Integrated Reservoir Characterization: Key to Unlocking Gas Resources of the Upper Mannville Incised Valley Systems (Lower Cretaceous, West-Central Alberta)

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Abstract

Tight gas resources cover a wide spectrum of reservoir types, and are represented by a large variety of reservoir ranging from shale gas and conventional. The pore structure is an important control of fluid mobility and storage capacity in these reservoirs. However, due to their complexity, the relation between macroscopic description and the hydraulic properties of these reservoirs is not straightforward. Consequently, an efficient integration of geology, petrophysics and reservoir engineering becomes key to managing exploration risk and optimizing development strategy of these reservoirs.

In this paper, we present the preliminary results of an integrated approach to describe and characterize the Lower Cretaceous incised valley fill reservoirs of the Upper Mannville Group. In West-Central Alberta, these reservoirs have been penetrated by thousands of wells, which generally target deeper zones. However, regional production and well log data suggest that these sandstones could contain very large volumes of gas in both conventional and tight reservoirs. These lithic sandstones exhibit a complex mineralogy with various amounts of quartz, feldspars, rock fragment, clays and opaque minerals. As a consequence, gas-bearing sandstones have unusual log signature that makes reservoir quality and fluid interpretation more challenging. Furthermore, porosity is not always a good indicator of permeability and reservoir deliverability. This is probably due to a pervasive diagenetic overprint associated with burial and compaction that affect the porous network and the porosity-permeability relationship. Vertical and lateral variations of reservoir quality at various scales result from the superimposition of differential diagenesis on depositional trends.

The aim of this study is to improve our understanding of the impact of lithofacies and diagenesis on the porous network, and to define rock types representative of the hydraulic properties of the reservoir. 70 core samples have been collected from 8 wells for a petrographic and paragenesis description. Porosity and permeability measurements using the DARCYLOG™ method have been performed on 24 of these core samples. Nuclear magnetic resonance (NMR) analysis has been carried out on the same samples, as well as 34 chip samples collected in the same stratigraphic interval from 9 additional wells. Finally, QEMSCAN® analysis provided additional

information on the bulk modal mineralogy, lithotypes and independent quantification of texture, porosity and pore size distribution on a selection of 40 of the aforementioned samples, including cores and cuttings.

The ultimate goal of this work is to improve greatly our ability to assess the reservoir properties and their spatial variations in these lithic sandstones, by designing a workflow which integrates stratigraphy, sedimentology, mineralogy, petrography, diagenesis and petrophysics. Recent advances in quantitative rock analysis both on core and cuttings, together with an efficient integration of the large amount of data publically available, offer a new opportunity to unlock significant gas resources in the Upper Mannville incised valleys, as well as similar challenging reservoir systems.