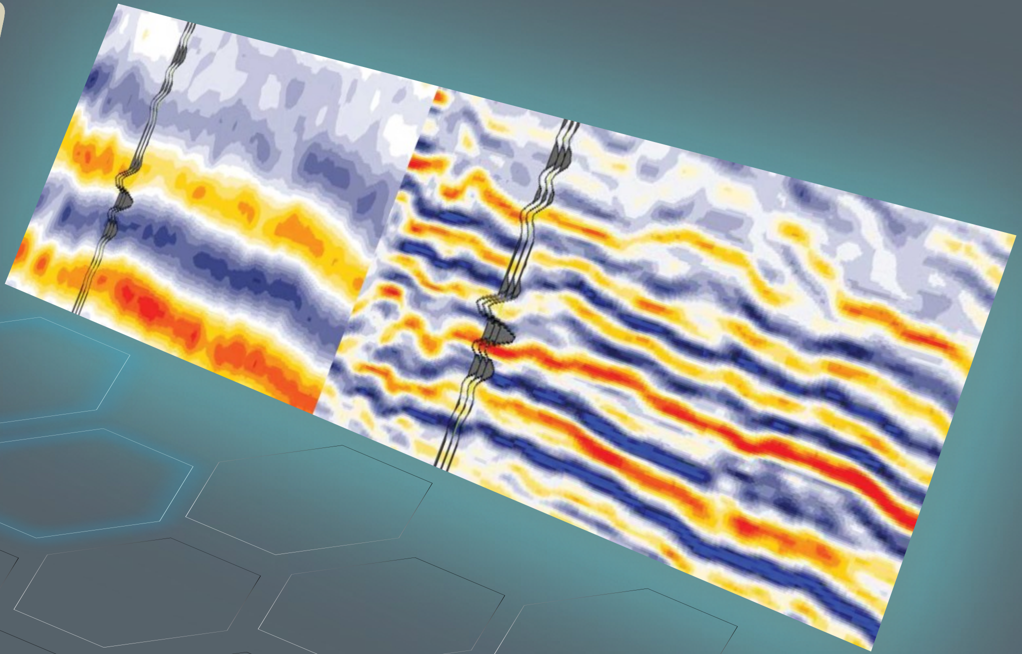
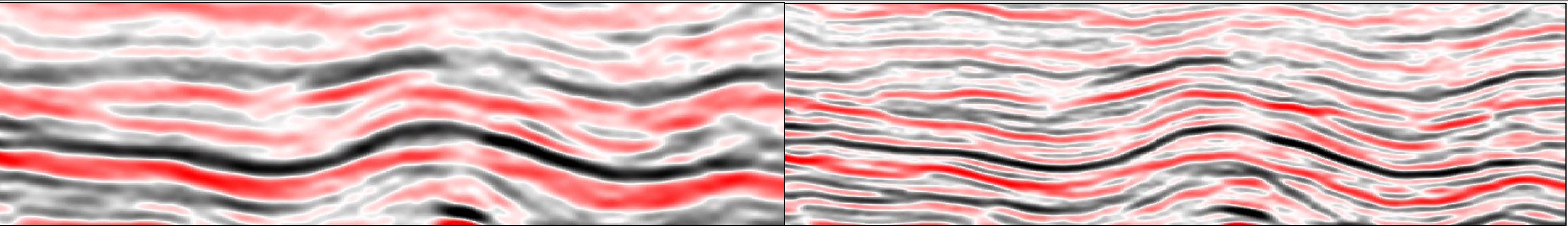
Seismic Geometric Decomposition

Detailed Seismic characterizations



CAYROS group 2023

SGD LEADS TO BETTER-INFORMED DECISION MAKING



Seismic Geometric Decomposition is a powerful set of seismic workflows that facilitate the detailed analysis of internal seismic reflector architecture. This approach generates high-definition seismic volumes that can be utilized to enhance the accuracy of structure and stratigraphic analysis within standard interpretation workflows.

The output of the SGD process is a series of detailed seismic volumes, which can be used to better delineate the fault system, identify external and internal reservoir architecture, recognize reflectivity patterns for geomorphological analysis, and generate high-resolution rock property volumes.

With SGD, geoscientists can gain valuable insights into complex geological structures and better understand the behavior of hydrocarbon reservoirs, resulting in more informed decision-making and improved exploration success.

The core of SGD workflows is a US Patented technique.

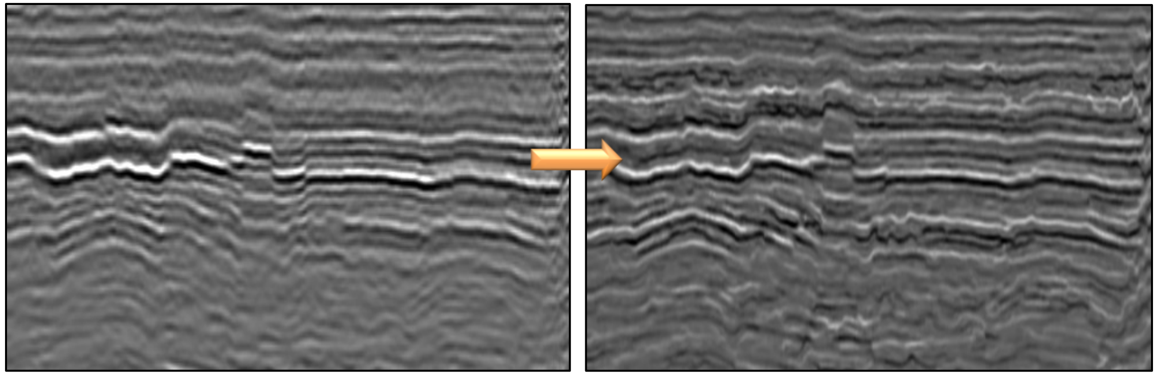
CAYROS COMPETITIVE SEISMIC CHARACTERIZATION

In addition to performing a wide range of standard seismic characterizations, we also specialize in utilizing SGD workflows.

Seismic Geometric Decomposition (SGD) is a series of seismic workflows that enable the capturing of internal architecture of seismic reflectors. The workflow for a disruptive seismic characterization using all SGD attributes and machine learning is as follows:

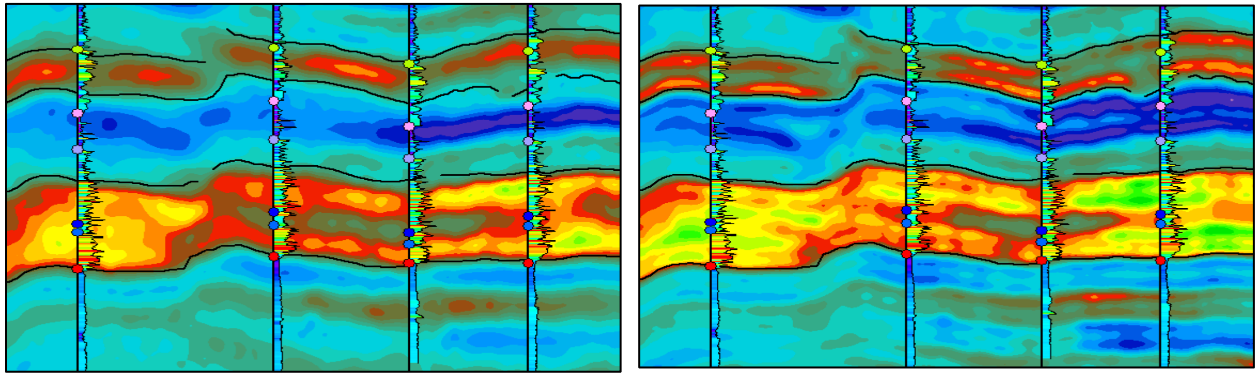
- Pre-processing and conditioning of seismic data.
- Application of all SGD attributes to generate high-definition seismic volumes.
- Application of machine learning algorithms to identify patterns and features in seismic data.
- Integration of machine learning results with SGD attribute volumes and well information.
- Interpretation of seismic data using the new generated seismic vintages.
- Standard workflows to produce high resolution Fault, Curvature, Spectral Decomposition, 3D Facies and Rock Property volumes (EEI, AVO, Simultaneous Inversion…etc)

SGD MAIN CHARACTERIZATION WORKFLOWS



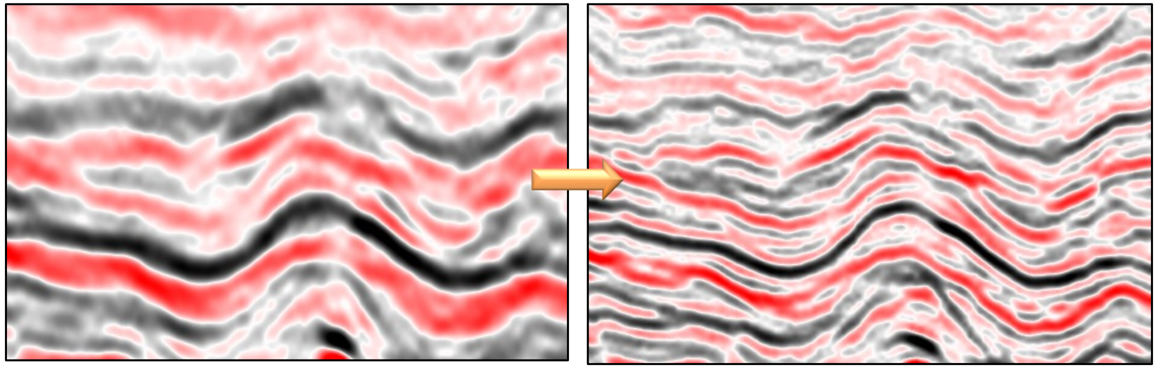
Fibonacci Reconstruction

Fibonacci Reconstruction technique is a method used to enhance the quality of seismic data by improving both low and high frequencies. This approach is particularly useful for improving the accuracy of structural and stratigraphic analysis in areas with no well information



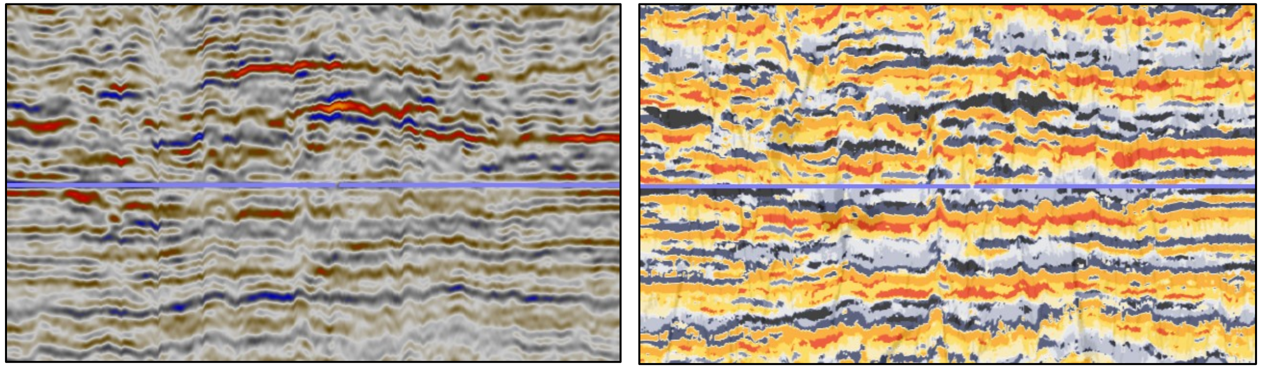
SGD Spectral Inversion

SGD Spectral Inversion is a technique that utilizes high frequency components generated by the Seismic Geometric Decomposition (SGD) method, combined with machine learning algorithms, to produce high resolution rock property volumes.



SGD HF

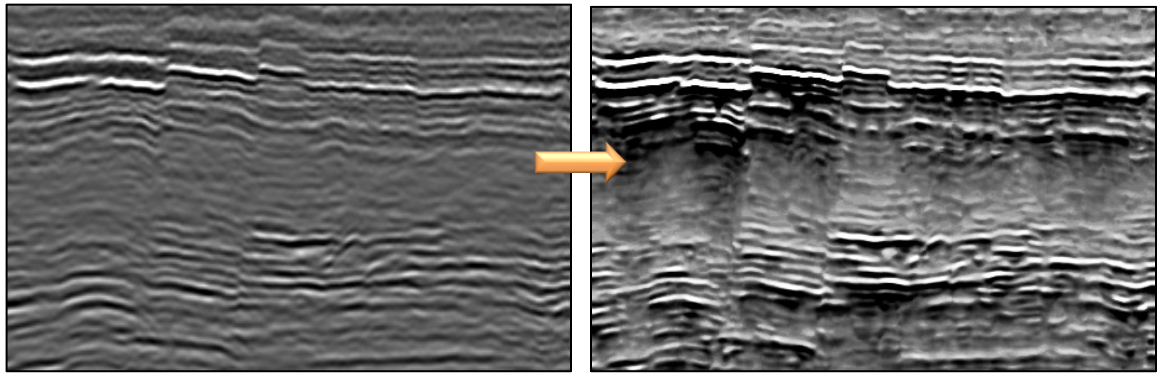
SGD HF is designed to honor the amplitude spectrum of seismic data, allowing it to capture the full range of seismic frequencies. This enables the method to produce detailed fault mapping and high-resolution images of subsurface structures. By using SGD HF, internal reservoir architecture can be accurately captured and analyzed.



SGD 3D Facies

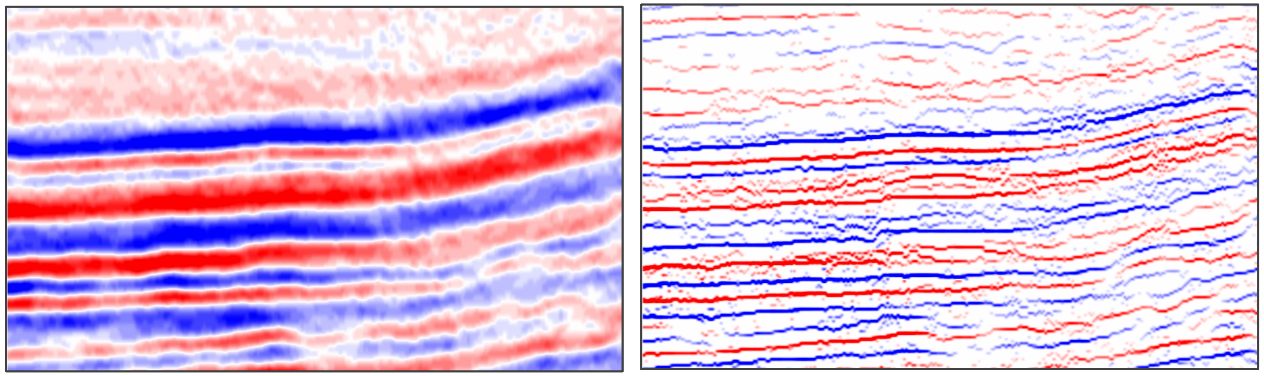
SGD 3D Facies analysis is a powerful technique for capturing valuable insights into subsurface properties. By using a combination of SGD attributes, colored inversion, and machine learning algorithms, this workflow accurately captures lateral changes in the reflectivity pattern, providing detailed information on subsurface structures and properties.

SGD MAIN CHARACTERIZATION WORKFLOWS



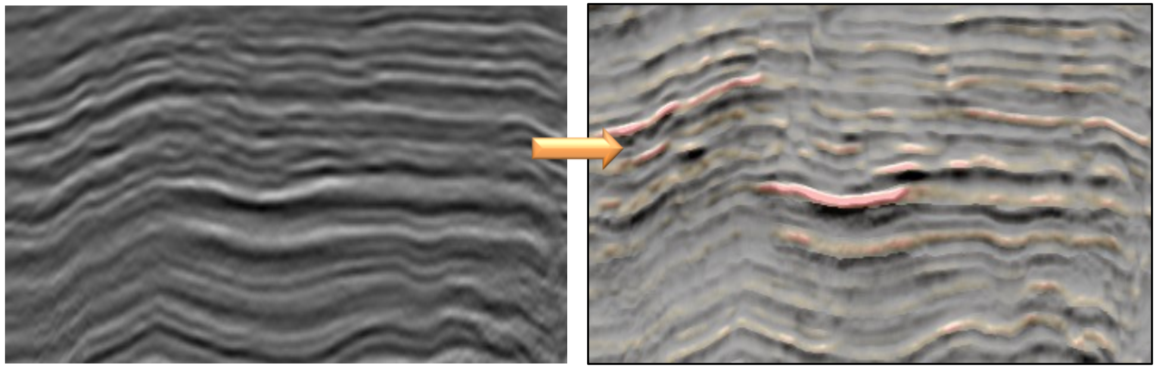
SGD TERRAIN

By generating seismic volumes with texture or morphology appearance, SGD Terrain allows for the rapid detection of Structural and Stratigraphic Patterns that would be difficult to identify using traditional seismic analysis techniques.



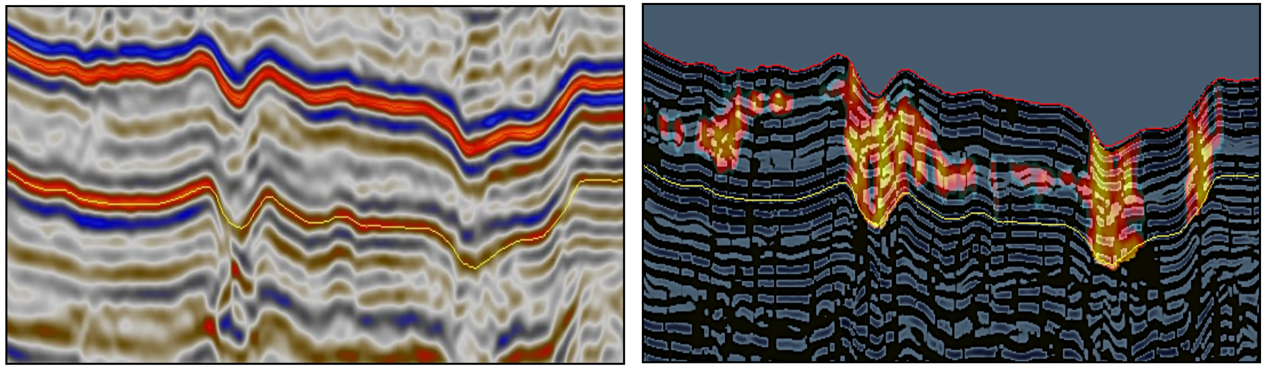
SGD Layering

SGD Layering is a seismic workflow that is specifically designed to optimize the identification of subtle internal reservoir features. This is achieved by using SGD High Frequency (HF) as input to a thin reflectivity inversion.



SGD TERRACE

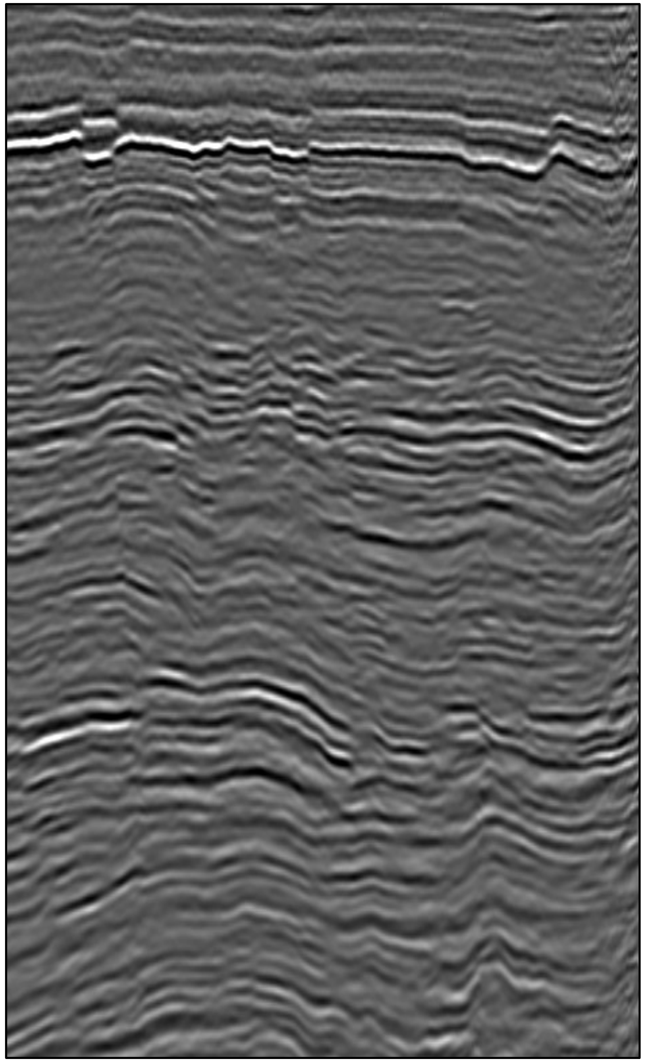
SGD Terrace is a powerful seismic attribute that is specifically designed to optimize the vertical and lateral delineation of stratigraphic features. By capturing the relative acoustic impedance bandwidth, SGD Terrace accurately represents the subsurface geology, while also providing a relief texture that enables rapid identification of features of interest.



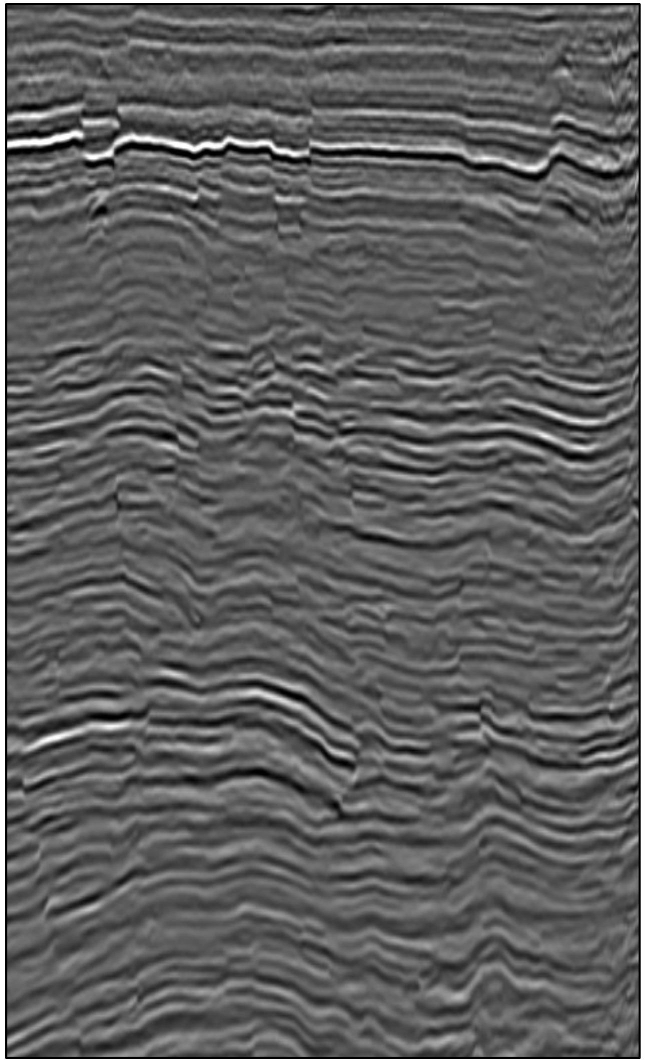
SGD Estrata

SGD Estrata is a seismic workflow that is specifically designed to capture subtle changes in the curvature of seismic reflectors. This enables the generation of high-resolution curvature volumes that can be used to optimize the delineation of a wide range of geological features, including paleo karst and subtle stratigraphic features.

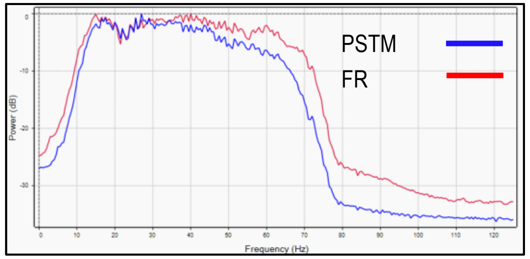
FIBONACCI RECONSTRUCTION

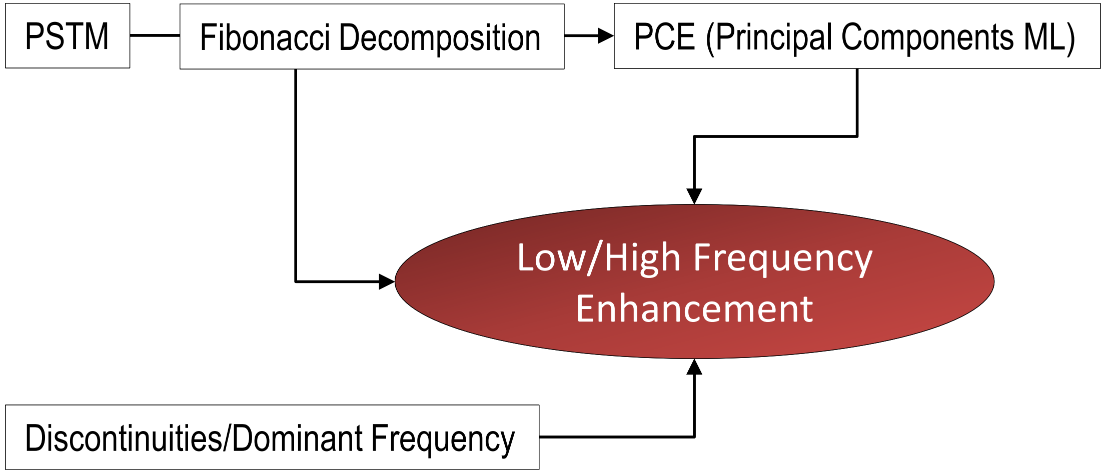


PSTM



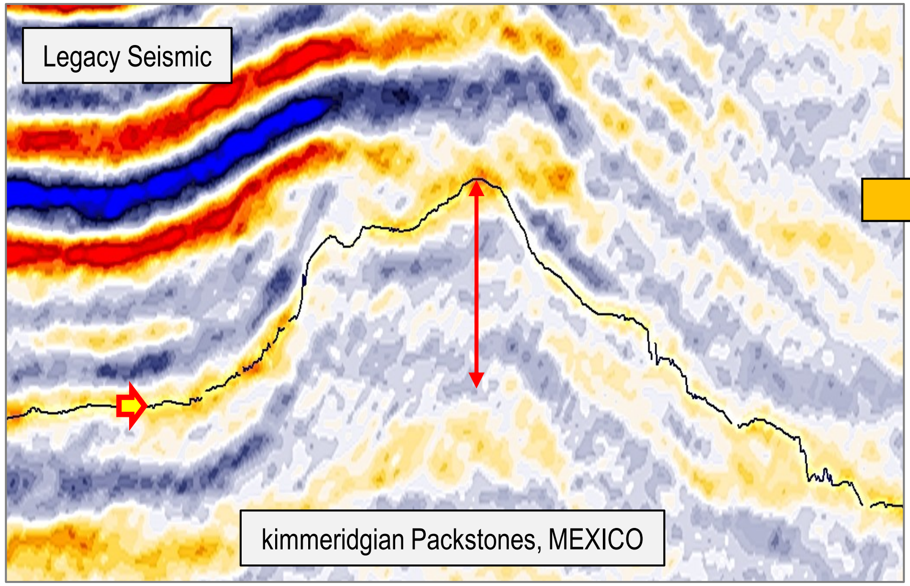
Fibonacci Reconstruction

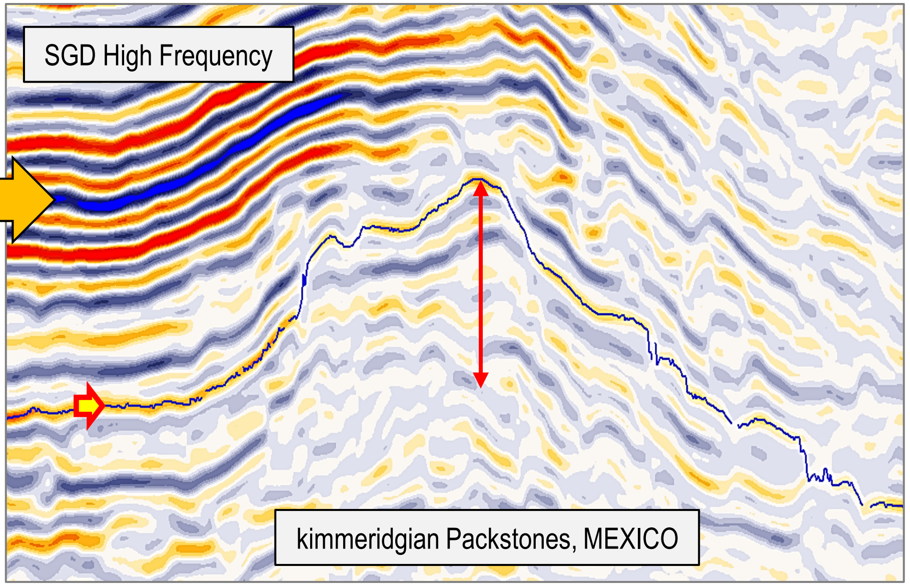


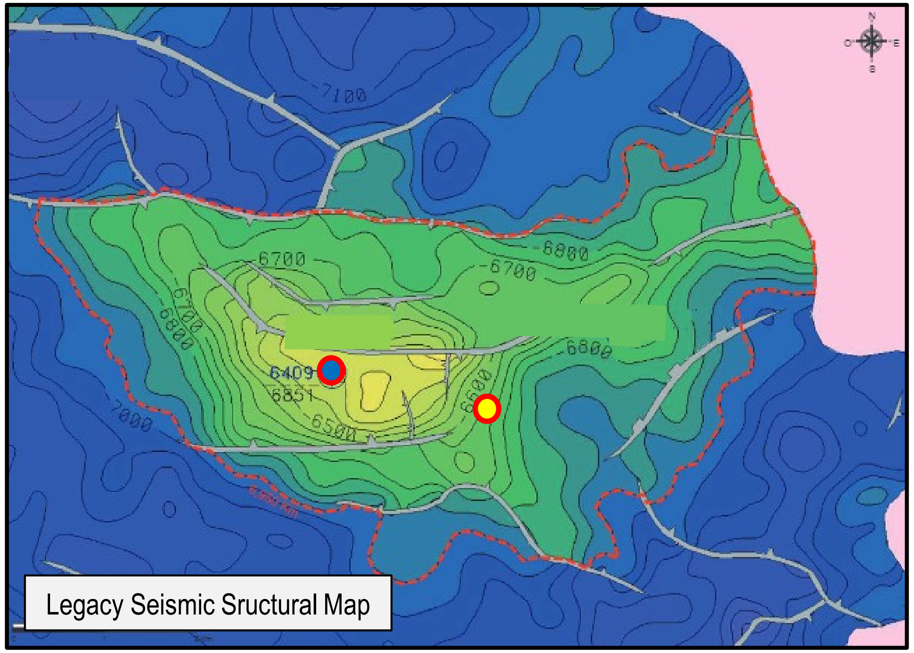


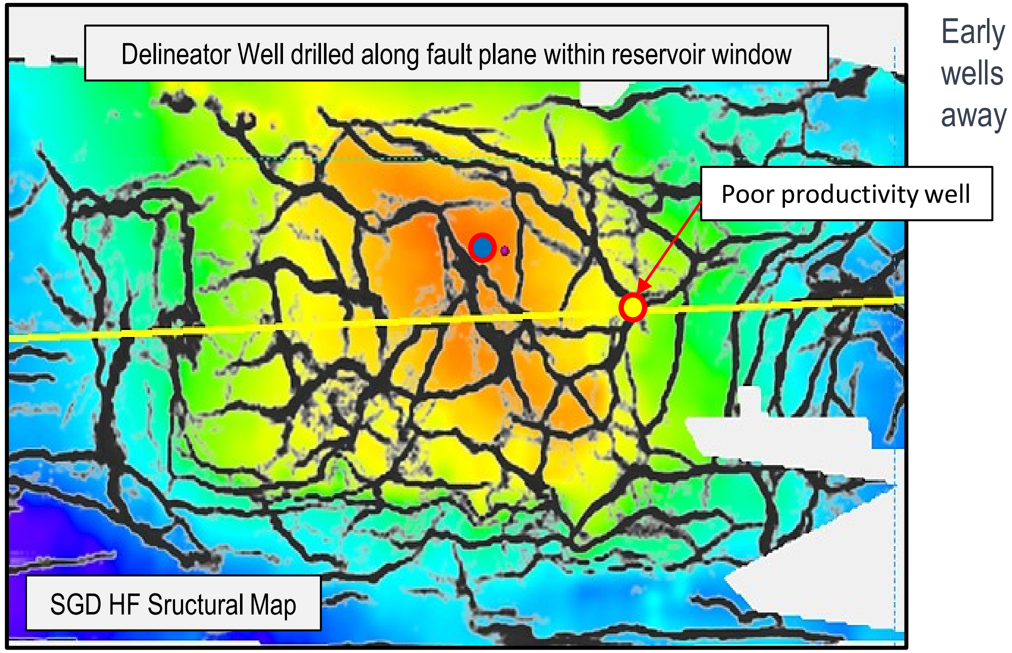
"**Fibonacci Reconstruction**" is a seismic workflow designed to optimize both ends of the seismic spectrum. First, a Fibonacci Spectral Decomposition is applied to the input volume, and then machine learning is used to find the Principal Low Frequency Components of the seismic trace. The output is combined with both a Dominant Frequency and a Continuity volume to better delineate fault planes. Finally, the calculated volume is amplitude-compensated and structurally oriented filtered. The workflow does not require well data, which is important when working in areas with no such information available.

HIGH RESOLUTION RESERVOIR SEGMENTATION - SGDHF









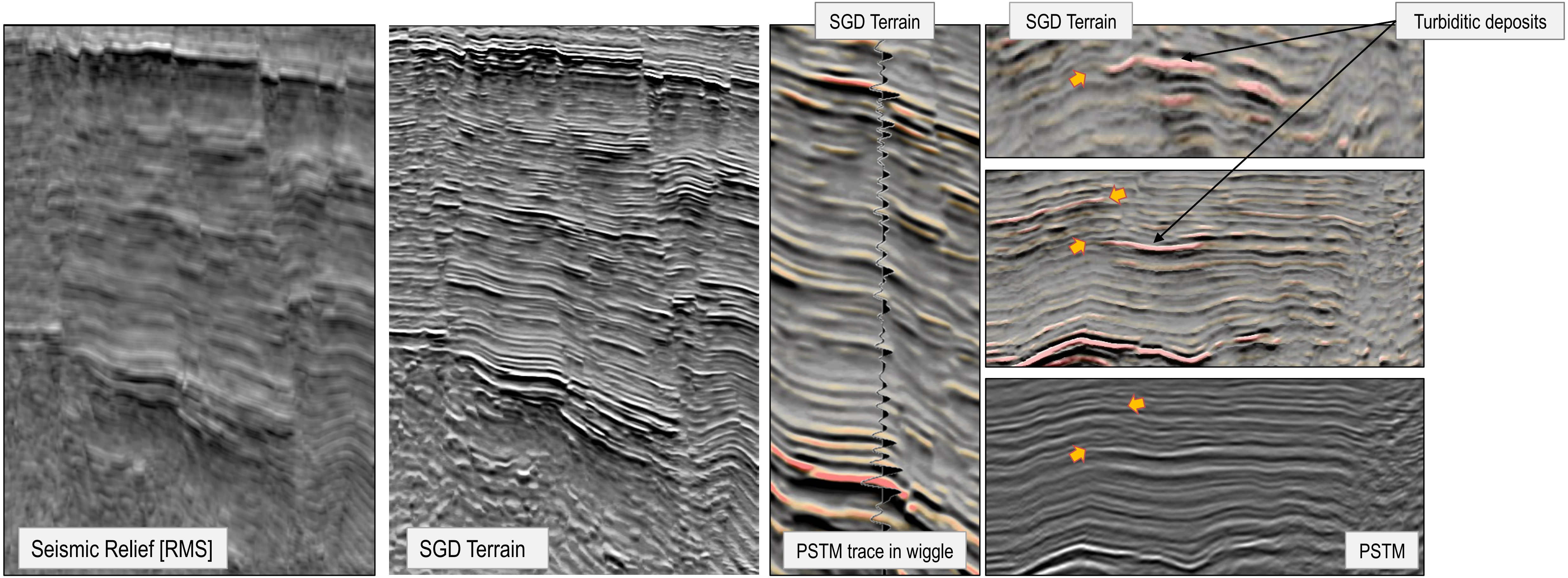
The images on the left show the segmentation and compartmentalization for a natural fractured carbonate reservoir (Jurassic).

A very low frequency Legacy Seismic 7Hz (left) failed to delineate properly the complex fault setting of the field. The first delineator well was drilled along the fault plane within the window of interest with low production results.

After running SGD processes a very detailed segmentation delineation showed the high structural complexity of the reservoir.

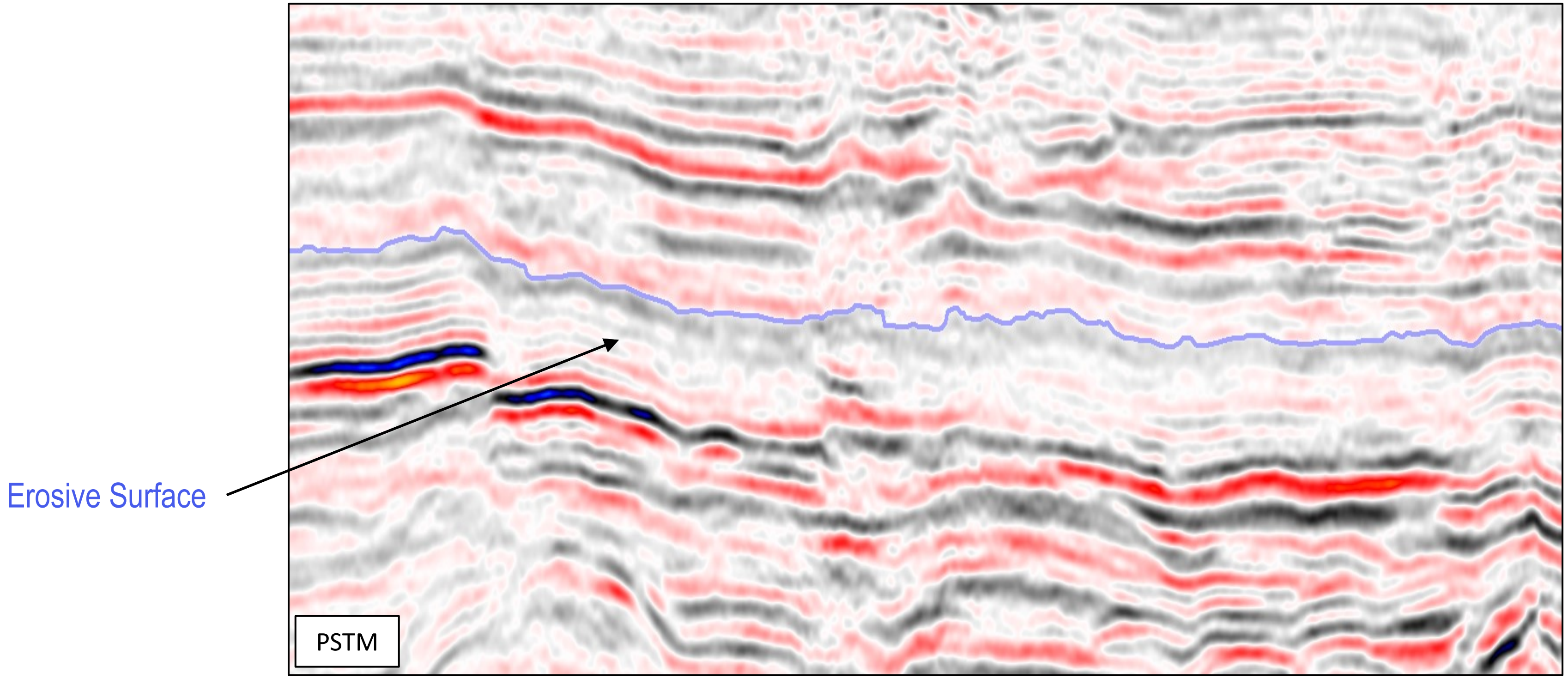
Early water breakthrough and poor productivity wells can be prevented by positioning wells away from faults.

SGD TERRAIN



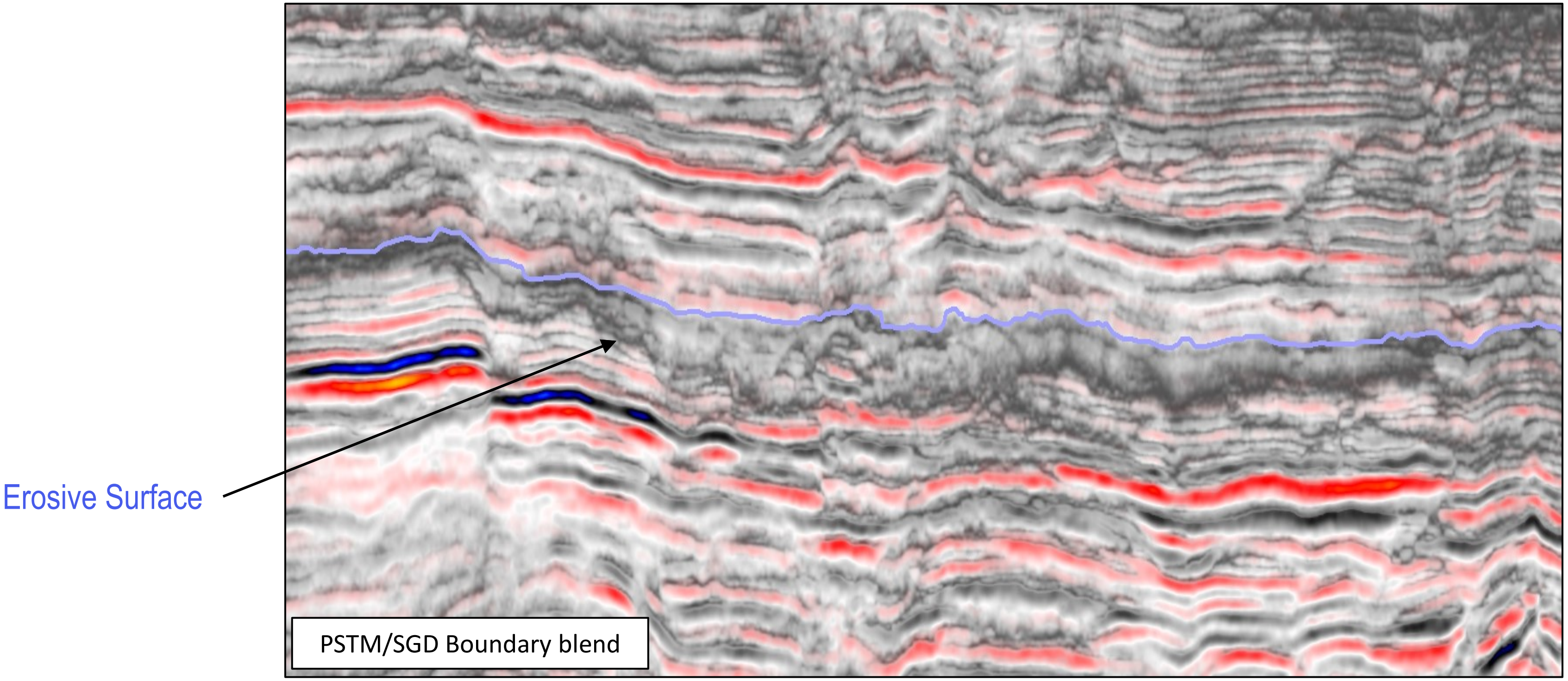
SGD Terrain, has proven to be highly effective in the rapid identification of stratigraphic features. In this particular case, the technique successfully highlighted a turbiditic deposit characterized by a fan lobed geometry that was overlooked when using standard 3D seismic analysis. **SGD Terrain** provides enhanced detail compared to traditional workflows like Seismic Relief. It accurately captures the phase and proper onset of the original Pre-Stack Time Migration (PSTM), which contributes to a more accurate interpretation of the subsurface features

SGD BOUNDARIES



The SGD Boundaries is particularly useful in mapping subtle stratigraphic features that may not be readily apparent in standard seismic interpretation. It can aid in identifying channels, pinch-outs, onlap or downlap relationships, and other stratigraphic geometries that influence reservoir distribution and connectivity. By applying this type of discontinuity attribute to a seismic volume, geoscientists can identify potential stratigraphic boundaries and distinguish between different rock units based on their seismic response. These boundaries may correspond to lithological changes, erosional surfaces, unconformities, or other significant geological features.

SGD BOUNDARIES



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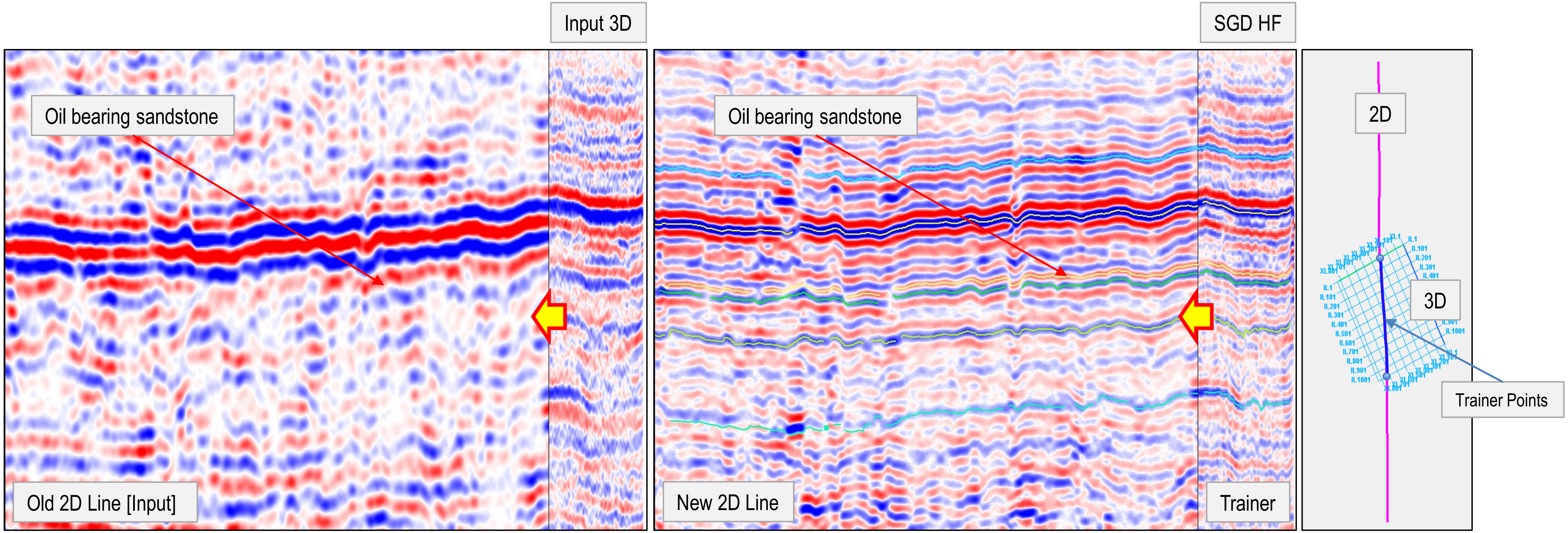
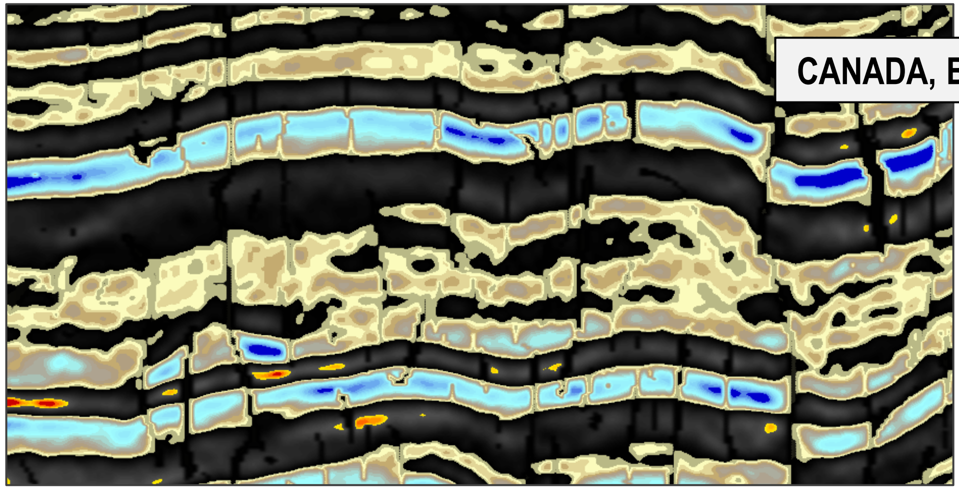
2D LINE RECONSTRUCTION : MACHINE LEARNING



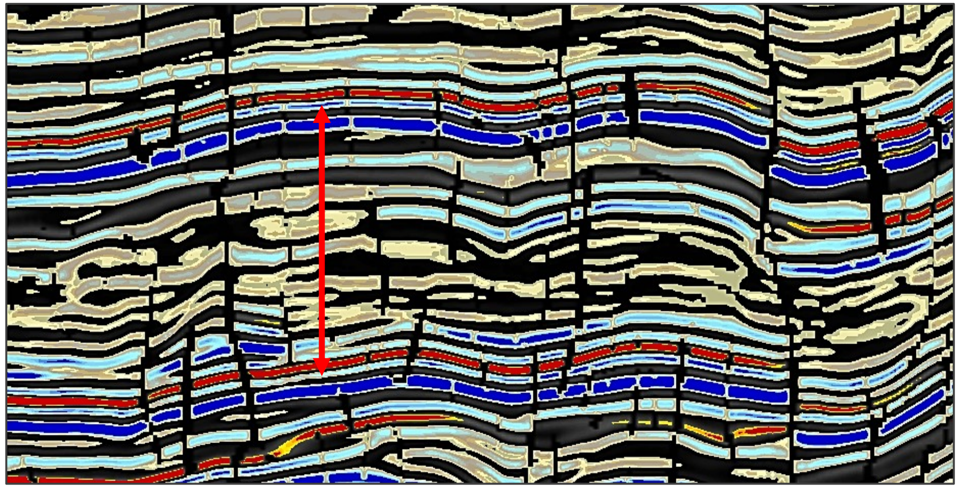
The workflow for reconstructing old legacy 2D lines involves iterative processes incorporating Fibonacci Decomposition, SGD Frequency Enhancement, and Machine Learning. By utilizing the 3D seismic traces as training data, the workflow generates a new 2D vintage that exhibits enhanced consistency with both the Phase and Amplitude Spectrum of the 3D survey. This targeted approach is particularly suitable for exploration areas with extensive 2D coverage, and it prioritizes the reconstruction of overlapping lines, which then serve as training data for intersecting lines located outside the 3D survey boundaries.

PALEO KARST DELINEATION – SGD ESTRATA

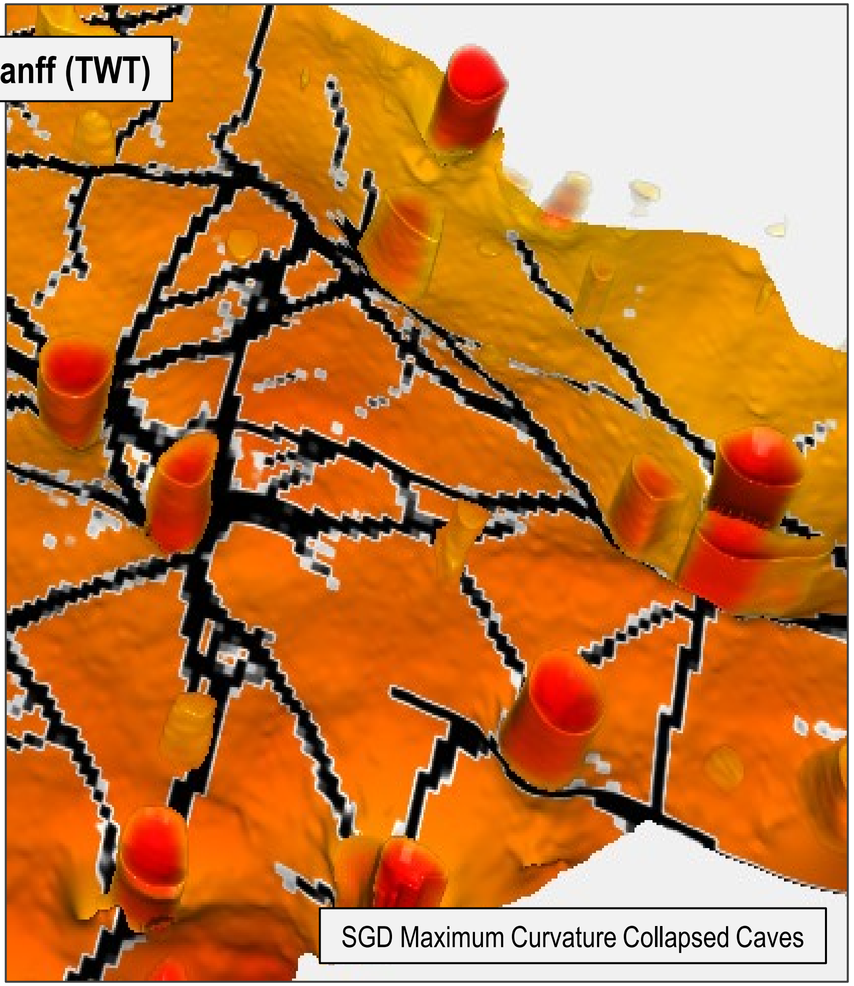
Legacy Seismic



SGD Seismic



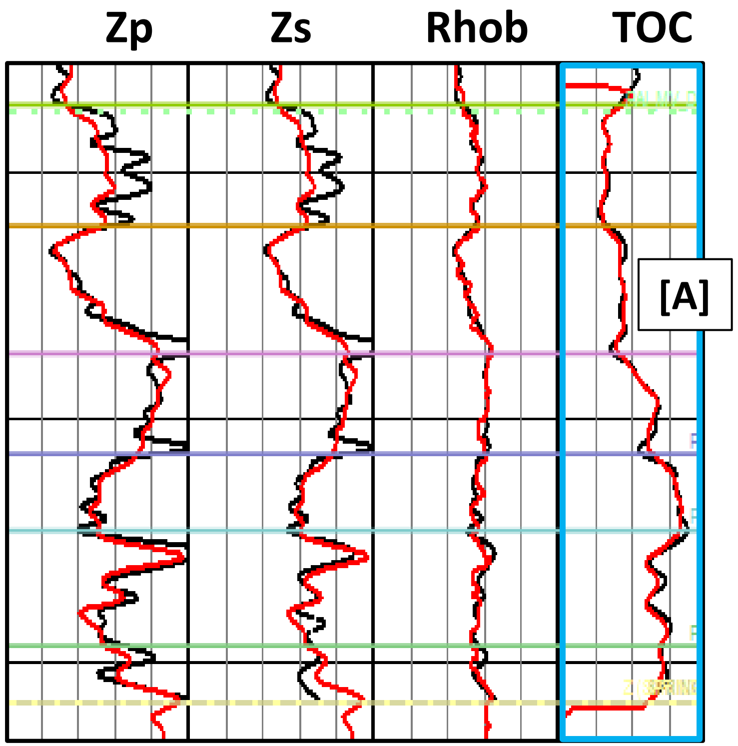
CANADA, Banff (TWT)

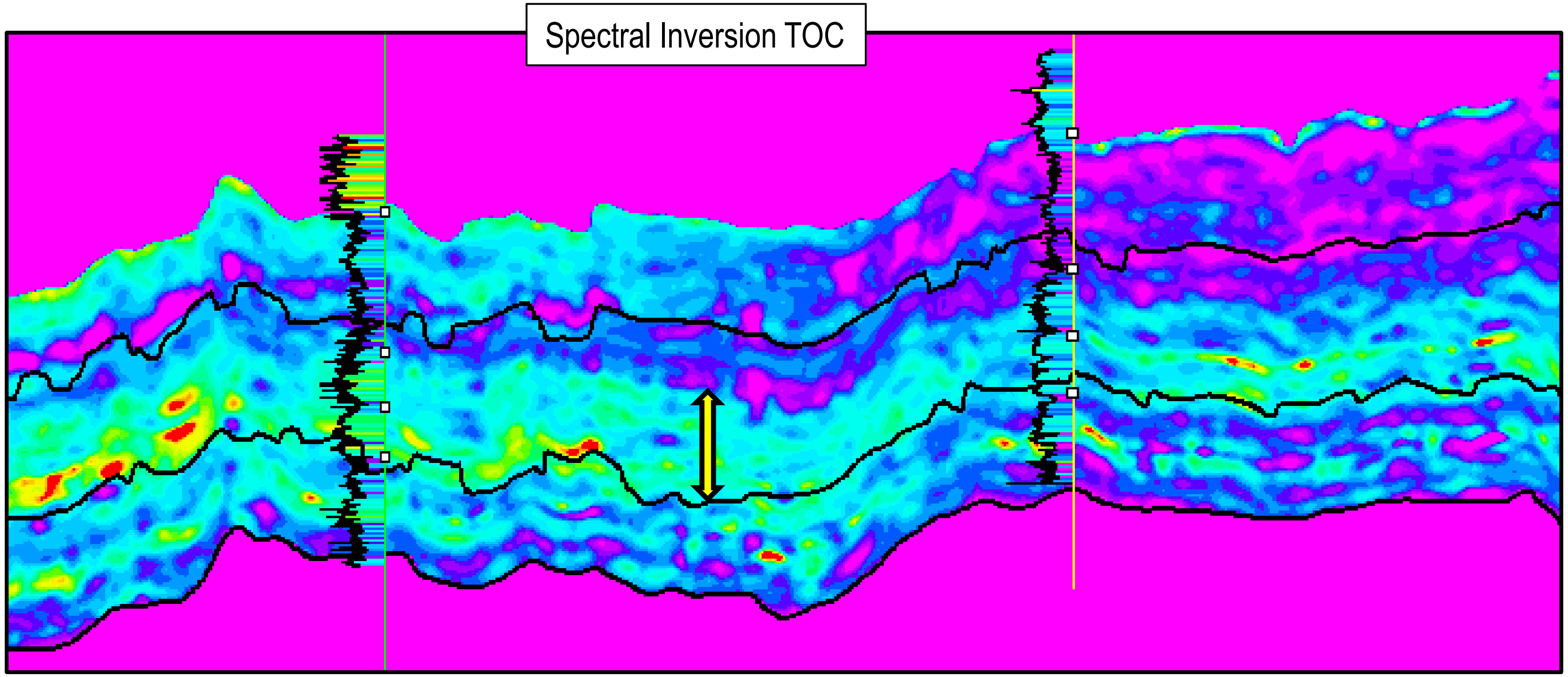


SGD Maximum Curvature Collapsed Caves

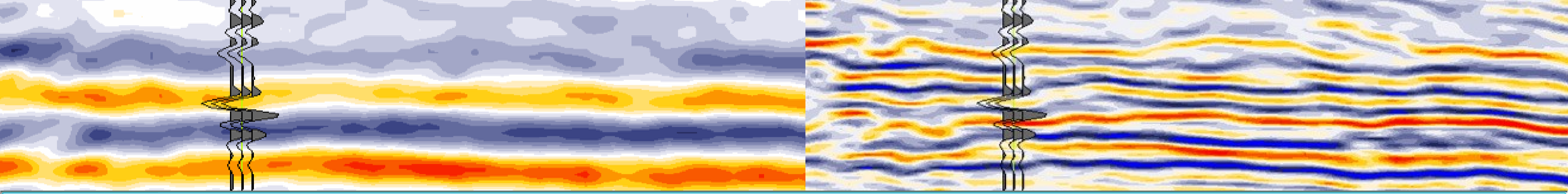
In the context of an unconventional field, accurate delineation of subtle faulting and the geometry of collapsed caves is a critical challenge to support future horizontal drilling campaigns. To address this challenge, the Seismic Geometric Decomposition (SGD) Estrata workflow was utilized to generate a high-resolution vintage, which was then used to generate a detailed Curvature volume. The application of appropriate opacity thresholds enabled the detection of a complex network of Collapsed Paleo-Caves interconnected by a system of radial faulting, providing valuable insights for future drilling campaigns

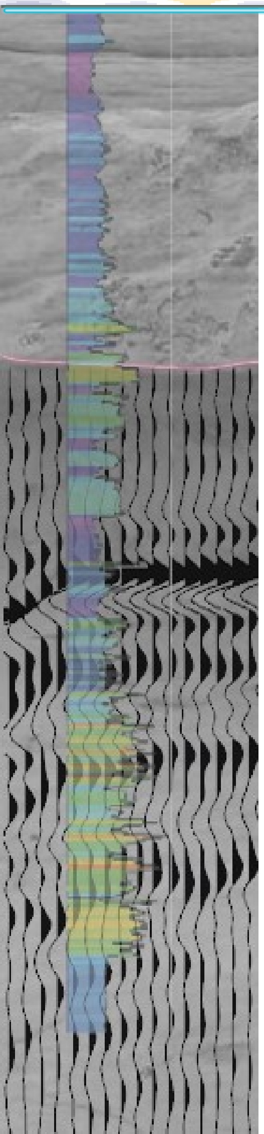
UNCONVENTIONAL: SGD SPECTRAL INVERSION FOR TOC





SGD Spectral Inversion is a powerful seismic workflow that generates elastic volumes, including Zp, Zs, and Rhob, to capture key subsurface properties. Using a Deep Learning algorithm, a Total Organic Carbon pseudo volume is then produced by integrating and supervising all the elastic volumes (+ LambdaRho, MuRho, Poisson, and Poisson Impedance) with a filtered version of the TOC log. This approach is highly effective, as shown by the high correlation match observed in track [A], which accurately reflects the TOC input log (black).





Carbonates, Unconventional, Clastics

Where SGD has been applied

MEXICO
Ayatsil, Xikin, Complejo Bermudez, Sen Tsimin-Xux, Pit, Baksha, Sihil, Tsimin, Xanab, May, Tekel, Ayin, Caan, Ixtal, Onel, Kuil, Samaria Terciario, Tizón

VENEZUELA
Perla Field, Horcon, Barua Motatan, Carabobo

RUSSIA
YK, SK, SN, Avustovskoye, Kolva, NO, Karabashky

ARGENTINA
Austral Basin, San Jorge Basin, Neuquén Basin

PERU
Bretaña Field, block 95

NORTH SEA
Piper Alfa, Claymore, Tartan, Scapa, kildrummy Monarb, Rowallan, Yeoman, Beatrice, Petronella

KURDISTAN
Topkhana, Kurdamir

COLOMBIA
Chipiron, Capachos

ALGERIA
South East Illizi, Reganne

COLUMBUS BASIN, TRINIDAD AND TOBAGO
Teak, Samaan, Poui

VIETNAM
HSD

LYBIA
K-N186, B-N186, J-N186

CANADA
Banff

GUYANA
Jaguar

MEDITERRANEAN SEA
Lubina & Montanazzo

BRAZIL
Carioca, Lapa

USA
Lasalle Field, Eagle Ford. Barnett Shale

NORWAY
Yme Field

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