González, R.J., Reeves, S.R., Eslinger, E. and García, G.: "Development and Application of an Integrated Clustering/Geostatistical Approach for 3D Reservoir Characterization, SACROC Unit, Permian Basin", Paper 111453-MS presented at the 2007 SPE/EAGE Reservoir Characterization and Simulation Conference, Abu Dhabi, 28-31 October.

Preview Abstract

A new 3D reservoir characterization approach is developed that integrates clustering and geostatistical methods. The approach applies clustering methods to well logs and core data for lithology interpretation, reservoir quality characterization, and also for prediction of core porosity and permeability values. Since complete log suites are usually unavailable, clustering is also used to generate synthetic "complete" log suites. In this way, "core" parameter profiles, with high vertical resolution, can be generated for many wells. Geostatistics is then applied to the resulting dataset, and three-dimensional spatial patterns of clusters, porosity, and permeability are utilized to generate reservoir characterizations for flow simulation models.

An advantage of the approach is the application of a soft computing software based on maximum likelihood principles which permits clustering using mixed variables; probabilistic assignment of samples to each multi dimensional cluster; prediction of missing data during the process; lithology estimation of clusters based on a built-in "expert" system; and development of multiple relationships among core and log data for each cluster.

The approach was applied in the platform area of the SACROC Unit (Permian basin), acknowledged as a highly complex carbonate reservoir. In 2004 and 2005, three wells were drilled in this area, were fully cored through the reservoir (~ 800 ft) and porosity and permeability measurements taken on a foot-by-foot basis.. These measurements jointly with modern well logs were utilized to develop models that firstly predict acoustic impedance (product of sonic and density) from only gamma-ray and neutron porosity logs (widely available), and secondly porosity and permeability from these three combined logs. The generalized models, applicable across the platform area, have successfully replicated acoustic impedance where independent data existed for verification, as well as previously acquired core data. This seems to validate the applicability of the new approach in this highly heterogeneous carbonate reservoir.

Unlike seismic inversion and other "data mining" or geostatistical approaches for 3D reservoir characterization, the method described herein can yield, based on the presented example, what appears to be a high resolution result consistent with the known reservoir character.