Effective Delivery of Reservoir Compliant Seismic Data Processing

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ABSTRACT

Modern seismic acquisition delivers broadband seismic data of 5 to 6 octaves starting just above 2 Hz. Long or multi-offset surveys also deliver high-quality pre-stack data, which in principle allow for the inversion of seismic data for amplitude variation with angle (AVA) effects with much higher accuracy than just a decade ago. However, data processing and imaging prior to inversion also face new challenges. Addressing these challenges requires rigorous quality control of data processing in a reservoir compliant manner. The key objective of this paper is to show how low-frequency seismic and AVA compliance, both crucial for elastic inversion, can be monitored and calibrated during processing. In general, the procedure of monitoring the quality of seismic data contains a set of qualitative and quantitative measures starting from early processing stages e.g., source de-signature. However, the inversion compliance of seismic data is mainly measured on migrated images/gathers. Therefore, we conduct a set of intermediate migrations, usually on a subset of the entire dataset, to evaluate key processes before full production migration such as de-multiple or de-ghosting. We employ a set of statistical and deterministic measures throughout this processing sequence that indicate the quality of the processed data for reservoir property estimation. These measures include wavelet estimation, wavelet-decomposition in orthogonal domain, AVA-fit and corresponding attribute analysis, elastic inversion and well-tie misfit. Tracking key geological and reservoir markers are essential in this quality monitoring procedure. We demonstrate the application of this quality monitoring procedure on datasets from the North Sea and offshore Gabon, representing two different geological scenarios with associated processing challenges. We focus on pre-migration processing steps such as de-multiple and post migration processes such as Radon de-multiple, residual moveout correction and de-noising. We show that through meticulous quality control of processing stages both in data and reservoir parameter domains, as well as tracking known reservoir markers such as hydrocarbon contacts and bright-spots, the processing parameters can be tuned and the reservoir compliance of data preserved. In particular, high data quality from both low-frequency and AVA standpoint can be ensured. We discuss the limitations of the monitoring process and identify potential areas for further improvements.