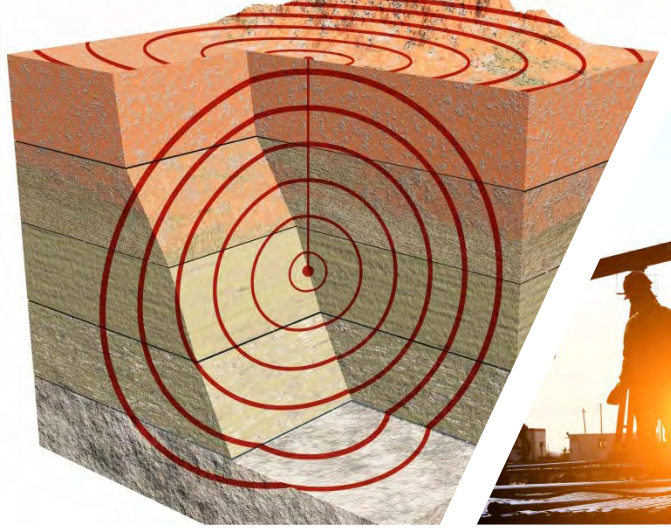
PENTATEX GROUP

Construction | Consulting | Engineering



ANALYSIS OF GEOPHYSICAL DATA

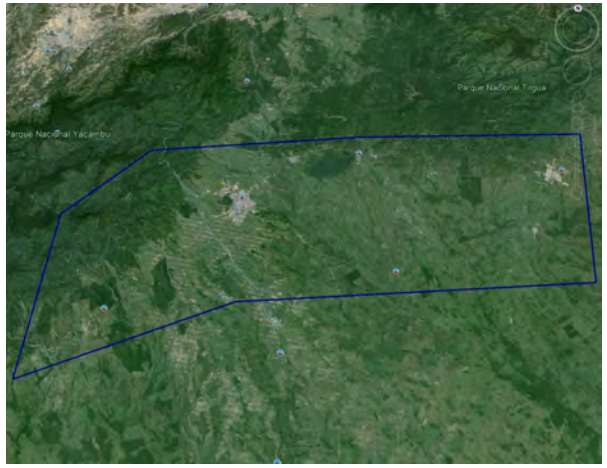
- Applied Geophysics
- Tomographic Pseudo Geometry
- Fourier Multidimensional Reconstruction
- Well Geophysics

Applied Geophysics

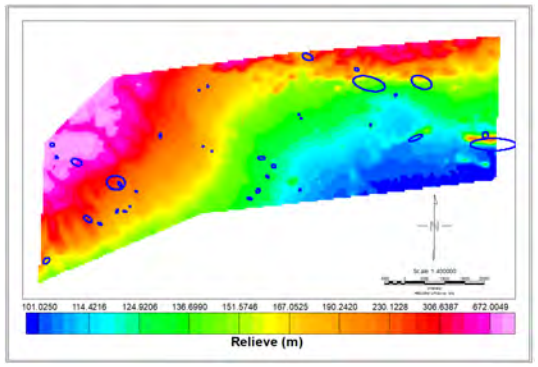
Application: Oíl & Gas

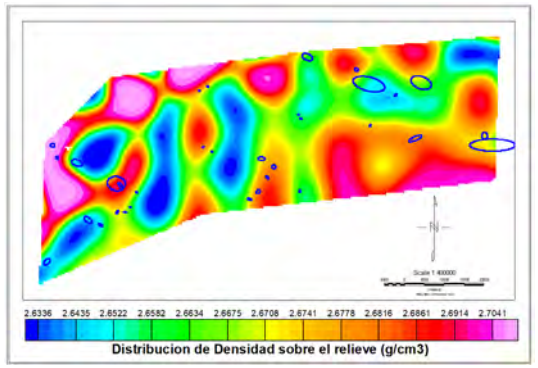
PENTATEX GROUP

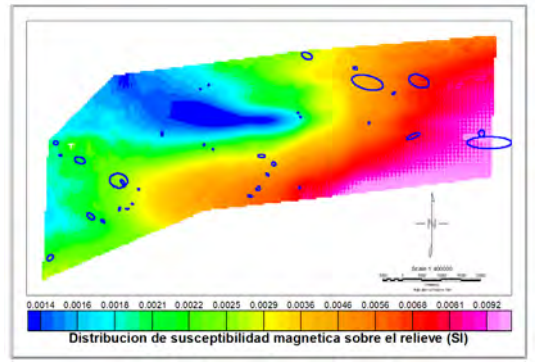
- Generation of 3D depth models of gravimetry, magnetometry and magneto telluric inversion.
- Integration of these models with geophysical, geological or information from remote sensors.
- Analysis of the main structures and geological objectives from these generated models.

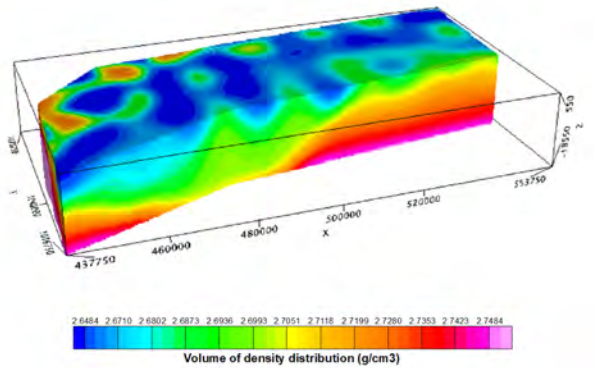


Study Area

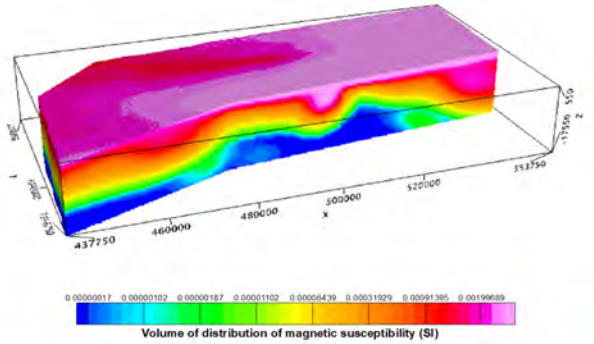








3D Gravimetric Inversion

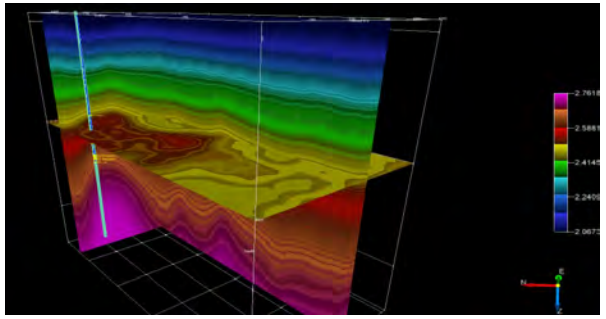


Magnetic 3D Inversion

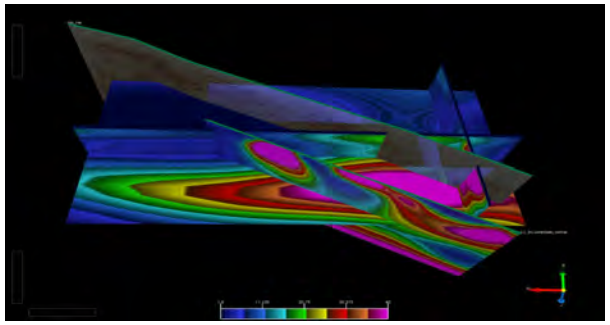
Applied Geophysics

Application: Oíl & Gas

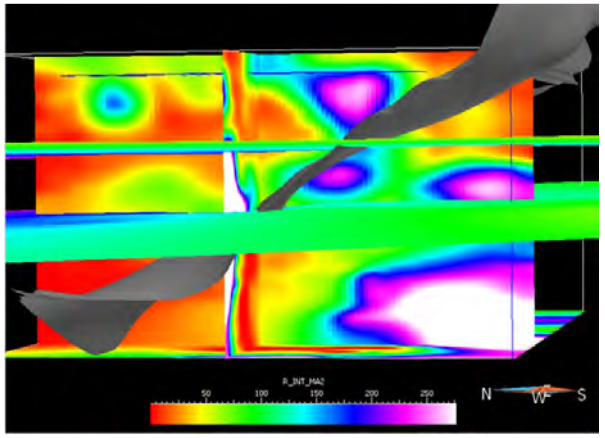
PENTATEX GROUP



3D Gravimetric Inversion

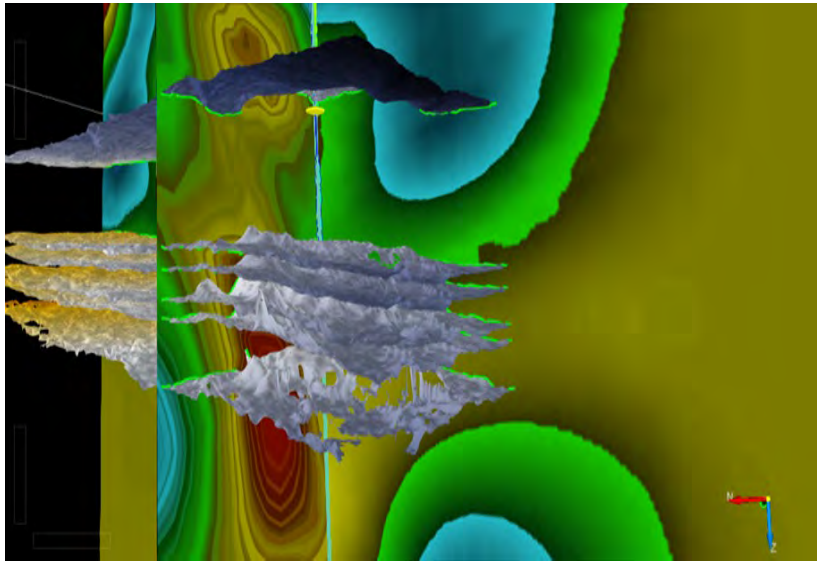


Magnetic 3D Inversion

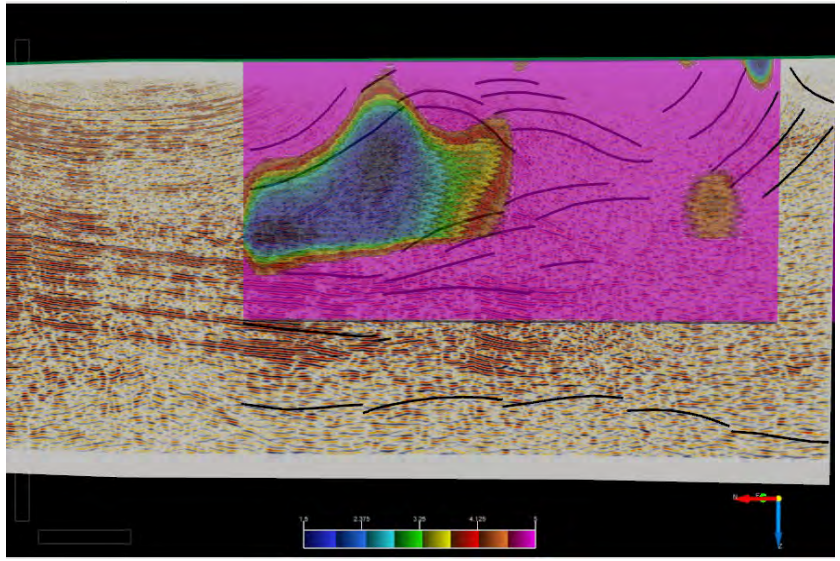


3D inversion Telluric magnet for geological and structural interpretation.

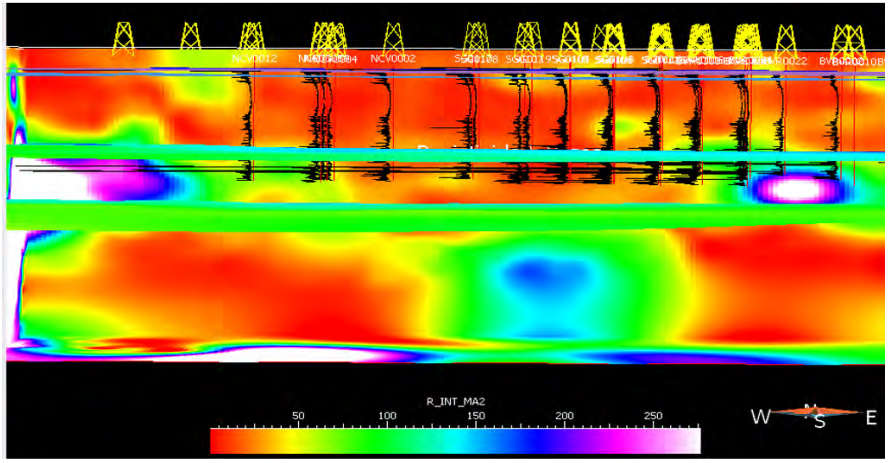
3D Telluric Magnet inversion to identify contrasts related to the presence of: a) hydrocarbons, b) seismic data, c) well logs.



a) Hydrocarbons



b) Seismic data



c) Well logs

Tomographic Pseudo Geometry

Application: Oil & Gas

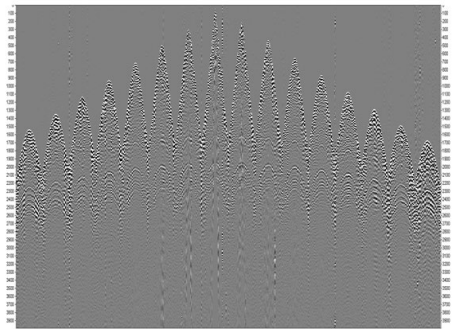
PENTATEX GROUP

Fast and precise method, the images are originally generated in the transverse plane, with the development of programs, they can be reformatted in multiple planes, even generating three-dimensional images and virtual navigation.

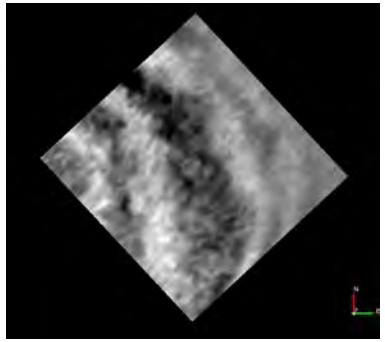
Advantages and benefits

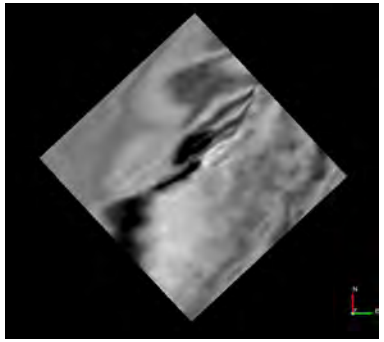
- Fast data acquisition
- Uses of WIFI or nodal systems
- Considerable reduction in environmental damage.
- 3D image in real time for better quality control.
- Considerable reduction in acquisition and processing costs.
- In combination with Applied Geophysics, it is an effective tool for exploratory evaluation and early production.

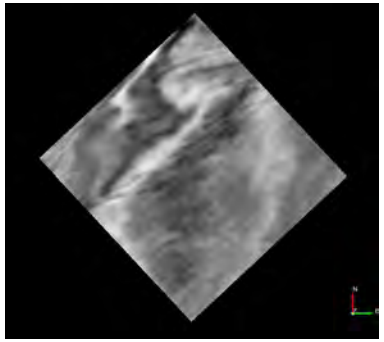
Wide Azimuth Geometry vs Pseudo Tomography

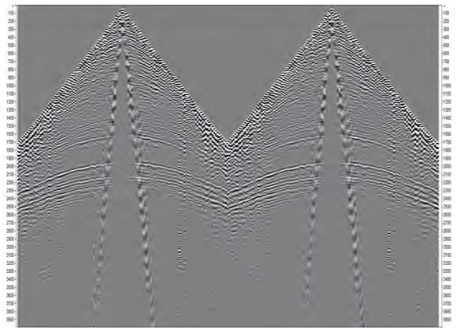


16 Lines

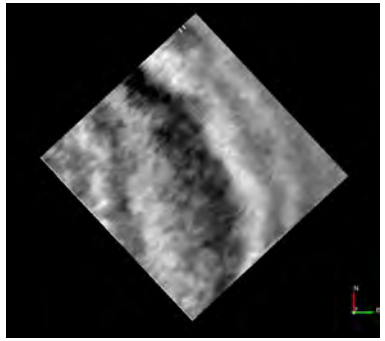




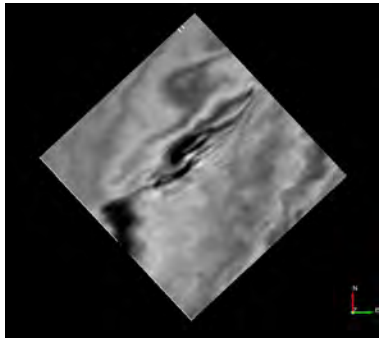




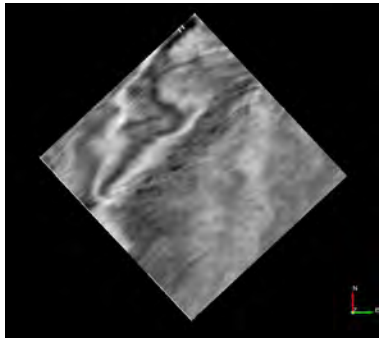
2 Lines



TS 1560



TS 1940

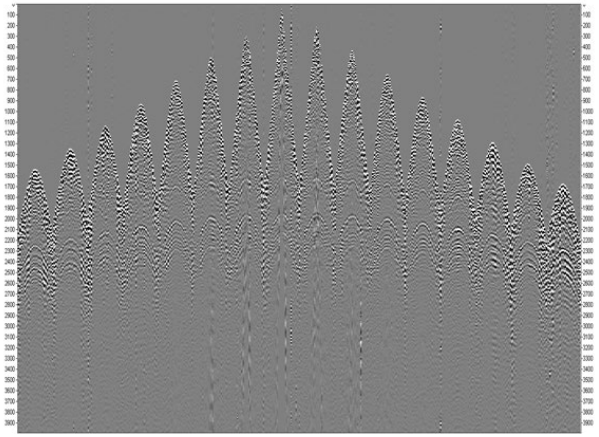


TS 2200

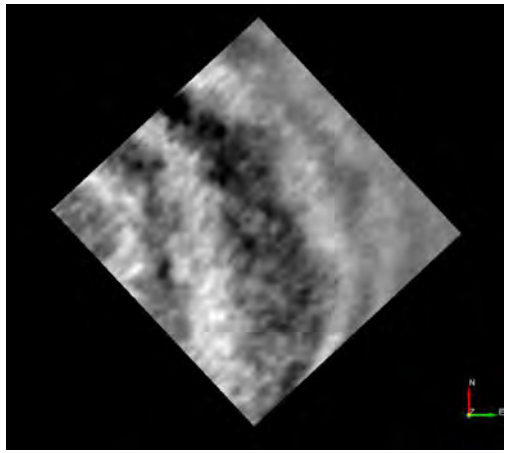
Tomographic Pseudo Geometry

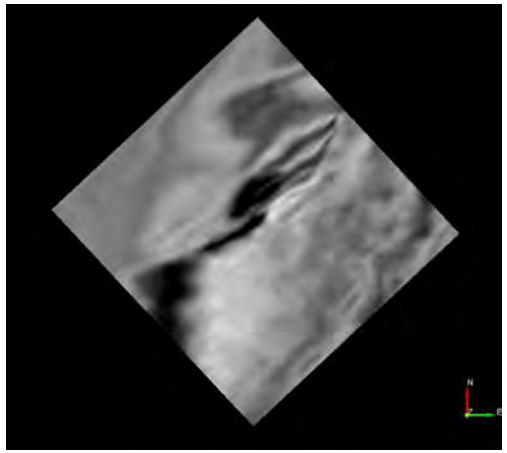
Application: Oíl & Gas

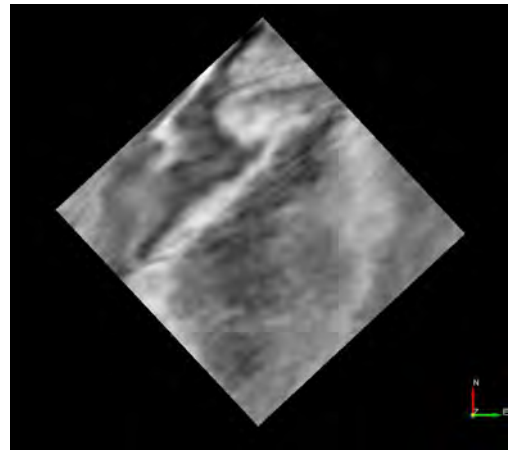
PENTATEX GROUP

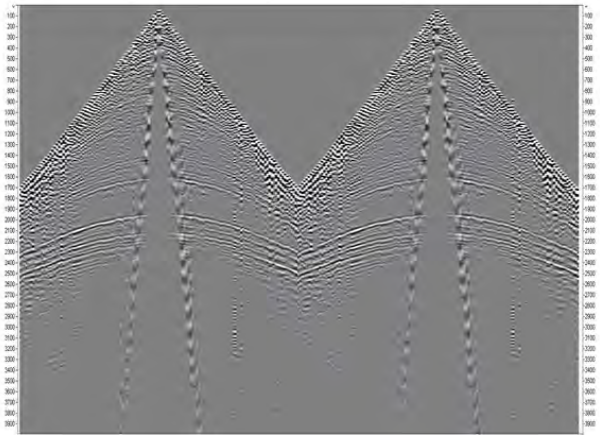


16 Lines

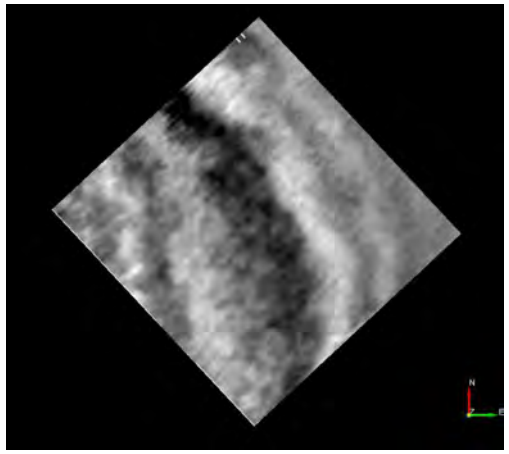








2 Lines



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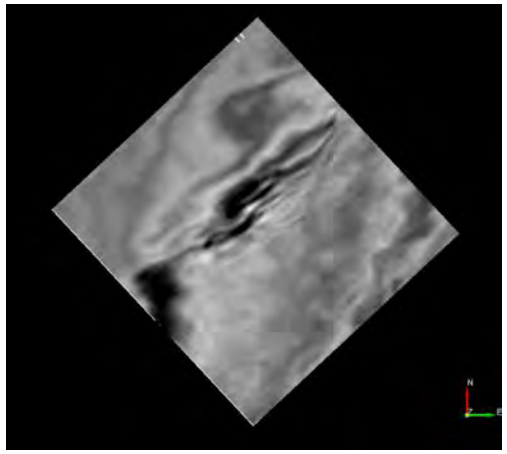

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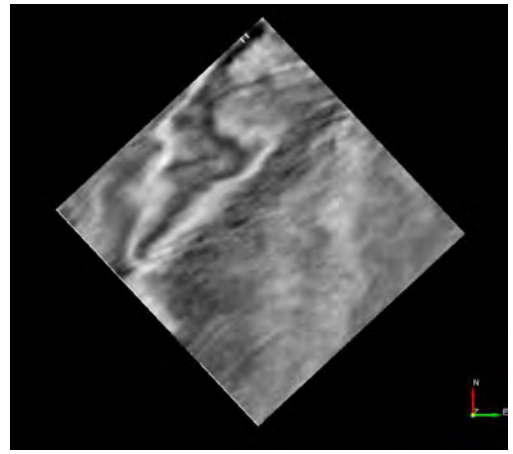
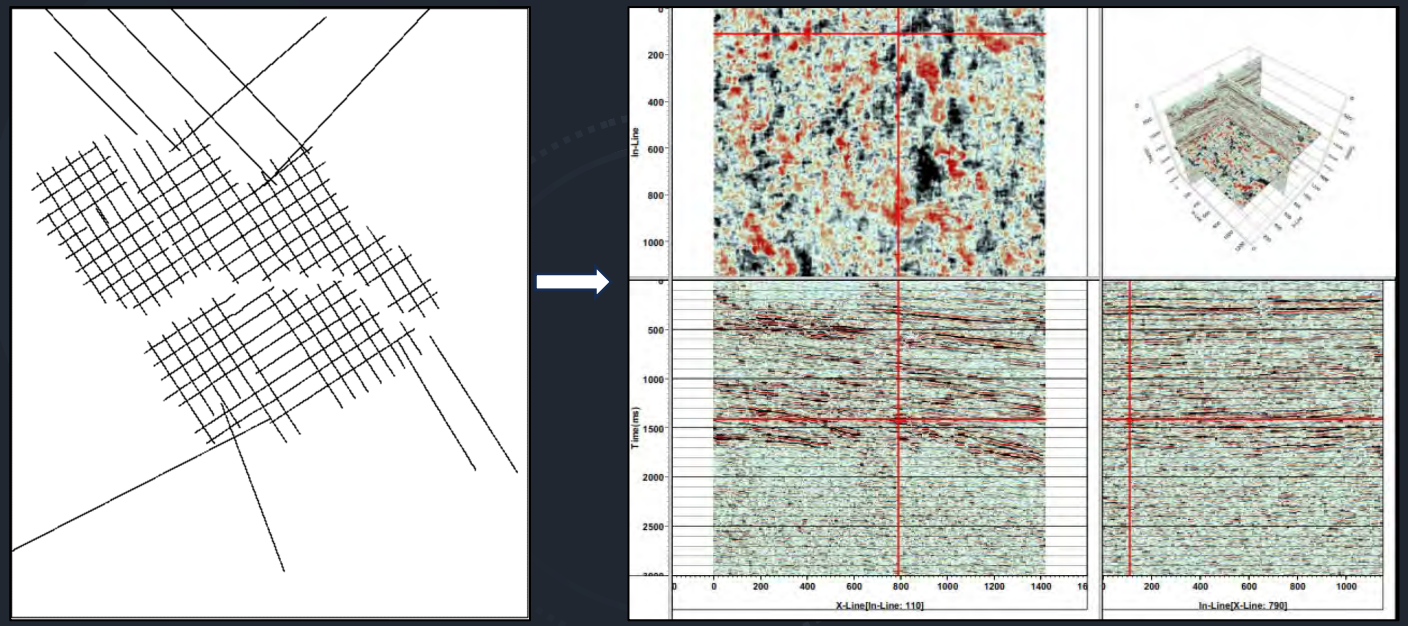


TS 2200

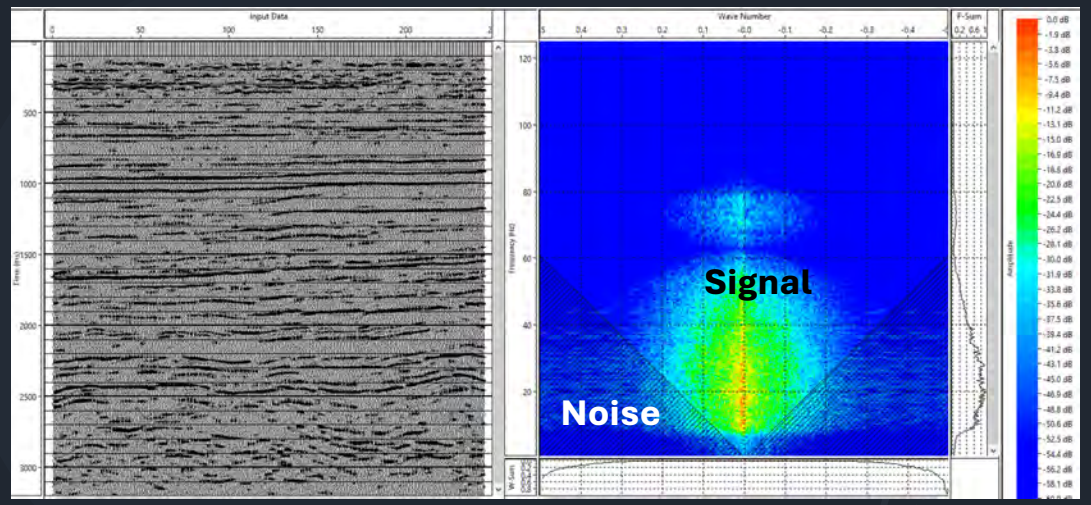
Multidimensional Fourier Reconstruction



Our Seismic Data Optimization Service is based on **Fourier Multidimensional Reconstruction** from 2D seismic lines, focuses on the generation of models of an area for exploration and/or early production studies, consolidating it in a 3D data volume, and An optimal visualization is achieved that will provide more precise elements for the interpretation process based on horizons of this data.

From 2D seismic lines, a **Fourier Multidimensional Reconstruction** is performed, which is based on the calculation of the Fresnel Radius to define the minimum mesh necessary to find the radiated energy (amplitude of the seismic trace) and a simple 3D seismic cube is obtained, where attributes can be applied and a cooperative interpretation can be made with other types of data that are available, and thus have a better vision of the study area.

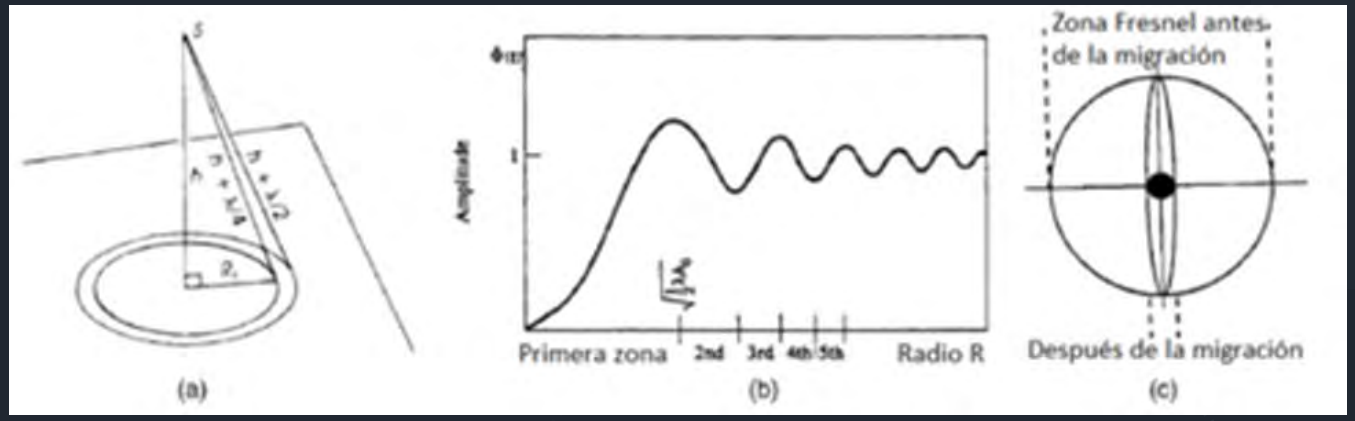
Multidimensional Fourier Reconstruction



F-K diagram.
In the F-K diagram, the interval of wave number and frequency where the signal and noise are found is defined, which allows the **Multidimensional Fourier Transform** algorithm to be limited in these ranges, giving priority to the signal and not the noise.

Hence the importance of having 2D seismic sections with a high signal-to-noise ratio and distances between them of no more than 2000 m.

FRESNEL ZONE



FRESNEL ZONE DIAGRAM.

(a) For the source and receiver coincident at S, the radius of the first Fresnel zone is R1 (perpendicular to h). The second Fresnel zone is the annular ring. The higher order zones (not shown) are also annular rings. The dominant wavelength is λ. Another way of looking at this is that a reflection point in the subsurface influences a similar Fresnel zone on the surface.

(b) Accumulation of energy that is integrated outward from the point of reflection.

(c) Migration collapses the Fresnel zone to a much smaller area, but two-dimensional migration collapses it in one direction.

HOW DO WE DO IT

PENTATEX GROUP

Phase I: Collection and Evaluation:

- We obtain information from the existing seismic information about the area of interest. The signal-to-noise ratio, frequency content and positioning are evaluated.

Phase II: Check the interceptions between the seismic lines:

- By creating a single file in SEG-Y format, we join seismic lines with the same characteristics, i.e., number of samples, sample interval, and record length.

Phase III: Grid Generation:

- Construction of the mesh by calculating the Fresnel diameter.

Phase IV: Parameterization of the Multidimensional Fourier Reconstruction:

- It consists of the estimation of the frequency ranges, calculation window, maximum inline wave number, maximum crossline wave number, number of iterations and the amplitude threshold.

Phase V: Process of parallelizing the Multidimensional Fourier Reconstruction:

- We begin the logical processing of parallelization through the use of multicore computing equipment

Phase VI: Quality control:

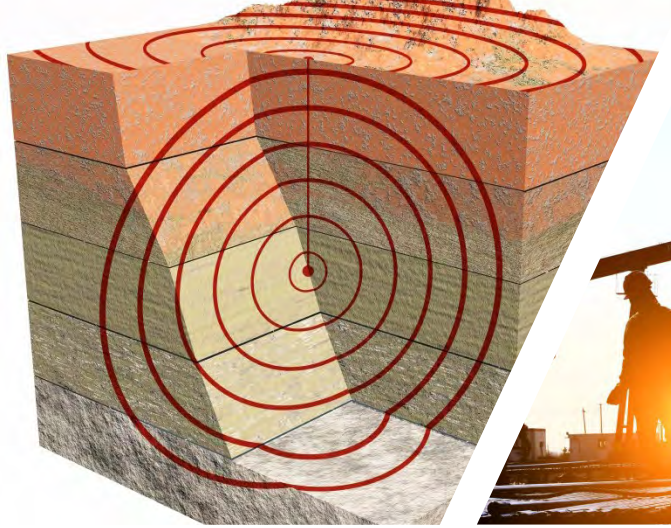
- We apply a validation protocol through comparison with the reference 2D seismic line to achieve a result consistent with the original data.

Phase VII: Generation of seismic cubes

- We produce seismic cubes from multidimensional Fourier reconstruction stacked and migrated in the time domain (SEG-Y format).

Phase VIII: Visualization:

- In this phase, we are able to show the main characteristics of the study area for interpretation.




Our success cases
Country: Argentina

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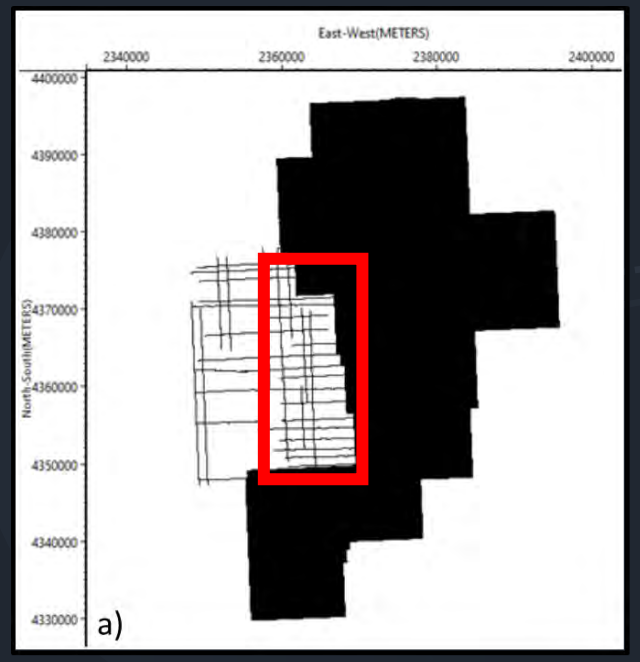
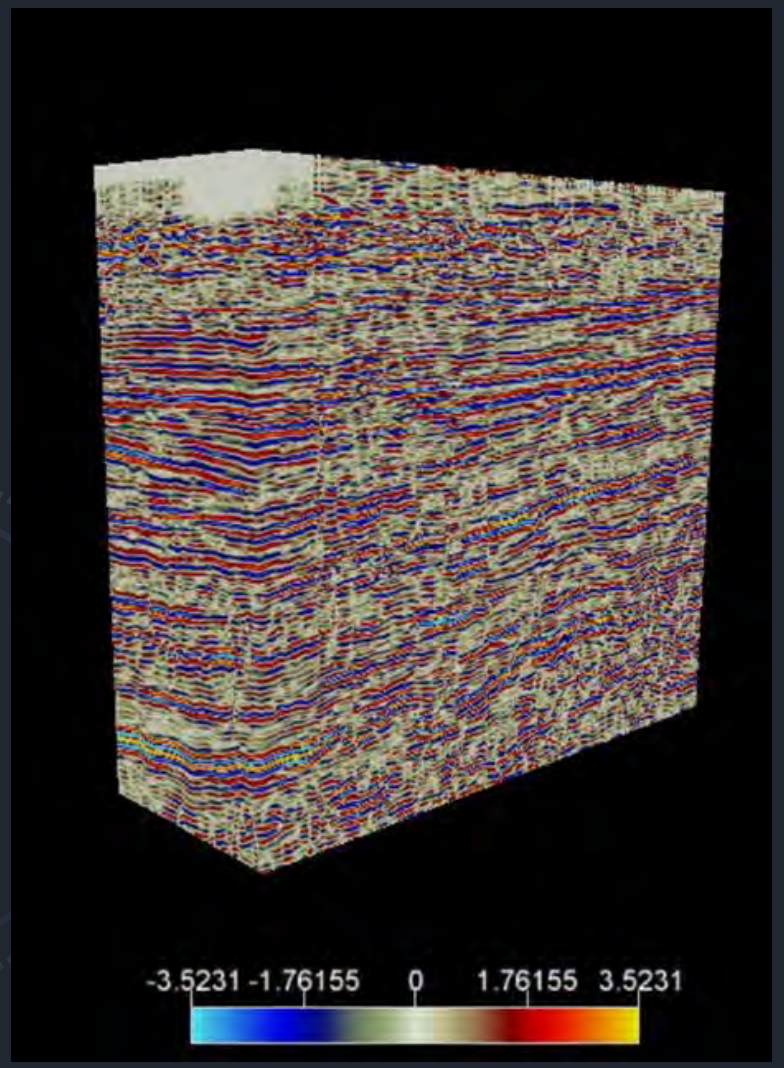
Multidimensional Fourier Reconstruction

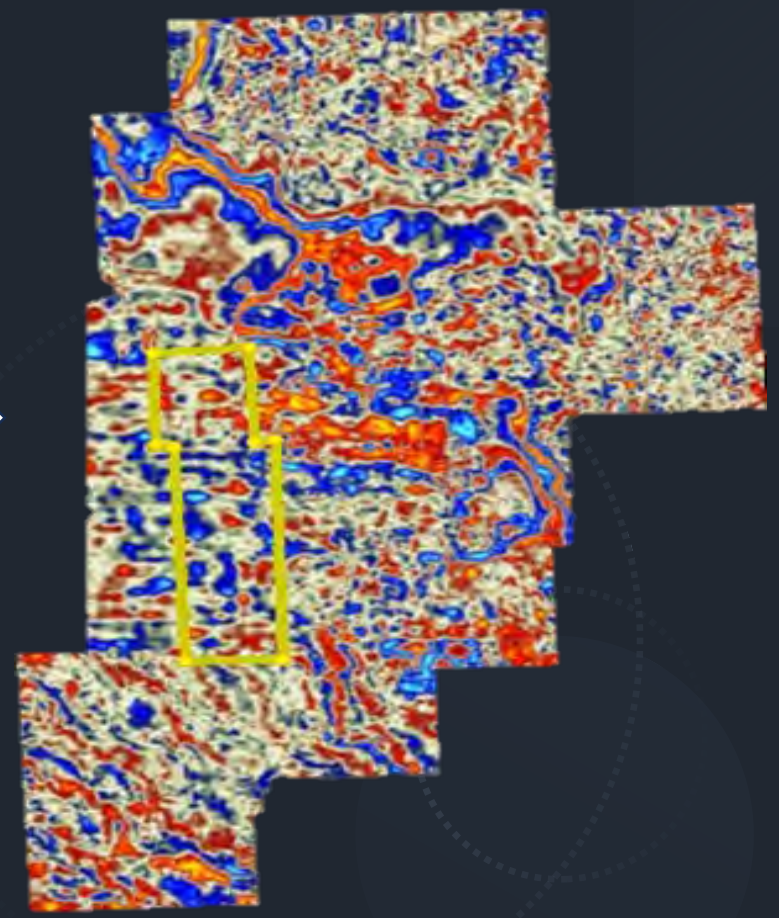
Case 1
Multidimensional Fourier Reconstruction
Southern Basin.
Argentine



Study area with 2D lines.



Reconstructed cube in the study area.



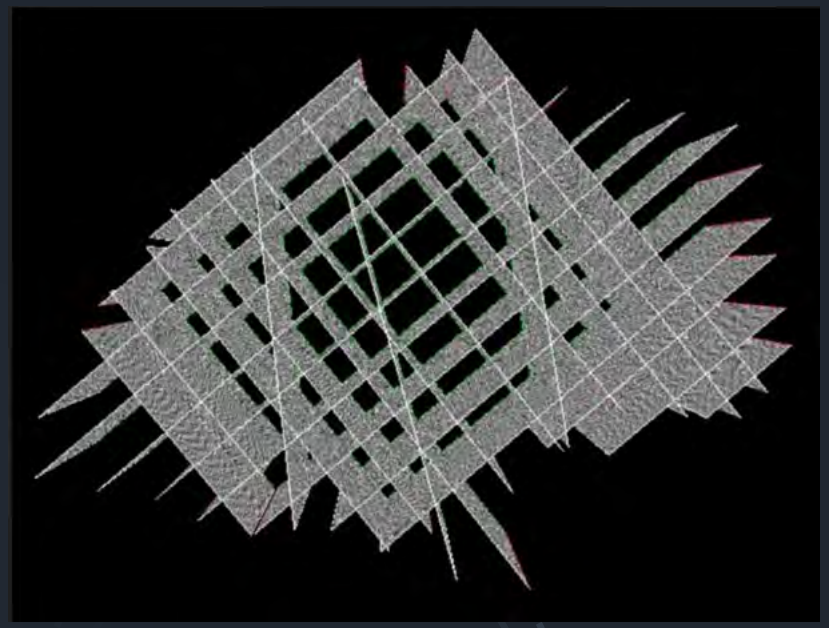
Reconstructed cube in the study area.

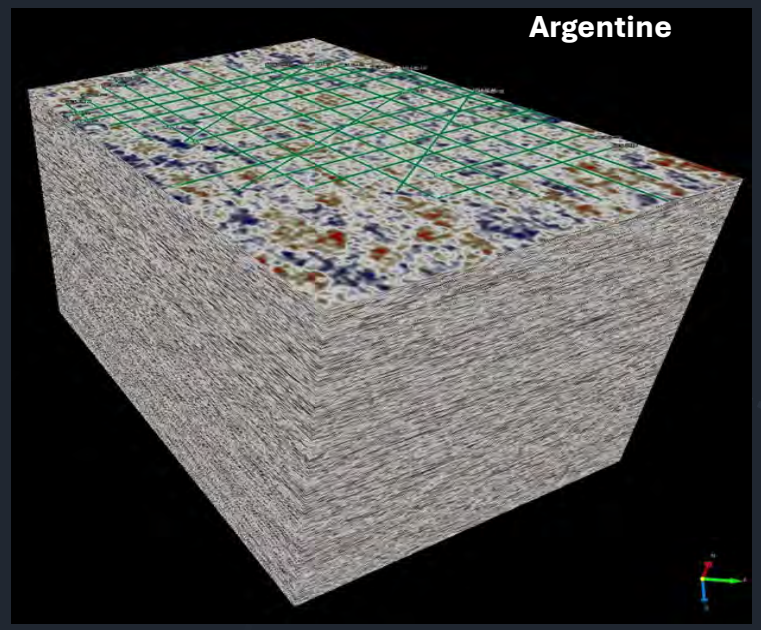
PENTATEX GROUP

Multidimensional Fourier Reconstruction

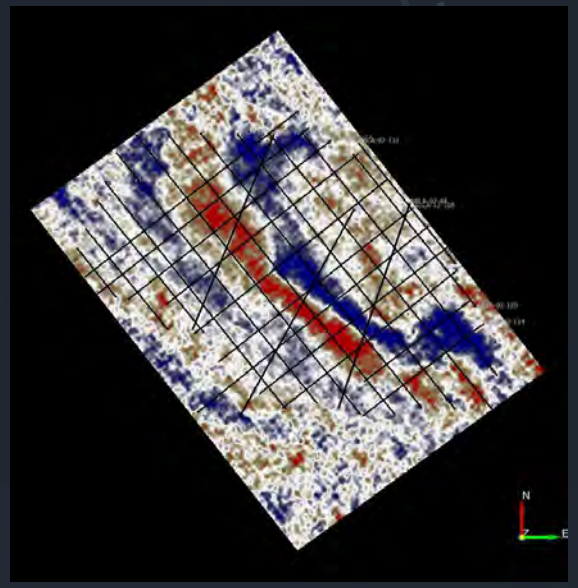
Case 2
Multidimensional Fourier Reconstruction
Southern Basin.
Argentine

Study area with 2D lines.

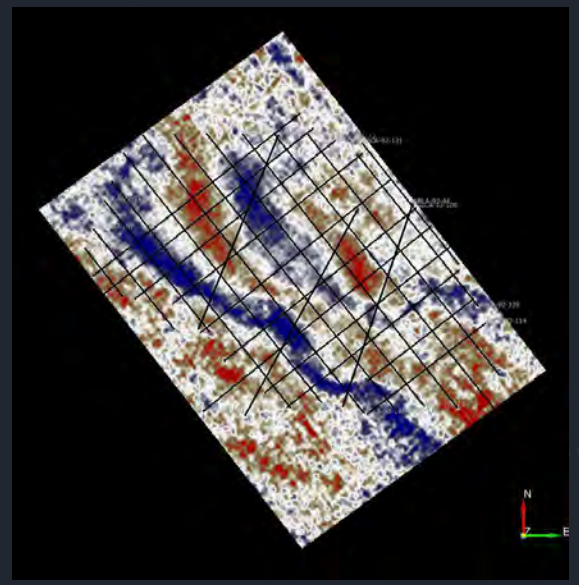


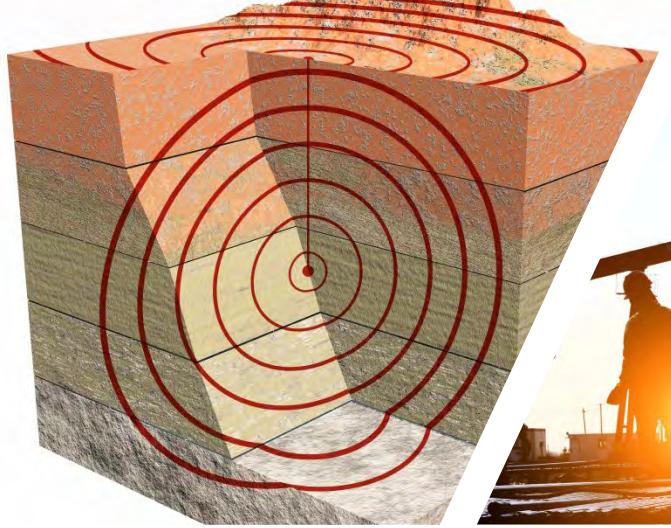


Reconstructed cube in the study area.



Slice Reconstructed cube.






Our success cases
Country: Venezuela

PENTATEX GROUP

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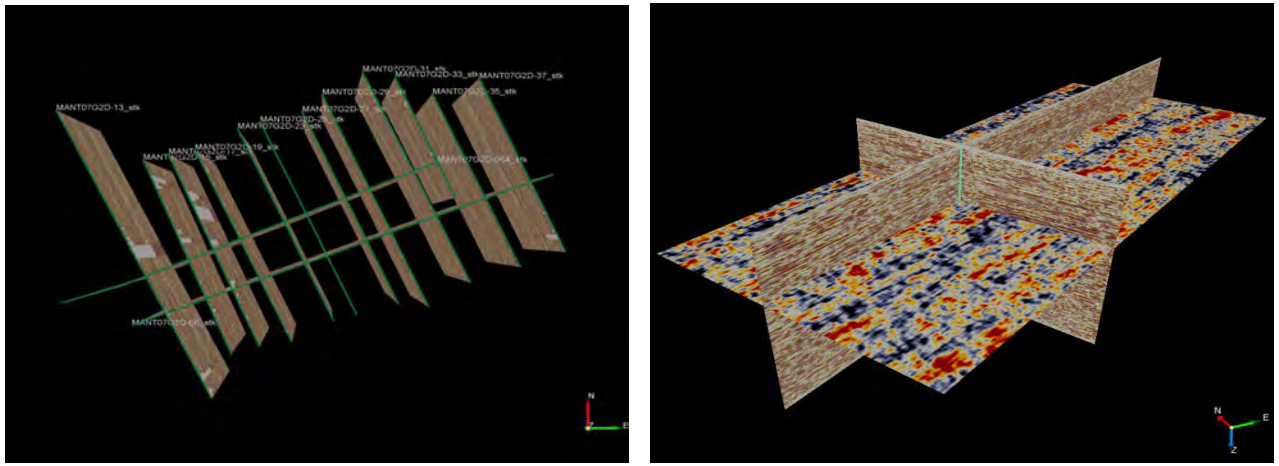
Application: Oíl & Gas

Case #3
Multidimensional Fourier Reconstruction
Barinas-Apure Basin (Venezuela)
Simple 3D Studio

PENTATEX GROUP

This area had been explored by means of a **2D seismic survey**, a well was drilled without commercial success. Information was available corresponding to **13 seismic lines**, in an area that was difficult to access and flooded.

From the operational point of view and environmental permits this would take about **2 years** and a budget that would be around **$150MM**, in order to carry out a 3D seismic acquisition.

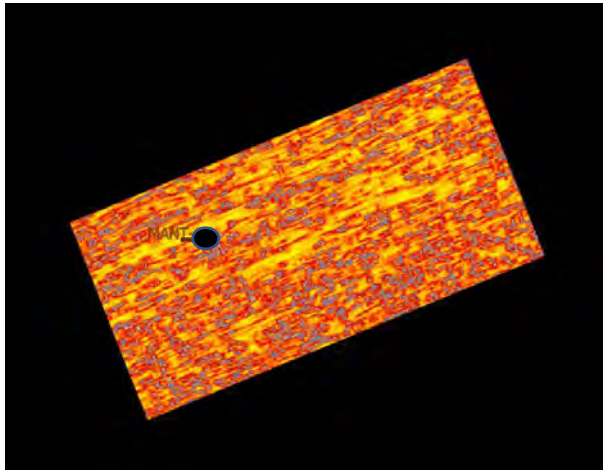


a) Plan View Original 2D Seismic Lines

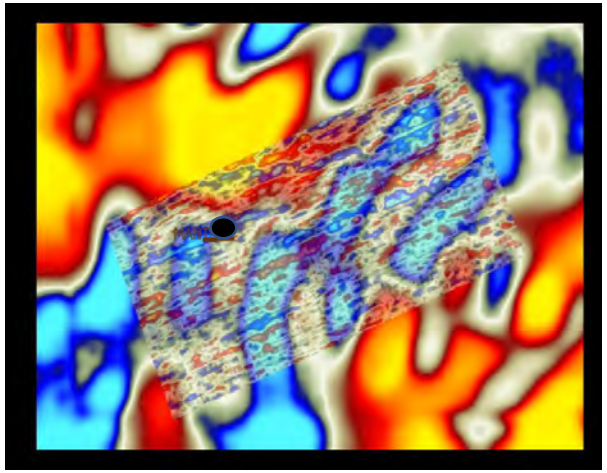
It was decided to work with the available seismic information and apply a **Multidimensional Fourier Reconstruction**, which was carried out in **3 months**, by reviewing and validating the existing data, to subsequently generate the **simple 3D cube**, covering **3,825 km²** of the study area.

Additionally, we worked with gravimetric and magnetic data that were available in the study area.

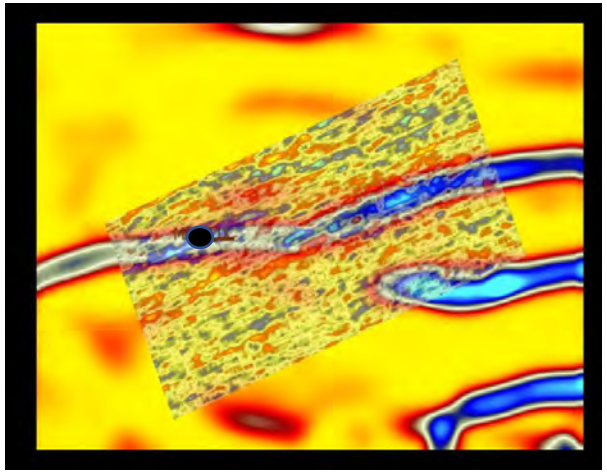
- **Exploratory Well**



b) 3D view of the reconstructed volume



c) Gravimetric Inversion



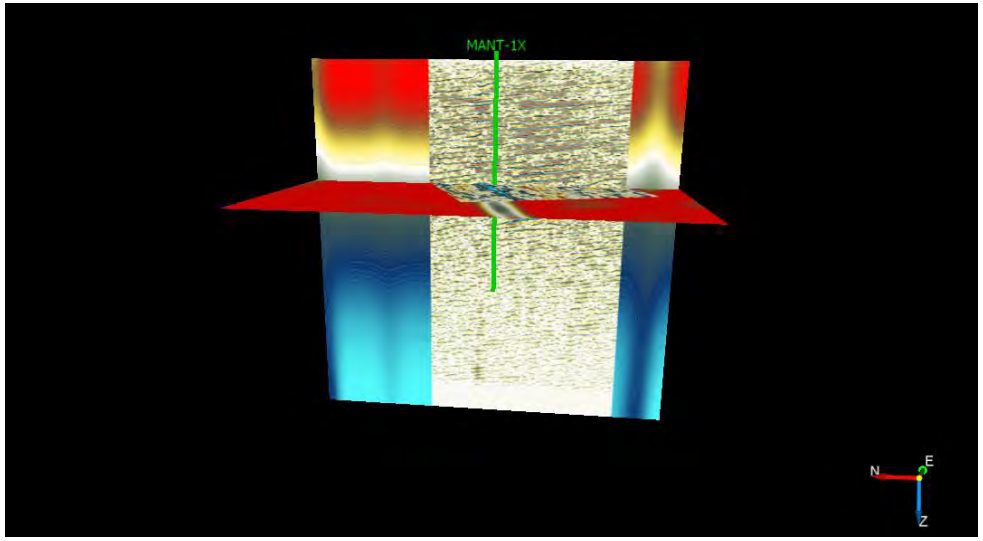
d) Magnetic Inversion

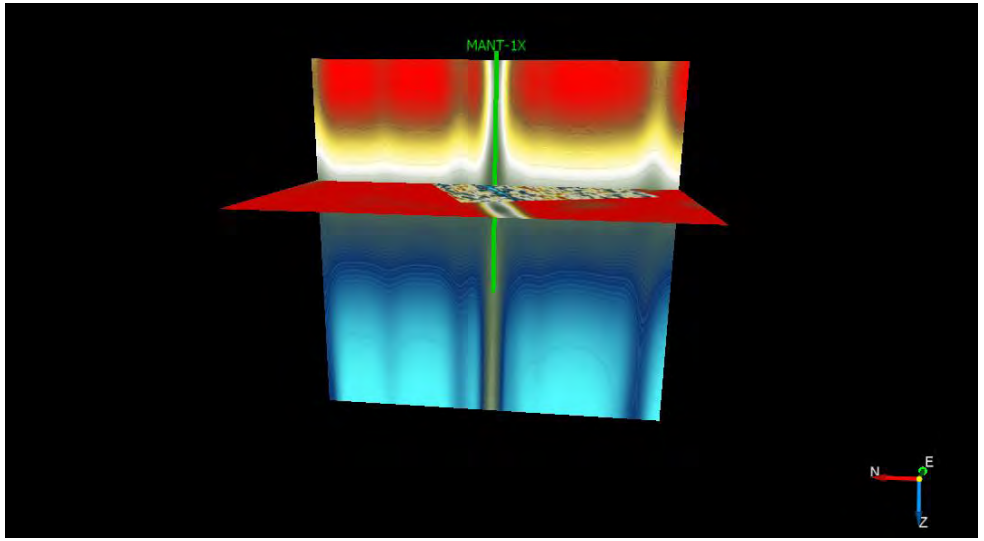
Application: Oíl & Gas

Case #3
Multidimensional Fourier Reconstruction
Barinas-Apure Basin (Venezuela)
Simple 3D Studio

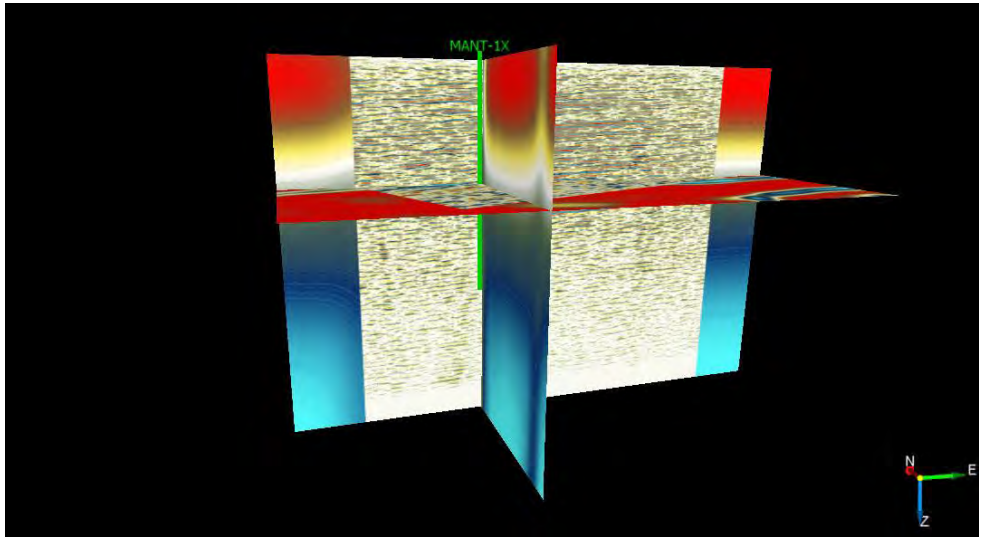
PENTATEX GROUP

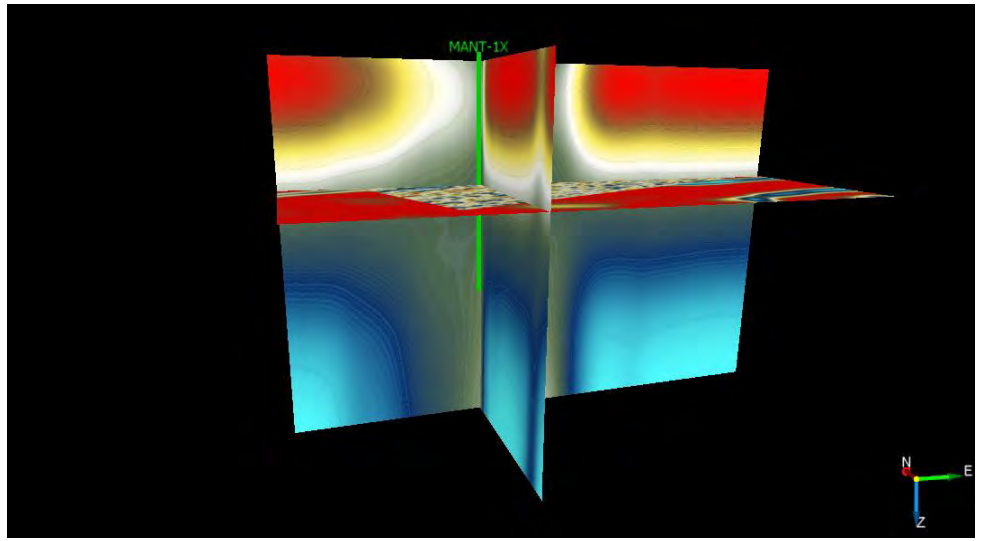
Inline





Crossline





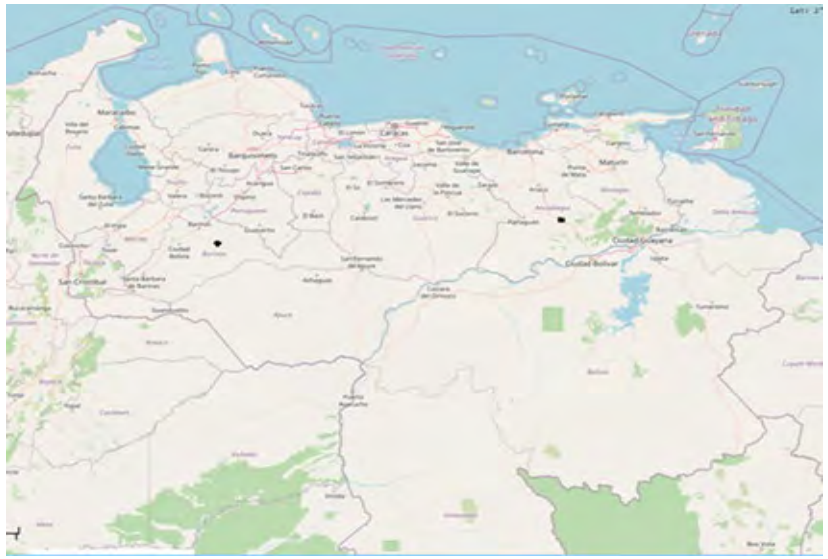
Application: Oíl & Gas

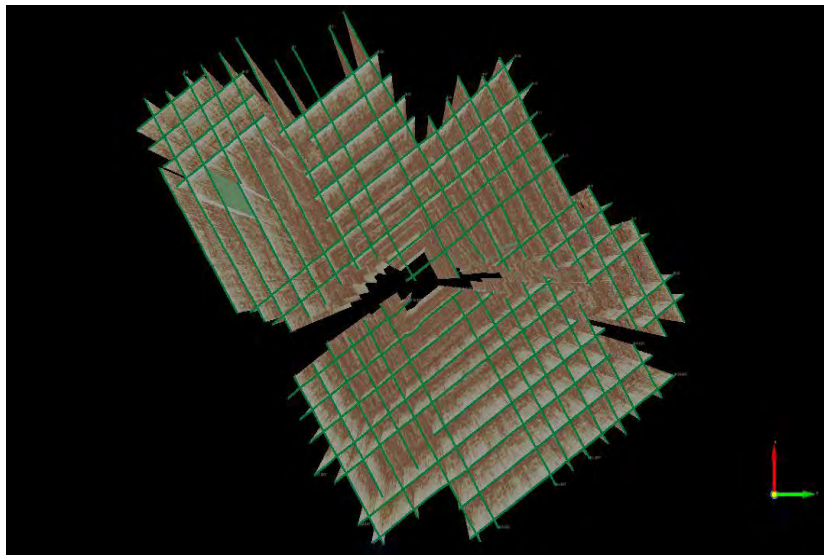
Case #4
Multidimensional Fourier Reconstruction
Barinas-Apure Basin (Venezuela)
Simple 3D Studio

PENTATEX GROUP

This area had been assigned to a private company to carry out re-exploration studies, evaluate its potential and decide if it was economically profitable for exploitation. This area had information corresponding to **36 seismic lines**, in an area that was difficult to access.

From the operational point of view and environmental permits this would take about **1 year** and a budget that would be around **$40MM**, in order to carry out a 3D seismic acquisition.



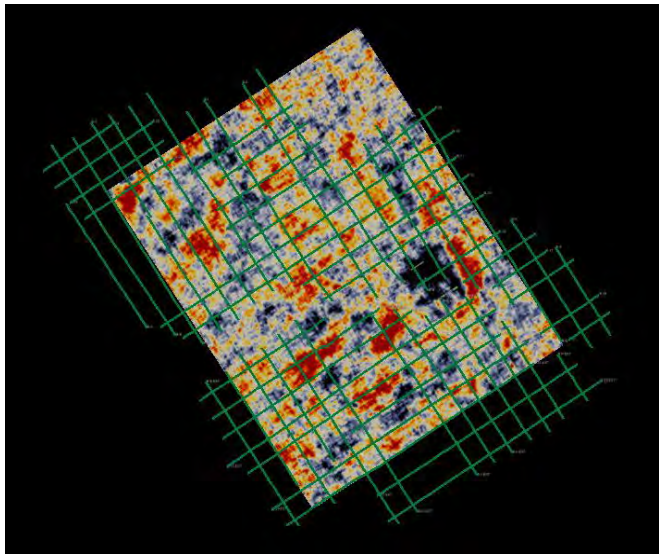


a) Plan View Original 2D Seismic Lines

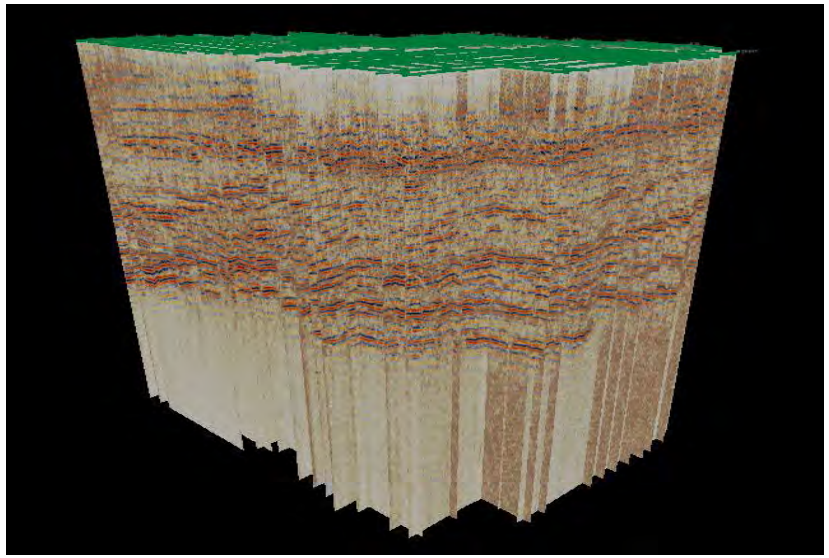
It was decided to work with the available seismic information and apply a **Multidimensional Fourier Reconstruction**, which was carried out in 1 month, the existing data were reviewed and validated, to subsequently generate the **simple 3D cube**, covering **4000 km²** of the study area.

In the time section, an amplitude anomaly was evident that was not possible to see with the 2D seismic and due to the lack of information due to the obstacle of the river present in the area.

So it is another area to re-evaluate from an exploratory point of view.



b) 2D plan view



c) Simple 3D view of the reconstructed volume

COMPARISON CHART

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Value added	Conventional Model	Our Model
Data reliability	Interpreting 2D seismic lines has many visualization limitations between the lines.	Parameterization using an algorithm that we have developed. Once the data processing is executed, a reorganization and a 3D visualization model are automatically obtained.
Execution time	The execution time of a new 3D seismic project in the study area would be approximately 2 years, which includes acquisition and processing.	The execution time based on this methodology in the study area would be approximately 1 month, since we start from available information.
Financial Benefit	The cost for the execution of a 3D seismic project depending on the serious area can vary between US$50MM. And US$100MM.	The cost for the execution of this methodology would be approximately 1% to 5% of a 3D seismic project.

Well Geophysics
Application: Oil & Gas

PENTATEX GROUP

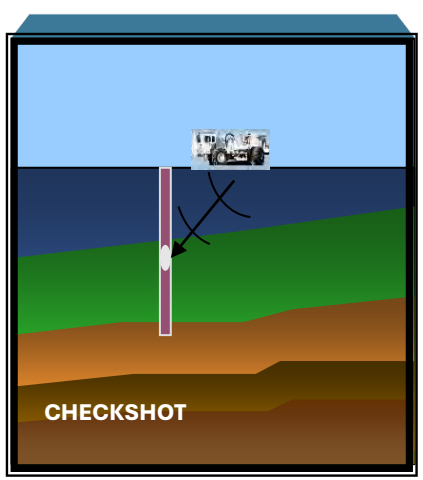
Seismic Profile Processing (VSP)

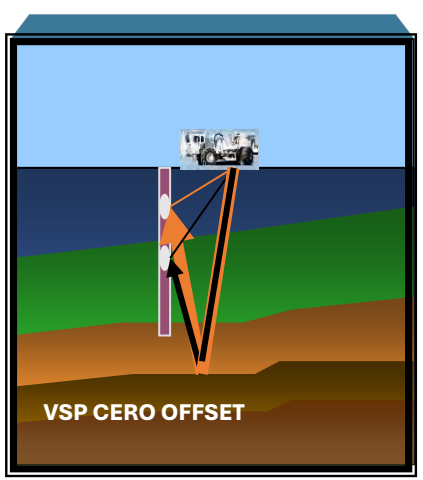
Scope of Service:

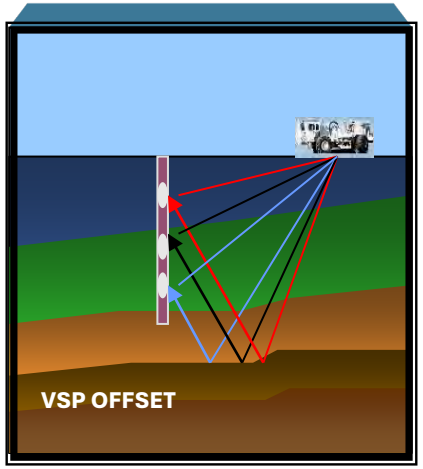
With this service we can process Well Geophysical data that would consist of:
Vectorization of VSP Zero Offset image to the workstation in SEGY format.
Design and modeling of Seismic Profiles
Check Shot Processing (CHECK SHOT)

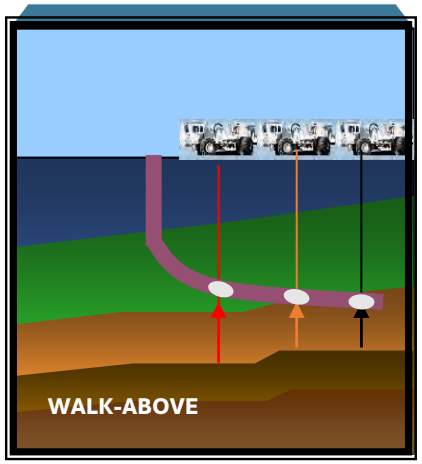
Seismic Profile Processing:

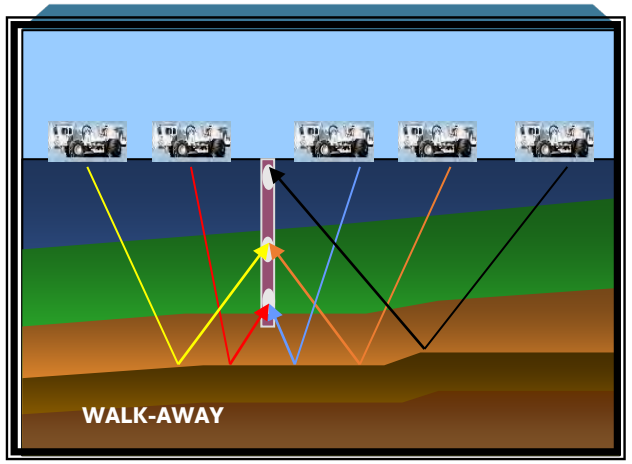
- **VSP**
- **VSP OFFSET**
- **WALK-ABOVE**
- **WALK-AWAY**
- **WALL-AROUND**
- **VSP 3D**

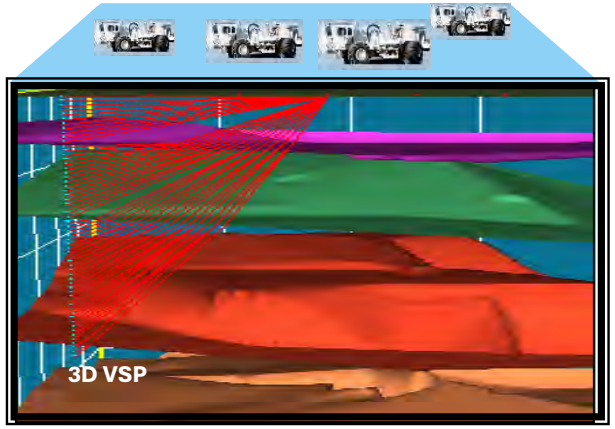










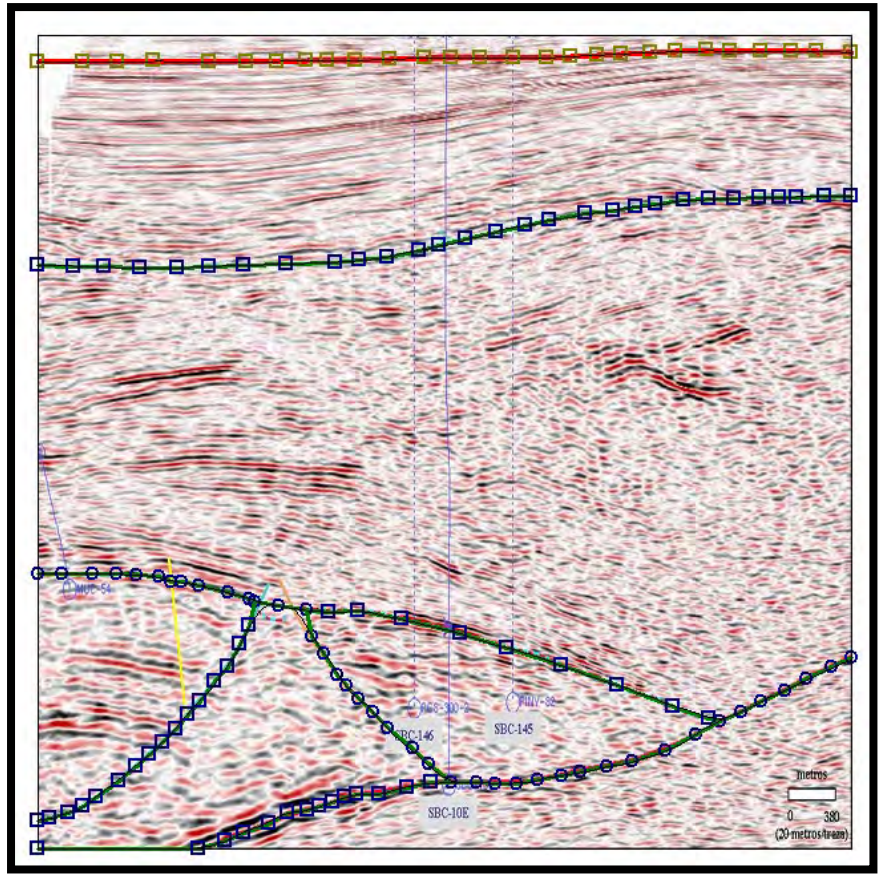


Well Geophysics
Application: Oil & Gas

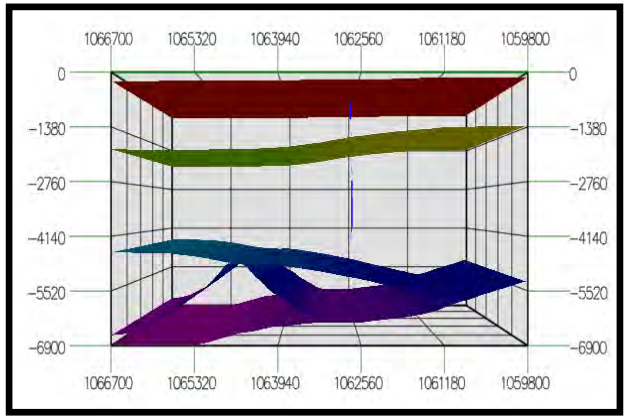
PENTATEX GROUP

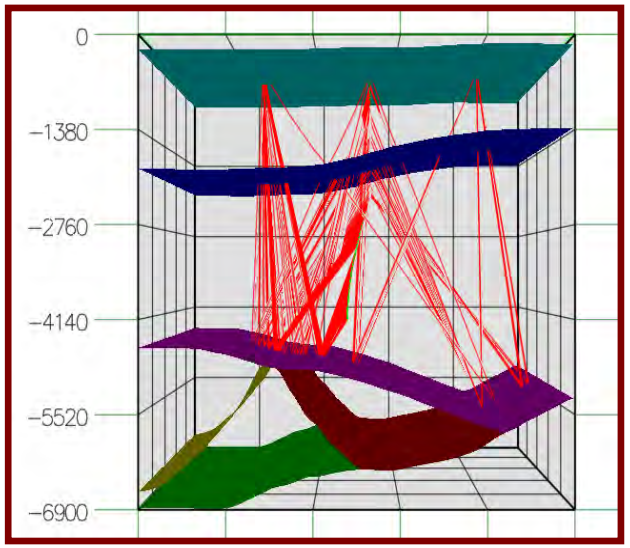
Seismic Profile Processing (VSP)

Design and/or Modeling

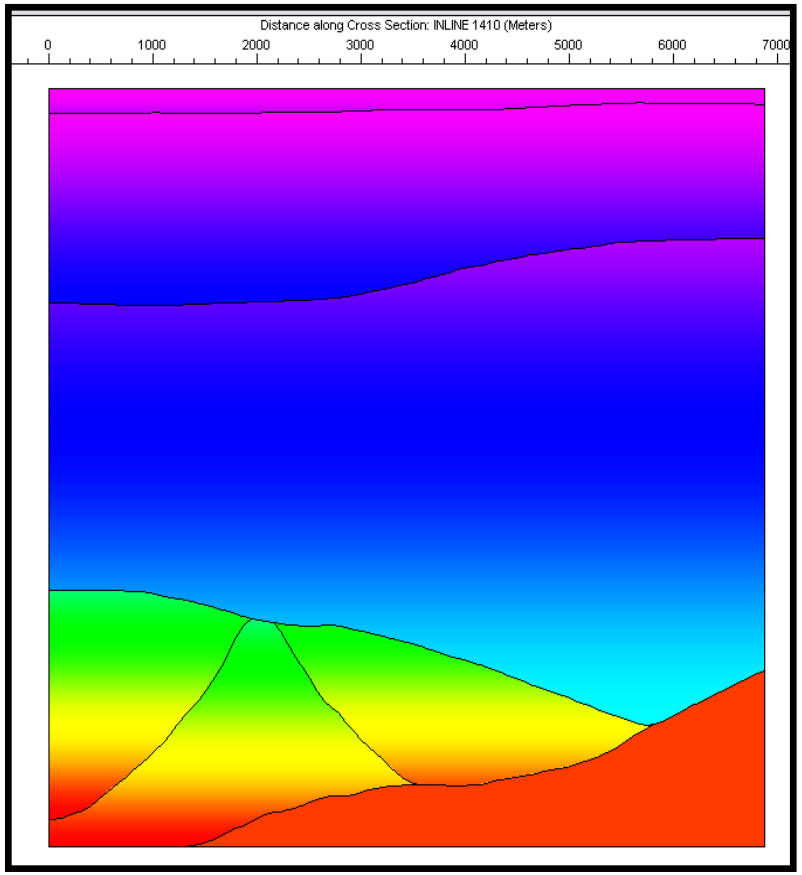


Interpreted seismic line





2.5D Model



Velocity Model

Well Geophysics
Application: Oil & Gas

PENTATEX GROUP

Seismic Profile Processing (CheckShots)

First Arrivals:

1.- Picking of first arrivals.

2.- Verticalization of the depths of the acquired levels and the times of first arrivals.

3.- Generation of the TZ Table (Time and Depth).

$$T_V = T_0 . \cos\left(\arctan\left[\frac{A}{B} \right] \right)$$

4.- Calculation of speeds (Interval, Average, RMS).

Sonic Record Edition:

The information recorded from the well is taken into account (Caliper, Gamma Rays, Resistivity) and with these the areas of anomalies not consistent with the geology are determined, and which will be edited.

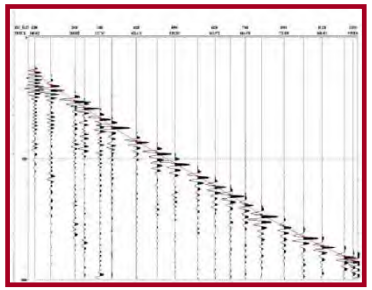
Calculation of Acoustic Impedance (AI) and Reflectivity Coefficient (CR):

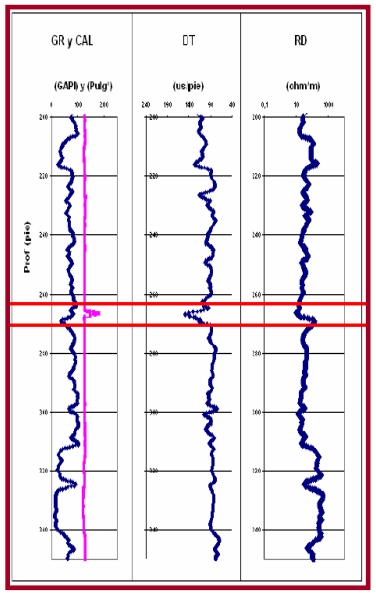
The AI is obtained from the multiplication of the Sonic Register and the Density Register.

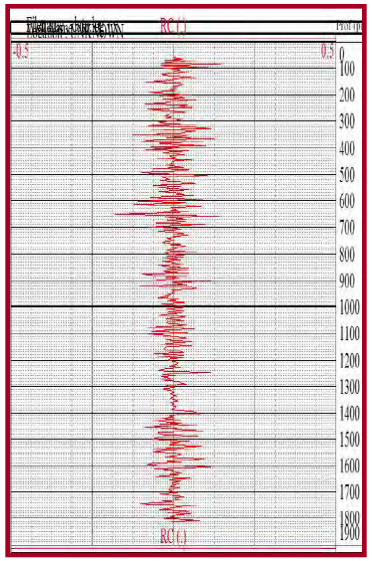
The CR is obtained from the Clipper AI record reason.

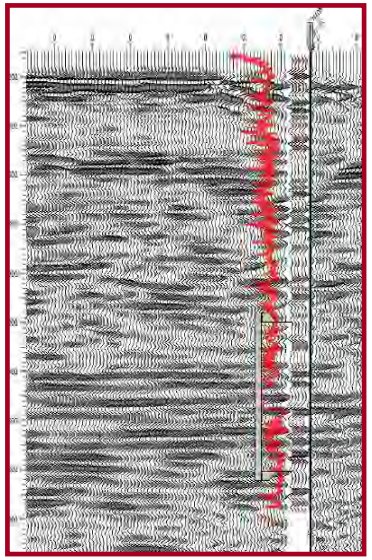
Synthetic Seismogram (SS) and Correlation with the Processed Seismic:

The SS is obtained by convolution of the CR with a phase 0 Ormsby type filter, with a variable frequency range (usually 10 - 30 Hz), and then the SS is calibrated with the processed seismic.









Images of Processing (Check Shot)

Well Geophysics
Application: Oil & Gas

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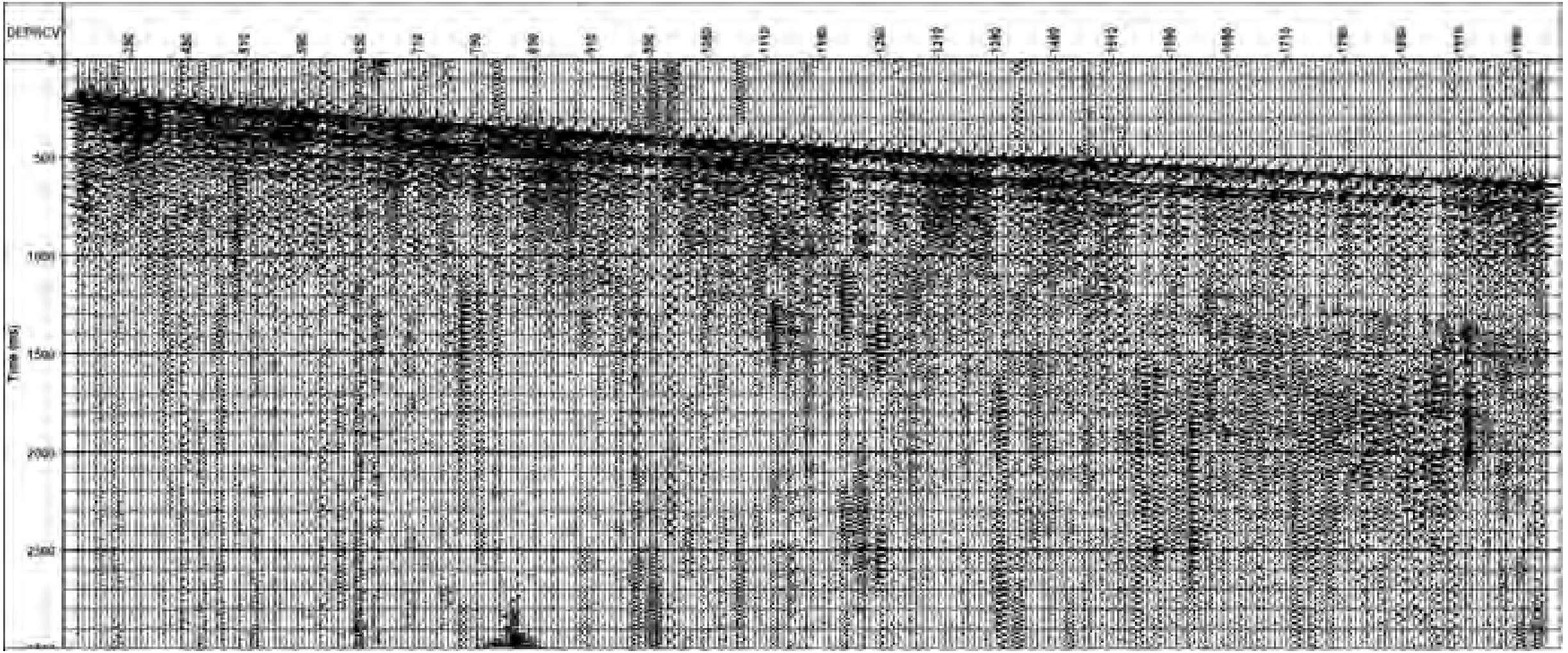
Seismic Profile Processing (VSP)



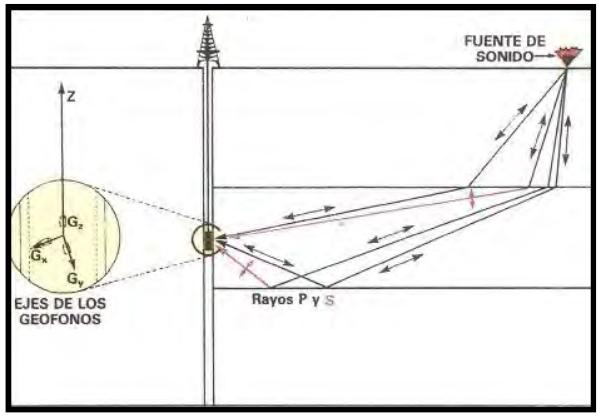
Review and assignment of acquisition geometry.

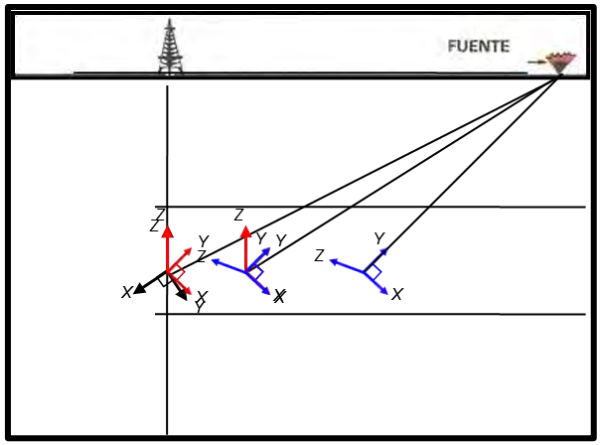
Well Geophysics
Application: Oil & Gas

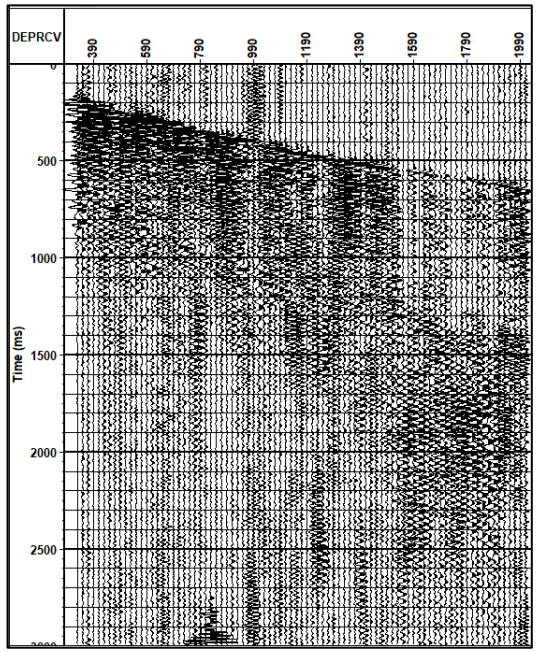
PENTATEX GROUP

Seismic Profile Processing (VSP)

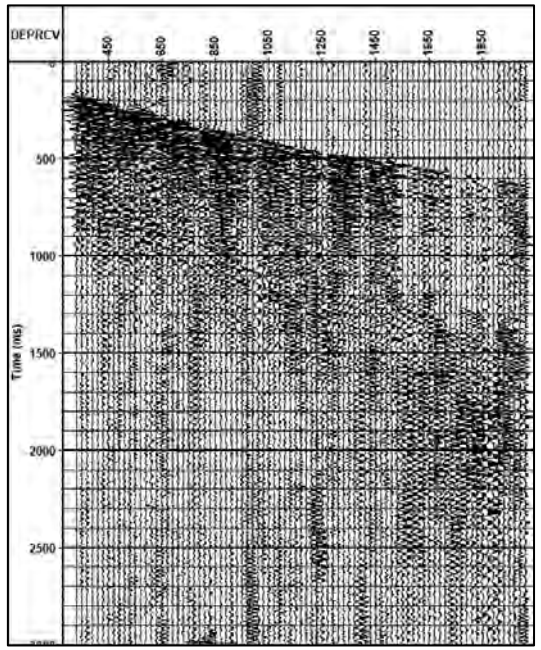
Orientation of the components in the direction of the source.



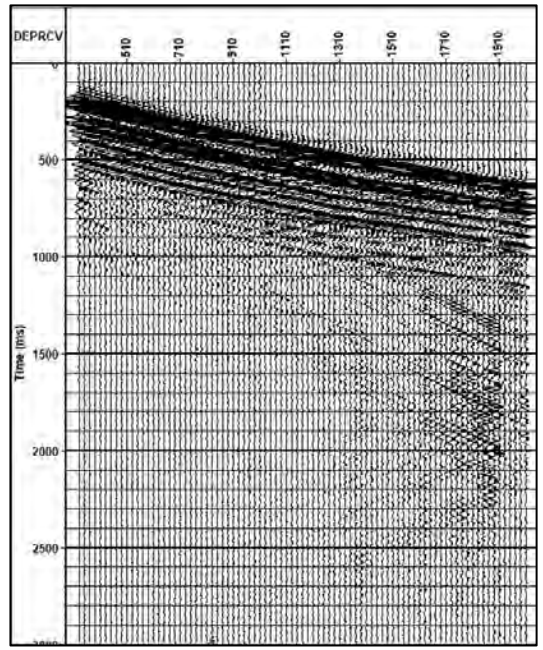




Component X



Component Y



Component Z

Well Geophysics
Application: Oil & Gas

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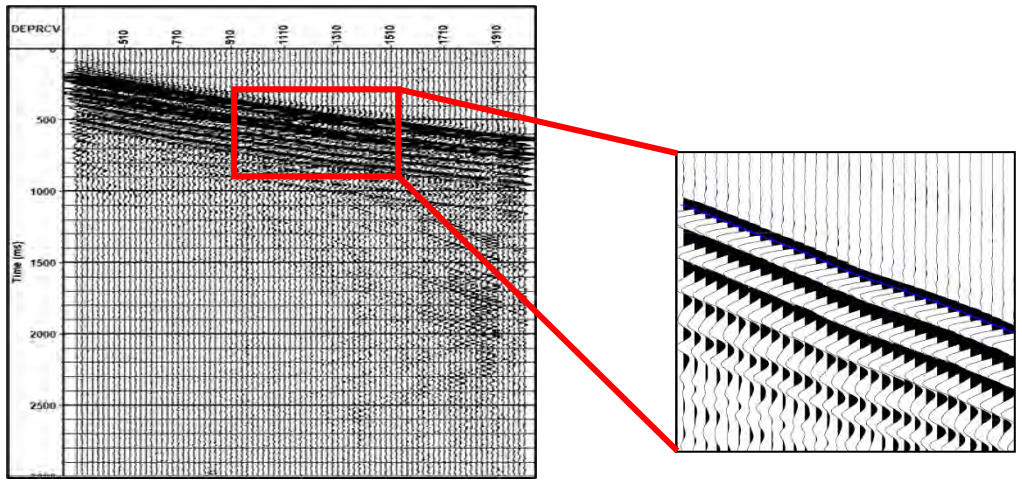
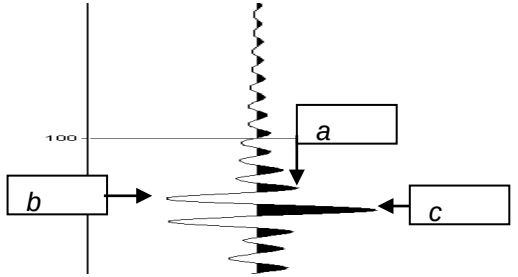
Seismic Profile Processing (VSP)

Picking of first arrivals.



Calculation of vertical transit time.

$$T_V = T_0 . \cos\left(\arctan\left[\frac{A}{B} \right] \right)$$



Time Break (ms)	TWT (ms)	Difference (ms)
a-138	276	0
b-143	286	10
c-150	300	14

Well Geophysics
Application: Oil & Gas

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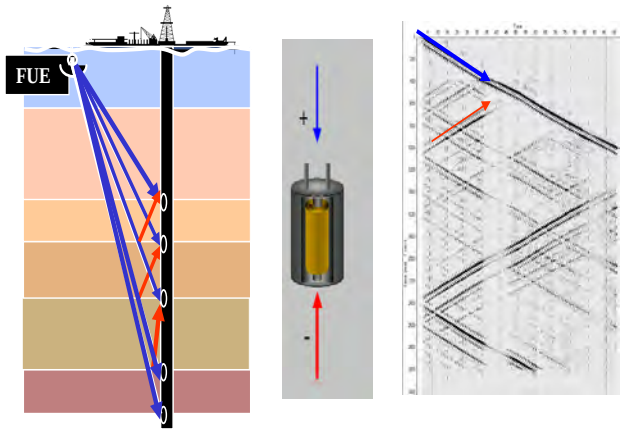
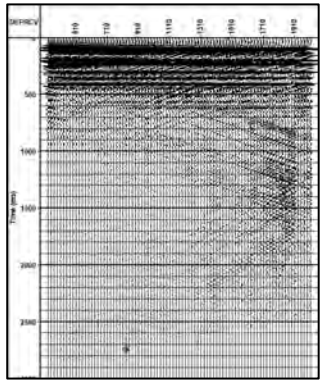
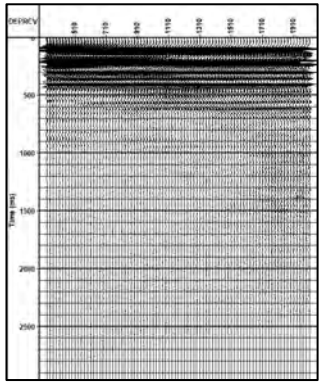
Seismic Profile Processing (VSP)

Separation of the wave field, ascending and descending.

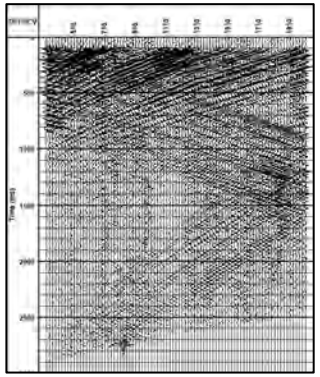




Acquired wave field horizontalized

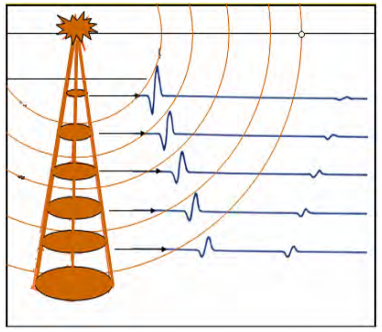


Downward wave field horizontalized

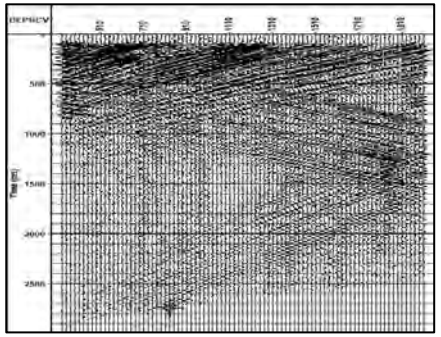


Ascending wave field horizontalized

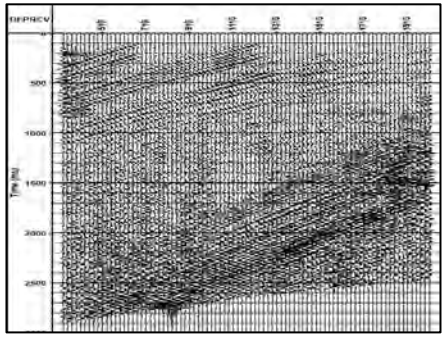
Correction for spherical divergence



Spherical divergence effect diagram



Data without correction



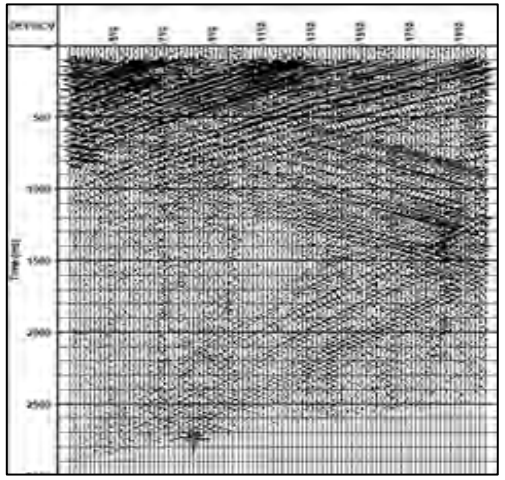
Data with correction

Well Geophysics
Application: Oil & Gas

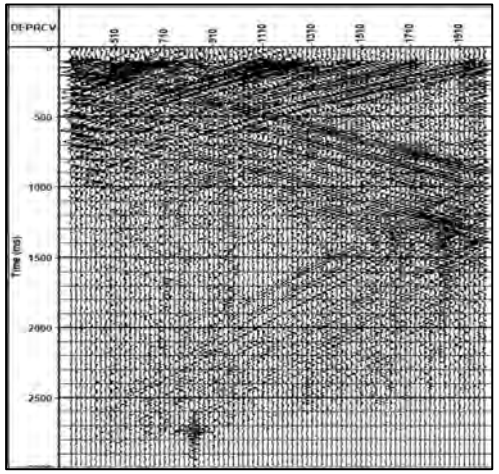
PENTATEX GROUP

Seismic Profile Processing (VSP)

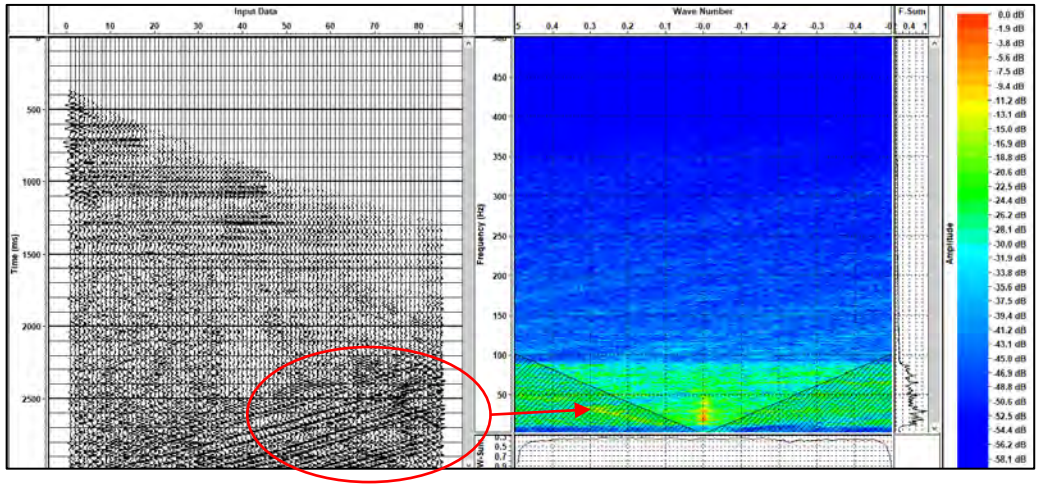
Deconvolution and filters.

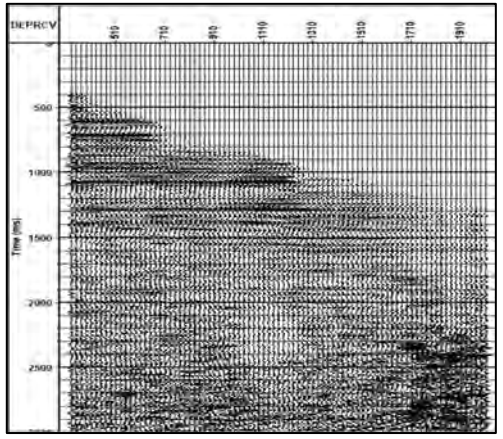


Before Deconvolution

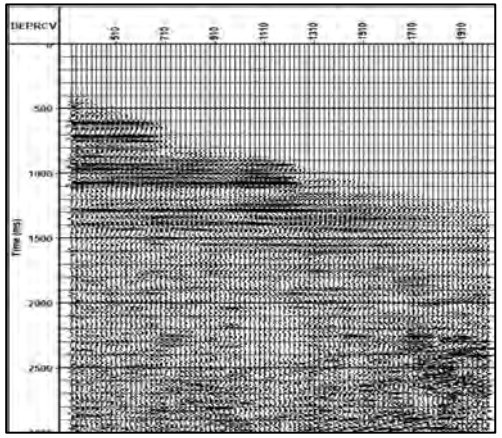


After Deconvolution

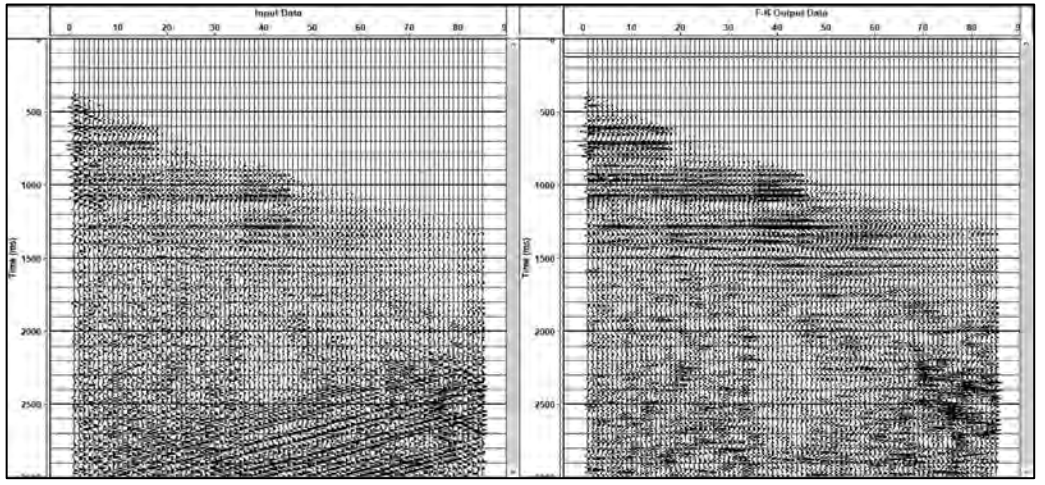




After Median Filter



After BP Filter



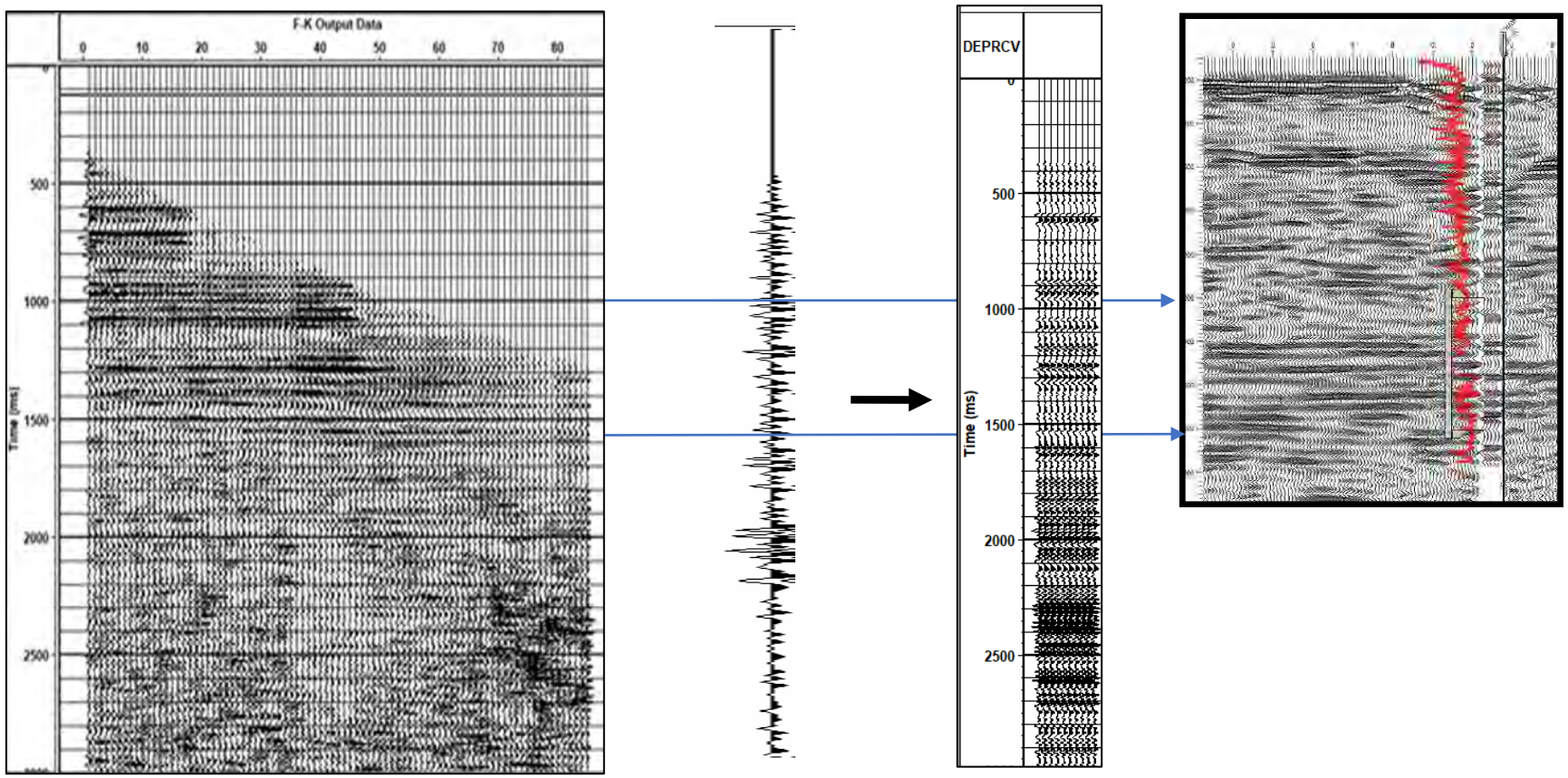
Slope Filters

Well Geophysics
Application: Oil & Gas

PENTATEX GROUP

Seismic Profile Processing (VSP)

Determination Double travel time, “Corridor stack” and interpretation.



Double travel time

Corridor stack

Conclusiones

PENTATEX GROUP

- ✓ These methodologies generate confidence in our clients, through a pilot test with their own data and the efficiency of our results is verified.
- ✓ Our service is applied in exploratory areas and re-exploration areas, to determine their economic potential.
- ✓ Our results demonstrate efficiency and economic accessibility to our clients, with optimized delivery times.
- ✓ We work in synergy with the client, during the application process, we establish collaborative work with the operational areas that affect the exploratory processes, this allows us to establish support in the validation of the results obtained.
- ✓ Our specialists have proven experience in the area, and we have the versatility to promote and apply our methodology anywhere in South America, as we have demonstrated with the work carried out.

Protection of information

PENTATEX GROUP

- We have Google servers to safeguard our clients' information.
- Encrypted Data Transmission and Secure Connection through VPN.
- Availability of information from anywhere in the world.

PENTATEX GROUP

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PENTATEX GROUP