Application of Coherency Technique on 3D Seismic Data

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Application of 3-D seismic coherence has provided improved understanding of structural and stratigraphic details of the subsurface, leading to revised 3-D geologic models. Presented here is a description of the Coherence Cube methodology and various new applications with results from Saudi Aramco fields. It is intended as both an introduction to the technology, and to demonstrate the power of its use as a complementary 3-D volume to the conventional 3-D seismic volume for 3-D seismic interpretation. This technology reveals important geologic information that may be totally overlooked using conventional processing.

The ability to measure three-dimensional spatial variations in the seismic waveform, with dip and azimuth comprehension, is an extremely powerful capability. The basic seismic waveform contains a measure of time, frequency, amplitude and absorption quantities. These vary spatially as the recorded seismic responds to lateral variations in the physical and geometric properties and lithology facies. Measuring these combined changes in the seismic response allows the interpreter to map these changes if recorded by the seismic technique. The seismic coherence measurement, as applied here, is an attempt to capture these changes. This coherence response can be decomposed into various attributes in order to identify the components that are changing.

The application of coherence to pre-stack seismic data, to optimize the imaging of faults and fractures by selective offset contributions based on coherence, is presented. The coherence technique can be used also to separate the imaging of structural effects on the shorter offsets from the pore fluid effects seen on the longer offsets. The use of coherence technology in the pre-stack data creates an interesting opportunity in the area of amplitude versus offset analysis. For example, the coherence technique can be used to establish the gradient changes of the seismic waveform across the recorded offsets. Calibrating this response across a known anomaly such as a gas-oil contact can be used as the diagnostic seismic fingerprint to search for similar anomalies. This has a major advantage over conventional amplitude versus offset studies as it is based on waveform response rather than on amplitude alone.

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