A New Method for Petroleum Resource Assessment of Unconventional Tight-Shale Plays

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Abstract

We propose an innovative approach for assessing petroleum resource potential in unconventional tight-shale resource plays. The primary feature of this approach is the consideration of a dual-porosity model that accounts for petroleum storage in mixed porous media consisting of both rock matrix micro-pores and organic nano-pores. Unconventional tight-shale reservoirs typically vary from tight sandstone or carbonate to organic rich shale/mudstone, most of which comprise a mixed succession of tight sandstone/carbonate interbedded with organic rich shales. Such hybrid tight-shale resource plays are commonly a closed petroleum system with the crude oil and natural gas originating from the organic-rich shale and being stored within the stratigraphic interval that also includes the tight reservoir. Depending on the predominant lithology and thermal maturity, the matrix porosity may provide the principal storage for expelled petroleum, whereas additional petroleum remains within “organic” pores in the source rock kerogen. The matrix and organic pores have very different physical and chemical properties including, water/oil wettability, pore size distribution, and natural gas adsorption capacity. The geological controls of these two porous media types vary significantly that have important implications in resource evaluation. Inference of the resource potential in such an unconventional reservoir system is challenging because a conventional volumetric assessment approach considers only the dominant porous media, whether it is the organic matter or the lithic matrix. Simultaneous consideration of both storage systems resolves issues resulting from the differences in reservoir properties and characteristics as a function of pore system type. It also provides an improved estimate of resource potential for such hybrid reservoirs. This new approach is applied successfully to resource assessments of both the calcareous mudstones of the Utica Shale in the frontier domain of Quebec and the Duvernay Formation carbonate mudrock play in the mature Western Canada Sedimentary Basin. Our innovative analysis of these two plays shows that the proposed method can be applied successfully to different resource play types with variable reservoir characteristics and geological datasets.