TerraEx Group – FREE WEBINAR

29 January 2021 at 10 -11 am CT (Houston)

Modeling three ways from electro-facies: categorical, e-facies probabilities, and petrophysics with assignment

Geomodeling for petroleum reservoirs is conventionally done hierarchically using a facies concept intended to characterize the depositional environment followed by a distribution of properties in each facies. Many reservoir models do not directly use facies descriptions developed through sequence stratigraphic analysis and examination of core and image logs. Instead, they use electro-facies (or e-facies), which are categorical codes assigned from petrophysical log curves designed to capture the major facies groupings through some type of classification technique. Typically, a subset of wells that have been carefully geologically logged are used as training data to develop a set of rules that convert the suite of petrophysical logs (gamma ray, density, neutron, porosity, etc.) to a probabilistic interpretation of chosen facies for each interval in every well. The e-facies classification workflow, a guided machine learning, has 3 main elements: 1) Training set of petrophysical curves and interpreted facies; 2) Probabilities of each facies at each location; 3) Assigned most probable facies, the resultant e-facies log.

This study describes and compares three approaches to the development of e-facies geomodels using the 3 elements as conditioning data. Each approach arrives at the same type of result: a 3D model of categorical e-facies codes that can be used as domains within which rock and fluid properties can be distributed. A case study example from the North Sea will be shown.

The first approach is direct simulation of categorical e-facies at well location, which is standard. It takes the e-facies logs (element 3) as conditioning data and uses a method for simulating categorical variables, such as Plurigaussian simulation or sequential indicator simulation, to directly build a 3D facies model.

The second approach is direct simulation of petrophysical logs (element 1) at well locations as conditioning data. It uses a method for simulating correlated continuous variables to build 3D models of the log responses; these are then converted to 3D e-facies using rules developed through the cluster analysis.

The third method works directly with the e-facies probabilities (element 2) from the cluster analysis workflow. These probabilities are spatially modeled directly using transforms and simulated as continuous variables in 3D. E-facies codes are assigned through post-processing by taking the e-facies with maximum probability at each 3D location.

Conclusions

The comparative studies in this paper demonstrate a variety of methods for creating 3D simulations of categorical facies. All of the methods rely on a procedure for creating e-facies from petrophysical logs. The three different approaches to e-facies simulation offer the different types of control over the spatial properties, e.g., facies transition probabilities. The quality of the 3 sets of simulations can be checked using entropy measures.

Reference: Garner, D.L., Srivastava, R.M., Yarus, J.Y. 2015. **Modeling Three Ways from Electro-facies - Categorical, E-facies Probabilities, and Petrophysics with Assignment** (abstract) EAGE Petroleum Geostatistics, Biarritz, September 7-11.