

Black oil window rocks from the Devonian Duvernay Formation: Insights from fabric and organic matter analyses using FIB-SEM and other unconventional techniques

Brad Culver, B-32 Exploration Ltd, Suite 650, 635 – 8th Avenue SW, Calgary, AB, T2P 3M3, Canada

Raphael Wust, AGAT Laboratories, 2730 39th Avenue N.E., Calgary, AB, T1Y 7H6, Canada

Summary

The Devonian Duvernay Formation in Alberta (Canada) is a self-sourced hydrocarbon resource play composed of carbonate and siliciclastic mudstones. During the time of deposition, the basin was surrounded by reefal structures that led to interbedded carbonate debris and basinal sedimentary units. Upper and lower organic-rich shales represent the completion targets that produce a range of hydrocarbon products.

Results, Observations, Conclusions

In this study, we investigated pore-networks, organic matter and mineral fabric at various scales to better understand the relationship of oil-generation, storage, pore development and mineral interaction during diagenesis. Petrographic and Scanning Electron Microscopy (SEM) of Duvernay archive core samples from the northern basin shows significant confined and expelled black oil, while the Focused Ion Beam (FIB)-milled samples provided high resolution details of bitumen and clay fabric. Oil expulsion was observed on clay-surfaces and although organic pores were abundant, it is conceivable that some of the hydrocarbons may derive from slot-pores within the clay-platelets or mineral dissolution pores. Here we present evidence that during diagenesis and organic maturation, mineral fabric and texture development may have helped trap some of the migrating hydrocarbon phases.

Of major interest in the Duvernay is the organic matter sourcing and composition. Several studies have demonstrated that the majority of the organic matter currently observed within samples is composed of amorphous matter with fluorescent, non-fluorescent, and micronized properties, mostly bitumen. Smaller amounts of spores, liptodetrinite and alginites are also observed. Pre- and post-toluene treated samples investigated with the FIB-SEM show no changes within the organo-pores of the bituminous phases suggesting that organo-pore development may have been before peak-hydrocarbon production. In addition, complex clay fabrics and clay platelets indicate that mineral diagenetic processes may have been paramount during HC generation and in particular important for the trapping of some of the expelled liquids.



Novel/Additive Information

The study provides an overview of hydrocarbon expulsion in samples from the Black Oil Window in the Norther Duvernay Basin and looks at diagenetic, clay mineral, and organic changes during burial and discusses potential insights into understanding these unconventional reservoirs.