Assessing Shale Gas Potential of the Upper Colorado Group, Southern Alberta: A Multidisciplinary Approach

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Summary

Shale gas resources are gaining more consideration as a viable production objective in Canada, especially in light of overwhelmingly successful production from shale gas plays in the United States. Overall declining production from conventional gas reservoirs makes it even more necessary to develop shale gas resources. When evaluating shale gas resources, a multidisciplinary approach must be employed in order to fully understand all aspects of a shale gas petroleum system. In this study, the shale gas potential of the Cretaceous Upper Colorado Group in the Medicine Hat Field in southern Alberta is evaluated.

A wide range of techniques are assessed in order to refine methods for evaluating shale gas potential in these Upper Colorado Group shales, as well as other potential prospects. Geochemical, sedimentological, petrophysical and geomechanical methods are integrated towards this end. Determination of bulk and clay mineralogy by x-ray diffraction is employed to ascertain variability in clay, quartz, calcite, and dolomite content of the shales. High resolution grain size analyses are also employed. The data collected are used to assess the viability of predicting these parameters through the use of artificial neural network interpretation of petrophysical logs. Data obtained are used to assess the potential for gas flow, formation damage and susceptibility to fracturing.

The Upper Colorado Group shales in the study area were deposited in a distal marine setting. These shales are laterally extensive and quite thick (up to 350 metres). Organic matter is characterized by Type II/III kerogen and is thermally immature with respect to the oil window. Total organic carbon content of the shales is up to 8 wt. %. Natural gas contained within the shales is primarily biogenic methane stored in both the free and adsorbed state. There is a positive correlation between total gas content and total organic carbon content (TOC) of the shales. There is also a positive correlation between the amount of gas stored by adsorption and both total organic carbon content and pressure. It is thus likely that a significant proportion of gas within the shales is stored by adsorption. Sandstone/siltstone interbeds within the shales tend to have lower TOC values. These intervals are more likely to contain a higher proportion of free gas, as opposed to adsorbed gas, as the primary gas storage mechanism.

Ideal shale gas prospects are characterized by the following parameters. They are thick and laterally extensive shale successions. The TOC content may range from 1 to 20 wt. %. They have either natural permeability conduits (sandstone/siltstone interbeds or fractures), or the mechanical properties are such that the shales can be successfully fractured through induced processes. These units should contain minimal amounts of swelling and/or migrating clays. Shale gas prospects should also have low water saturation and high gas content. The ideal reservoir is overpressured and gas saturated; a significant proportion of the gas remains in the reservoir and has not been expelled or migrated from the shales.

The majority of production from Colorado Group shales in the Medicine Hat Field of southern Alberta is likely to come from the coarser-grained siltstone and sandstone intervals within the finer-grained shales, as these intervals act as permeability conduits. This is opposed to production originating from brittle and hence easily fractured intervals. Optimal production sites are therefore likely to be facies dependent, in that facies containing a higher abundance of siltstone or sandstone intervals (coarser-grained intervals) are more suitable for shale gas production. The Upper Colorado Group shales show excellent potential for gas production and should be regarded as a noteworthy target for shale gas exploitation.