Abstract

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STRATAL GEOMETRIES OF THE CRETACEOUS CARBONATE SYSTEMS – APPLICATION OF MULTIPLE VOLUME A TTRIBUTE ANALYSIS TO 3D SEISMIC DATA FROM THE PERSIAN GULF

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In the Sirri oil fields (Iranian Persian Gulf) at least twelve medium-scale (15-100 m) sequences can be differentiated in Barremian to Santonian strata on the basis of “coarsening / fining” upward successions derived from gamma ray logs. These sequences are generally below the resolution of seismic data. A wide trough or peak may represent two log-derived depositional sequences. Therefore, the small-scale variability observed in wireline logs, which represents variations in depositional energy, is difficult to map laterally using original seismic amplitude data. The seismic response to the top boundaries of the Gadvan, Dariyan, Kazhdumi, Mauddud, Khatiyah, Laffan and Ilam Formations were interpreted throughout the seismic volume. A good well- to seismic tie and the lateral continuity of these horizons allowed a confident interpretation of visible geometric features. However, the interpreted horizon maps can only provide insights into the variability at the top and base of the bounding surfaces and not from within them.

Inspection of high quality 3D seismic data from the Sirri oil fields indicates that efforts to significantly improve seismic imaging of Cretaceous carbonate sequences are critical to advances in the area of volume-based attribute interpretation. Stratal geometry and internal architecture within Cretaceous carbonate successions has a major effect on geophysical response. Primary seismic reflection events do not necessarily follow clinoformal stratal surfaces and internal variability of these surfaces is not recognizable using single seismic attributes. Conventional 3D seismic interpretation on the basis of seismic reflection characteristics cannot detect the heterogeneous nature of high-frequency cyclicity of the depositional units. The application of multiple seismic volume attributes integrated with stratal slicing and visualization technology provided new opportunities to better understand the internal heterogeneity of the carbonate reservoirs in Sirri.

In order to expand the information content for the 3D seismic interpretation, seven different attribute volumes were generated. The components of the generated multi-dimensional dataset contain geologically meaningful patterns or clusters, noise and redundant data. Using a linear transformation procedure namely: principal component analysis, the large dataset is represented in a new vectorial space with a smaller dimension. Only those components with most contribution to the meaningful elongation patterns of the data were selected. This procedure adsorbed the noise and redundant data as separate components. A hierarchical classification of the selected components created a single 3D multiattribute seismic facies classification volume. The geological information extracted from this data volume is far more diagnostic than the seismic reflection data. The new insights into the internal architecture of the Cretaceous carbonates are essential for further sequence stratigraphic analysis and reservoir characterization.