SeisSpace® Software

OVERVIEW
Delivering large volumes of data quickly and accurately remains the hallmark of any seismic processing system. With intuitive analysis tools, state-of-the-art geophysical algorithms and an optimized parallel infrastructure, the SeisSpace® Seismic Processing System helps teams get the most out of their seismic data, while increasing productivity and reducing project cycle times.

BENEFITS
Easy-to-Use
Building, executing, and managing multiple processing flows has never been easier in a production processing environment. The SeisSpace Navigator provides the professional processor with all the tools required to design, execute and oversee processing jobs from small validation tests to large processing jobs that task thousands of compute nodes.

Seismic data, velocities and other tables can be interrogated and displayed at the click of a button. Seismic Compare is a powerful and interactive tool that makes it easy to compare data from multiple iterations or to aggregate data from multiple sources into a single display that provides the processor with all the information needed to tackle the most complex geophysical problems.

Scales to Hardware
The SeisSpace processing system and parallel trace processing engine is designed for efficient sorting and processing of data for a variety of geophysical workflows from noise attenuation to depth imaging. JavaSeis was developed from the ground up to support parallel execution in large distributed environments. JavaSeis allows reading and writing to the same dataset simultaneously by independent jobs enabling SeisSpace users to easily build jobs that scale across multiple nodes without having to manually split and combine the data. SeisSpace users can easily recover from job or hardware failures incrementally without having to rewrite entire datasets. SeisSpace provides graphical tools to interactively visualize the results while the data is still being processed to confirm the results are as expected long before the job has completed.

SeisSpace enables the processor to be able focus on the science instead of being a glorified data manager.

KEY VALUE
» Derive greater value from your seismic data investment with a comprehensive suite of geophysical algorithms
» Increase productivity and reduce cycle times with our optimized volume-processing engine
» Better understand the subsurface and characterize the reservoir with our suite of depth imaging tools
» Easily develop and integrate new proprietary geophysical algorithms
» Collaborate closely with interpreters during the processing sequence by leveraging SeisSpaceLINK to create a dynamically connection with DecisionSpace®
FEATURES

Data Conditioning

The software includes hundreds of modules for processing goals, such as statics, flattening, deconvolution, filtering, multiple suppression, AVO, scaling, interpolation, and velocity analysis.

In addition to the wide array of 2D algorithms such as the radon transform displayed in Figure 3, the software also provides interactive full-waveform 3D noise-suppression tools, such as FKK and FXY deconvolution. Interactive visualization tools are provided to help design complex filters such as the FKK filter that varies by azimuth, frequency, and surface location. In Figure 4 the left image is a wave number “k” versus frequency slice along a single azimuth. The right image is an all-azimuth kx versus ky slice through a specific frequency. These built-for-purpose tools provide the required visual feedback for designing and applying complex filters.

Processing and Merging Prestack Seismic Surveys

Although 3D seismic data are being acquired in larger volumes than ever before with wider azimuths and higher fold, the spatial sampling of these volumes is not always adequate for certain seismic processing sequences. Simultaneous interpolation in all five seismic data dimensions inline, crossline, offset, azimuth, and frequency has great utility in predicting missing data with correct amplitude and phase variations as was shown by Trad in 2009 (figure 5). 5D interpolation is now commonly used in anti-aliasing workflows such as suppressing acquisition footprint noise and when combining multiple vintage prestack seismic surveys. SeisSpace provides the processor with industry standard algorithms such as Minimum weighted Norm inversion (MWNI) along with unique graphical tools, such as the QC plot shown in Figure 6 to help design the interpolation operators.

Geologically guided data enhancements

Structure tensor technology developed by the Center for Wave Phenomena (CWP) at the Colorado School of Mines provides sophisticated new techniques for geologically enhancing images and deriving new structurally constrained attributes. SeisSpace provides these exciting new structure tensor derived technologies to the processors while enabling the use of a powerful parallel processing system. Structure tensors are utilized for numerous workflows such as;

» Smoothing along structures while preserving discontinuities such as faults or channels
» Computing additional structure oriented attributes such as semblance, azimuth and dip
» Constraining velocity updates in Migration Velocity Analysis (MVA) or Full Waveform Inversion (FWI) workflows to provide geological constraints
» Computing fault tracking which is an attributed utilized by DSG for Automated Fault Interpretation
The SeisSpace structure tensor tools are utilized in many diverse workflows and below are a few of the key applications;

» Figure 8a shows an example of a stacked seismic volume before and after applying structure oriented smoothing.
» Figure 8b shows an example where structure oriented dip has been overlaid with the seismic.
» Figure 8c is an example showing how structure tensor information can be used to constrain a velocity update with some additional geological context. The left panel shows then unconstrained velocity update while the panel on the right is the velocity update after tensor based constraint.

Depth Imaging
The Landmark Depth Imaging (LDI) software suite can be added to your SeisSpace system as an add-on set of tools delivering advanced imaging technology, such as acoustic and elastic forward modeling, reverse time migration, illumination and visibility analysis, tomographic velocity updating, poststack demigration/remigration, and full waveform inversion.

Forward modeling technology now available in LDI was utilized to model the SEG SEAM Phase I data. According to the SEG, “SEAM Phase I: Challenges of Subsalt Imaging in Tertiary Basins, with Emphasis on Deepwater Gulf of Mexico” has been a resounding success!

The SEAM project has taken much effort to generate realistic synthetic data for a complex salt body typical of the Gulf of Mexico. (Fehler, 2009; Abriel, 2009; Fehler & Larner, 2008; Bednar et al., 2006) “The model dimensions and data collection are of realistic size. The combination of model size and data collection parameters increased the compute by a factor of 52,000x over that of the 1996 SEG Salt model commonly used in the past for subsalt synthetic tests. (Aminzadeh et al.,1995; Aminzadeh et al.,1996; House et al.,1996)”

Imaging Algorithms
Landmark provides depth imaging algorithms suitable for workflows from unconventional prospects to complex subsalt deep water targets. SeisSpace provides industry standards such as Kirchhoff time and depth imaging, one-way wave equation algorithms and advanced reverse time migration algorithms.

Figure 8a

Figure 8b

Figure 8c

Figure 9: SEG SEAM Phase I

Figure 10: Left image is a standard wave equation migration; right image is advanced reverse time migration of the SEAM data.
The SeisSpace patented nonlinear stack enhancement tool can dramatically improve the final depth image quality as can be seen in this example from the SEAM project. Figure 11 is a depth slice from the SEAM model beneath the salt body. The left panel Figure 11a illustrates that the conventional stack of this poorly illuminated region suffers from residual noise and continuity of the sediment layers is muddled and hard to interpret. The right panel Figure 11b shows that applying the 3D nonlinear stack enhancement approach gives dramatic improvement in the image quality.

Visibility Analysis
Seismic visibility analysis quantitatively estimates the reflection strength for shots and receivers from a target event. The overall visibility strength illustrates whether the target event is visible or invisible to surface seismic imaging. These insights are applied to target-oriented imaging workflows and can be used in optimizing acquisition parameters to ensure sufficient reflections from the target.

Visibility analysis provides quantitative information about the data that needs to be migrated for a target event. It can dramatically shorten the processing cycle for iterative imaging and model building. In addition, visibility analysis provides useful insights into the study of poorly imaged targets such as subsalt areas, and can reduce noise from extraneous data.

Visibility analysis helps in optimizing acquisition parameters, such as long-offset and azimuth coverage for WAZ and other acquisition geometries. It is also helpful to determine the amount of data that needs to be licensed when just focusing on a prospect area.

Velocity Modeling
Developing accurate velocity models for depth imaging still remains one of the most challenging, time consuming and critical steps in delivering depth images. Seismic Compare provides the processor with all the necessary capabilities to create composite views of all the needed data such as stacked seismic volumes, interval velocity models and the anisotropic properties such as delta, epsilon, eta, prestack seismic gathers, semblance and residual moveout. In addition to bringing all these import data types together in an interactive view, Seismic Compare allows the processor to load multiple iterations of all these data elements and interactively compare the results from multiple iterations.
Collaborating with the Asset Team

Processors using SeisSpace software can easily collaborate with interpreters using the DecisionSpace® Geosciences suite, giving asset teams a better understanding of data amplitudes and structural seismic images while reducing reprocessing bottlenecks.

OPERATING SYSTEMS

» Linux Red Hat® CentOS 6.4 or higher

HARDWARE

» 2 GB Ram/Core, Dual-CPU Intel® or AMD® Processors

RELATED PRODUCTS

» Landmark Depth Imaging (LDI) Suite
» OpenWorks®
» DecisionSpace® Geosciences Suite

ONSHERE CONVENTIONAL AND UNCONVENTIONAL MARKETS

» Utilizing SeisSpace 10, processors can produce accurate and timely seismic images of everything from low-permeability sands and naturally-fractured shale, to structurally-complex, overthrust environments. Processors can quickly in-fill missing data using 5D interpolation and 3D regularization along with merging overlapping 3D surveys onto a common grid.

OFFSHORE AND DEEPWATER MARKETS

» Processors can significantly reduce cycle-time for very large marine datasets. SeisSpace 10 features industry-leading depth imaging algorithms (Kirchhoff, WEM, RTM) coupled with tomographic migration velocity (MVA) analysis tools deliver the most accurate representation of complex reservoirs.

Development Kit for Proprietary Algorithms

SeisSpace provides a mature, stable platform for developing proprietary algorithms. This environment makes it easy for energy companies, contractors, and third parties to develop and maintain differentiating technology. The standard license includes a development kit for building and integrating proprietary processing algorithms. As shown in Figure 16, geophysical developers can utilize modern tools and technologies to develop complex algorithms that can be integrated into the system and run in production alongside SeisSpace algorithms.

Scalable, parallel computing yields highly-efficient processing constrained only by the compute resources.

LANDMARK OFFSHORE

Landmark offers solutions to help you deliver on your business strategies. For questions or to contact your Landmark representative, visit us at www.landmark.solutions.

Sales of Halliburton products and services will be in accord solely with the terms and conditions contained in the contract between Halliburton and the customer that is applicable to the sale.

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