Towards the quantification of unique organic matter components in Duvernay Formation mudstones

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Summary

Organic matter-hosted porosity can be a critical component of the porosity-permeability system in tight, organic-rich hydrocarbon reservoirs. In some shale plays, thermal maturity has been identified as a significant factor for organic matter porosity development but this trend is not clear in other areas. Recent research has also revealed relationships between organic matter composition and porosity development. Organic matter particles or macerals in the same sample but with different original compositions may display drastically different porosity characteristics. Furthermore, kerogen porosity may differ from the porosity of generated products such as bitumen. The ability for generated hydrocarbons to migrate within the rock and then solidify into solid bitumen also means that these types of organic matter components can be detrimental to porosity and permeability as they occlude pores and pore throats.

In light of these observations, this study aims to develop a method that can routinely distinguish unique organic matter components and define their contribution to the rock properties. The current phase of this project combines XRD, QEMSCAN, He-porosimetry, MICP, NMR, FIB-SEM, Rock-Eval pyrolysis, and organic petrology to define preliminary relationships between organic matter, mineralogy, porosity, and permeability within the context of a previously defined depositional and sequence stratigraphic framework for the Duvernay Formation. The next phase of this project will integrate results from extended slow heating (ESH) Rock-Eval pyrolysis, and Raman spectroscopy.

Initial results suggest that 2 to 4 unique organic matter populations are present in Duvernay Formation mudstones, each with different porosity characteristics. Bitumen dispersed throughout the matrix typically exhibits complex porosity development with a large pore diameter range (rarely exceeding 500 nm), and likely represents an *in-situ* remnant of the original kerogen. In contrast, migrated bitumen, which is often observed in intragranular pores in microfossil tests and intercrystalline pores in pyrite framboids typically exhibits fine, sponge-like texture with pores rarely exceeding 50 nm in diameter. A third organic matter component contains no observable porosity and is present apparently as bed-parallel fracture-fill. Rather than fracture-filling migrabitumen, some or all of this non-porous component may actually be zooclast fragments, especially where fracture-filling morphology is less apparent.

Although the differentiation of these organic matter populations is thus far only qualitative, correlation to stratigraphically- and geographically- defined lithofacies and mineralogy trends have been observed. Particularly distinct changes in the organic and inorganic components of the mudstones occur across sequence boundaries.