Carbonate Facies Modeling Using Stochastic Algorithms and Guided by Seismic Attributes

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Abstract

Facies modeling has at least three advantages: 1) it gives a 3D geological insight at reservoir scale 2) it can be helpful for improving porosity and permeability models and 3) it leads to reduction of uncertainties associated with oil in place estimation and flow simulations. Greater geologic realism is obtained when seismic 3D trends are integrated into facies modeling. In this paper, Ilam Fm in the Sirri D Oil Field which is an Iranian offshore carbonate reservoir is studied and seismic attributes such as relative acoustic impedance and instantaneous phase will help modeling of litho-facies. These seismic attributes showed a good correlation with the litho-facies at well locations. The stochastic method, Sequential Indicator Simulation (SIS) with a seismic trend is used to obtain a 3D facies image for the Ilam Fm. The Ilam interval is divided into 5 geological zones and there are good evidences that carbonate turbidity channels exist within the zone Ilam 3. The stochastic object-based method is also implemented to model these channels as geomorphologic object. This approach is more geologically meaningful and the observed channels from seismic data are simulated.

Keywords: Reservoir Modeling, Structural Modeling, Facies Modeling, Sirri D, Ilam Formation, Seismic Attributes.

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Introduction

A geological reservoir model is used to select optimum places for drilling, hydrocarbon volumetric calculations and flow simulation. For geological reservoir modeling, the first step is structural modeling, which is the process of building the reservoir 3D grid. Properties will later be distributed in such a grid in the property modeling stage with stochastic or deterministic approaches. Facies modeling is the first stage in building an optimum static reservoir model. The stochastic methods for facies modeling are generally divided into pixel-based and object-based methods. When no information of geological objects is available, the pixel-based methods are suitable. In this case random facies models with fuzzy boundaries between different facies are simulated. The most common pixel-based algorithm is Squemtial Indicator Simulation (SIS). In order to guide geostatistical algorithms and reduce the randomness of SIS, it is better to use and external trend from seismic or geology. On the other hand, object-based modeling is good when we are sure that a geomorphologic object such as channel or reef exists. This method can produce sharp and clean facies boundaries and the images are more similar to the reality.

The Sirri D Oil Field which is loc1ated in the eastern part of the Persian Gulf is studied in this paper. The carbonate Ilam Fm is characterized and litho-facies are modeled with the help