Description of the relationship between reef growth and shallow marine channel system using different seismic attributes

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Seismic attributes are a helpful tool for the interpretation of faults, fractures, channels, or facies. In the course of a research project it was necessary to delineate a channel system and a reef body. These two features needed to be correlated in a timely manner. This means that we have to determine the time relation of reef growth and channel evolution. Firstly, several seismic attributes are tested on their principal application for delineation of the above described features. These attributes include coherence, curvature, spectral decomposition, and textural attributes based on the grey level co-occurrence matrix. Secondly, we bring the interpreted results into a time relationship in a sequence stratigraphic type of interpretation of the seismic attribute calculation.

Coherence is a representation of the similarity between waveforms of neighboring traces. Thus, it gives us valuable information on discontinuities in our seismic data, which may be caused by faults, channels, or fractures. For the calculation we use the software Package OpenTect (dGB Earth Sciences). The principal workflow consists of establishing volumetric dip and azimuth cubes (steering cubes), apply filtering, and compute a coherence cube after each work step. For the estimation of the structural dip three methods exist. These are the complex trace analysis (Luo et al., 1996 and Barnes, 1996), the discrete scan method (Marfurt et al., 1998), and the gradient structure tensor method (Bakker, 2002) and Höcker & Fehmers, (2002). The filters used were basically the mean (low-pass) filter, the median filter, and an edge preserving smoothing. Coherence can be calculated using several methods. These include crosscorrelation-based coherence (Babich & Farmer, 1995), semblance-based coherence (Marfurt et al., 1998), eigenstructure-based coherence (Gerzenstark & Marfurt, 1999), gradient structure tensor-based coherence (Bakker, 2002), least-squares-based coherence (Bednar, 1998), higher-order statistics-based coherence (Lu et al., 2005) and entropy measurement-based coherence (Cohen & Coifman, 2002). Another possibility for calculating coherence is variance-based methods, where the variance is in principal one minus the semblance. In this work we used semblance-based coherence estimations.

The aim of seismic spectral decomposition is to characterize the time-dependent frequency response of subsurface rocks and reservoir. For the calculation of spectral decomposed seismic cubes various methods exist. In this project a Fast Fourier Transform (FFT) and a Continuous Wavelet Transform (CWT) approach for calculation of the different frequency spectra was used. We calculated frequency cubes in 10 Hz steps and used RGB blending for visualization of these cubes. Seismic spectral decomposition cubes is a useful tool for interpreting stratigraphic features, for identification of thin beds, and especially for enhancing channel structures. All spectral decomposition calculations were done within OpenTect. For the CWT a Morlet type wavelet was used.

Curvature attributes describe in principal the degree of bending of seismic reflectors. For the primarily determination of curvature attributes, a dip and azimuth cube must be calculated. For this purpose a Fast Fourier transform approach for the determination of this dip and azimuth cube is used. Based on this cube, the shape index, the curvendness, minimum curvature, maximum curvature, as well as the most positive and negative curvatures can be calculated. These attributes define channel edges as well as reef boundaries.

Figure 1: Interpreted Inline in time domain showing the reef structure and the channel. The brace on the right indicates the vertical area used for the time-slice displays.