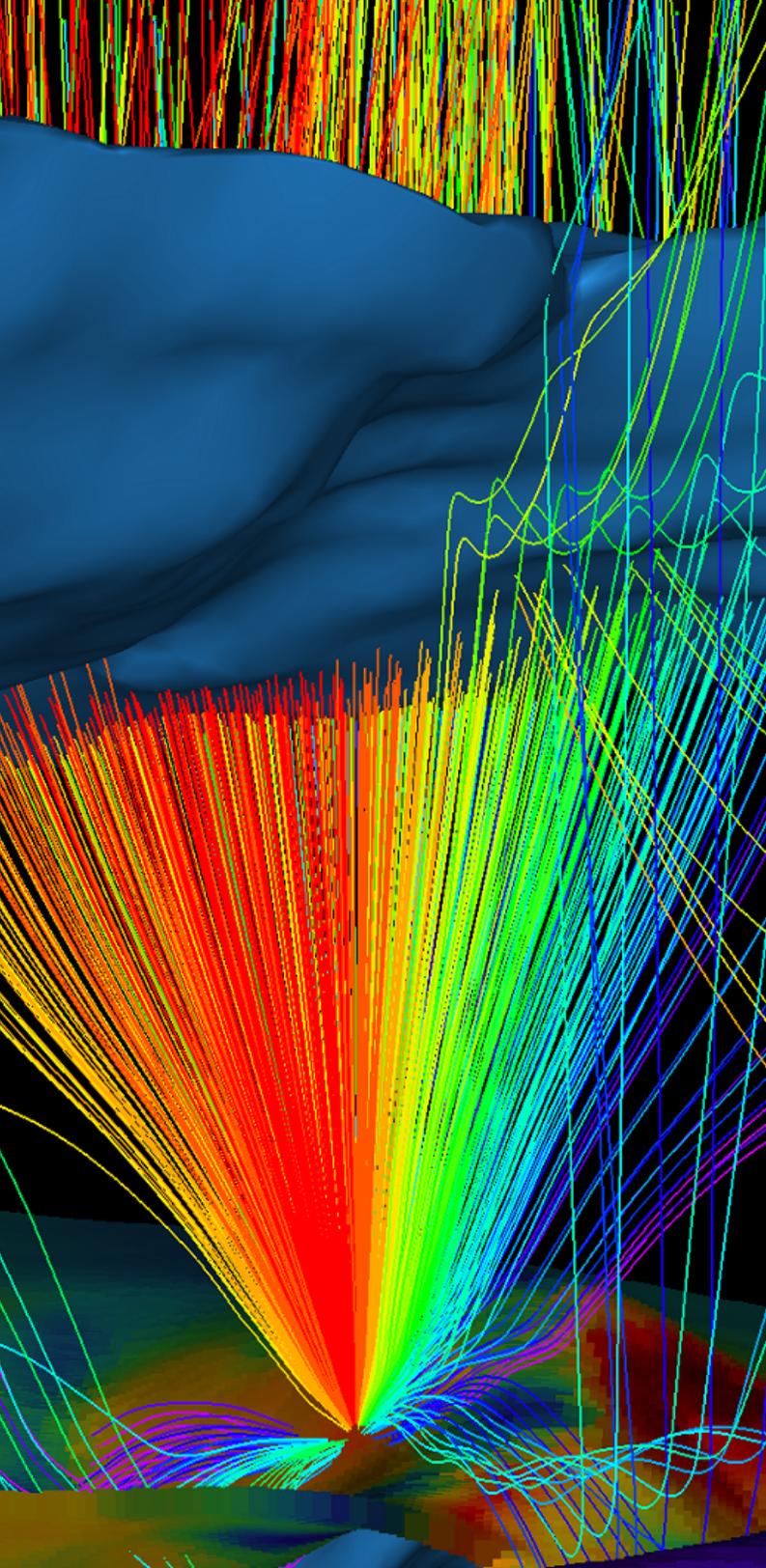
Directional angle decomposition implements both specular and diffraction imaging with real 3D isotropic/anisotropic geological models, leading to simultaneous emphasis on both continuous structural surfaces and discontinuous objects such as small faults and small-scale fractures. Structural attributes at each subsurface point, such as dip, azimuth and continuity, can be reliably derived directly from the directional angle gathers.



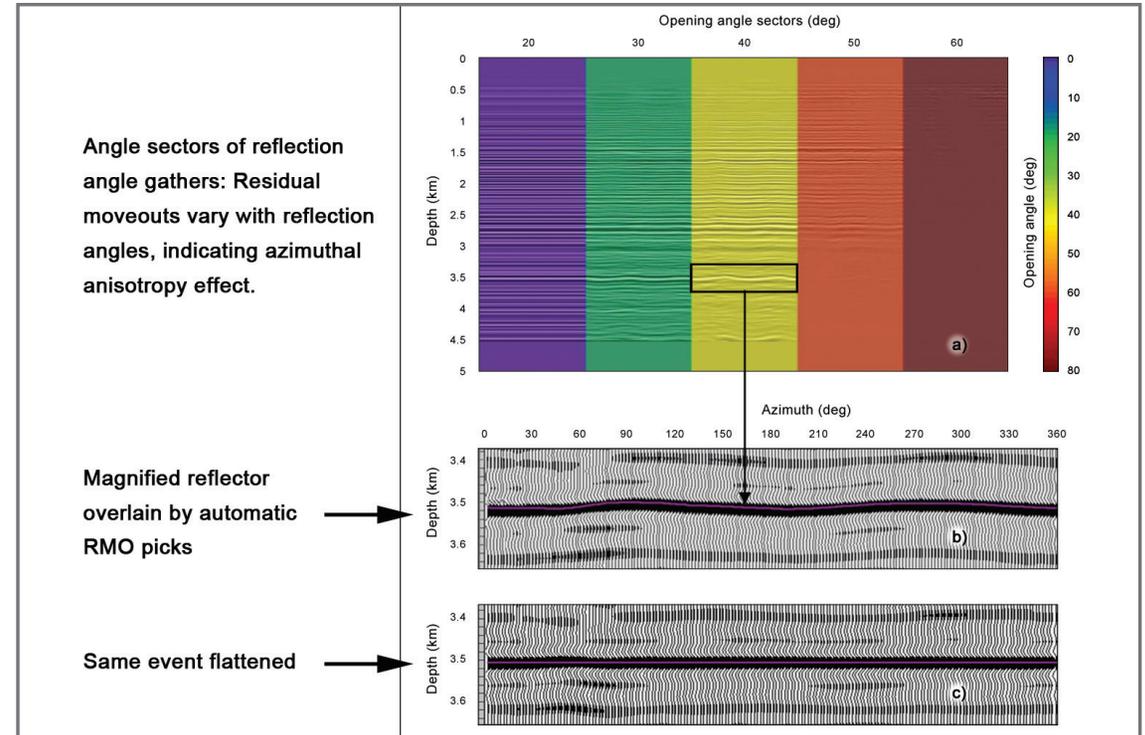
3D directional specularity gather.



Two views of 3D reflection angle gathers.



EarthStudy 360 reflection angle gathers provide “true amplitude” reflectivities that substantially increase the information needed to extract residual moveouts (RMO) and amplitude variations. The full-azimuth, angle domain RMO enables accurate velocity model determination (isotropy/anisotropy tomography). Full-azimuth, angle domain amplitude variations result in better reservoir characterization, with high-resolution elastic properties and high-resolution fracture determinations.



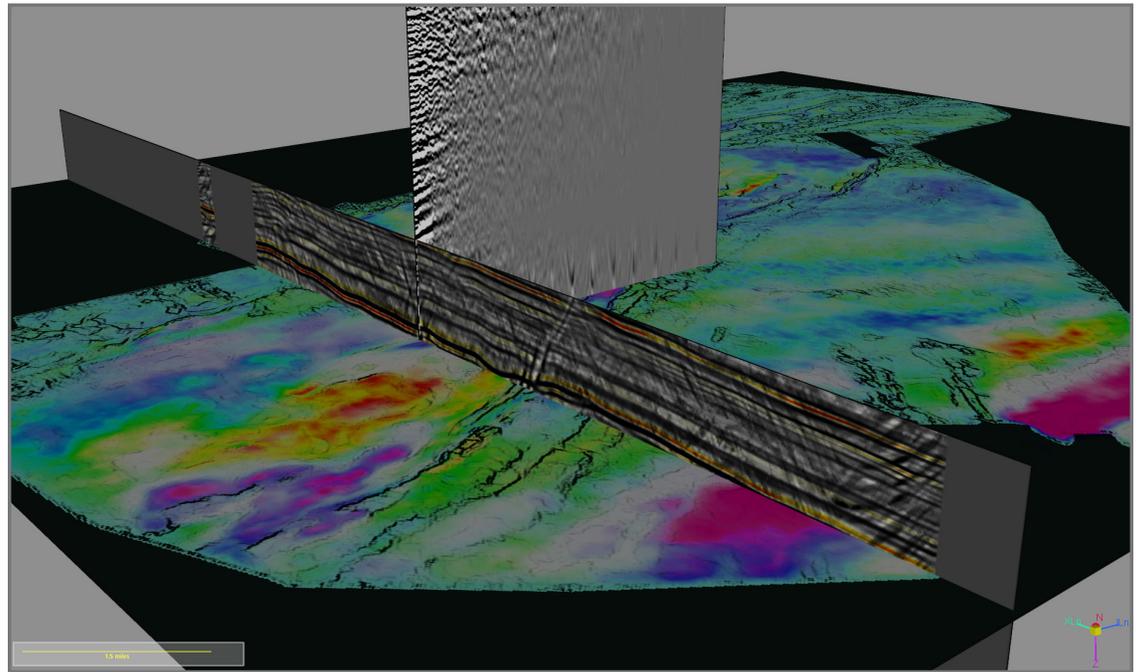
Angle sectors of reflection angle gathers: Residual moveouts vary with reflection angles, indicating azimuthal anisotropy effect.

# Aspen EarthStudy 360 Imager

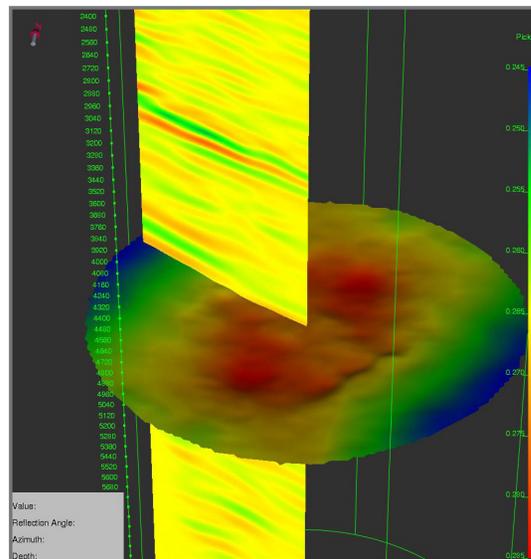
The EarthStudy 360 Imager is a CPU/GPU cluster-based solution that efficiently uses the full recorded wavefield to generate 3D full-azimuth, directional and reflection angle gathers. The Imager can be utilized to provide fast, target-oriented solutions for local analysis, and can also be used for imaging on a regional scale.

# Aspen EarthStudy 360 Tomography

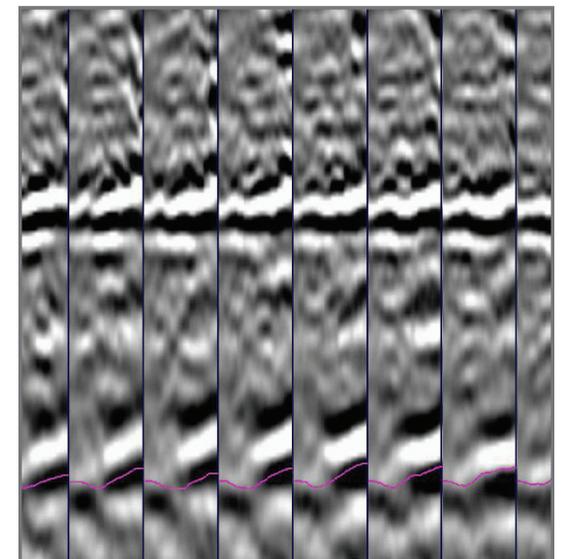
The tomography system uses input data extracted from EarthStudy 360 directional (directivity) and reflection (full-azimuth RMO) gathers to update the velocity model. The substantial increase in information about the subsurface improves accuracy and reduces uncertainty. This is especially important when determining anisotropy model parameters.



Highlight of fractures and faults using EarthStudy 360 diffraction imaging.



Automatic RMO picking along 3D reflection angle gather.



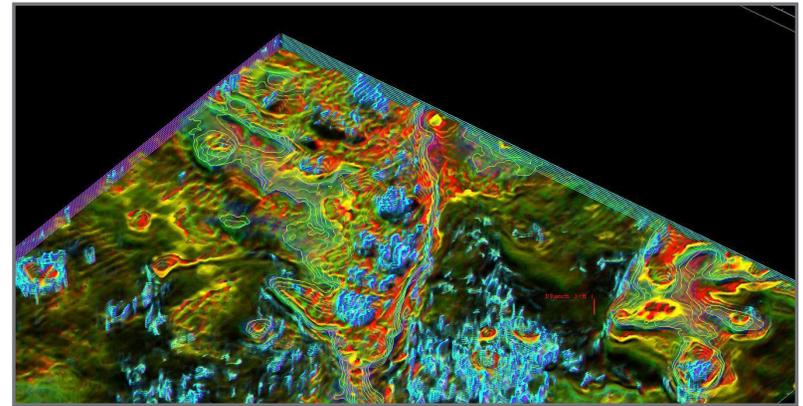
Azimuthal sectors extracted from 3D angle gathers.

# Aspen EarthStudy 360 as a Tool for Stress and Fracture Detection

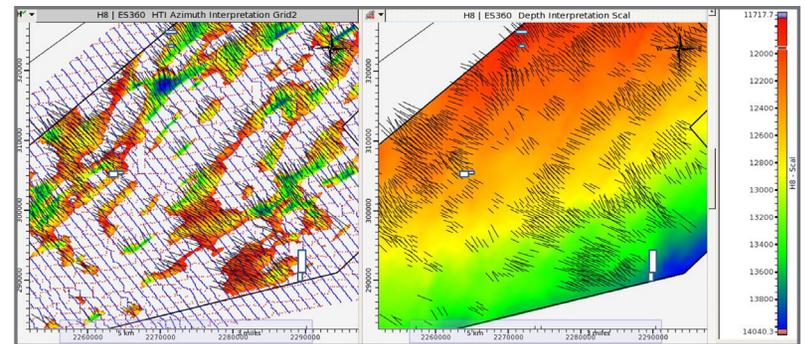
Aspen EarthStudy 360 uses both directional and reflection angle gathers to image and detect subsurface local heterogeneities such as small faults and fine fractures. Diffraction weighted stacks applied to directional angle gathers enable high-resolution imaging of the fracture system within the reservoir. Azimuthal-dependent residual moveouts (VVAZ) and amplitude variations (AVAZ), which can be automatically extracted from the full-azimuth reflection angle gathers, provide accurate information about the orientation and density of fracture systems. Additionally, applying azimuthal-frequency absorption analysis (FAVAZ) to these gathers makes it possible to directly predict permeable oil-gas saturation.

## Orthorhombic Model Support

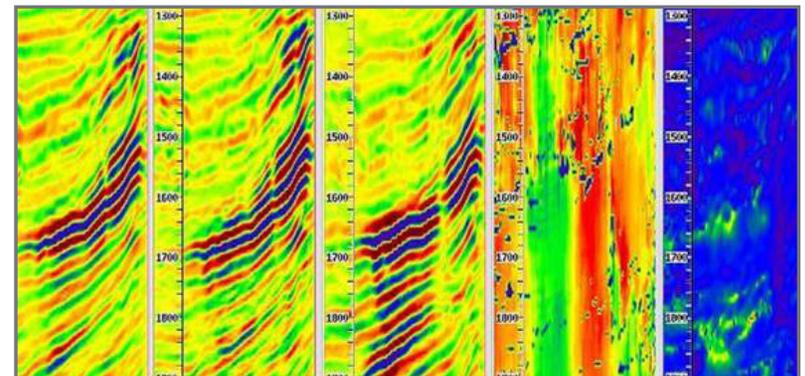
Running the EarthStudy 360 Imager with orthorhombic layer parameters allows users to fully validate the accuracy of their fracture analysis and improve imaging, in azimuthal anisotropic conventional and unconventional plays. This adds another level of confidence and results in better drilling decisions.



Fracture imaging.



Fracture vectors (data courtesy of Seitel Ltd.)

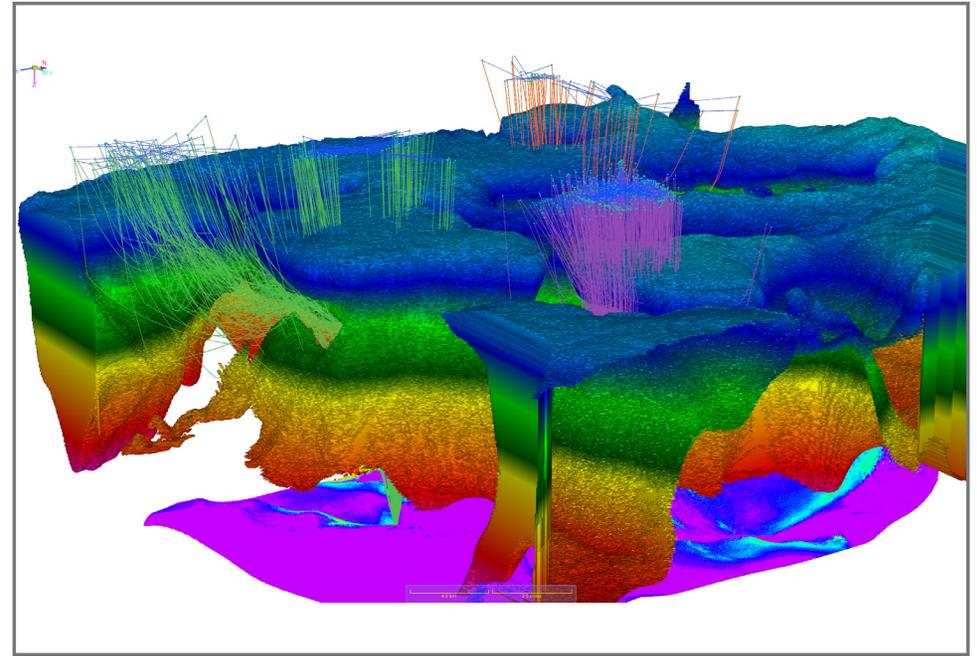


Full-azimuth reflection data (AVAZ attributes).

# Illumination for Seismic Data Mining

The Aspen EarthStudy 360 Illuminator is an advanced seismic data mining tool that provides a previously unattainable breadth of knowledge about ray propagation in complex areas.

The Illuminator uses an enhanced, 2D/3D, interactive and batch ray tracing technology that both quantifies and qualifies the relationship between the surface acquisition geometry and the subsurface angles in targeted areas. Launched from the integrated 3D Canvas, input for the Illuminator includes isotropic/anisotropic velocity models and optionally, data acquisition geometry. Interpreters can generate ray attributes, illumination and reliability maps to gain knowledge about the quality and integrity of the seismic image. A user who wants to know more about why certain areas have low reliability, has access to an extensive set of tools which deliver that knowledge. The results are displayed in a clear visual manner, simplifying even the most complex set of imaging characteristics.



Understanding subsalt uncertainty through illumination study.



# Features

- Support for isotropic and anisotropic models (VTI, TTI and Tilted Orthorhombic)
- Customizable to address specific exploration or development challenges, such as velocity determination and amplitude inversion
- Directivity-driven: Can run in preferred directions with respect to given background directivities (dip and azimuth)
- Beam steering: Performs tapered local slant stack, and migrates only energetic events
- Imaging with local slant stack events, providing significant multiple suppression
- All the display tools that enable visualization of EarthStudy 360 gathers: Velocity Navigator, 3D Canvas and 3D Gather Visualizer
- Generates optimal data for tomographic velocity updates and amplitude analysis
- Includes 2D/3D CRAM for generating conventional reflection angle gathers with no azimuth dependency
- Support for Ocean Bottom Cable acquisition data
- Support for Q Compensation, which compensates for dissipation and attenuation effects
- Support for converted wave mode when multiple component recorded data is available
- Support for definition of frequency as a function of depth
- Support for CPU and GPU clusters

## System Specifications

- 64-bit Red Hat® Enterprise Linux® 7.6+ and 8.4+
- Microsoft® Windows® 10 and 11 (for visualizing and analyzing EarthStudy 360 outputs, and for AVAZ/VVAZ workflows)

# The Aspen EarthStudy 360 Advantage

- Full-azimuth angle domain imaging and analysis maximize knowledge from seismic data.
- Optimizes ROI for deep water, unconventional shale resource plays and fractured carbonate reservoirs.
- Extracts unprecedented value from all modern and legacy seismic data acquisitions, notably those with wide and rich azimuth and long offset.
- Delivers highly accurate isotropic/anisotropic velocity models, especially in complex subsurface areas.
- Delivers high-resolution information about principal reservoir properties.
- Extends the capabilities of leading AspenTech SSE processing, imaging and analysis systems.

## Interoperability

All Aspen Epos™-based applications enable interoperability with third-party data stores, including:

- RESQML 2.0.1
- OpenWorks® R5000.10.6/7
- Petrel\* 2019, 2020 & 2021

*\*is a mark of Schlumberger*

*Original data courtesy of Devon Energy Corporation.*



## **About AspenTech**

Aspen Technology, Inc. (NASDAQ: AZPN) is a global software leader helping industries at the forefront of the world's dual challenge meet the increasing demand for resources from a rapidly growing population in a profitable and sustainable manner. AspenTech solutions address complex environments where it is critical to optimize the asset design, operation and maintenance lifecycle. Through our unique combination of deep domain expertise and innovation, customers in capital-intensive industries can run their assets safer, greener, longer and faster to improve their operational excellence.

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