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Stochastic Modeling of Water Saturation and Permeability of Multi-modal Carbonate Oil Reservoirs Using the Intrinsic Pore Geometries and Capillary Forces

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SUMMARY

Abstract

The three dimensional modeling of initial water saturation (*SW*) and permeability (*K*) is a critical task in the complex carbonate reservoirs, since most of the world's giant fields produce oil from those types of reservoirs. The modeling process becomes more challenging when dealing with carbonates that hold multiple pore systems. Levrett-J and and Thomeer functions are the best known methods to assess the water saturation from the analysis of Mercury Injection Capillary Pressure (MICP) data. However, Thomeer method appears to be the most adapted for the assessment of water saturation for complex multi-model pore systems like limestone reservoirs. In this paper we will introduce the Thomeer method, which takes into account physical properties of the rock such as wettability, capillary pressure, pore size and heterogeneity. Then, we will present an overview of the Mercury Injection Capillary Pressure (MICP) which allows the measurement of the Thomeer parameters and the physical properties of the core plugs. Then we will present the adopted workflow for stochastic modeling of *SW* and *K*. This workflow starts with the upscaling of the Thomeer parameters from the core plug size to the reservoir model cell size, using a formalism that takes into account the heterogeneity of the pore systems. The second step of the workflow consists in the stochastic modeling of Thomeer parameters in the reservoir model taking account the upscaled data, the variogram of the data and the uncertainty attached to those upscaled data. The last step of the workflow corresponds to the validation of the computed Thomeers parameters by ensuring that the combination of those parameters is consistent with the MICP measurements performed in the same field. The modeling workflow of *SW* and *K* was embedded into a risk assessment system in order to assess the impact of the uncertainty of Thomeer parameters on the in-place hydrocarbon volume and the fluid flow.
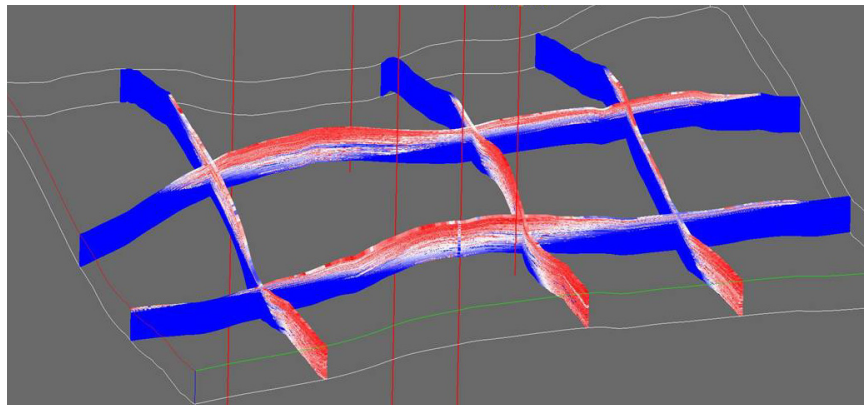
Figure 1 Water Saturation Model from Carbonate Reservoir.