



Paradigm 19p3

Leading Science
Deeper Insights



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The Paradigm 19p3 release offers additional functionalities and enhancements to support Emerson's strategic focus on usability, productivity, automation, performance and collaboration in all E&P software domains, from seismic processing and imaging to reservoir modeling. The result is more efficient workflows, accurate results that reduce uncertainty, and cost savings across our customers' entire organization.

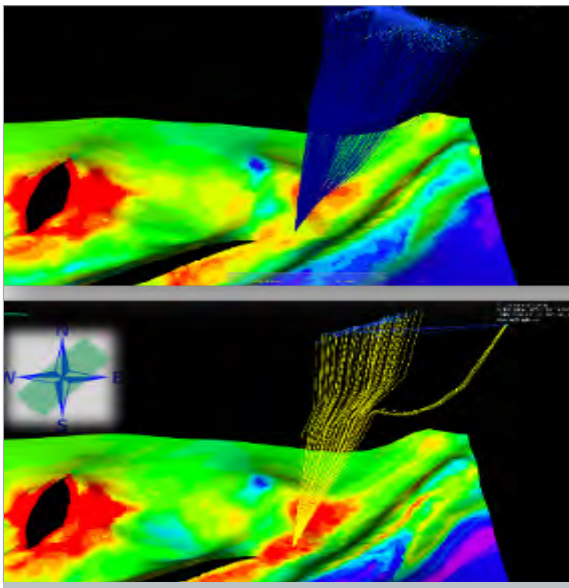
Available both as a cloud-hosted and on-premise solution, Paradigm 19p3 continues to deliver best-in-breed software applications and workflows while ensuring maximum flexibility, scalability and performance at all levels of use.

The Kaleidoscope Project

Kaleidoscope is a technology collaboration project between Emerson and Repsol designed to bring advanced subsurface seismic imaging technologies to the oil and gas industry.

The objectives of this collaboration include:

- **Time to result.** Accelerate the time to first oil by collapsing the time from seismic imaging to prospect identification. By embedding the Kaleidoscope technologies in Emerson's E&P seismic imaging, interpretation, and modeling platform, the power of Repsol's technology with Emerson's high-end



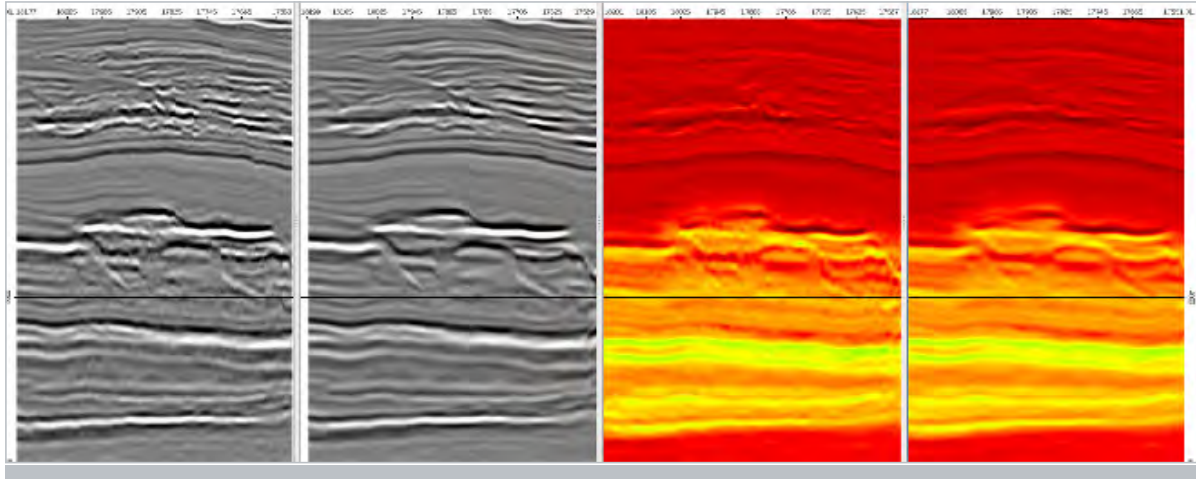
▲ Full-azimuth illumination before (top) and after (bottom) raw filtering. Tempest velocity model courtesy of Devon Energy.

visualization and interpretation establishes the connections needed to compress project timelines.

- **Democratization of technology.** Democratization allows geoscientists from Repsol and other oil and gas operators to experience and exploit the value of advanced subsurface imaging technology.
- **Better asset team cooperation.** Kaleidoscope is a valuable asset for improving ties between the seismic imaging, modeling, and seismic interpretation communities. Advanced tools that were previously used by seismic imaging experts are now available to interpreters for their daily work, enhancing collaboration across domains.
- **Cloud enablement.** Based on Emerson's experience in cloud deployment of workstation and high-performance computing (HPC) applications, the full advantage of cloud services and cloud computational elasticity can be leveraged for the complete suite of Kaleidoscope applications.
- **Deep water and onshore prospecting and evaluation.** Originally developed for deep water objectives, many of the applications have been adapted to onshore seismic acquisitions, increasing the value for oil and gas operators with significant onshore assets.

Paradigm 19p3 includes the following Kaleidoscope applications:

- **Full-azimuth Illumination:** New functionalities for understanding how seismic acquisition affects illumination. This technology, which has always been available to seismic imaging specialists and seismic interpreters, is now also a useful tool for seismic processing and acquisition specialists. Structural guided seismic enhancement: Improves seismic images along the structure.
- **Velocity Accelerators**
 - **Seismic guided velocity smoothing:** Smooths the velocity grid in way that is guided by the seismic structure, providing a geologically consistent result.
 - **Seismic guided velocity interpolation of well logs and vertical functions**
 - **Desalting:** Enables editing an existing velocity model to exclude a salt body and replace it with background sediment velocity; the new velocity model can serve as a background model for tomographic updates or migrations.



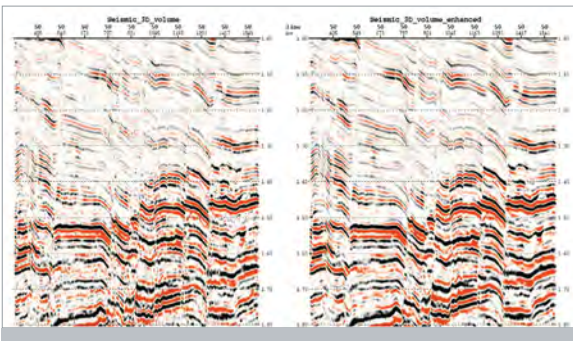
▲ From left to right: Input seismic, enhanced seismic, original velocity attribute, structurally smoothed velocity attribute, using the structural smoothing tool.

- Seismic poststack demigration/migration (RTM-based) for rapid and accurate redepthing
- Structural guided seismic enhancement: Enhances seismic images along the structure using the structural tensor to enhance correlated events and clean up noise, while preserving important discontinuities such as faults and channels. The result is an enhanced seismic image optimized for interpretation.
- Partial Stacking - An application designed to improve the seismic image when stacking Vector Offset Gather (VOG).

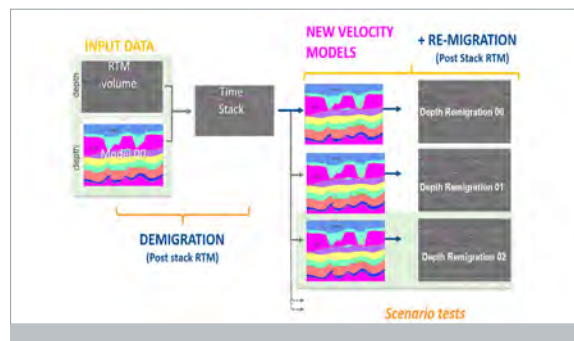
High-resolution Seismic Processing and Imaging

- Refraction tomography and refraction/reflection tomography for accurate and consistent shallow-to-deep velocity model building; highly performant on large datasets
- Ability to vary the tomography grid with depth, enabling high resolution shallow modeling
- 3D refraction tomography for shallow velocity model building in time processing workflows

- A framework for running parallel tomography jobs with different parameters enhance productivity and understanding of sensitivities and uncertainty.
- EarthStudy 360 GPU cluster support provides a performance boost for large-scale ultra-dense data sets consisting of high maximum shot fold.
- EarthStudy 360 support for shot input mode removes hardware requirements for large local disks, improving cost effectiveness, especially for the cloud.
- Elimination of I/O initialization time, improving EarthStudy 360 productivity, particularly important for cloud runs.
- A converted wave imaging mode in EarthStudy 360 delivers substantial improvements in areas below gas clouds or salt domes.
- Significant extensions to 3D Kirchhoff migration workflows, including an OVT binning application.
- Additional usability and productivity when handling large numbers of 2D lines.



▲ Original seismic image (left); improved image (right) using the structural-guided enhancement tool.



▲ Poststack seismic demigration migration (RTM-based) workflow

- New options for seismic noise attenuation by radial trace transformation, seismic residual statics solutions, and seismic survey merging by 5D data reconstruction.
- Echoes support for Python script, enabling the easy addition of custom modules.

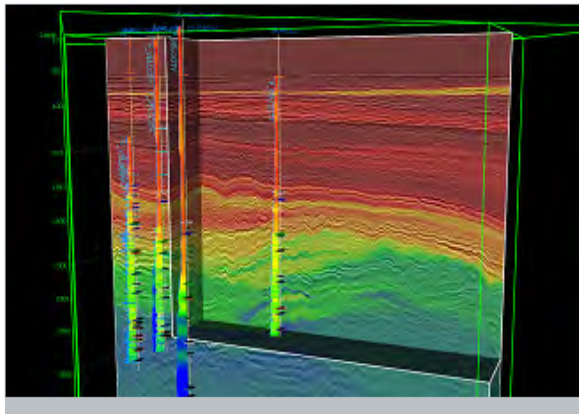
High-resolution Seismic Interpretation Workflows for Interpreters

Using a workflow-driven user interface, the Emerson portfolio of Workflows for Interpreters offers unique, best-in-class technologies in the same integrated platform where day-to-day interpretation is performed. Advanced functionalities, such as seismic classification, advanced visualization, geobody picking, quantitative seismic interpretation, and others, are available directly within a comprehensive interpretation environment, with no need to move to specialized software from third-party vendors.

With a seamless workflow, consistent user interfaces, and common viewers, Workflows for Interpreters preclude the need to learn new applications, and eliminate the challenges associated with moving data between platforms, including the risk of data duplication, loss of data integrity, etc. The integrated workflow improves productivity while also enabling faster product adoption and a reduced learning curve.

New Workflows for Interpreters include Principal Component Analysis and Multi-body Geobody Detection (created by migrating Stratimagis™ and VoxelGeo™ functionalities into the Integrated Canvas).

- Chained workflows: The ability to chain workflows together adds efficiency to the overall interpretation workflow and marks a significant step towards automation and retrieval of repeating workflows.
- Import and display of outcrop data in 2D interpretation windows, to validate and guide interpretations in poor-quality onshore seismic data.



▲ Seismic guided interpolation: Interpolated velocity from logs overlaid on seismic

Poststack velocity modeling

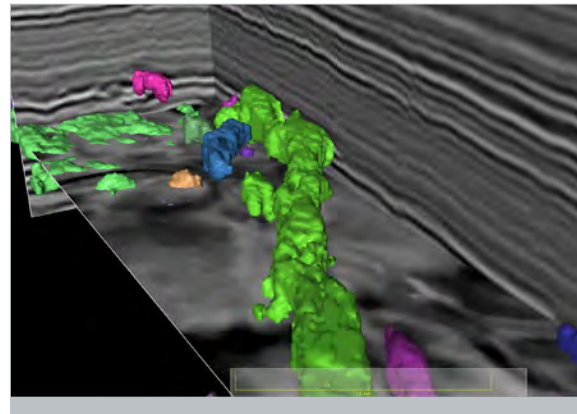
- Enhanced workflows for velocity modeling with wells as the primary input – from calibrated time-depth curves or on-the-fly intersection of well trajectories with seismic interpretations in time.
- Calibration of velocity models and seismic velocity functions using checkshots.

Quantitative Seismic Interpretation

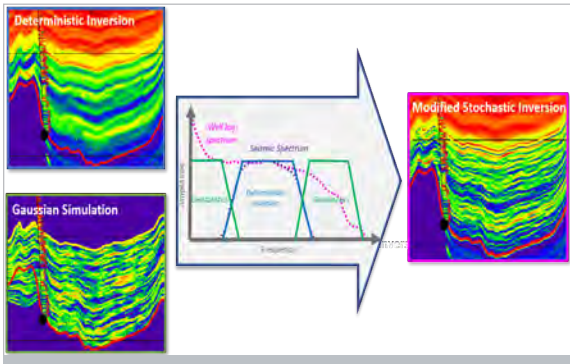
- A groundbreaking stochastic inversion workflow (Modified Stochastic Inversion – MSI), demonstrating excellent performance and the ability to handle very complex sub-surface structures.
- 3D Geostatistical Operations workflow enabling the creation of log volumes using SKUA/GOCAD technology.
- Enhancements to rock physics analysis, including a powerful multi-attribute crossplotting capability that boosts productivity and improves the user experience.

Formation Evaluation

- Increased efficiency through new data query and visualization tools, including a timeline view showing operational events for a well; these lead to vastly improved information management productivity.
- Improved user experience when setting up a real-time geosteering environment through streaming WITSML data directly into the Geolog™ Geosteer™ module.
- Early detection of hydrocarbons present in the drilled formations through the addition of a mud gas analysis module, enabling safer drilling through early detection of gas kicks.



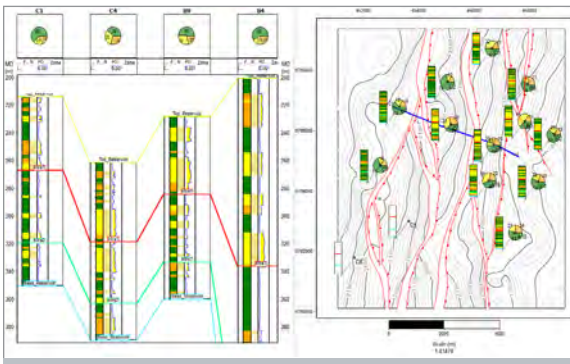
▲ Workflows for Interpreters employ a workflow-driven UI while offering best-in-class technologies in the same integrated platform where day-to-day interpretation is performed.



▲ The innovative MSI workflow creates multiple high-frequency realizations of the reservoir that match the seismic data.

Geological Modeling

- Increased support for batch processes and parallel runs, and smoother integration with Tempest™ ENABLE, improving the usability of integrated reservoir modeling and uncertainty workflows.
- Streamlined automation in SKUA-GOCAD™, enhancing the ability to re-run all reservoir workflows for fast model update and uncertainty quantification, considerably reducing time-to-business decisions.
- A combination of Jacta reservoir risk assessment, SKUA structural uncertainty (faults and horizons), and SKUA-GOCAD's dynamic modeling workflows, to enable systematic, comprehensive, and rigorous reservoir uncertainty analysis. This automation enables SKUA-GOCAD to become a core component of Big Loop™.
- Refine SKUA-GOCAD UVT-based models to better fit high-resolution input data. Use to construct robust models, boosting confidence and empowering model-centric geophysical workflows such as tomography and stratigraphy-constrained velocity modeling.

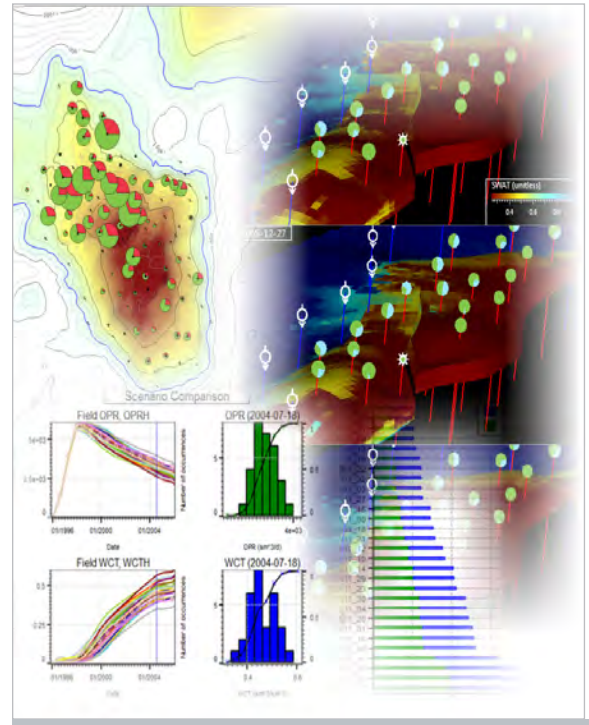


▲ 2D displays in SKUA-GOCAD and StratEarth improve ease of use and ensure better data visualization, QC and interpretation.

- Improved usability of velocity conversion tools and better management of Seismic Reference Datum, significantly simplifying velocity modeling workflows for offshore fields.
- A 3D factorial kriging algorithm which decomposes a property into multiple components based on spatial analysis of the input signal, allowing a reduction in both noise levels and seismic acquisition footprints.
- Improved data flow between SKUA-GOCAD and Epos for well markers and stratigraphic data, increasing efficiency and facilitating collaboration between users.
- Enhanced usability for various 2D displays, significantly reducing the number of mouse clicks needed to perform specific tasks.

Data Management and Open Systems

- Audit trail for well operations performed in Epos applications.
- Seismic collections and seismic maturity labeling and tracking.
- Line List activation from Session Manager.
- Unique seismic identifier.
- Recent and survey sessions.
- Deployment of Python environment as a part of Geolog installation.



▲ Reservoir uncertainty workflow - an integrated display of results.



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