

Using VSP data to evaluate the response of seismic attributes for reservoir characterisation

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Seismic trace and sequence attributes are commonly utilised for interpretation of seismic data. The meaning and use of these attributes are well documented in the literature. However, an “optimum set” of attributes for characterisation of a particular reservoir is usually not known a priori. Finding the optimum attributes can be a lengthy process. We propose an alternative approach where optimum attributes are selected based on VSP data analysis. VSP data allows us to investigate the response of seismic attributes with respect to variation of a specific property of interest such as porosity, fracture density, fluid type, etc., with depth.

The approach we propose can be summarised as follows:

- Analysis of down-going VSP waves and computation of various seismic attributes;
- Correlation between attributes computed from up and down-going energies;
- Selection of optimum attributes;
- Correlation of VSP-derived attributes with attributes computed on 3-D seismic data;
- Map attributes to characterise the variation of a specific property across the reservoir.

Particular attention was devoted to the analysis of instantaneous frequency (IF). IF computation relies on the Hilbert transform which is, most of the times, obtained via the Fourier transform, therefore it is unable to properly handle the non-linear and non-stationary nature of seismic data. IF is also well known for being very sensitive to noise. We propose to use the Empirical Mode Decomposition (EMD) method, an adaptive wavelet-type spline decomposition based on the local characteristic time scale of the data, to obtain the fundamental oscillating modes and then compute the IF on the wavelet space.

The proposed VSP-based attribute analysis approach, aimed at an improved reservoir characterisation, is tested on several three-component VSP data sets acquired offshore North-West Shelf and correlated with surface seismic.