Integrated 3D reservoir modeling of the Monteith Formation -Tight Gas Sandstones in the Western Canada Sedimentary Basin, Alberta, Canada

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Summary

The Monteith Formation is an important tight gas reservoir in the Deep Basin, Alberta, and consists of a progradational succession of shallow marine sediments, non-marine carbonaceous and coaly, coastal plain facies, and coarse-grained fluvial deposits, from base to top, respectively. This study compares rock properties and production performance of the uppermost lithostratigraphic unit (“Monteith A”) and the lowermost portion (“Monteith C”) of the Monteith Formation in the Western Canada Sedimentary Basin (WCSB) in Alberta.

The approach involves multi-scale description and characterization techniques using cores and drill cuttings, including multiple laboratory measurements of key reservoir parameters such as porosity and permeability. A second stage of the study involves the use of laboratory measured reservoir properties obtained from cores and drill cuttings and their integration with well logs to produce a numerical 3D model of the study area. The 3D model is used to history match gas production, and forecast performance of new wells in those areas where the geologic model indicates potential drilling locations. The ultimate goal is to provide a better understanding of the distribution of reservoir properties in the study area, for developing drilling prospects and their production potential.

This study provides an enhanced methodology for reservoir characterization of tight gas reservoirs based on the identification and comparison of three different rock types for each lithostratigraphic unit: depositional, petrographic, and hydraulic, respectively; to generate a more accurate reservoir description, and to better understand the key geologic characteristics that affect gas production potential.

In general, the Monteith Formation is characterized by rocks with relatively low porosity (close to zero up to ±7%), and low permeability (0.01 to ~ 1 mD). During this study the determination of two reservoir flow-units based on geologic framework, petrophysical rock/pore types, storage capacity, and flow capacity, was crucial for improving the understanding of future reservoir performance. It is clear that production of these low- permeability sandstones are strongly affected by changes in reservoir quality within these stratigraphic intervals. But the diagenetic processes, burial history and reservoir architecture also have significant influence on reservoir properties.

The reservoir modeling stage mentioned above is carried out by implementing a recently developed methodology that integrates a Variable Shape Distribution (VSD) model, capable of

capturing different reservoir properties through the whole scale spectrum without any data truncation. This new methodology introduces an extension of the VSD approach for reservoir simulation purposes. In the original application when matching input information in the VSD equation, each data point is assigned an integer according to its ranking (Nt) in the overall sample population. If these integers are used in a normal score transformation for reservoir simulation, the hard data (for example permeability) will not be honored. As a result, in order to honor the hard data, the integers have been replaced with real numbers determined by calculating the values that produce the exact data points when input into the VSD equation. Since this equation has an exponential form it cannot be solved directly for Nt and it is necessary to perform an iterative process to find the exact values.

In summary, coarse-grained fluvial sandstones of the “Monteith A” unit have better rock quality than the shallow marine sandstones of the “Monteith C” interval. This is the result of larger pore throat apertures ranging between 0.5 and 1 microns, relatively higher proportion of preserved intergranular pore space within these coarser-grained framework grains. Furthermore, the best production performance is found from wells that are producing from the uppermost interval. The resulting 3D reservoir modeling will allow to better field development strategies for this and other similar unconventional gas reservoir in the Deep Basin of Alberta.

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