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Constraining 2-D Maps to 3-D Reservoir Descriptions - Field Study

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Abstract

It is well established in reservoir description process that coarser scale of the data has less uncertainty associated with it. For example 3D seismic data may provide information about column average porosity data. Many procedures in the literature are developed for integrating such column averages in 3D property distribution.

This paper extends the analysis to generating 3D simulation processes where the coarser scale information represents both the facies data and porosity data. Coarse scale facies information can be available from two sources: 3D seismic data providing net to gross ratio (NTG) without identifying the exact location of sands and shales, or an experienced geologist drawing general trends in geological bodies in 2D which need to be reconciled in 3D modeling.

We developed a procedure for Priobskoe field in Siberia, where such 2D trend maps are available. NTG is a continuous property, whereas, we needed to build a sand/shale distribution in 3D maps. We used indicator simulation in 3D to generate probability distribution of facies in 3D space. The trends for generating sand/shale distribution were either obtained from 2-D maps or geological knowledge. To match the NTG at each wells, we sampled the probability distribution in such a way that the percentage of sand and shale exactly matched with the NTG value in 2D map. The procedure can be extended to match 3D distribution within certain error limits of 2D data. Once the sand/shale distribution is created, we sample porosity values using 3D well data such that appropriate values of porosity are assigned to sands so that 2D average porosity match with 3D data.

The procedure is validated in Priobskoe field and we were able to generate alternate 3-D descriptions which are conditioned to 2-D data.

Introduction/Background

Reservoir Modeling is a process to generate a mathematical representation of the actual reservoir. The model is built based on the available data. There are various data types that may be used for generating such model. However, the process of integrating these data is not a simple task due to several reasons such as differences in scale, resolution, quality, etc. One of the common examples is the integration of well log data with seismic attributes/maps. In this case, high vertical resolution and sparse areal distribution of well log is integrated with poor vertical resolution but good areal coverage from seismic. The integration for such process requires a good handle on the volume support from each data set.

This report presents a methodology to address the above issue, i.e., to integrate 2D data into 3D reservoir model. Such methodology has been established in the literature¹⁻⁴ as they are commonly used for integrating seismic data into reservoir model. In the case of seismic data integration, the exact match between the conditioning data and the estimated result after integration process may not be required. However, for the case integrating previously Approved Reserves Estimates, maps must be strictly honored by the generated geological models.

The approach used for solving the problem is a geostatistical methodology which has been widely used in the petroleum industry. The method used in Geostatistics to estimate value at interwell location is known as Kriging process. The name kriging comes from Danny Krige, a South African geoscientist, who first applied this technique to gold mines. Later, the mathematical validity and foundation was provided by Matheron¹. This technique becomes increasing popular nowadays due to the advancement of computer technology.

Geostatistics takes advantage of the fact that in many natural phenomena, measurements of a variable reveal that the variable values measured close to each other are similar. As the distance between the measured values increases, the similarity between the two measurements decreases. Geostatistics takes advantage of this similarity and captures the spatial