The Upper Devonian Duvernay Formation of Alberta: an Integrated Geochemical and SEM Imaging Study in a Sedimentological and Stratigraphic Context

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The Upper Devonian Duvernay Formation is a shale formation that is a significant unconventional exploration target in Alberta, particularly for liquids, in addition to being an important source of oil in conventional reservoirs. We focus on the origin of heterogeneities in TOC, silica and clay contents of the Duvernay that are significant to the producibility of hydrocarbons. Sea level exerts a first order control on the sedimentology and stratigraphy of the Duvernay, which in turn are linked to mudstone composition and development of organic porosity. Establishing relationships between sea level cycles and reservoir properties is an important part of our research.

We report here on results and interpretations from long cores in five wells across the maturity gradient, including high resolution geochemical datasets. Interpretations are compared to a parallel sedimentological and stratigraphic analysis, providing an unusual opportunity for independent corroboration of models. Basinal facies are generally carbonate-poor mudstones, massive to finely laminated and typically enriched in pyrite. Shallower water facies are more carbonate-rich, often bioturbated, and contain a higher abundance of silt-sized shell debris.

TOC decreases in carbonate-rich intervals and SiO_2 varies inversely with carbonate content. Geochemical redox proxies indicate that deposition of TOC-rich intervals was associated with more reducing conditions. We interpret a mixed source for the silica which varies depending on the interval. Shale composition exerts control over porosity and pore size distribution and the potential of the pore system to store and deliver gas.

Ion milled SEM samples, representing a range of TOC values, were analyzed by SEM. Types and abundance of porosity varied with TOC content and maturity. By integrating geochemical properties and petrophysical parameters within the context of sea level, our goal is to improve the identification and prediction of favourable locations where all factors affecting production are optimized.