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Enhancing Stratigraphic Features by Spectral Decomposition, Case Studies from Saudi Arabia

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ABSTRACT

Spectral decomposition has proven successful in identifying stratigraphic features in clastic depositional environments, such as fluvial channels and glacial valleys, and also in structural features, such as faults (Partyka, Gridley & Lopez 1999; Peyton, Bottjer & Partyka 1999; Partyka 2001; Giroldi & Alegria 2005; Chopra & Marfurt 2016). This paper presents a workflow on the application of spectral decomposition in a carbonate depositional environment with which a large subsurface channels system was revealed on the northern area of Eastern Province of Saudi Arabia. Three-dimensional seismic-amplitude data contain ample geological information, but the amplitude data is usually skewed towards the dominant frequency of the seismic source wavelet. Spectrally decomposed-seismic data provide more focused-amplitude spectrum that can reveal geologic features of different sizes at different and more appropriate frequencies. Consequently, obscured geologic features appear on the conventional 3D seismic amplitudes can be imaged with crisper and richer details at specific frequencies. The workflow to be presented consists the following processes: (1) systematic horizon interpretation and mapping (close to the target features), (2) seismic amplitudes extraction to discern if any subsurface features exist, (3) seismic-amplitude spectrum and frequency transforms (Discrete Fourier) with seismic horizon at the center of a time window (120-160 ms) to generate a frequency cube (0 to Nyquist Hz), (4) extract frequency horizons to make RGB-blended maps of three frequency horizons with low, intermediate, and high dominant frequencies to reveal geologic features of different sizes, and (5) finally, for regional mapping, spectrally decomposed 3D seismic volumes can be created with a dominant frequency best discriminating most features. A study of a large Late Cretaceous channels system was carried out over six 3D and merged 3D surveys using this workflow in east part of Saudi Arabia. This newly revealed channels system indicates that the top of the Late Cretaceous formation is an important unconformity with substantial subaerial exposure time, and has some profound implications to the hydrocarbon exploration and production in the area.