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Post-stack seismic image optimization for fracture seismic attributes – a practical guide to SSIO methodology

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Summary

To address current challenges in the oil and gas industry, many exploration and production (E&P) companies are moving toward the digital transformation culture in pursuit of a more efficient and effective way to work.

During reservoir characterization, post-processing seismic image enhancement techniques can help enable faster and better decisions based on a simplified structural framework and key features, such as seismic fractures and faults (Fehmers and Höcker, 2003).

Introduction

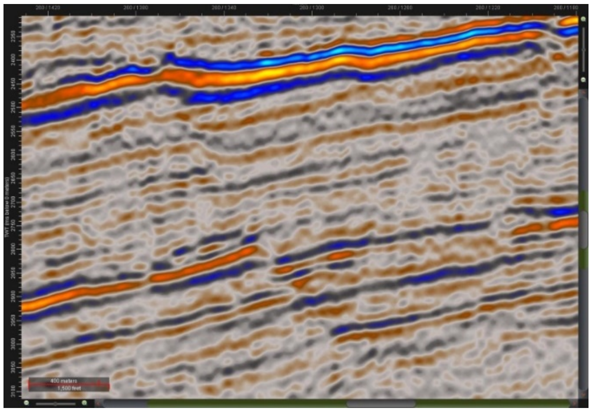
Seismic data quality is crucial to the interpretation process. High-quality seismic data can help interpreters identify the principal features to improve structural interpretation as well as reduce interpretation time, whereas poor-quality data increases uncertainty and interpretation time because principle features are more difficult to identify. Additionally, interpreters do not always have the budget or the time to perform a pre-stack reprocessing project.

Separation of background noise from the actual signal can be challenging. Moreover, the actual process necessary to understand the petroleum system is a parallel work, with the interaction of several geoscientists who use an iterative workflow to define a basic structural framework for a sophisticated and detailed model.

This work presents Phase 1 of the structural seismic interpretation optimization (SSIO) methodology, in which structural oriented filters are used to search for continuity in the seismic reflections. The structural filters remove the background noise in the seismic to enable analysis of stratigraphic features. This methodology helps reduce the manual and automatic seismic interpretation time and provides a better structural volume calculation, thus allowing for quick analysis of the potential risks in the area of interest to help enable better business decisions.

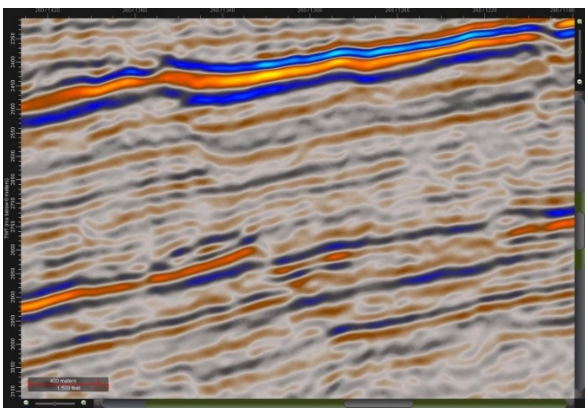
Method

Phase 1 of the SSIO methodology applies structural oriented filters to reduce the seismic acquisition footprint and create a cleaner seismic image. Each seismic image is unique; therefore, to improve understanding of fault changes, different sets of parameters (e.g., lines, traces, and samples) should be tested by applying *across-fault* and *fault preservation* smoothing filters.

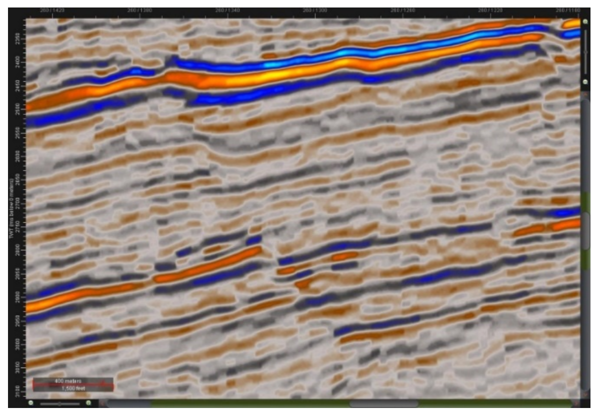


(a)

Figure 1. (a) Pre-stack time migration (PSTM) seismic without filters; (b) PSTM seismic using the across-fault smoothing filter—five lines × five traces × nine samples; (c) PSTM seismic using the fault preservation smoothing filter—five lines × five traces × nine samples.



(b)



(c)

After applying all the parameter sets, the filters highlighted the main structural components of the area of interest. The structural filters (Figure 1) are used for different reservoir characterization purposes. The first volume (Figure 1b) uses the *across-fault* smoothing filter to interpret the semi-automatic horizon using auto trackers and the calculation of the seismic curvature (positive and negative) attributes (Chopra and Marfurt, 2007). The second volume (Figure 1c) uses the *fault preservation* smoothing filter to calculate the seismic semblance attributes.

Conclusions

The use of the structural oriented filters, along with in-house techniques, can help improve two-dimensional (2D) and three-dimensional (3D) post-stack seismic volumes quickly and easily to suit business needs.

Based on the positive results achieved during Phase I, Phase 2 of the SSIO methodology is expected to generate a set of cleaner structural attributes that are ideally suited for the implementation of machine-learning techniques.

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