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Effects of Post Stack Seismic Data Conditioning on Impedance Inversion for Reservoir, Brazilian Pre-salt, Santos Basin

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SUMMARY

Seismic data conditioning improves sinal- to- noise ratio (SNR), mitigate uncertainties and shrink noise artefacts, taking care to preserve the signal associated to geologic features. In the frame of Brazilian Pre-Salt, Santos Basin, which is strongly affected by Salt noise, will be proposed a efficient and straightforward method to deal with seismic data.

Introduction

It's well known that there are many methods of data conditioning that improve the signal to noise ratio, but the process applied to the data in this study was carefully performed to preserve the signal associated with geological features within the Pre-Salt context of the Santos Basin. In this data there is a lot of noise associated with the salt/migration smiles. This study looks at a proposed methodology to reduce this sort of noise which is a different approach in comparison to the most common methodologies of noise reduction.

In this magnitude of depth, it must be noted the very intense attenuation of frequency content. The noise-reduced data, will be used as an input into the process of spectral balancing at the target level to improve the vertical resolution.

The main objective of this article is to use the conditioned data as input for acoustic inversion, in order to get better results, when compared to the same process with the raw data as the input. Two of process will be compared: the first comparison will be between the raw data and the noise reduced data. The second comparison will be between the noise reduced data and the spectral balanced data as an input into the acoustic inversion.

Methodology – Data Conditioning

The workflow (Figure 1) which has been used to reduce the noise was:

1. Determine the grid oriented filter size, a large filter in XY directions and small in Z, will reduce the continuity of the vertical noise associated with the salt/migration smiles.
2. Apply this grid oriented filter and then calculate the dip and azimuth (reference volume). These volumes 'steer' the structurally oriented noise filter along the structure.
3. Finally, a structurally oriented mean noise filter is applied to the raw seismic volume which is, guided by the reference volume.

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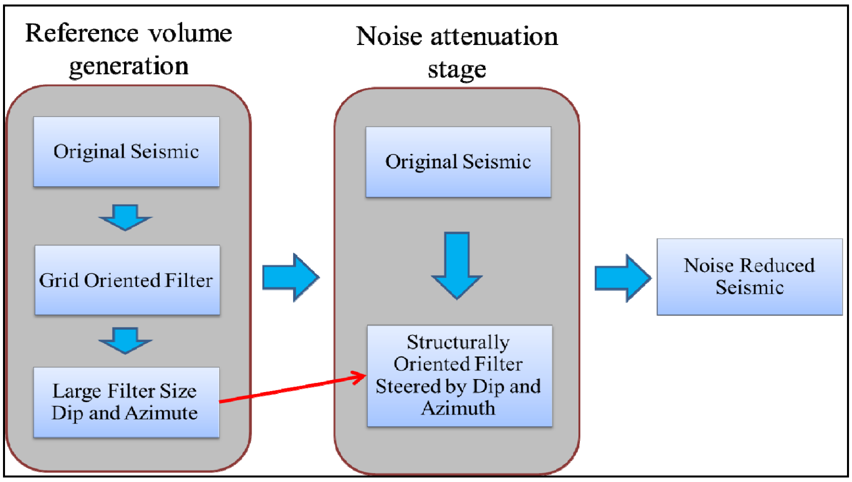
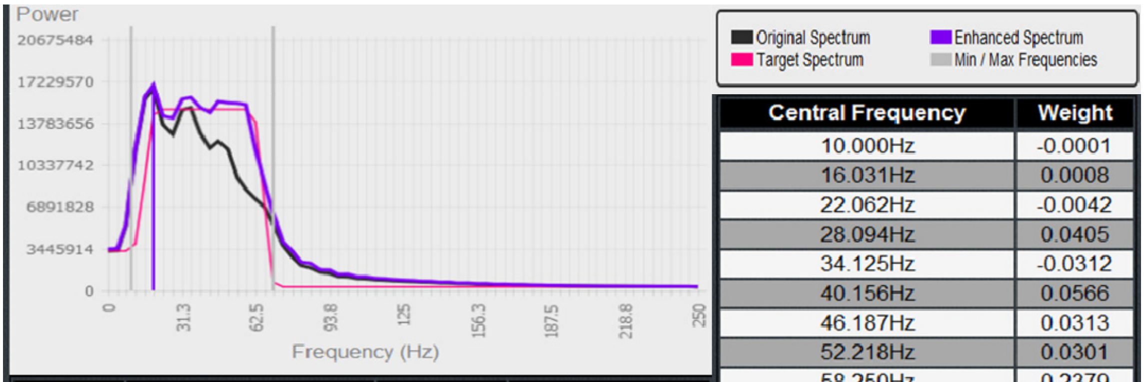


Figure 1 *Noise attenuation workflow. The structurally oriented filter used is a simple mean 2D filter which runs across the data, voxel by voxel, calculating the local mean according to the orientation given by the dip and azimuth. The window which is calculated the mean can be controlled according to the level of noise on the data.*

Once generated, the noise-reduced volume is used as input into the process of spectral balancing, at the target level. This process, which is controlled interactively, is to produce a white spectrum where all frequencies equally contribute to the total spectrum. This is achieved by applying weights to central frequencies and then summing them back to the noise reduced data (figure 2), taking care not raise the high-frequency noise and not to change the dominant frequency of the data, thereby preserving its regional trend.



	Dominant Frequency	Bandwidth	Mean Frequency
Original	19.500Hz	46.900Hz	48.491Hz
Enhanced	19.500Hz	54.700Hz	49.660Hz

Central Frequency	Weight
10.000Hz	-0.0001
16.031Hz	0.0008
22.062Hz	-0.0042
28.094Hz	0.0405
34.125Hz	-0.0312
40.156Hz	0.0566
46.187Hz	0.0313
52.218Hz	0.0301
58.250Hz	0.2379
64.281Hz	-0.0095
70.312Hz	0.0007

Figure 2 *The effect of Spectral Balancing on the frequency spectrum of the data.*

Methodology – Acoustic Inversion

In geosciences, the seismic inversion process estimates the quantitative rock-petrophysical properties from the reflection seismic data, such as porosity, lithology and fluid saturation of a reservoir (Chopra & Marfurt, 2007). Simply stated this important process, is based on a straightforward convolution of a reflectivity model and an estimated wavelet to produce synthetic traces, which are compared to the seismic input, then the reflectivity model is updated, to carefully ensure the match between the synthetic and seismic data (Tonellot *et al*, 2001) (figure 3).

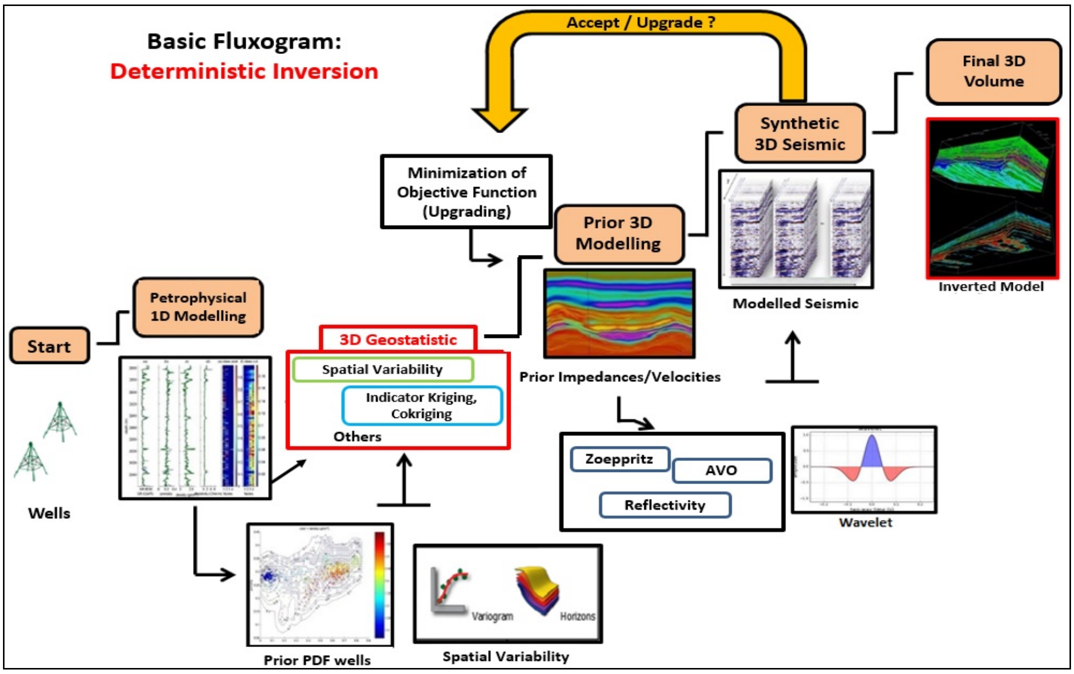


Figure 3 *Deterministic Inversion workflow.*

Case Study – Pre-Salt data of Santos Basin

The study area for this work is the Pre-Salt carbonate reservoirs, in the Brazilian offshore Santos Basin, which are Aptian in age and located in ultra-deep water (~ 2,4km water column).

Two areas of time-migrated seismic data were chosen for the study:

- Area A, went through the following process: structurally oriented noise attenuation and followed by acoustic inversion.

- Area B, had applied to it the whole process described in the previous sections: noise attenuation, spectral balancing and finally acoustic inversion.

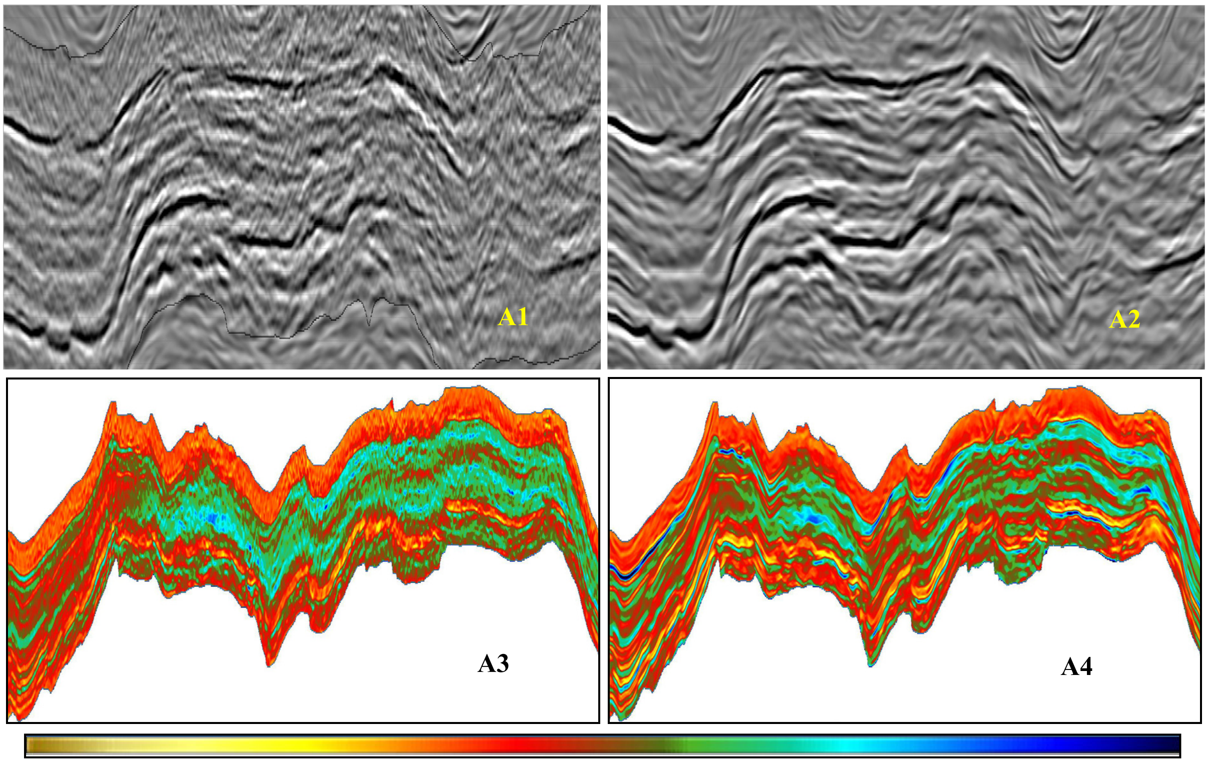


Figure 4 *Area A. The A1 figure shows the raw seismic data, A2 the noise attenuated seismic, A3 the acoustic inversion of the raw seismic data and A4 the inversion of the noise-attenuated data. Colours nearer to yellow have low impedance and colours nearer to blue are high impedance.*

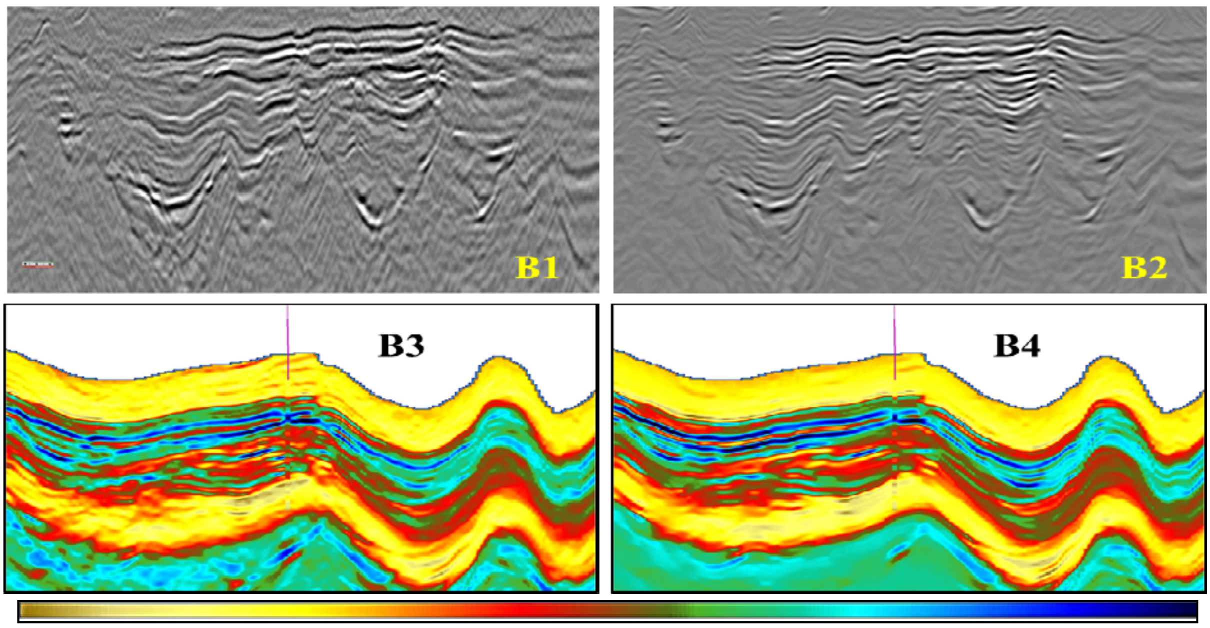


Figure 5 *Area B. Figure B1 shows the raw seismic section, B2 the spectral balanced seismic, B3 the inversion of the noise attenuated data and B4 the inversion of the spectral balanced data. The colours nearer to yellow have low impedance and the colours nearer to blue are high impedance values.*

Estimated wavelets for the acoustic inversion in area A are shown in figure 6.

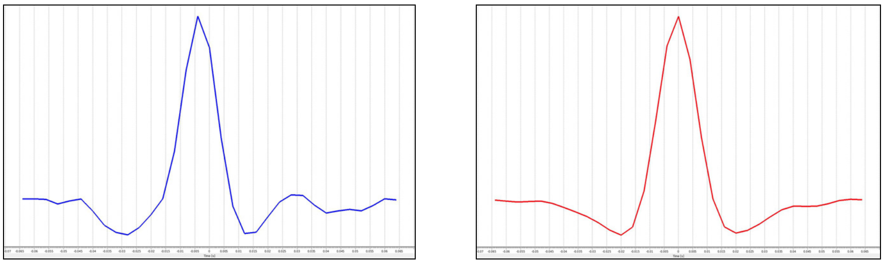


Figure 6 *Wavelets in time domain (x axis). The wavelet extracted from the raw data is on the left and the wavelet extracted from the conditioned data structurally oriented filtering is on the right side.*

Conclusions

Seismic data conditioning has shown to be an essential tool for reservoir characterization. Applying data condition to seismic data improves the quality of the data (Figure 4 –A2). The acoustic impedance result (Figure 4 –A4) is also of higher quality: improvement of lateral/vertical continuity and much less Salt noise than the raw seismic, respectively (Figure 4 –A1) and (Figure 4 –A3). Applying a spectral balancing workflow to Area B has also increased the vertical resolution (Figure 5) of the data.

The estimated wavelet based on the conditioned seismic dataset (structurally oriented noise attenuation) of field A (Figure 6, right side panel) is characterized by a more symmetrical shape, centered at 0-time and more well-behaved side lobes than estimated wavelet from the raw seismic dataset of field A (Figure 6, left side panel).

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References

Chopra, S., Marfurt, K. [2007] Seismic Attributes for Prospect Identification and Reservoir Characterization. *Society of Exploration Geophysicists Abstracts.*

Tonellot, T., Macé, D., Richard, V. [2001] Joint Stratigraphic Inversion of angle-limited stacks. *Society of Exploration Geophysicists Abstracts.*