AVO precondicioning for seismic inversion

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Abstract

We present a workflow for AVO precondicioning that seeks for increasing the signal to noise ratio and the seismic resolution. Our goal is to improve the final result of seismic inversion and fluid detection.
The workflow adopts the curvelet transform and a Q inverse filter based on the reflectivity method.
We present some results that show the advantages of the precondicioning.

Introduction

Two important goals of the seismic method applied to hydrocarbon exploration and production is fluid detection and litology interpretation. The main methodologies to extract lithology and fluid information from seismic amplitudes are based on inverse theory.

Although seismic inversion is considered as a single algorithm by many authors, the main issue of this paper is to treat ~~the~~ seismic inversion as a complete workflow, including steps for an iterative precondicioning of seismic amplitudes and for quality control (based on an inference approach). An example of this inference work can be found in Loures and Theodoro (2007).

To improve the signal to noise ratio and the seismic resolution we create a flow based on the curvelet transform (Candès e Donoho, 2000) and the inverse Q filter. The inverse Q filter applied is based on the reflectivity method. A good reference can be found in Wang (2008).

Previously to the inverse Q filter, the curvelet transform is applied to denoise the data on the offset domain. The section below is a simple introduction of the curvelet transform.

The curvelet transform

Curvelet transform was introduced by Candès and Donoho (2000). It is a directional transform, which represents edges and singularities along curves with needle-shaped elements, with directional sensitive and smooth counters. In comparison with wavelets, curvelet uses fewer coefficients for representation of wedges or wave fronts.

Curvelets are interesting because efficiently address important problems faced with seismic data, for example:

- Optimally representation of objects with edges;
- Optimally sparse representation of wave propagators;
- Optimal image reconstruction in severely ill-posed problems.

The curvelet transform has a property of sparsity, i.e. most of the energy of the signal is localized in just a few coefficients.

Results

This section shows the result of the preconditioning on image-gather data. Figure 1 shows the imput an image gathers processed with PSTM following an amplitude preservation algorithm. We can recognize multiples and randon noise on this dataset.

Figure 2 shows the image gathers after denoising with the curvelet transform. We can observe the better quality of the signal after treatment.

Figure 3 shows the image gathers after inverse Q filtering, with improvements on the vertical resolution.

Conclusions

The curvelet transform provides a good result denoising the data, keeping the signal energy. The inverse Q applied after the curvelet denoising shows good stability, increasing the vertical resolution of the signal.

Acknowledgements

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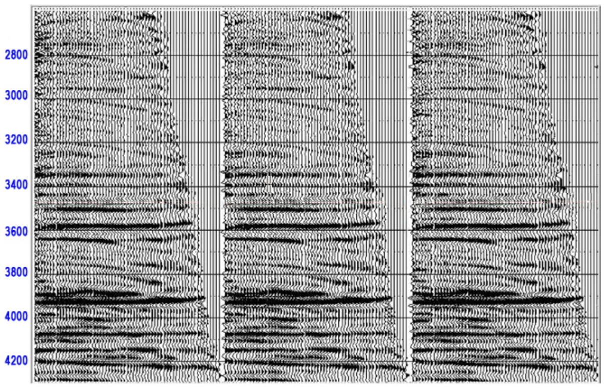

FIGURE 1: Input image gather samples of the data.

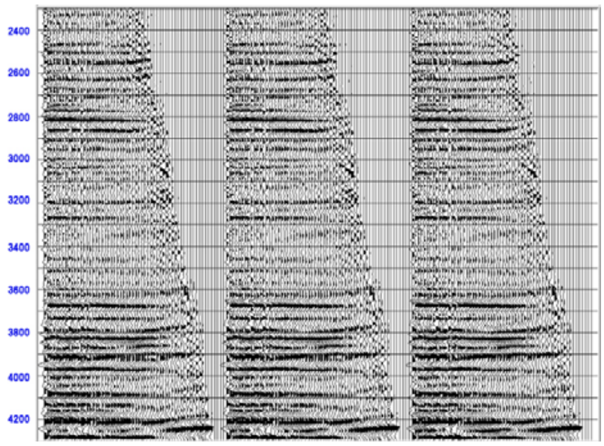

FIGURE 2: Image gathers samples after denoising with the curvelet transform. Observe the better quality of the signal.

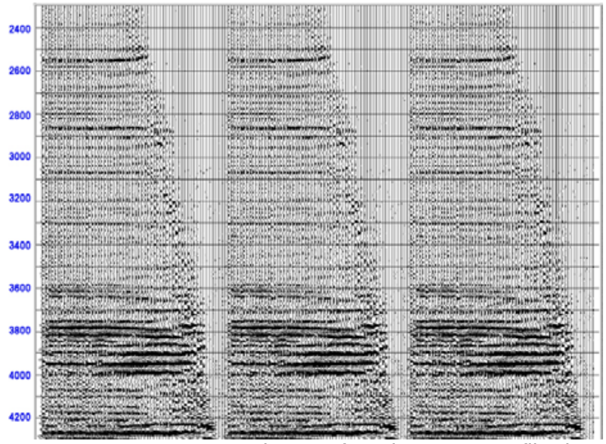

FIGURE 3: Image gathers after inverse Q filtering, presenting improvements on the vertical resolution.