Echos

Seismic Processing

Echos

The industry standard for seismic processing and data analysis

As the industry standard for seismic processing, Echos enjoys widespread usage among international and domestic oil companies, seismic contractors, universities and research institutions. The system is ideal for customers needing reliable, 24x7 computations on high-performance computing clusters, as well as the interactivity required for detailed analysis and continuous image improvement. Echos is routinely deployed to condition seismic data for depth imaging, seismic characterization, interpretation and pore pressure prediction projects.

An Efficient and Versatile Solution

Paradigm™ Echos™ is the oil and gas industry's leading seismic processing system for generating 2D and 3D seismic images of the subsurface. Its popularity is based on its breadth of geophysical applications, its leading-edge geophysics, its transparent blending of batch interactive processing, its architecture for computation parallelization, and its versatile programming development kit for client customization.

Echos is the cornerstone of the Paradigm seismic data analysis offering for advanced seismic processing and imaging tasks, such as 5D data regularization, 3D surface related multiple suppression, challenging noise suppression, signal enhancement, curved ray prestack time migration and Reverse Time Migration. As a member of the Paradigm seismic data analysis family, Echos is used routinely to condition data for depth imaging, seismic characterization (AVO and inversion), seismic interpretation, and pore pressure prediction projects carried out with the Paradigm software suite.

Full Scalability

Through its modular design, open architecture, and adherence to standards, IT professionals and geophysicists can configure and optimize the Echos system according to their throughput requirements, user requirements and business objectives. Running on Linux® 64-bit operating systems, and deployed on the Paradigm Epos™ infrastructure, Echos is fully scalable, from a single laptop to high-performance computing clusters. The system is easily adaptable to multiple users performing multiple tasks.

Innovation in Seismic Data Analysis

Echos is widely appreciated for its highly interactive approach to job building, parameter testing and interactive data analysis. Special interactive and data comparison windows are designed to allow users to quickly see the impact of new processes, parameters and workflows on their seismic data. The outcome of operations performed with these windows includes fully parameterized job flows that can be applied immediately to the entire dataset, with no disruption, on hundreds of compute nodes.

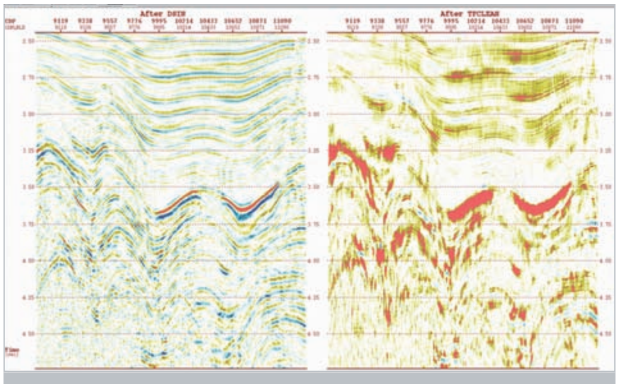
Additionally, the Echos system is fully equipped with a rich set of interactive data analysis applications for seismic survey geometry definition and QC, velocity analysis, signal analysis, trace header analysis, first break picking and QC, and trace editing and muting. All of these applications produce results that can be immediately used in batch processing.

Advanced Geophysical Applications

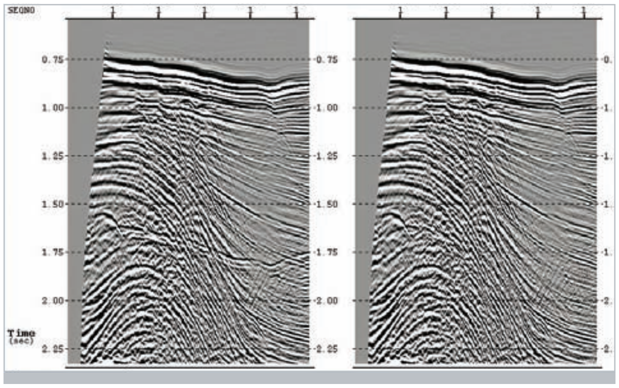
Echos includes a comprehensive library of close to 300 modules for geometry definition, amplitude scaling, wavelet extraction, deconvolution, multiple suppression, noise suppression, statics estimation, interpolation, velocity analysis, seismic imaging and seismic attribute extraction. These applications are based on a robust infrastructure that includes dynamic trace header interpolation, high-fidelity trace sample interpolation, and advanced interpolation methods that handle coordinate data with high precision. The system also supports second, fourth and sixth order normal moveout corrections (NMO).

Surface Related Multiple Attenuation (SRMA)

Surface multiples from irregular 2D and 3D water bottoms are best predicted by the convolution of pre-stack seismic traces from all possible surface multiple reflection locations, and best removed by adaptive subtraction procedures. The Echos SRMA solution is designed for 2D and 3D seismic surveys. It incorporates a true azimuth implementation and is able to handle in-fill and feathering. The application requires minimum data preparation requirements, eliminates the sparse inversion step, and is optimized for cluster computing. In addition to SRMA methods, the Echos system also includes high-resolution Radon transforms and wave equation techniques for the suppression of multiple energy.



▲ Echos seismic data analysis with relative permeability extractions



▲ Surface-related multiple attenuation

5D Data Regularization

Echos includes 5D Fourier and Radon transform-based sampling and interpolation algorithms that utilize a localized set of seismic data to reconstruct the seismic signal. These algorithms have evolved to address a number of common seismic processing issues. Applications include: reducing the footprint effects of an irregular acquisition geometry; equalizing survey geometry differences when merging multiple 3D seismic surveys, interpolation of missing traces and the regularization of the offset and azimuth distribution prior to seismic imaging, and velocity analysis for improved azimuthal analysis of amplitude and traveltime variations. The last area of use is an important enabler for extracting detailed reservoir characterization information from seismic data, such as full-azimuth fracture information and diffraction imaging in EarthStudy 360™.

Model Based Ground Roll Attenuation

Surface waves are a particular form of coherent seismic noise that can contaminate the seismic record. Techniques that address such noise have gained importance with the shift to point source and receivers in land seismic acquisition. The application of standard noise suppression techniques can attenuate only some of the noise, and attempts to apply stronger noise suppression filters may adversely affect amplitude quality. Estimating near surface elastic parameters from the seismic record, modeling the ground roll and then using adaptive subtraction to attenuate the ground roll has advantages in both the handing of the coherent noise, and in the preservation of the underlying seismic signal.

Time-Frequency Analysis

The time-frequency transform and domain describe the energy density of a signal simultaneously in time and frequency. Mapping from signal space to time-frequency space is performed by decomposing the trace into several discrete frequency components over small running time windows. In Echos, this decomposition is performed with Gabor-Morley filters, resulting in a high-resolution and stable decomposition.

In Echos, the time-frequency decomposition is used for:

- Sample-by-sample noise suppression to remove noise bursts from seismic data
- Spectral Decomposition for thin bed detection and attenuation analysis
- Frequency band extension for high-resolution signal analysis
- Dual porosity relative permeability estimation

Deghosting

The large impedance contrast at the water surface causes ghost reflections to appear on marine seismic data, which interfere constructively and destructively with the reflected energy from the subsurface. Echos estimates and applies a recursive deghosting filter to towed streamer or ocean bottom seismic data to attenuate the negative effect of this interference. It uses least squares minimization to estimate the source and receiver ghost times, and the reflection coefficients at the air/water contact.

Curved Ray Prestack Time Migration

Echos can serve as host for the GeoDepth™ prestack time migration add-on module, one of the most popular choices for Kirchhoff imaging in the industry. Parameterized like a standard Echos module, this prestack time migration includes options for:

- Acquisition footprint suppression using Voronoi scaling
- Imaging from floating datum and surface topography
- Image gather, target line or full volume output
- 2nd or 4th order traveltime solutions
- Isotropic or anisotropic curved ray solutions

Reverse Time Migration (RTM)

Reverse Time Migration (RTM) is a preferred solution for imaging seismic data in areas of complex wave phenomena. It is able to handle the most severe combinations of structural dip with high velocity contrast, conditions common in salt basins and other geologic basins with complex structures and velocity distributions. Developed in conjunction with Acceleware® Corporation, Echos RTM includes:

- 2D and 3D prestack and poststack imaging
- Streamer, OBC and onshore solutions
- Isotropic and anisotropic imaging
- Common Image Gather output
- Variable density for both isotropic and TTI models in RTM
- Surface seismic and subsurface (VSP) seismic imaging
- Imaging or forward modeling
- Multi-core CPU or GPU processing

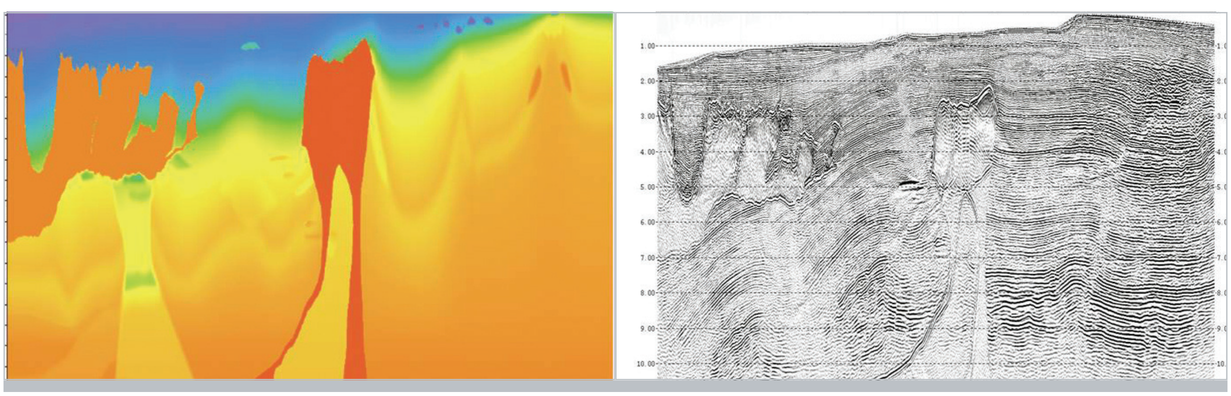
Multi-Component Processing

Echos is equipped with a full suite of seismic processing modules to transform converted wave recordings to interpretable images of the subsurface. The system offers applications for ocean bottom cable deghosting, coupling analysis and correction, orientation analysis and correction, S-wave splitting analysis and correction, rotations to obtain horizontal and vertical shear wave fields, common conversion point binning, converted wave velocity analysis, non-hyperbolic moveout and stacking. Output gathers can be used to initiate 3D converted wave time or depth migrations in the GeoDepth velocity model building and depth imaging system. In addition, many Echos geometry QC applications have been enhanced to support the QC of converted wave data.

Production Monitoring

Echos includes a rich set of utilities used to monitor the progress of jobs running on clusters and cluster performance. These include:

- System CPU and memory usage display for network parallel jobs
- Network-wide job monitoring in a single window
- Job summary list with job display filters
- Composite parallel job performance display
- Per module and per host oriented parallel job display
- Job performance information, including time displays and throughput information



▲ BP 2004 salt model and Paradigm RTM image

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Features

- Customizable production seismic computing
- Innovative link between seismic data and processing parameters and sequences
- A comprehensive library of close to 350 seismic processing applications
- High-performance 5D data regularization
- Multi-component processing
- Production oriented, automated Q determination from seismic data
- Enhanced velocity field generation with the GeoDepth Velocity Navigator add-on module
- Improved subsurface images with the GeoDepth Kirchhoff 3D prestack time migration add-on module
- Depth imaging with RTM (Reverse Time Migration)

Interoperability

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

- RESQML 2.0.1
- OpenWorks® R5000.10
- GeoFrame® 2012
- Petrel* 2017 & 2016
- Recall™ 5.4.2

*(*is a mark of Schlumberger)*

System Specifications

- Red Hat® Enterprise Linux® 6.8 and subsequent minor releases, and 7.1 and subsequent minor releases

The Paradigm Advantage

- Geophysical integrity obtained in over 25 years of customer usage
- State-of-the-art seismic processing and imaging solutions, including SRMA, 5D interpolation and RTM
- The industry's best interactive link between seismic applications, parameters and data
- Data compatibility with other Epos-based products, for expanded workflows and project coverage
- An open solution with programming libraries and tool kits for client customization
- A highly efficient parallel framework and infrastructure for cluster optimization

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