Modeling of Lithological Heterogeneity in Relation to the Rock's Physical Properties in a Heavy Oil Reservoir, NE Alberta.

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Summary

Understanding reservoir rock's lithology is the essential task in any reservoir characterization work because; the variations of reservoir/petrophysical properties (porosity, permeability, and water saturation), acoustic and elastic properties (velocity of P and S waves and various elastic moduli) all are primarily controlled by the variation of lithology. The term "lithology" embraces a wide range of rock's properties (grain size, grain shape, sorting and color, texture, mineralogical compositions, primary and secondary sedimentary structure etc.) and among them grain size is by far the most important parameter that defines the principal rock type (such as sandstone, siltstone, claystone/mudstone). In a sand-mud clastic sequence, like the McMurray Formation, the relative percentage of the subordinate constituents (after the predominant grain size) modified the rock's lithology (a pure sand tends to be shaly sand due to the substantial amount of clay materials in the predominant sand size particles, or a mudstone tends to silty/sandy due to the presence of substantial amount silt/sand size particles in the predominant clay size materials), which eventually changes petrophysical, acoustic and elastic properties. Grain size is also directly related with the specific surface area which is not commonly used in the petrophysical calculation, though it is an important parameter in the prominent Kozeney-Carman permeability model. For a porous material, specific surface area can be defined as the surface area of the pores and pore channels per unit of bulk volume, per unit of grain volume and per unit of pore volume.

This presentation deals with the generation of 3D models of the grain sizes along with the 3D models of the specific surface area of the pores (per unit of pore volume) for the whole McMurray Formation and their application in the petrophysical model. The generated 3D models (grain size and specific surface area of the pore volume) show strong correlation with the other 3D models (V_{sh} & facies models from V_{sh}, porosity).

The derived parameters (grain size and specific surface area of the pore volume) are used in the various forms of Kozeney-Carman permeability equations and the obtained results shows strong correlation with the permeability model resulting from the equation developed from the laboratory measured data (from porosity-permeability relationship).