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Lithological discrimination using a Wavelet Based Fractal Analysis at the Teapot Dome Field, Wyoming-USA

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In this work, we have applied a Wavelet Based Fractal Analysis (WBFA) to well logs and seismic data at the Teapot Dome Field, Natrona Country, Wyoming-USA, trying to characterize a reservoir using fractal parameters, as intercept (b), slope (m) and fractal dimension (D), and to correlate them with the sedimentation processes and/or the lithological characteristics of the area. The WBFA was first applied to the available logs (Gamma Ray, Spontaneous Potential, Density, Neutron Porosity and Deep Resistivity) from 20 wells located at sectors 27, 28, 33 and 34 of the 3D seismic of the Teapot Dome field. Also the WBFA was applied to the calculated curve of water saturation (Sw). At a second step, the method was used to analyze a set of seismic traces close to the studied wells, extracted from the 3D seismic data. Maps of the fractal parameters were obtained. A spectral analysis of the seismic data was also performed in order to identify seismic facies and to establish a possible correlation with the fractal results.

The WBFA results obtained for the wells logs indicate a correlation between fractal parameters and the lithological content in the studied interval (i.e. top-base of the Frontier Formation). Particularly, for the Gamma Ray logs the fractal dimension D can be correlated with the sand-shale content: values of D lower than 0.9 are observed for those wells with more sand content (sandy wells); values of D between 0.9 and 1.1 correspond to wells where the sand packs present numerous inter-bedded shale layers (sandy-shale wells); finally, wells with more shale content (shaly wells) have D values greater than 1.1.

The analysis of the seismic traces allowed the discrimination of shaly from sandy zones. The D map generated for the seismic traces indicates that this value can be associated with the shale content in the area. The iso-frequency maps obtained from the seismic spectral analysis show trends associated to the lithology of the field. These trends are similar to those observed in the maps of the fractal parameters, indicating that both analyses respond to lithological and/or sedimentation features in the area.