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Facies Modeling from a Non-Representative Data Set: An Example in Middle Devonian Carbonates, Clarke Lake Field, British Columbia

Geocellular models are typically populated using the statistical distribution of parameters such as porosity and permeability in the observed data. However, the observed data come from wells that are drilled for specific reasons, and may not provide a representative distribution. This paper discusses the approach used to account for nonrepresentative sampling of Middle Devonian Carbonates in a geocellular model intended for use in simulating a carbon storage project.

The model encompassed the Beaverhill Lake and Upper Elk Point Groups over an area of 3000km^2 in the vicinity of Fort Nelson, BC. The data set used included logs from 322 wells, core analyses from 29 wells, and analyses of 22 drill stem tests and 18 open flow tests, 72km of 2D seismic lines and 60 km^2 of 3D seismic. The rocks in the study can be roughly subdivided into three regional groupings: shales and argillaceous limestones in the off-reef area, reef margin carbonates, and backreef carbonates. The porosity and permeability of these rocks is controlled by hydrothermal dolomitization of the carbonates, which is in turn controlled by both the depositional facies and by fracture networks. In all three regions, the geographic distribution of wells was likely not representative of the entire area. In the off-reef area, wells were clustered around features believed to be pinnacles, so that the well data likely overrepresented the amount of clean carbonate present. Within the heavily drilled reef margin, few wells penetrated far below the uppermost Slave Point, so that the deeper rocks were poorly represented. Backreef wells were concentrated in areas near basement faults that might provide hydrothermal fluids for enhanced porosity.

Using the reef edges and pinnacles derived from seismic and the literature along with well data, all cells in the area were categorized as limestone, shale, or dolomite. Within the well bores, dolomites were subdivided using core analysis, petrophysical analysis or visual examination of the logs as tight dolomites, vuggy dolomites and super-vuggy dolomites. Wells were rated for their proximity to basement faults and the reef margin, allowing a semi-quantitative assessment of how the relative proportions of these styles of dolomites varied geographically. This relationship was then used as a probability function within the Petrel™ facies modeling. The resulting model may better represent the relative proportions of these facies in the rock and their geographic distribution than a model based strictly on the observed proportions.