Seismic Attributes

Seismic Attributes
Enhancing the Seismic Data

When used collectively, Emerson seismic attributes provide details of the structural, stratigraphic and fluid framework not readily visible in seismic amplitude images.

Improve the Subsurface Image

Seismic attributes provide the seismic interpreter with new images that enhance the physical and geometric descriptions of the subsurface. Geometric attributes facilitate the definition of both the structural and stratigraphic framework of the seismic interpretation, while physical attributes may be used as direct hydrocarbon or lithologic indicators. When the seismic response is more complex, attributes may be used to drive advanced interpretation and analysis processes, such as neural network classification, neural network well log prediction, or data reduction schemes like principal component analysis.

Add Value to Interpretation

To meet the needs of traditional seismic data interpretation as well as more advanced and automated classification approaches, Emerson has created a comprehensive library of physical and geometric attributes. A set of traditional Hilbert attributes is augmented by a large selection of derivative attributes, as well as seismic feature and content enhancement attributes such as spectral decomposition, volumetric curvature, volume dip, volume azimuth, and Lightscape™, a transformation for "illuminating" the subsurface. Together, they allow interpretations to proceed with more accuracy, confidence and value.

These attributes operate on the Epos™ integration framework, enabling them to service the full range of Emerson E&P software interpretation, modeling and reservoir characterization solutions without time-consuming data imports. Most of the attributes can be generated on-the-
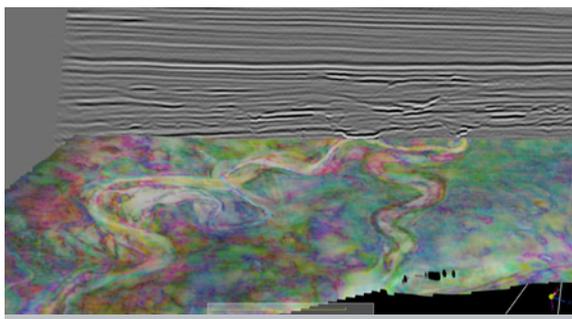
▲ RGB blending of three frequency bands calculated with spectral decomposition

fly, thus avoiding the need to call on special processing departments or create unnecessary intermediate files.

Standalone or Fully Embedded

The attribute packages can be used as a standalone application that operates on seismic files to create new attribute volumes. These functions are also embedded and easily accessible in the SeisEarth™ 3D Canvas interpretation and visualization window, with a subset available in the VoxelGeo™ volume-based seismic interpretation application. With a simple user interface, attributes generated in 3D Canvas and VoxelGeo are ideally suited for the multi-volume rendering and interpretation offered by both systems. Many attributes can be computed using GPU processing, enabling near-instantaneous computation of entire volumes. Additionally, the unique disk caching technology in SeisEarth allows users to roam through large attribute volumes that exceed the memory of the host workstation. The system also enables composite displays of several attributes for quick reference.

Grouped Attributes for Ease of Use

Emerson offers a comprehensive selection of attribute packages. The attributes emphasize different aspects of the seismic volume, enabling interpreters to extract more information with greater ease.

Automatic Fault Extraction (AFE) is a workflow guided application that automates the fault interpretation process. The application uses coherency or discontinuity data to ultimately create faults. The user has the ability to QC and constrain parameters to control the results produced in each step of the workflow.

AFE enables the seismic interpreter to quickly pick hundreds of faults at a time, accelerating the process of identifying, extracting and modeling geologic discontinuities.

The ***Complex Trace and Seismic Trace Analysis Attribute*** package contains a rich set of over twenty different seismic attributes computed from the "complex" seismic trace. These are routinely used to enhance both the physical and geometric description of the subsurface. Automatic Depth/Time/Depth conversion is available for those attributes which must be processed in the time domain.

Coherence Cube® is a patented, industry-leading technology used to extract structural and stratigraphic discontinuities from seismic data volumes. Multiple methods are available for image enhancement. The Coherence Cube package also offers basic complex trace attributes computed on the traces within the aperture, as well as the discrete dip and azimuth volumes
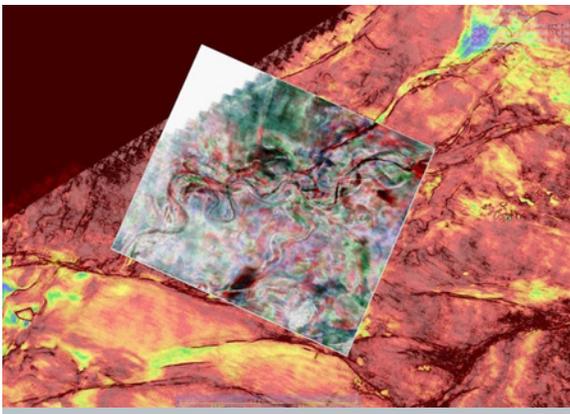
used by the Coherence Cube process. Coherence Cube is part of the Seismic Attribute feature enhancement bundle, which also includes Volumetric Curvature Attributes.

Curvature Attributes – Eleven Curvature Attributes, including Major Principal Curvature, Minor Principal Curvature, Most Positive Curvature and Most Negative Curvature, are available to detect small-scale changes in reflector curvature corresponding to folds, faults, fractures and depositional features.

The *Dip Steered Enhancement Attribute* enables users to smooth input volumes in a 3D dip-consistent manner. Most frequently used to enhance seismic amplitude volumes, it can also be used to smooth any other attribute volume (such as Coherence Cube) using dip and azimuth volumes computed in the Structural Attributes package.

Seismic Pore Pressure is a workflow-guided application for calculating pressure volumes from seismic interval velocities. Steps include computation of hydrostatic pressure, transformation of velocities into density, calculation of overburden pressure, and estimation of the velocities' normal compaction trend. The application then calculates pore pressure, vertical effective stress, horizontal effective stress, and fracture pressure using Eaton's methods.

Spectral Decomposition Attributes are designed to highlight geologic characteristics that respond differently to different frequency ranges of the seismic signal. Spectral Decomposition Calculation replaces the single input trace with a gather of traces corresponding to the spectral decomposition of the input attribute. The input to spectral decomposition is a seismic volume. The output is either a single volume containing the computed gathers, viewed in 2D or 3D Canvas as prestack data; or several volumes, each representing a different frequency band; or a single output volume relative to an interpreted horizon, where the different samples of the volume represent the different frequency volumes of the analysis. Creating spectral decomposition attributes enables illumination of individual structures such as overlapping channel systems with different frequency bands to better illustrate each channel, or to separate overbank deposits from specific channel deposits.

The *Structural Attribute* package includes four geometric properties that highlight the lateral relationships in seismic data: dip, azimuth, continuity and Lightscape. Lightscape applies directional lighting to a seismic volume to emphasize faults and feature boundaries. By simulating a light illuminating the surface from a user-selected location, the interpreter is able to see the volume as if it were an aerial photograph.
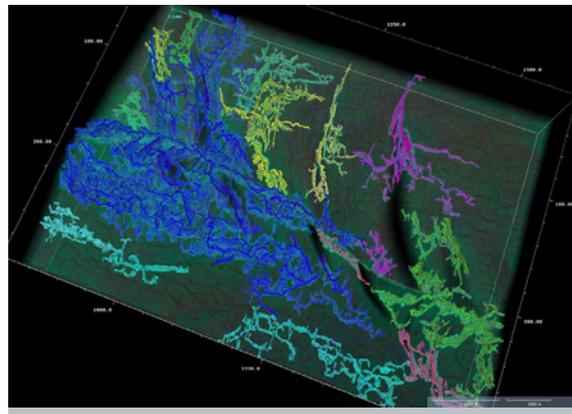
The *Trace Processing Attribute* package contains seven attributes which allow simple trace processes such as filters, scaling, phase rotation and others to be performed in a serial workflow.

User-Defined Attributes may be created via a scientific calculator-style user interface that allows the definition of input volumes, sections, input map grids and scientific functions, to create a variety of formulas. Each formula can be saved and subsequently applied to compute the desired volume, section or map grid.

User-defined attribute functionalities include "if-then" scenarios, multiple sample referencing, variables and comments. All of these enable the user to easily program highly complex computations, which are fundamental to advanced workflows such as pore pressure prediction.

Enhancing Classification and Reservoir Characterization

Seismic attributes are extremely useful for the reservoir characterization geoscientist tasked with building static reservoir models through well log unification, prediction or classification procedures. For users of Stratimagic™ for seismic facies classification and SeisFacies™ for multi-attribute classification, seismic attributes can serve as input to their respective classification schemes, to reveal patterns and details that are not evident from standard interpretation or inspection of the seismic data. For users of the Vanguard™ seismic inversion and property generation system, seismic attributes can be used to predict desired log curves through a neural network inversion. The resultant property volume provides useful input for building or verifying geologic models.

▲ Merge of signal envelope and coherency, with inset of an RGB blending display of spectral decomposition frequency volumes

▲ Subvolume detection of a fault system using an AFE fault enhancement attribute

EMERSON.

Interoperability

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

- RESQML 2.0.1
- OpenWorks® R5000.10
- GeoFrame® 2012
- Petrel* 2019 & 2018
- Recall™ 5.4.2

(*is a mark of Schlumberger)

System Specifications

- Microsoft® Windows® 7, 8.1 and 10
- Red Hat® Enterprise Linux® 6.8 and subsequent minor releases, 7.1 and subsequent minor releases

The Emerson E&P Software Advantage

- A rich set of geometric and physical attributes directly impacts all interpretation projects.
- Fast computation (multi-CPU and multi-GPU) and immediate system access to VoxelGeo, SeisEarth and Stratimagic/SeisFacies streamline the interpretation process.
- Multi-attribute volume visualization in VoxelGeo and SeisEarth facilitates attribute correlations.
- Image processing (voxel opacity) with attribute transformations optimizes visualization of subsurface features.
- Workflows incorporate automatic fault extraction and propagation.
- On-the-fly calculation option enables immediate attribute analysis.
- Versatile and powerful user-defined attribute calculator allows endless customized attribute options.
- Attributes are available in both time and depth domains.

Data courtesy of AWE Limited.

Coherence Cube is a registered trademark of Core Labs.

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