The use of seismic attribute in 2D data: a case study

Salomão Alencar Serra NUNES*, LAGESED – UFRJ
Maria Eliege GLÓRIA, LAGESED – UFRJ
João Paulo Miranda OLIVEIRA, LAGESED – UFRJ
Carlos Eduardo N. CARDOSO, LAGESED – UFRJ
Cláudio Luiz de Andrade VIEIRA FILHO, LAGESED – UFRJ
Júlia Peixoto de OLIVEIRA, LAGESED – UFRJ
Leonardo BORGHI, LAGESED – UFRJ

Abstract

The seismic reflection enables to determine geological structures and others geological features in subsurface, which allows generation of detailed geological models, with the support of geophysical logs (that contains lithological and petrophysical information). The present case study aims to discuss the importance of seismic attributes and how we interpret 2D seismic section support 2D seismic interpretation, located in Fazenda Cedro paleocanyon, onshore Espírito Santo basin. The use of seismic attributes were essential due to the structural and stratigraphical paleo environments (mixed shelf) complexity of the basin, which affect the recognition of the deepest reflectors.
The attributes are useful since seismic reflectors do not exhibit a good resolution or show some noise. This still unsolved problem is common in the first moment and needs this application treatment to enhance reflections and classify the comprehension of the data.
Each attribute used has its own particularity and attends a different purpose. The tecVA composes the volume of amplitudes technics, which was important in the interpretation of subsurface geological features, such as unconformities and faults. Besides, testing this attribute to delimit, without filtering in this case study, the contrast between sedimentary deposits and basement.
As a result it was possible to recognize the main differences between reflectors and their behavior depending on the attribute applied. The tecVA was important in unconformities and structural interpretation, while the RMS Amplitude + Phase shift in basement and sedimentary deposits differentiation.
In fact, the seismic interpretation may present its barriers according to the material used, but applying the right methods this work can become more practical and present more satisfactory results.

Introduction

This work has been done using a 2D seismic section located in the geomorphological province of Fazenda Cedro paleocanyon, onshore area of the Espírito Santo basin (figure 1). This area presents a very representative 2D seismic data coverage. At the same time, this data is from old surveys and processes, which does not show a good quality, besides presenting a very complex stratigraphy and structural geology. Within this context, the application of seismic attributes helps in the enhancement and identification of interesting features for the seismic interpretation. In this perspective, the attributes were applied to assist the interpretation of stratigraphic units, unconformities and faults.

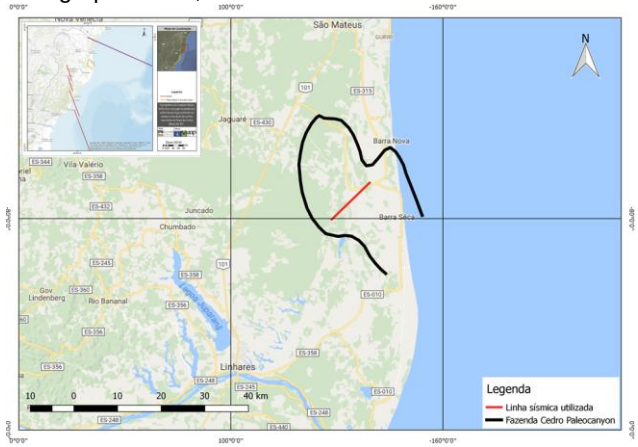

Figure 1- Map with the location of the study area, Fazenda Cedro Paleocanyon, onshore area of the Espírito Santos basin.

Method

Seismic attributes are measures, characteristics or properties derived from seismic data.
Attributes can be measured at a time point or by a time window, and can be measured in a single trace, a series of traces, and a surface or extracted volume seismic data (Astratti *et al*. 2012). Their calculation is useful because they help draw patterns, relationships, or traits that otherwise might not be apparent. The deduction or calculation of seismic attributes typically involves the treatment of data, including operations window settings, smoothing, averaging, filtering, finding maximum and minimum values, execution differentiations and integrations, analysis of changes in polarity or execution of spectral analysis or wavelet (Astratti *et al*. 2012).

According to Barnes (2001), the seismic attributes quantify specific characteristics, and decomposes seismic data into constituent attributes
Using the attributes, the following workflow was adopted for the seismic interpretation: (1) identification of the most appropriate attribute for the type of feature to be enhanced; (2) attributes application and (3) seismic interpretation (figure 2).

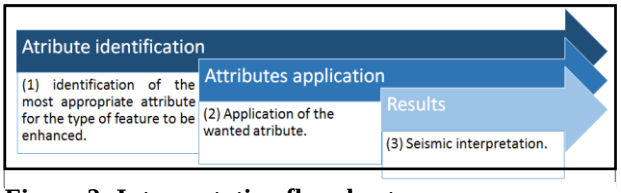

Figure 2- Interpretation flowchart.

Between the attributes used, each one has its particularity and works with different parameters, and generate different results. The figure shows the seismic attributes and their principles uses, according to Schlumberger (2011).

Seismic atribute	Principles
Phase shift	Commonly applied to improve the match between different phase of seismic data.
Remove bias	Used to remove deconvolution bias (constant that has been added or subtracted from the data samples), from seismic traces. It can be done when na inversion cube has been biased by the starting velocity or acoustic impedance.
RMS Amplitude	Computes the Root mean square (RMS) on instantaneous trace samples over a specified window.

Figure 3- Seismic attributes and their principles (Schlumberger, 2011).

The volume amplitude technique (tecVA) and the association of the RMS Amplitude and the Phase shift are actually sets of attributes that when associating and uniting their parameters, they are able to deliver, as a result, horizons that can be more easily recognized. The RMS Amplitude and phase shift is important in the recognition of stratigraphic heterogeneities. This attribute improves the visualization of regions with considerable impedance contrast response and, thus highlight deeper amplitudes that can be related to the basement, by the association of each attribute characteristics.
The tecVA aims to generate amplitude maps and seismic sections that reflect subsurface geology. It is a widely used attribute in the exploration of hydrocarbons, since seismic information is essential for the identification of seismic sequences, their stratigraphic units and their geological unconformities (Bulhões and Amorim, 2005).

Bulhões and Amorim (2005) verified that the RMS mean was used with the objective of eliminating the conveyer frequency, thus, only the desired information was extracted.
Based on a variation of the tecVA, the rotated phase, which is obtained by the application of the inverse Hilbert transform in the seismic data, results in a highlight of the high impedance contrasts (Bulhões and Amorim, 2005), which emphasizes precisely the horizons of interest in this work, like unconformities and stratigraphic units.
The RMS mean and the inverse Hilbert transform were applied in the Petrel® software through the RMS Amplitude and Phase shift attributes, however to create the tecVA attribute was also essential to use the Remove bias, which serves to remove the oblique direction deconvolution present in the seismic data, improving the quality of the seismic section (figure 4).

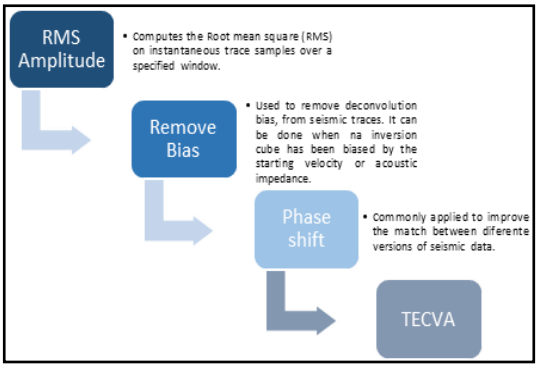

Figure 4- TecVA atribute workflow.

Results

It is possible to observe that except for the high impedance reflectors, there are less evident features, but they can be highlighted with the appropriated attribute.

A strike 2D seismic section, presented in figure 5, show the raw data, without any attribute application. This data was present with only black, gray and white color table.

There are some reflectors with high impedance that can be interpreted easily, but in some part the continuity of this reflectors is hard to map because of the data quality. Besides, is difficult to identify the sismofacies patterns, mainly when increase the depth. Apart from from this, mapping structural features, as faults, is not clear.

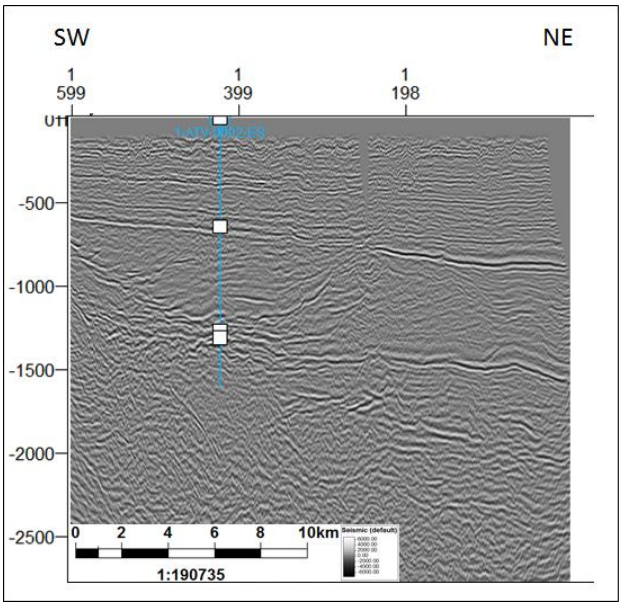

Figure 5- Seismic section without any atribute. Black, gray and white color table.

The application of tecVA attribute had a gain of amplitude, and it helped reflectors expressivity.

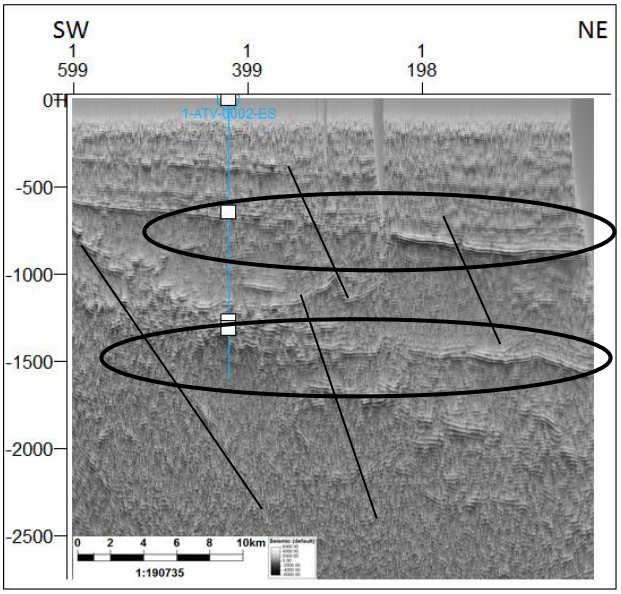

Figure 6- Seismic section with the result of tecVA atribute workflow, where it is possible to see some features enhanced (unconformities, faults).

As observed in figure 6, the tecVA improved the recognization of the sismofacies patterns and the mapping of strctural features, by reducing some data noise.
The delineation of the basement was not totally solved with the tecVA. We observed that without applying Remove bias some deep contrast was better highlight than tecVA. Thus, through the combination of the RMS Amplitude and the Phase shift was possible to show satisfactory imaging and a delineation of the basement (Figure 7). Apart from this, both attributes improve the interpretation of thickness sedimentary deposits, possibiliting to see the portions with great sedimentary deposits, (channels?).

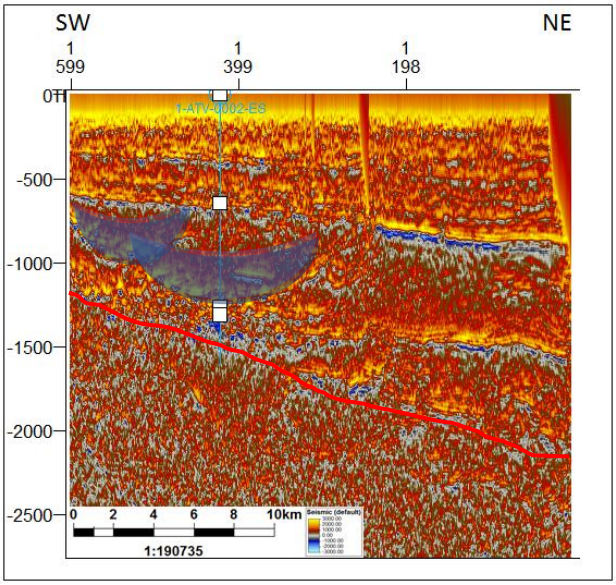

Figure 7- Seismic section with the set of attributes composed by RMS amplitude and Phase shift. Possible presence of channels and basement interpretation (in red).

Both, tecVA and combination of RMS Amplitude and Phase shift, were important during the interpretation, but each one for a specific objective.
Later, the tecVA attribute proved to be more effective and useful to detail some features, besides presenting a great performance when it comes to geological unconformities, as presented by Bulhões and Amorim (2005).
After applying the attributes, it was possible to make a more precise interpretation (figure 8).

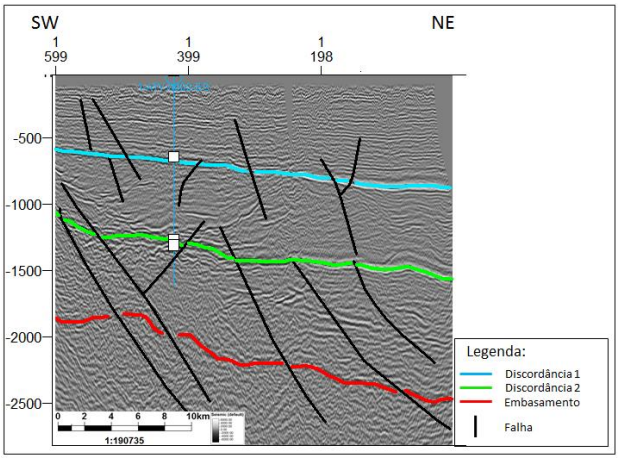

Figure 8- Interpreted seismic section.

Conclusions

The seismic attributes used in this work have been extremely important, by bringing more information about interpreted horizons, as well as faults and fractures. Through them, it was possible to better delineate and characterize the observed features. Throughout this work, the seismic attributes were excellent complements to the traditional seismic interpretation, and as a result, it helped to reduce the doubts, thus generating satisfactory products with a better precision.

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