Geological Expression 2D Workflow: A new way to get more from 2D seismic data

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Abstract

Within Brazil there exist more than 37 sedimentary basins containing over 1392 seismic surveys or 15.89 TB of seismic data (source web site ANP 2011), principally 2D lines, that have yet to be completely studied. In order to accelerate development Geological Expression workflows have been developed to aid the oil and gas industry with the interpretation of this large amount of data. Geological Expression is a workflow that utilises a data driven, interpreted guided approach for understanding and defining the geological elements imaged within the seismic data. Geological Expression defines a new paradigm in seismic interpretation with a workflow developed to bridge the gap between processing and interpretation to directly extract the geological information from seismic data

Introduction

The demand for oil and gas in frontier areas or mature provinces is becoming ever more complex but the use of innovative technologies plays an increasingly important role for sustainable economic success as well as the future development of the oil and gas industry. Much of this depends on our improved understanding of the subsurface geology. For this purpose, interpreters are heavily reliant on seismic data. Post-stack seismic data is prevelant in traditional structural interpretation. However today new technology trends have been focused on developing new ways to use image processing methods to investigate and analyse seismic data. Seismic attributes provide a method to highlight information that is present, but hidden in seismic reflectivity data and to understand the variety of ways in which the geology can be expressed within the seismic data. The visualisation and generation of attributes has been developed and used almost exclusively for 3D data. Nevertheless, many of these attributes can be run on 2D data by applying an exclusively developed workflow, "Geological Expression 2D". This workflow reduces interpretation time and provides a more precise definition, knowledge and understanding of the geology. The accuracy of this information enables better understanding of the technical and economic risk, allowing field development and production strategies to be optimised.

First Step

The Geological Expression 2D workflow begins with advanced noise cancellation techniques and data conditioning. This considerably increases the quality and improves the vertical resolution of 2D seismic data regardless of the geological environment and reveals the geology present in data; decreasing or eliminating the need for seismic reprocessing (Figure 1 and 2).

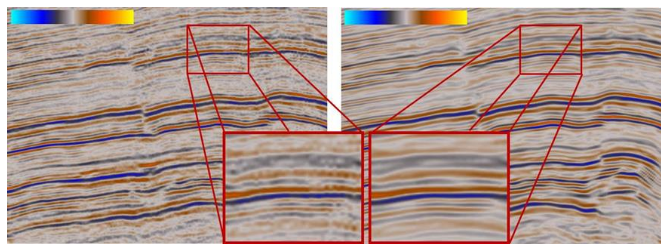

Figure 1: On the left, the original seismic data. On the right, the seismic data after coherent and random noise cancellation.

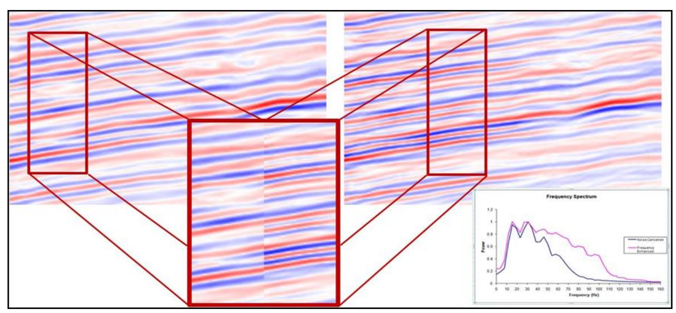

Figure 2: On the left, the seismic data with noise-cancellation. On the right, seismic data after spectral enhancement

Second Step

The second step is stratigraphic and structural imaging. Different attributes and combinations of attributes are used to characterise and highlight structural and stratigraphic characteristics. This step includes a workflow for the automatic detection of faults (Figure 3) that is applied to determine edges and geological faults. The spectral decomposition process with 2D RGB technique (Figure 4) combines three magnitudes of selected frequencies during the spectral decomposition process, so you can highlight stratigraphic variation such as a change in lithology, bed thickness or pore-fill as well as structural features such as faults.

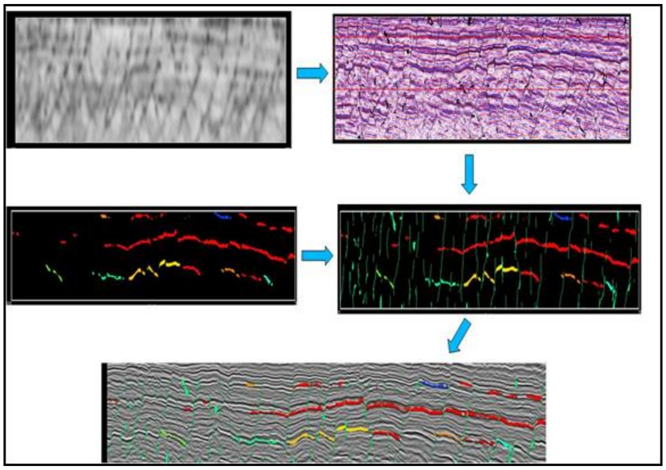

Figure 3-Automatic fault detection and generation of 2D Seismic Facies. The final result is a volume of reflectivity with the incorporation of faults and facies which allowing easy 2D interpretation.

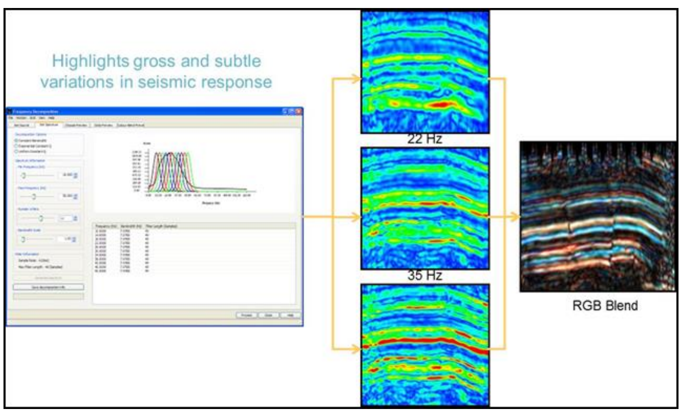

Figure 4 – Frequency Decomposition and 2D RGB Blending

Third Step

The final step of the workflow is the cross-correlation of multiple stratigraphic and structural attributes to generate seismic facies. The geomorphology facies have unique values in the dynamic range are embedded back into the reflectivity data (seismic sections). The combined seismic facies and reflectivity sections are then used to generate maps of seismic-fácies trends (Figure 3). Cross plotting either 2 or 3 attributes is also an effective way of identifying lithology trends and extracting geobodies which define their morphology (Figure 5).

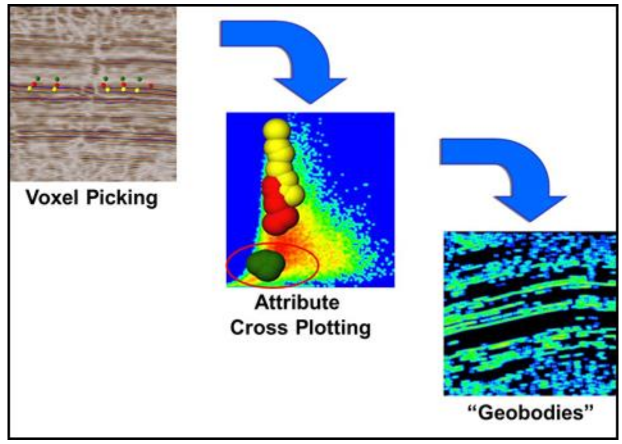

Figure. 5-Voxe l Picking and Cross Plot Analyses can be performed on 2D seismic data used to distinguish the seismic response of different lithologies. For example, selecting a polygon around the green dots, allows segmentation of bodies with this response (this is harder to interpret in the seismic section alone, without the support of the attributes).

Conclusions

The Geological Expression 2D workflows give interpreters access to:

Data conditioning

- Noise Cancellation eliminates noise and improves the continuity of the reflectors
- Spectral enhancement increasing vertical resolution

Structural and Stratigraphic imaging

- Automatic extraction of fault and geobody
- Frequency decomposition and RGB Blends to highlight the stratigraphic and structural features
- Interactive Seismic Facies Classification and Cross Plot to extract geobodies

Finally, the advanced workflows of Geological Expression 2D is faithful to our philosophy of making the connection between the processing and interpretation where geological information is extracted directly from seismic data as a way to maximize the accuracy of the information with better understanding of the technical and economic risk.

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References

Chopra S & Marfurt KJ, Seismic Attributes for Prospect Identification and Reservoir Characterisation. Society of Exploration Geophysicists, 2007

Henderson, J., Purves, S.J. and Leppard, C. [2007] Automated delineation of geological elements from 3D seismic data through analysis of multichannel, volumetric spectral decomposition data. First Break, 25(3), 87–93.

Henderson, J., Purves, S.J., Fisher, G. and Leppard, C. [2008] Delineation of geological elements from RGB color blending of seismic attribute volumes. The Leading Edge, 27, 342–350

Nunez M, , Castagna J, 2003, Multiattributes Analysis and Spectral decomposition Case of study Furial field and Stratton Field SEG Annual Meeting, Salt Lake City, Utah, July 2003